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Pilot Research of AI-Generated Scenarios in Nautical Simulator Training Using ChatGPT Plus

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ABSTRACT: This study presents a pilot research into the use of artificial intelligence (AI) for generating training scenarios in nautical simulators, focusing on their potential to support competency-based maritime training. AI-generated scenarios were created using ChatGPT Plus, following the guidelines of IMO Model Course 1.22 and STCW Convention A-II/1. These scenarios were developed by three scenarists with different levels of maritime expertise and subsequently evaluated by five MET experts. The evaluation process incorporated Multi-Criteria Analysis (MCA) and Intraclass Correlation Coefficient (ICC) to assess scenario complexity, assessment methodology, and compliance with maritime training standards. The study explores the strengths and limitations of AI-generated scenarios and considers the role of expert feedback in refining AI-assisted content. The findings contribute to the ongoing discussion on the applicability of AI in maritime education and highlight directions for further research, particularly in validating AI-generated training scenarios in real-world simulator environments.

1 INTRODUCTION

The education and training of seafarers are regulated by the requirements of the STCW Convention [1]. To support the implementation of these requirements, the IMO has developed specific Model Courses that provide clear guidelines regarding the content, scope, and competencies that seafarers must acquire. However, despite the precisely defined training objectives, a key challenge remains the assessment of seafarers' competencies and skills. Although it is assumed that instructors and evaluators meet the formal requirements for assessing competencies, the adequacy of assessment methods remains an open question. While the STCW Convention and IMO Model Courses establish standards, their practical implementation often varies. Additionally, there is a gap between educational programs and actual industry needs, further emphasized by the rapid digitalization and automation of the maritime sector [2]. Research [3] highlights that the STCW Convention still defines competencies based on shipboard functions rather than operational processes, thereby creating a disconnect between education and real industry demands. The education of seafarers in managerial positions requires additional training in various areas, as the current IMO standards do not adequately prepare them for the challenges of modern navigation [4].

To improve the non-technical skills of Officers of the Watch (OOW), the authors of [5] utilized the Uchida-Kraepelin (UK) test to assess situational awareness, decision-making, and communication. Simulator-based experiments demonstrated a correlation between test results and success in collision avoidance, confirming the test's potential application in seafarer training.

Simulations play a crucial role in modern maritime education and training. Cloud-based simulations offer greater flexibility and skill enhancement through repetition, yet exercises need to be better designed to foster engagement and collaborative learning [6].

One of the emerging research directions aimed at improving Maritime Education and Training (MET) is the application of Virtual Reality (VR). An analysis of immersive learning methodologies shows that VR training enhances cognitive effort and retention by 25.93% compared to traditional learning methods [7]. However, the implementation of VR in seafarer training presents challenges, such as insufficiently realistic modelling of fire-fighting and evacuation scenarios [8]. Additionally, VR applications have been developed for Fast Rescue Boat (FRB) training. Although VR enhances seafarers' preparedness, it has proven most effective when combined with traditional real-world training [9]. Beyond VR, eye-tracking technology (ETT) enables the analysis of seafarers' navigational performance and the identification of perceptual errors. Research findings [10] indicate that seafarers frequently exhibit an over-reliance on ECDIS and visual observation at the expense of using RADAR/ARPA, potentially leading to navigational errors.

Regarding the effectiveness of training with modern technologies, confidence in learning via cloud-based simulators has been identified as a key predictor of success, while extroversion positively correlates with candidate motivation [11]. However, the same study found no significant correlation between prior academic knowledge and training outcomes.

In the context of modernizing maritime education, an increasing number of MET institutions are modifying existing curricula by integrating digital, technical, and soft skills to align with contemporary demands. For instance, research conducted at the Lithuanian Maritime Academy (LMA) proposes a Work-Integrated Learning (WIL) approach, which combines academic and practical training [12]. These institutions are adapting learning methods to Generation Z, which favours digital tools, flexibility, and interactive approaches [13]. A study conducted in Japan found that practical exercises are the most effective learning method, whereas traditional lectures are the least effective, underscoring the need for interactive teaching strategies to enhance the appeal of maritime careers [14].

