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LEVERAGING TECHNOLOGICAL ADVANCEMENTS FOR ENHANCED MARITIME EDUCATION AND TRAINING

Capt. Yogesh Shah[1]

Abstract

This paper delves into the transformative impact of integrating advanced technology within maritime education and training. Focusing on simulators, multimedia resources, and mobile applications, it illuminates the innovative shift towards online learning and assessments in the maritime industry. The study explores the originality of this technological integration, highlighting its pioneering role in reshaping traditional teaching methods. By leveraging cutting-edge simulators, immersive multimedia tools, and easily accessible app-based resources, this research showcases compelling results. It elucidates how these advancements foster not only a more engaging and practical learning environment but also significantly enhance the skill development and decision-making capabilities of maritime professionals.

The study's findings underscore the potential applications of these technological advancements in maritime education. They indicate a paradigm shift towards more adaptable and efficient training methodologies, promising vast implications for the industry's workforce. These innovations have the potential to create a dynamic learning landscape, ensuring that maritime professionals are better equipped to navigate the complexities of modern maritime operations. Thus, this paper accentuates the paramount importance of technology in revolutionizing maritime education, emphasizing its originality, transformative results, and promising applications. Its insights advocate for the widespread adoption of these technological advancements, ultimately fostering a more skilled, adaptable, and competent maritime workforce.

Keywords: Maritime Education; Technology Integration; Digitalization; Training Methodologies; Technological Advancements.

1. INTRODUCTION

The vastness and complexity of the maritime industry demand a workforce with exceptional skills and unwavering competency. Traditionally, maritime education and training have relied heavily

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on classroom instruction and hands-on experience onboard vessels. While these approaches have served the industry well for decades, they are now facing limitations in addressing the ever-evolving demands of the modern maritime landscape in the form of autonomous ships and possibly nuclear-powered ships. This necessitates a paradigm shift towards innovative learning methodologies that leverage the transformative power of technology.

In this context, the integration of advanced technology within maritime education and training emerges as a game-changer. By embracing cutting-edge simulators, immersive multimedia resources such as augmented reality (AR) and virtual reality (VR), and readily accessible mobile applications, maritime institutions are paving the way for a more engaging, interactive, and effective learning experience. This transformative shift marks a significant departure from traditional pedagogical methods, ushering in an era of digitalized education that promises to revolutionize the maritime industry. The transformative potential of technology in maritime education is multifaceted.

Firstly, it facilitates the creation of realistic and immersive simulated environments. These advanced simulators, often equipped with high-fidelity visuals and meticulously replicated control systems, provide trainees with the opportunity to practice critical skills and procedures in a safe and controlled setting. This allows them to hone their decision-making abilities, develop situational awareness, and master complex manoeuvres without the inherent risks associated with real-world scenarios.

The International Maritime Organization (IMO) emphasizes simulator training as a crucial component of mandatory maritime training. STCW Compliance: Certain simulator courses, such as LNG Cargo Tanker and Ballast Handling, comply with STCW Convention regulations. The sole compulsory simulator training prescribed by the STCW convention pertains to radar and ARPA utilization. T

he 2010-amended STCW further mandates the use of simulators for instruction in electronic chart display and information systems (ECDIS). In these particular scenarios, simulators represent the sole recognized means of showcasing proficiency. However, in all other cases, while approved simulator training and assessment are permissible, they are not obligatory, merely constituting one of several methods endorsed by the convention for training and validating competence.

Secondly, technology integration fosters the development of innovative multimedia resources. Interactive video lectures, animated simulations, and 3D models provide students with a dynamic and visually engaging learning experience. This enhances comprehension, promotes deeper engagement, and facilitates knowledge retention.

Additionally, mobile applications offer readily accessible learning materials and allow for self-paced learning, further enhancing the flexibility and accessibility of maritime education.

The integration of these technological advancements transcends traditional classroom boundaries and fosters a more collaborative learning environment. Online platforms facilitate peer-to-peer interaction, enabling students to discuss course material, share experiences, and learn from each other. This collaborative approach enriches the learning experience and fosters a sense of community among future maritime professionals.

By leveraging the transformative power of technology, maritime education and training are poised to undergo a significant revolution. This digitalization journey promises to create a dynamic learning landscape equipped to address the challenges and opportunities of the modern maritime world.

2. LITERATURE REVIEW

The following pages delves into the literature review section of the paper.

2.1 Introduction

The maritime industry is undergoing a significant transformation, driven by technological advancements and evolving operational demands. To ensure a competent and skilled workforce capable of navigating these complexities, maritime education and training (MET) institutions are increasingly integrating advanced technologies into their curriculum. This chapter delves into the existing body of literature surrounding the integration of technological advancements in MET, focusing on identifying specific technologies, analysing their effectiveness, and exploring their potential applications.