Chatbot technology is also becoming an important tool for interactive maritime learning. A study [15] describes the design of the AI-powered chatbot "FLOKI" developed for training in COLREGs, allowing students flexible and self-paced learning. User experience evaluation indicated that the chatbot enhances understanding of regulations, with suggested improvements such as voice interaction and expanded rule coverage.

An analysis of existing competency assessment methods in simulator-based training identified the strengths and limitations of subjective and objective techniques, including eye-tracking technology [16]. The authors concluded that current methods are often insufficiently objective and that more authentic assessment approaches are needed to better reflect real working conditions at sea. Supporting this argument, Karahalil et al. [17] emphasize the necessity of replacing the traditionally subjective assessment methods, which rely on instructor experience, with more objective and systematic approaches to enhance training efficiency.

Although the use of simulators is regulated by the STCW Convention, there is still a lack of empirical research on optimal pedagogical practices for valid and reliable simulator-based training outcomes [18]. Authors in [19] research the reliability and validity of an assessment tool based on the Analytical Hierarchy Process (AHP) and Bayesian Networks to reduce assessor bias. The results indicate that the tool improves the reliability of technical competency assessments, whereas the evaluation of teamwork (non-technical competencies) remains a significant challenge.

Given the challenges associated with objectively assessing seafarers' competencies, the increasing presence of AI technology in education and training raises the question of whether artificial intelligence can contribute to improving this process. Recent research increasingly explores the potential of AI tools. In this study, the authors examine ChatGPT Plus as a tool for generating scenarios in nautical simulator exercises, with the aim of optimizing the evaluation process and enhancing seafarers' competency development.

This paper is structured as follows: Chapter 2 presents the research methodology, Chapter 3 outlines the research findings, and Chapter 4 provides a discussion and comparative analysis of the results, followed by conclusions in Chapter 5.

2 METHODOLOGY

This study examines the use of artificial intelligence (AI) in creating scenarios for a nautical simulator, in accordance with IMO Model Course 1.22 – Bridge Resource Management [20] and the provisions of the STCW Convention A-II/1. The authors utilized this IMO model course and, through a random selection method, identified a section from Appendix III – Example of an Exercise Scenario as relevant for this research. The selected scenario covers the voyage period before and after pilot embarkation, as outlined in Table 1.

The diversity in the professional and educational background of the authors enables an analysis of how expertise influences the quality of AI-generated scenarios, providing insights into different approaches to creating navigational situations.

The scenario creators are categorized into three groups:

– Scenario creator I is student of Nautical Studies and Transportation at the Faculty of Maritime Studies, Kotor, and has no previous seafaring experience. However, the student has user experience in operating a nautical simulator both during faculty studies and earlier in maritime high school education;
– Scenario creator II is holder of Master CoC, with 14 years of seagoing experience and 9 years of experience in maritime education, including advanced proficiency in operating a nautical simulator;

– Scenario creator III is a person who does not have a seafaring background and is not from the field of nautical sciences. However, this person has 30 years of experience in maritime education, although without familiarity with nautical simulator.

Table 1. Initial input for the exercise scenario [20]

	Technical	Non-technical
Before Pilot Arrival	Contacting with VTS, Pilot stations, etc. using SMCP; Following company ISM procedures; Preparing of Pilot ladder/combination; Reducing safe speed and contacting engine-room; Giving any visual or sound signals if necessary; Etc.	Sharing information with authority; Sharing information with deck team for Pilot ladder arrangement; Sharing information with engine-room; Bridge team should be organized for port arrival – Master, duty officer, helmsman, lookout; Engine team should be organized for port arrival; Proper communication with the bridge team (asking officer(s) for information, challenge and response, closed-loop communication on the bridge); Etc.
After Pilot Embark.	Reducing speed; Using radar/ECDIS for traffic monitoring; Following safe navigation procedures (echosounder, ECDIS, radar, IALA buoys, position fixing, etc.); Following coastal navigation procedures and local requirements. Etc.	Sharing and exchange of information with Pilot (tugboat bollard capacity, breaking force of lines and bollards, first line, mooring side, etc.); Concentrating on primary tasks; Discussion options with team members and Pilot; Balancing authority and assertiveness; Etc.