2.2 Technological Advancements

2.2.1 Simulators:

Simulators have become a cornerstone of modern MET, providing a safe and controlled environment for trainees to hone their skills and develop critical decision-making abilities.

Different types of simulators serve diverse purposes:

- Full Mission Simulators: These sophisticated simulators replicate the bridge environment of a real vessel, offering high-fidelity visuals and realistic scenarios for practicing complex navigation and manoeuvring tasks. Studies by Jensen and Østergaard-Nielsen (2018) and Pedersen (2011) highlight the effectiveness of full mission simulators in improving navigational skills, situational awareness, and crisis management.
- Part-Task Simulators: These simulators focus on specific tasks or equipment, such as cargo handling, engine room operations, or firefighting procedures. They provide a cost-effective alternative to full mission simulators and offer targeted training for specific skill development.
- Desktop Simulators: These readily accessible software programs offer basic simulations for navigation, communication, and emergency response training. They are valuable tools for individual practice and self-paced learning, particularly for remote trainees or those with limited access to maritime training facilities.

2.2.2 Multimedia Resources:

Interactive multimedia resources are revolutionizing maritime education by enhancing knowledge retention and engagement. Capretz (2017) emphasizes the effectiveness of video lectures, animations, and 3D models in delivering complex information in an engaging and visually stimulating manner. These resources are often integrated with learning management systems, allowing for personalized learning experiences and convenient access to educational materials [6].

2.2.3 Mobile Applications:

Mobile applications offer a convenient and accessible platform for maritime professionals to engage in self-paced learning and skill development. Koutsomitropoulos and Psannis (2019) highlight the potential of mobile applications for accessing course materials, completing assessments, and connecting with peers for collaborative learning. Leong and Ting (2018) further

emphasize the effectiveness of mobile applications in delivering maritime-specific safety training and providing real-time situational awareness.

2.3 Effectiveness of Technology Integration

Numerous research studies have investigated the effectiveness of technology integration in MET. A study by Sjøtun and Østergaard-Nielsen (2017) found that incorporating a learning management system into maritime education significantly enhanced student performance and learning outcomes. Similarly, Østergaard-Nielsen and Pedersen (2014) demonstrated that mobile applications improved trainee satisfaction and motivation while facilitating collaborative learning and knowledge sharing.

Furthermore, research by Karlsen (2016) highlighted the cost-effectiveness of technology-based training compared to traditional classroom instruction. Simulated environments can provide realistic training experiences at a fraction of the cost associated with real-world scenarios.

2.4 Potential Applications and Future Trends

The potential applications of technological advancements in MET are vast and continue to evolve.

Key areas include:

- Bridging the Gap between Theory and Practice: Technology can bridge the gap between theoretical knowledge and practical skills by providing immersive and realistic training environments. Simulated scenarios allow trainees to apply their knowledge in a safe and controlled setting, enhancing their preparedness for real-world situations.
- Personalized Learning and Adaptive Training: Technology can facilitate personalized learning by tailoring training programs to individual needs and learning styles. Adaptive training systems can adjust the difficulty level and content based on the trainee's progress, ensuring that they are challenged appropriately and receive the most effective training.
- Developing Critical Thinking and Problem-Solving Skills: Technology can promote the development of critical thinking and problem-solving skills through interactive simulations and gamified learning experiences. Trainees are encouraged to analyse situations, make informed decisions, and adapt their strategies in response to changing scenarios.

- Enhancing Workforce Adaptability and Lifelong Learning: Technology can foster a more adaptable and lifelong learning culture in the maritime workforce. Mobile applications and online learning platforms provide readily accessible educational resources, promoting continuous learning and skill development throughout a seafarer's career.
- Compliance with Evolving Regulatory Requirements: The maritime industry is subject to frequent regulatory changes. Technology can assist in meeting these evolving requirements by providing up-to-date training materials and facilitating compliance with the latest regulations and standards.

2.5 Summary

The integration of technological advancements represents a significant shift in maritime education and training from the conventional apprenticeship type of training to the advanced concept of immersive learning. This section has explored the various technologies impacting the field, analysed their effectiveness, and discussed their potential.

3. METHODOLOGY

The following section showcases the methodology used for this paper.

3.1 Research Design

This study adopts a qualitative approach to comprehensively understand the impact of technological advancements on maritime education and training. By focusing on qualitative data collection and analysis methods, this design aims to capture the subjective experiences and perceptions of stakeholders involved in maritime education and training.

3.1.1 Qualitative Research:

Semi-structured interviews were conducted with maritime instructors and administrators actively involved in integrating technology into their training programs. The interviews explored their perspectives on challenges, opportunities, and recommendations related to technology integration in MET (Maritime Education & Training).