Scenario creators were assigned the task of generating scenarios using the same AI model – ChatGPT-4o Plus. Each creator developed one scenario, aiming to structure it in accordance with maritime training standards and real operational challenges in navigation, relying on their own interpretation of these requirements. To ensure consistency and that all scenarios were solely influenced by AI-generated content, they were prohibited from consulting any external sources, including literature, internet searches, or other reference materials. The only permitted tool for scenario creation was AI assistance, with the exception of the STCW Convention and IMO Model Course 1.22, which were provided as reference guidelines to support alignment with regulatory and training requirements.

As a starting point, it was agreed to initiate communication with ChatGPT-4o Plus using the following prompt:

"The task is to develop an exercise for a nautical simulator, with a detailed scenario structured in accordance with IMO Model Course 1.22 and STCW A-II/1. In addition to the scenario, a comprehensive guide for candidate assessment must be created. The exercise scenario should include the segments 'Before pilot arrival' and 'After pilot embarkation,' as outlined in the attached table 1 (extracted from IMO Model Course 1.22)."

To ensure a structured, systematic, and transparent research approach, a workflow diagram has been developed to illustrate the key stages of this study (Figure 1).

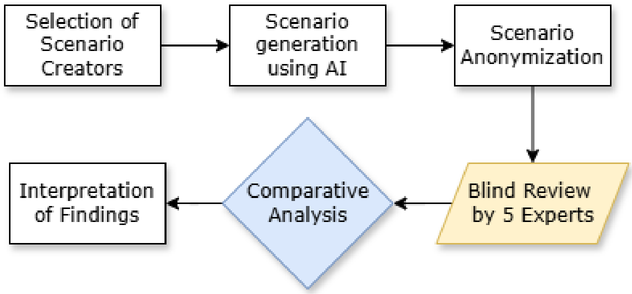

Figure 1. Research workflow

While the AI-generated scenarios were created using ChatGPT Plus, the involvement of human expertise played a crucial role in refining these scenarios. Scenario creators were tasked with developing and refining the scenarios to the point where they felt the content was adequate for understanding the scenario and creating the subsequent exercise for the simulator. The authors refrained from intervening to indicate when the scenarios were 'complete' to allow for an exploration of how the creators' expertise influenced the development of the AI-generated content. The degree of interaction between the scenario creators and ChatGPT varied, influenced by their individual levels of expertise.

2.1 *Evaluation Methodology*

The scenario evaluation was conducted by five external experts to ensure a comprehensive and objective assessment. All experts possess seagoing experience and extensive expertise in maritime education and training, particularly in delivering Bridge Resource Management courses. To enhance methodological rigor, a blind review approach was applied, anonymizing the scenarios to ensure that assessments focused solely on content quality rather than authorship. This external review provided an additional layer of validation, ensuring that the findings reflect diverse professional perspectives. Table 2 provides an overview of the backgrounds of both the scenario authors and the external experts, ensuring transparency in the evaluation process.

Table 2. Background of authors and experts involved in evaluation process

Role	Origin	CoC	MET experience [years]
Expert 1	Croatia	Master	9
Expert 2	Croatia	Master	12
Expert 3	Croatia	Master	20
Expert 4	Montenegro	Master	20
Expert 5	Poland	Master	15

The evaluation followed a comparative analysis, integrating both qualitative and quantitative approaches to identify structural differences and similarities among the scenarios. Experts examined key components, including:

– Aim and objective – the intended purpose and learning goals of the scenario;
– Scenario details – situations, conditions, expected actions, and decision-making points;
– Assessment guide – the extent to which the scenario incorporates elements relevant to candidate evaluation.

In addition to these key components, the expert assessors were provided with clear guidelines outlining the importance of each criterion. For instance, the 'Aim and objective' component was assessed based on how well the scenario’s learning goals aligned with the training needs of maritime professionals. The 'Scenario details' were evaluated for clarity, realism, and relevance to practical training, including whether the decision-making points were appropriately challenging and applicable to real-world scenarios. The 'Assessment guide' was analyzed to determine how well the scenario incorporated methods for evaluating participant performance, ensuring the scenario was not only instructional but also assessable in terms of learning outcomes.

The expert evaluators were also given a scoring methodology to assign numerical values to each component. The scoring system ranged from 1 to 10, where 1 represented poor performance and 10 represented an excellent scenario. Each criterion was rated individually, and the total score for each scenario was the sum of the scores across all components. Experts were instructed to provide narrative feedback to support their ratings, offering insight into why a particular scenario scored highly or low. The final score for each scenario was calculated by averaging the ratings of all five experts.

To ensure a comprehensive evaluation of scenario design, a Multi-Criteria Analysis (MCA) was employed to assign weighted scores based on predefined criteria, including scenario complexity, assessment methodology, and adherence to maritime training standards. The Intraclass Correlation Coefficient (ICC) was calculated to assess the reliability and consistency of experts' assessments. The ICC values, which range from 0 to 1, provide insight into the consistency of the experts' assessments. A high ICC value (close to 1) indicates strong agreement among experts, while a low value (close to 0) suggests significant variability in their ratings. This structured approach, combining quantitative scoring with narrative analysis, provided both a numerical ranking and qualitative insights into critical scenario elements. The integration of ICC results strengthened the evaluation process, ensuring its robustness. The quantitative findings, supported by ICC analysis, complemented and validated the qualitative observations, offering a nuanced understanding of variations in scenario design.

2.2 *Limitations of the Study and Evaluation Process*

While this study provides valuable insights into the structure, content, and pedagogical relevance of AI-generated training scenarios, certain limitations should be acknowledged. A key limitation is the variability of AI-generated content, as identical prompts do not always produce consistent results. Additionally, the absence of real-world validation means that the practical applicability of these scenarios in actual training environments remains uncertain. Since the study was conducted without testing the scenarios in a nautical simulator, their effectiveness in real-life instructional settings could not be fully assessed.

The evaluation process itself also presents certain challenges. Although a structured Multi-Criteria Analysis (MCA) was employed to introduce a quantitative dimension to the assessment, expert judgment remained integral to the evaluation. While the blind review approach minimized bias, expert subjectivity cannot be entirely eliminated, as assessments are influenced by individual expertise and experience. Despite these constraints, the methodological framework, combining both quantitative scoring and qualitative analysis, ensures a structured and transparent approach to scenario evaluation. This contributes to a deeper understanding of how AI can support the development of maritime training exercises.

3 RESULTS

While the AI-generated scenarios were created using ChatGPT Plus, the level of human involvement varied considerably based on the creator's expertise. Scenario creator III, with minimal prior experience in maritime training, was generally satisfied with the outputs generated by ChatGPT and made few modifications. In contrast, scenario creator I, with relevant knowledge but limited practical training experience, used the AI-generated content as a basis to explore relevant maritime applications, further refining the task structure. Scenario creator II, an expert in maritime education, provided more targeted feedback to ChatGPT, specifying exact details regarding traffic conditions, vessel types, and specific evaluation criteria for the exercise, ensuring that the scenario aligned with practical training needs.