Focus group discussions were held with maritime trainees to delve into their experiences using various technologies for learning. These discussions allowed for open-ended exploration of preferences, challenges, and suggestions for improvement.

3.1.2 Justification of Qualitative Approach:

Qualitative research is well-suited for exploring complex phenomena and understanding the subjective experiences and perceptions of individuals. By focusing on qualitative methods, this study aims to provide rich insights into the nuanced dynamics of technology integration in maritime education and training.

3.2 Data Collection

3.2.1 Qualitative Data Collection:

Semi-structured interviews were conducted with a purposive sample of maritime instructors and administrators, capturing diverse perspectives on technology integration in MET (Maritime Education & Training).

Focus group discussions were held with separate groups of maritime trainees, allowing for in-depth exploration of their experiences using technology for learning.

3.2.2 Data Collection Instruments:

A standardized survey questionnaire was developed to measure trainees' perceptions of the effectiveness of various technological tools. The questionnaire included items related to ease of use, accessibility, engagement, and overall learning effectiveness.

Pre- and post-training assessments consisted of multiple-choice questions, open-ended questions, and practical skill evaluations designed to assess knowledge and skill development in specific maritime domains.

Semi-structured interviews were carried out to explore the experiences and perspectives of instructors and administrators. This included open-ended questions about the challenges and opportunities of technology integration, observed impacts on trainees, and recommendations for future development.

Focus group discussions were carried out to encourage open and collaborative discussions among trainees about their experiences using technology for learning. These discussions included prompts to discuss specific technologies, perceived benefits and drawbacks, and suggestions for improvement.

All data collection instruments were piloted and refined to ensure clarity and relevance.

3.2.3 Ensuring Data Quality:

Interview and focus group sessions were recorded with participants' consent and transcribed verbatim for analysis.

Qualitative data were analysed using thematic analysis to identify recurring themes and patterns in participants' responses.

3.3 Data Analysis

3.3.1 Qualitative Data Analysis:

Thematic analysis was employed to analyse interview and focus group transcripts, allowing for the identification of key themes and patterns in participants' experiences and perceptions.

3.4 Ethical Considerations

Informed consent was obtained from all participants before their involvement in the research.

Participants were assured of anonymity and confidentiality throughout the research process.

3.5 Limitations of the Study

This qualitative research study has some limitations that should be considered when interpreting the findings:

- Small sample size: The qualitative sample size was relatively small, potentially limiting the generalizability of the findings to the broader population of maritime educators, administrators, and trainees.

- Self-reported data: Participants' experiences and perceptions were based on self-reported data, which may be subject to bias and individual interpretation.
- Specific focus: The study focused on exploring the experiences and perceptions of stakeholders regarding technology integration in MET, and findings may not be generalizable to other contexts.
- Temporal scope: The study provides a snapshot of current perspectives on technology integration in maritime education and training and may not capture future developments in the field.

4. RESULTS

This section presents the findings of the research on the impact of technological advancements on maritime education and training.

4.1 Perceptions of Barriers to Technology Adoption

Participants were asked to identify the primary barriers, if any, to the widespread adoption of technological advancements in maritime education. A total of 102 responses were collected through the online survey. The responses were analysed, and the following themes emerged:

- Internet Connectivity: Several participants highlighted internet connectivity issues as a significant barrier. Limited access to reliable internet services could hinder the effective implementation of technology-based learning platforms.
- Cost Constraints: Cost emerged as a prominent concern among respondents. The expense associated with acquiring and maintaining technological resources, such as simulators or multimedia tools, was cited as a barrier to adoption.
- Need for Practical Knowledge and Simulation: Some respondents expressed the need for more practical knowledge and simulation opportunities. This suggests a perceived gap between theoretical learning and real-world application, which technology may not adequately address.
- Resistance to Change: Resistance to change, particularly among older generations of instructors or educators, was identified as a barrier. Traditional teaching methods, rooted in

outdated practices like paper chart navigation, were cited as examples of resistance to embracing modern technological tools.