The expert evaluations revealed certain differences in the quality of the generated scenarios. Some of these variations can be attributed to the individual expertise of the creators, while others seem to be influenced by the way the AI model was utilized in the creation process. These differences were primarily related to how much the scenario creators relied on the outputs provided by ChatGPT, which varied depending on their level of expertise. For example, the creator with minimal prior experience in maritime training generally accepted the AI-generated content with minimal modification, while the more experienced creators interacted more actively with the model, refining the scenarios to better fit practical training requirements. This pattern suggests that the involvement of human expertise played a key role in shaping the final scenario outputs, with more experienced creators leveraging their knowledge to guide the AI model more effectively. The specific contributions of both human expertise and AI model outputs in the scenario development process will be a topic for future research.

To systematically compare the evaluated scenarios, the following tables present the expert ratings and their descriptive statistics. Table 3 presents the individual scores assigned by five experts for each scenario based on three key criteria: Aim & Scope (A&S), Scenario Details (SD), Evaluation Part (EP). It shows the Average Score (AS), as well.

Table 3. Expert Ratings for Scenario Assessment

Expert	A&S	SD	EP	AS
	Scenario I			
Expert 1	9	9	9	9
Expert 2	9	8	10	9
Expert 3	9	8	9	8.67
Expert 4	10	9	10	9.67
Expert 5	10	10	10	10
	Scenario II			
Expert 1	8	8	9	8.33
Expert 2	9	10	10	9.67
Expert 3	10	10	10	10
Expert 4	6	6	6	6
Expert 5	9	9	8	8.67
	Scenario III			
Expert 1	8	9	9	8.67
Expert 2	10	10	10	10
Expert 3	10	10	10	10
Expert 4	7	7	7	7
Expert 5	8	8	9	8.33

ChatGPT Plus assessed the scenarios as shown in Table 4.

Table 4. ChatGPT Plus Ratings for Scenario Assessment

Scenario	A&S	SD	EP	AS
I	9	9	8	8.67
II	8	8	7	7.67
III	10	10	9	9.67

To provide a quantitative summary of the assessment results, Table 5 presents the descriptive statistics of the evaluation scores, including the mean, median, minimum, maximum, and standard deviation for each criterion across all scenarios. These statistical measures help identify variations in expert assessments and highlight potential discrepancies in scenario complexity and evaluation methodology.

Table 5. Descriptive Statistics of Scenario Evaluation Scores

Expert	A&S	SD	EP	AS
	Scenario I			
Mean	9.4	8.8	9.6	9.27
Median	9.0	9.0	10.0	9.0
Min	9.0	8.0	9.0	8.67
Max	10.0	10.0	10.0	10.0
Standard Deviation	0.490	0.748	0.490	0.490
	Scenario II			
Mean	8.4	8.6	8.6	8.53
Median	9.0	9.0	9.0	8.67
Min	6.0	6.0	6.0	6.0
Max	10.0	10.0	10.0	10.0
Standard Deviation	1.356	1.497	1.497	1.409
	Scenario III			
Mean	8.6	8.8	9.0	8.8
Median	8.0	9.0	9.0	8.67
Min	7.0	7.0	7.0	7
Max	10.0	10.0	10.0	10
Standard Deviation	1.200	1.166	1.095	1.128

To assess the level of agreement among expert, the Intraclass Correlation Coefficient (ICC) was calculated for each evaluation criterion. Higher ICC values indicate stronger agreement, while lower values suggest greater variability in assessments. The calculated ICC values for the three evaluation criteria—Aim & Scope, Scenario Details, and Evaluation Part—along with the overall ICC value, are presented in Table 6.

Table 6. Intraclass Correlation Coefficient (ICC) Values

Criteria	Aim & Scope	Scenario Details	Evaluation part	Overall
ICC Value	0.85	0.78	0.72	0.79

The results indicate that the highest level of agreement was observed for Aim & Scope (ICC = 0.85), followed by Scenario Details (ICC = 0.78) and Evaluation Part (ICC = 0.72). The overall ICC value across all criteria was 0.79, reflecting the consistency of expert assessments throughout the evaluation process.