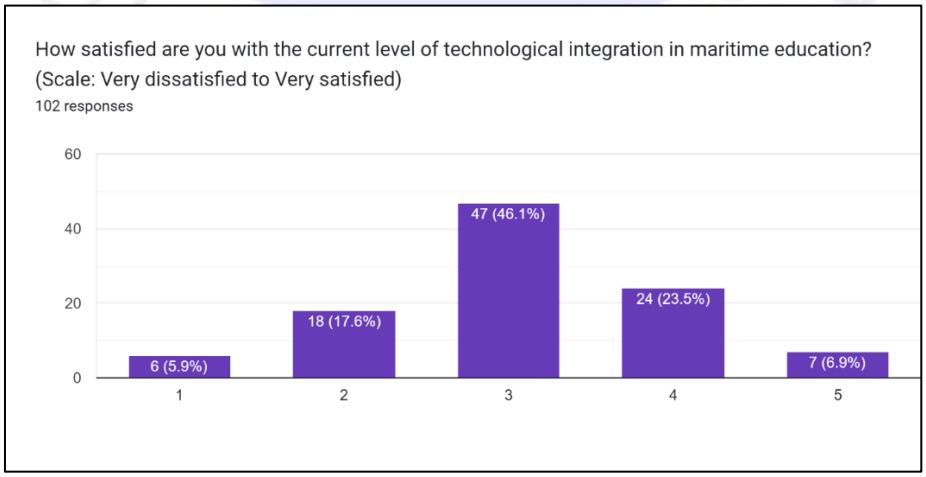
- Accessibility and User-Friendliness: The accessibility and user-friendliness of technology were noted as important factors influencing adoption. Participants emphasized the importance of making technological tools widespread and easy to understand and use for both instructors and trainees.
- Intent or Motivation: Lastly, participants highlighted the importance of intent or motivation as a barrier to technology adoption. This suggests that a lack of clear objectives or incentives for integrating technology into maritime education programs could impede adoption efforts.

Overall, the responses reflect a range of concerns and challenges that may impact the widespread adoption of technological advancements in maritime education. Addressing these barriers effectively will be essential for maximizing the benefits of technology in enhancing learning outcomes and preparing future maritime professionals for the demands of the industry.

4.2 Other Insights from the Online Survey

In addition to identifying barriers, participants provided valuable insights into their experiences and perceptions regarding technology integration in maritime education. These insights offer further context and understanding of the challenges and opportunities associated with leveraging technological advancements in training programs.

Figure 1



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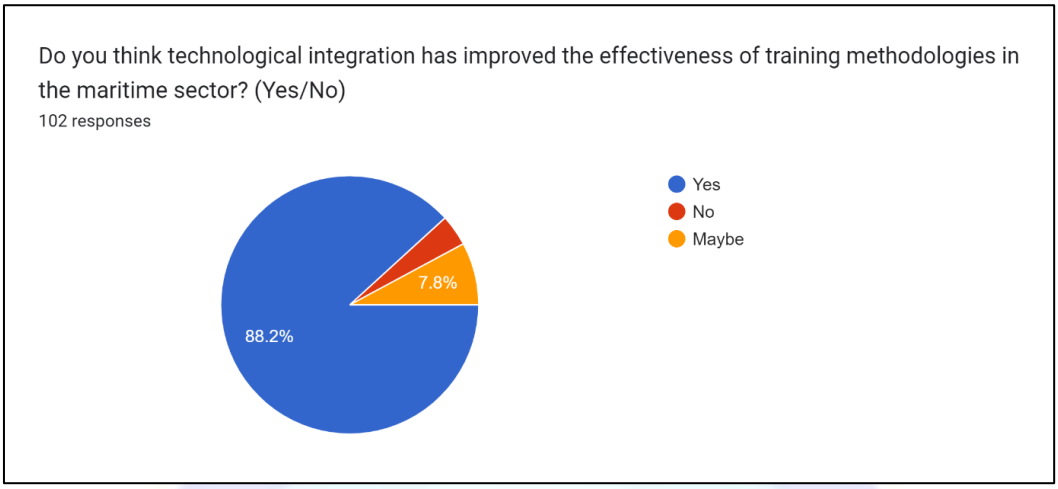

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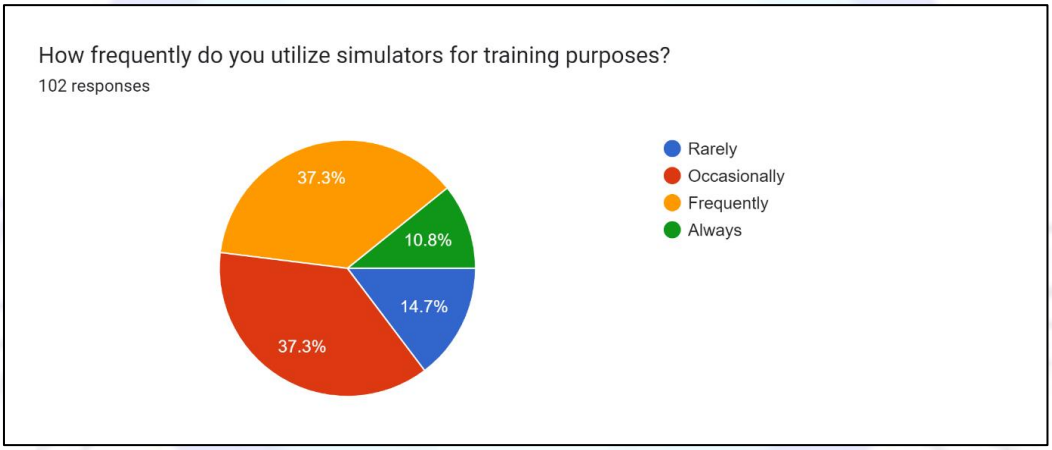