Further interpretation and discussion of these findings are presented in Chapter 4.

4 DISCUSSION

The results of this study provide valuable insights into the feasibility and effectiveness of using artificial intelligence for generating training scenarios in maritime education. The evaluation of AI-generated scenarios revealed important trends in their structure, quality, and alignment with existing maritime training standards. During the discussion, the creator of Scenario I stated that significant effort was invested in achieving the highest possible quality of the scenario. The creator of Scenario II acknowledged deliberately omitting certain details, assuming they were implicit and did not require explicit clarification. On the other hand, the creator of Scenario III indicated difficulties in further developing the scenario due to a lack of subject-matter knowledge, seafaring experience, and familiarity with simulators.

The expert evaluations demonstrated differences in the quality of the generated scenarios, as reflected in the descriptive statistics and Intraclass Correlation Coefficient (ICC) analysis. Scenario I consistently received higher scores across all criteria, suggesting that its structure and content closely adhered to maritime training standards. Scenario II, on the other hand, exhibited greater variability in scores, which may indicate inconsistencies in its design or differences in expert interpretations. Scenario III received moderate ratings overall, with a mean score slightly higher than Scenario II. However, Scenario II had the lowest minimum scores (6.0 in all categories), suggesting that certain aspects of the scenario were perceived as less developed by some evaluators.

The ICC results further highlight the consistency among experts. A high level of agreement was observed for the Aim & Scope criterion (ICC = 0.85), indicating that the scenarios' objectives were well understood and consistently assessed. The Scenario Details criterion showed slightly lower agreement (ICC = 0.78), suggesting minor variations in the interpretation of scenario components. The Evaluation Part criterion had the lowest ICC value (0.72), reflecting some divergence in how expert assessed the effectiveness of the evaluation framework embedded in the scenarios. The overall ICC value of 0.79 confirms that the assessment process was reliable but also highlights areas for potential refinement.

Beyond numerical assessments, qualitative feedback from experts provided further insights into the strengths and limitations of the AI-generated scenarios. Expert 1 noted that Scenario III appeared to be a general template rather than a context-specific exercise, unlike Scenarios I and II, which seemed to be more tailored to particular navigational conditions. This raised several questions regarding the geographical scope and structure of the scenario, including:

- The starting and ending points of the exercise in geographical terms;
- The need for an additional role to simulate the presence of a pilot during the "After Pilot Embarkation" phase;
- The practical execution of certain tasks, such as preparing the pilot ladder in accordance with SOLAS requirements.

Expert 2 was concerned about the traffic density specified in the scenarios. He pointed out that a 2NM radius with multiple vessels may be unrealistic for a pilotage-focused scenario, where excessive emphasis on RADAR/ECDIS monitoring could distract visual lookout. Furthermore, expert 3 questioned whether debriefing sessions were planned after each phase of the exercise, as pausing the scenario for discussion could influence the flow of training. Experts 4 and 5 emphasized the need to clarify assessment criteria and scoring thresholds, particularly in Scenario II, to ensure consistency in evaluation. Expert 5 expressed concern about the environmental conditions in the Scenario I, particularly the inclusion of a 4-knot tidal stream in the Dover TSS, which was perceived as excessively strong for the intended training context. This suggests the need for better calibration of environmental parameters to align with realistic operational scenarios.

While AI-generated scenarios demonstrate structured design and adherence to maritime training standards, certain limitations remain. One key challenge is the variability in AI-generated outputs—identical prompts do not always produce consistent results, raising concerns about reproducibility in training. Additionally, AI lacks the ability to fully incorporate contextual nuances and experiential knowledge that MET experts naturally integrate into training exercises.

Another critical aspect is the need for human oversight in refining AI-generated content. Although AI can assist in structuring scenarios, experienced maritime educators are essential for adapting exercises to real-world challenges, regulatory requirements, and industry best practices. The moderate agreement observed in the Evaluation Part criterion suggests that further refinement of assessment criteria is necessary to ensure a more consistent and objective evaluation framework.