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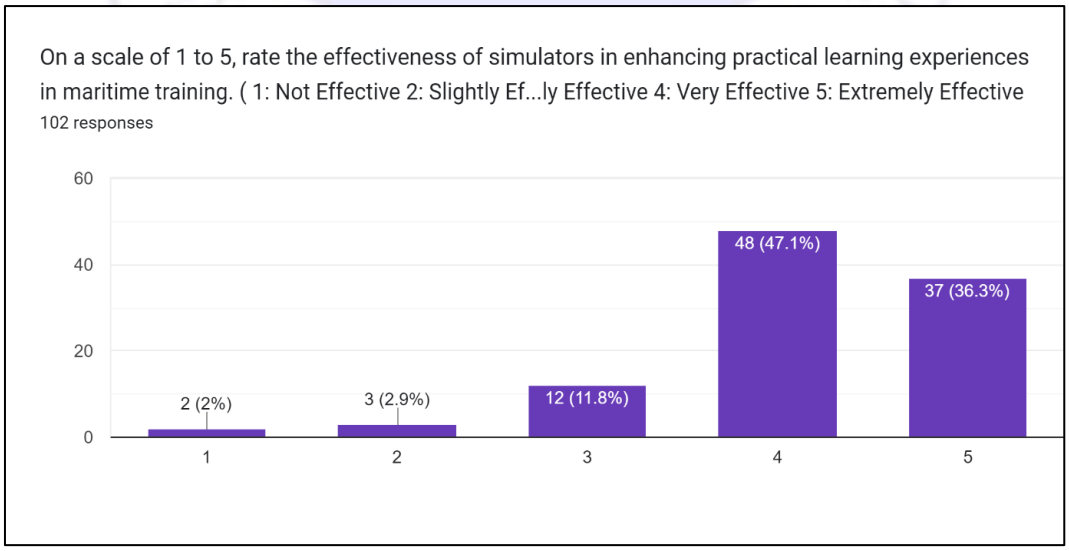

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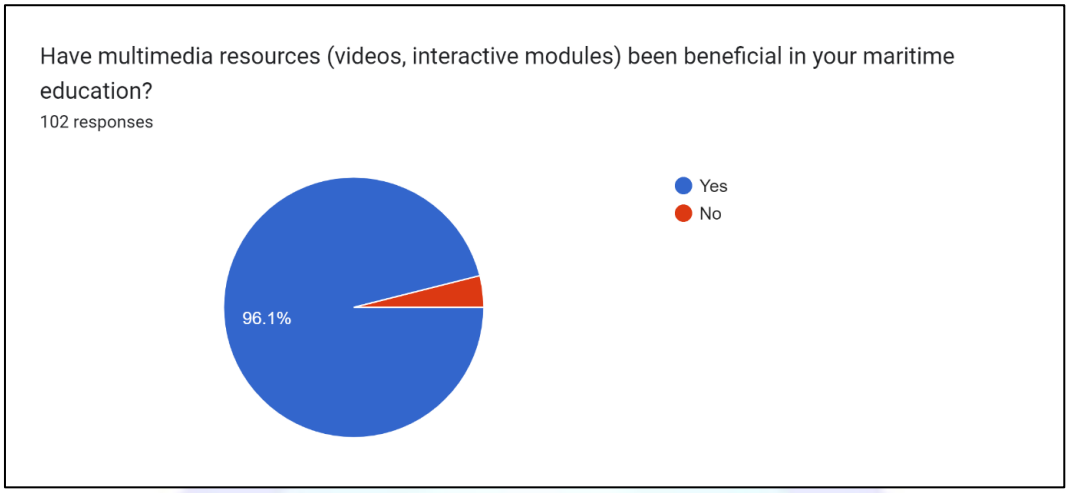