5 CONCLUSION

This study examined the application of artificial intelligence in the development of training scenarios for nautical simulators, specifically in accordance with IMO Model Course 1.22 and the requirements of the STCW Convention A-II/1. By utilizing AI-generated scenarios, the research aimed to assess their alignment with established maritime training standards and their potential contribution to the competency development of seafarers. The findings indicate that AI-assisted scenario creation can provide structured and comprehensive training exercises that reflect key navigational challenges. The evaluation process, conducted by MET experts, demonstrated a high level of consistency in assessing scenario objectives, structure, and evaluation components. The results of the Intraclass Correlation Coefficient (ICC) analysis confirmed the reliability of expert assessments, with variations observed across different criteria.

An important insight from this study is the potential benefit of involving individuals with different backgrounds in the initial stages of scenario development. While MET instructors possess the technical expertise necessary for refining and perfecting training exercises, early input from students or individuals non-strictly of maritime background could help ensure that the scenario structure and key details are explicitly outlined. This collaborative approach allows for a clearer foundation upon which instructors can apply their experience and professional knowledge to refine and optimize the scenario for training purposes. By incorporating multiple perspectives in the initial design phase, MET instructors can create more comprehensive and well-balanced training exercises that align with both regulatory standards and real-world operational challenges.

Future research should focus on conducting experimental studies where AI-generated scenarios are implemented in actual training environments, with performance metrics used to assess their impact on skill development. Moreover, combining AI-generated content with human expertise could enhance the effectiveness of training scenarios. AI could be used as a supplementary tool to assist instructors in designing exercises, while experienced MET experts provide necessary refinements and adaptations based on practical knowledge. Such collaboration could optimize the balance between automation and human expertise in maritime education.

By advancing AI applications in maritime training, this study contributes to the ongoing development of innovative, technology-driven educational approaches that support the professional growth of seafarers and the broader maritime industry. These findings highlight the need for further research into the practical implementation of AI-generated scenarios in simulator-based training and underscore the importance of establishing standardized assessment frameworks to ensure objective and reliable competency evaluation.

REFERENCES

[1] IMO, International Convention on Standards of Training, Certification and Watchkeeping for Seafarers. IMO, 2017.
[2] T. T. Türkistanli, “Advanced learning methods in maritime education and training: A bibliometric analysis on the digitalization of education and modern trends,” Comput. Appl. Eng. Educ., vol. 32, no. 1, Jan. 2024, doi: 10.1002/cae.22690.
[3] A. Gundic, D. Zupanovic, L. Grbic, and M. Baric, “Determining Competences in MET of Ship Officers,” TransNav, Int. J. Mar. Navig. Saf. Sea Transp., vol. 15, no. 2, pp. 343–348, 2021, doi: 10.12716/1001.15.02.10.
[4] V. Pavic, S. Tominac Coslovich, N. Kostovic, and I. MiŁlov, “Current Challenges in Professional Education

and Training of Seafarers at Management Levels on Oil Tankers," TransNav, Int. J. Mar. Navig. Saf. Sea Transp., vol. 17, no. 3, pp. 695–700, 2023, doi: 10.12716/1001.17.03.21.

[5] M. Saito and T. Takemoto, "Study on Education and Training Methods to Enhance Non-technical Skills of OICNW Using the Psychological Test," TransNav, Int. J. Mar. Navig. Saf. Sea Transp., vol. 17, no. 1, pp. 121–125, 2023, doi: 10.12716/1001.17.01.12.

[6] W. Gyldensten, A. C. Wiig, and C. Sellberg, "Maritime Students' Use and Perspectives of Cloud-Based Desktop Simulators: CSCL and Implications for Educational Design," TransNav, Int. J. Mar. Navig. Saf. Sea Transp., vol. 17, no. 2, pp. 315–321, 2023, doi: 10.12716/1001.17.02.07.