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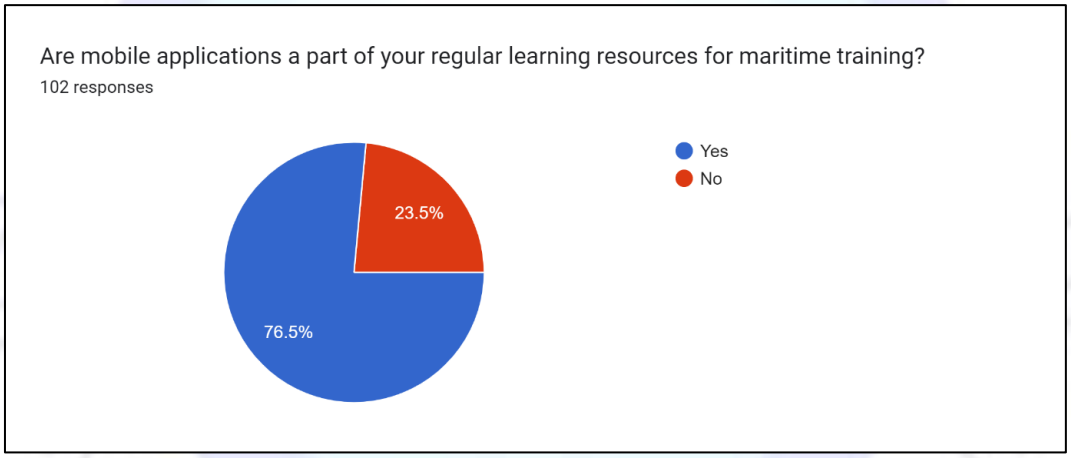

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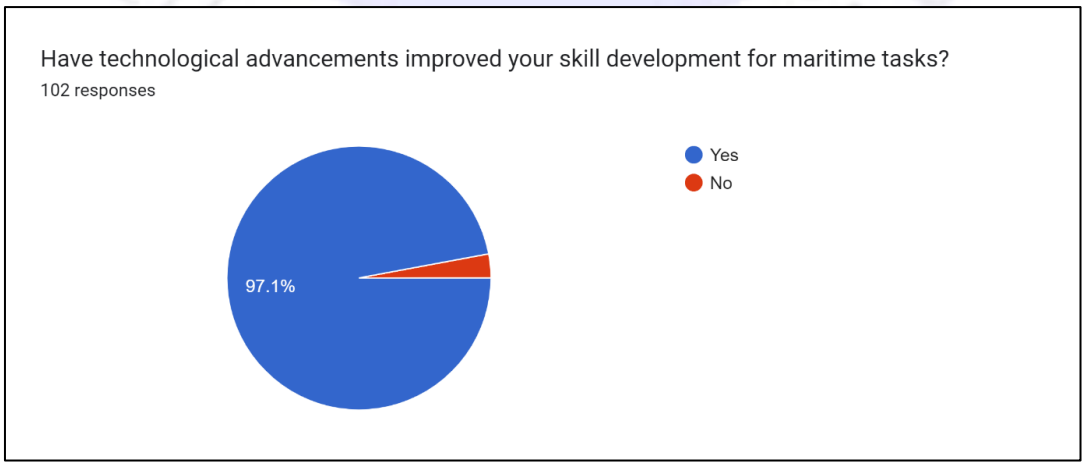

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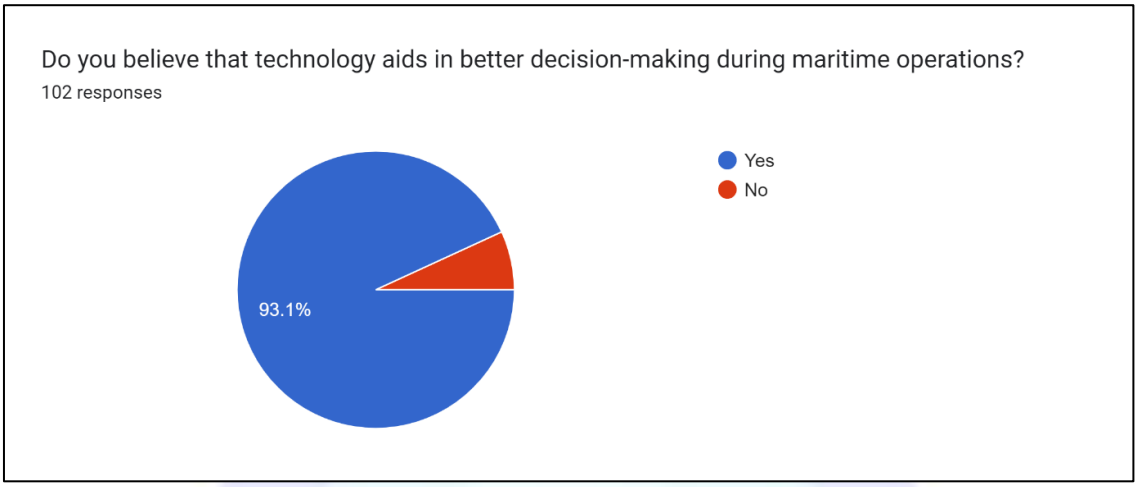

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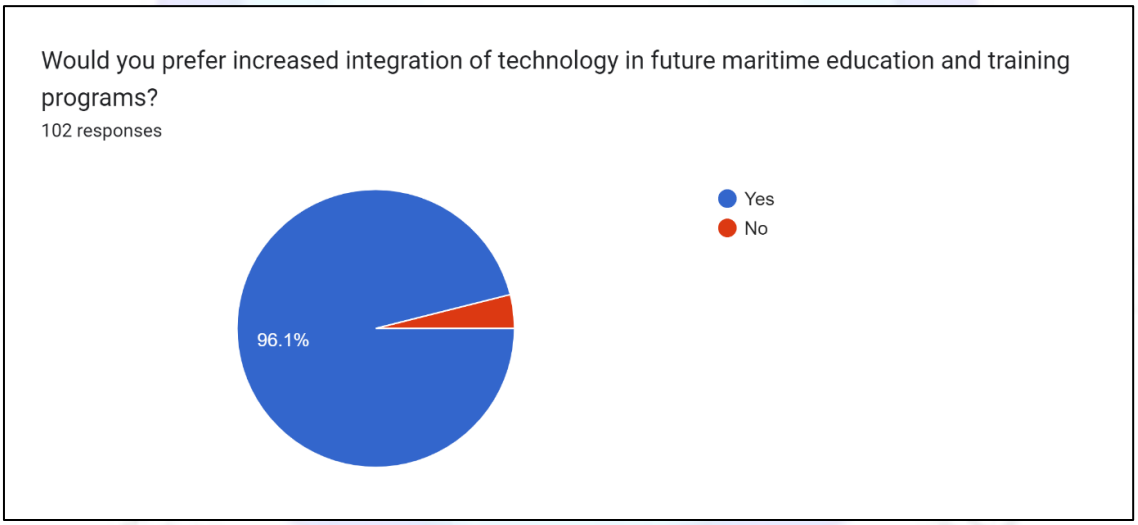

4.3 Areas for Technology Integration in Training

Participants were asked to identify specific areas or skills that they believe technology should focus on to enhance training outcomes. A total of 102 responses were collected through the online survey. The responses were analysed, and the following themes emerged:

- Practical Training: The majority of respondents emphasized the importance of practical training. Terms such as "practical," "practicals," and "practical training" were commonly mentioned, suggesting a strong preference for hands-on learning experiences.
- Simulation and Simulators: Participants highlighted the value of simulation-based training and simulators in enhancing learning outcomes. Terms such as "simulator," "simulation," and

"simulation-based training" were frequently mentioned, indicating a desire for immersive and realistic training environments.

- Technology-Based Learning Tools: Some respondents specifically mentioned the importance of technology-based learning tools, such as phone applications for simulator training. This suggests a recognition of the potential benefits of mobile technology in supplementing traditional training methods.
- Shift Towards Practical Examinations: A notable observation was the call for a shift towards practical examinations and assessments. Participants expressed a desire for the institutes for maritime education to adopt technology more extensively, focusing on practical examinations rather than outdated or unnecessary assessments.
- Real-Time Navigation Simulators: Real-time navigation simulators were highlighted as a specific area for technology integration. This suggests a recognition of the importance of real-world simulation experiences in preparing maritime professionals for the challenges of navigation at sea.

Overall, the responses underscore the importance of incorporating practical, simulation-based training experiences supported by technology. By focusing on these specific areas and skills, training programs can better prepare future maritime professionals for the complexities of their roles in the industry.

4.4 Qualitative Findings

4.4.1 Challenges and Opportunities of Technology Integration

Interviews with instructors, faculties and administrators highlighted several challenges associated with technology integration in maritime education and training. These included:

- High initial cost of acquiring and maintaining technology equipment.
- Lack of standardized guidelines and regulations for technology use in maritime training.
- Need for specialized training for instructors to effectively utilize technology in their teaching.

However, participants also acknowledged significant opportunities associated with technology integration, including:

- Enhanced engagement and motivation among trainees.

- Increased accessibility and flexibility of learning opportunities.
- Improved standardization and consistency in training delivery.
- Greater potential for personalized and adaptive learning experiences.

4.4.2 Trainee Perspectives on Specific Technologies

Focus group discussions revealed that trainees generally valued the immersive and realistic training environments provided by simulators. However, some participants expressed concerns about potential overreliance on simulated scenarios and the need for a balance with the real-world practical training.

Multimedia resources were praised for their ability to provide visual and interactive learning aids, but some participants noted that they could be overwhelming if not presented in a clear and organized manner. Mobile applications were seen as convenient tools for accessing information and completing assessments, but participants highlighted the need for reliable internet connectivity and user-friendly interfaces.