[7] M. V. Miyusov, L. L. Nikolaieva, and V. V. Smolets, "Future Perspectives of Immersive Learning in Maritime Education and Training," Trans. Marit. Sci., vol. 11, no. 2, Oct. 2022, doi: 10.7225/toms.v11.n02.014.

[8] G. Vukelic, D. Ogrizovic, D. Bernecic, D. Glujic, and G. Vizentin, "Application of VR Technology for Maritime Firefighting and Evacuation Training—A Review," J. Mar. Sci. Eng., vol. 11, no. 9, p. 1732, Sep. 2023, doi: 10.3390/jmse11091732.

[9] A. Ujkani, A. Kumar, and R. Grundmann, "Development of Maritime VR Training Applications and Their Use in Simulation Networks: Fast Rescue Boat Training in EMSN Connect," TransNav, Int. J. Mar. Navig. Saf. Sea Transp., vol. 17, no. 2, pp. 323–329, 2023, doi: 10.12716/1001.17.02.08.

[10] I. Petrović and S. Vujičić, "Use of Eye-Tracking Technology to Determine Differences Between Perceptual and Actual Navigational Performance," J. Mar. Sci. Eng., vol. 13, no. 2, p. 247, Jan. 2025, doi: 10.3390/jmse13020247.

[11] S. Hjellvik and S. Mallam, "Integrating motivated goal achievement in maritime simulator training," WMU J. Marit. Aff., vol. 22, no. 2, pp. 209–240, Jun. 2023, doi: 10.1007/s13437-023-00309-2.

[12] I. Bartusevičiene and E. Valionienė, "An Integrative Approach for Digitalization Challenges of the Future Maritime Specialists: A Case Study of the Lithuanian Maritime Academy," TransNav, Int. J. Mar. Navig. Saf. Sea Transp., vol. 15, no. 2, pp. 349–355, 2021, doi: 10.12716/1001.15.02.11.

[13] I. Bartusevičienė, M. Kitada, and E. Valionienė, "Rethinking Maritime Education and Training for Generation Z Students," Reg. Form. Dev. Stud., pp. 16–29, Oct. 2023, doi: 10.15181/rfds.v41i3.2543.

[14] T. Takimoto, "Case Study of Compare Maritime and Ocean Educational Style for under MET," TransNav, Int. J. Mar. Navig. Saf. Sea Transp., vol. 15, no. 1, pp. 101–107, 2021, doi: 10.12716/1001.15.01.09.

[15] A. Sharma, P. E. Undheim, and S. Nazir, "Design and implementation of AI chatbot for COLREGs training," WMU J. Marit. Aff., vol. 22, no. 1, pp. 107–123, Mar. 2023, doi: 10.1007/s13437-022-00284-0.

[16] H. M. Tusher, S. Nazir, S. Ghosh, and R. Rusli, "Seeking the Best Practices of Assessment in Maritime Simulator Training," TransNav, Int. J. Mar. Navig. Saf. Sea Transp., vol. 17, no. 1, pp. 105–114, 2023, doi: 10.12716/1001.17.01.10.

[17] M. Karahalil, M. Lützhöft, and J. Scanlan, "Formative assessment in maritime simulator-based higher education," WMU J. Marit. Aff., vol. 22, no. 2, pp. 181–207, Jun. 2023, doi: 10.1007/s13437-023-00313-6.

[18] C. Sellberg, "Simulators in bridge operations training and assessment: a systematic review and qualitative synthesis," WMU J. Marit. Aff., vol. 16, no. 2, pp. 247–263, May 2017, doi: 10.1007/s13437-016-0114-8.

[19] J. Ernstsen and S. Nazir, "Performance assessment in full-scale simulators – A case of maritime pilotage operations," Saf. Sci., vol. 129, Sep. 2020, doi: 10.1016/j.ssci.2020.104775.

[20] IMO, Bridge resource management - IMO Model Course 1.22. IMO, 2023.