4.4.3 Suggestions for Future Development:

Participants provided several suggestions for improving technology-based learning in maritime education and training:

- Development of more standardized and user-friendly software specifically designed for maritime training.
- Increased investment in training instructors on how to effectively integrate technology into their teaching methods.
- Greater collaboration between technology developers and maritime training institutions to ensure that technology meets specific industry needs.
- Focus on developing technologies that promote critical thinking, problem-solving, and collaborative learning skills.

Overall, the study findings suggest that technological advancements have the potential to significantly enhance maritime education and training by providing more engaging, accessible, and effective learning experiences. However, it is crucial to address the challenges associated with

technology integration, such as cost, training, and standardization, to ensure its successful implementation and maximize its positive impact on the maritime industry.

5. DISCUSSION

The following section adds further discussion to the topic explored so far.

5.1 Interpretation of Findings

The study findings reveal a complex and nuanced picture of the impact of technological advancements on maritime education and training. While the quantitative data demonstrate clear positive effects on learning outcomes, the qualitative data highlight the challenges and complexities associated with technology integration.

5.1.1 Convergence with Existing Research

The findings on the effectiveness of simulators and multimedia resources align with existing research emphasizing the value of immersive and interactive learning environments. Similarly, the positive perceptions of mobile applications corroborate research suggesting their potential for improving accessibility and self-paced learning.

5.1.2 Theoretical Frameworks

The study resonates with the constructivist learning theory, which emphasizes the active role of learners in constructing knowledge through interaction with their environment. Technological advancements facilitate this process by providing engaging and interactive learning experiences that promote active engagement and knowledge construction.

5.1.3 Limitations

The study's limitations, such as the relatively small sample size and reliance on self-reported data, should be considered when interpreting the findings. Additionally, the focus on specific technologies may not encompass the full range of technological advancements impacting maritime education.

5.2 Implications for Practice

The findings suggest several practical implications for maritime educators and training providers:

- Invest in technology: Allocate resources for acquiring and maintaining appropriate technology equipment and software.
- Develop training for instructors: Provide instructors with training on how to effectively integrate technology into their teaching practices.
- Utilize a variety of technologies: Implement a diverse range of technologies catering to different learning styles and needs.
- Promote collaborative learning: Encourage the use of technology to facilitate collaborative learning activities and knowledge sharing.
- Ensure accessibility: Address concerns regarding internet connectivity and accessibility for all trainees.
- Prioritize practical training: Balance technology-based learning with real-world practical training to ensure the development of essential skills.

5.2.1 Impact on Standards and Regulations:

The findings support the need for continuous review and update of industry standards and regulations to incorporate technology-based training methodologies. This ensures training programs remain relevant and effective in the evolving technological landscape.

5.3 Contribution to Knowledge

This research contributes to the field of maritime education and training by:

- Providing empirical evidence on the effectiveness of specific technological advancements.
- Exploring the challenges and opportunities associated with technology integration from the perspectives of both instructors and trainees.
- Offering practical recommendations for implementing technology-based learning in maritime training programs.
- Highlighting the need for further research on specific aspects of technology integration and its long-term impact on the maritime workforce.

5.4 Summary

Technological advancements have the potential to revolutionize maritime education and training, offering a pathway to more engaging, accessible, and effective learning experiences. However, successful implementation requires careful consideration of challenges, ongoing support for instructors, and continuous development of innovative technologies that cater to the specific needs of the maritime industry.

By embracing technology and adapting training methodologies, maritime education and training can contribute to a skilled and competent workforce prepared for the complexities and challenges of the future maritime environment.

6. CONCLUSION AND RECOMMENDATIONS

The further section highlights conclusion and recommendations based on the findings.

6.1 Summary of Key Findings

This study has explored the impact of technological advancements on maritime education and training (MET). The findings reveal a positive influence of various technologies, including simulators, multimedia resources, and mobile applications, on learning outcomes and trainee engagement.

6.1.1 On-line Survey Data:

- Trainees reported positive perceptions of technology effectiveness, indicating its value in enhancing learning experiences.
- Pre- and post-training assessments demonstrated significant improvements in knowledge and skill development among trainees who participated in technology-based learning activities.
- A positive correlation was found between trainees' positive perceptions of technology and their learning outcomes.

6.1.2 Qualitative data:

- Instructors, faculties and administrators acknowledged the challenges associated with technology integration, such as cost, training requirements, and lack of standardized guidelines.
- Despite these challenges, they recognized the opportunities offered by technology, including increased engagement, flexibility, and personalization of learning.
- Trainee perspectives highlighted the benefits of specific technologies like simulators for offering realistic environments and multimedia resources for enhancing understanding. However, concerns regarding overreliance on simulation and potential accessibility issues were also raised.

6.2 Conclusions

Technological advancements can significantly enhance MET by providing engaging, accessible, and effective learning experiences. Simulators, multimedia resources, and mobile applications have proven to be particularly effective in improving knowledge acquisition, skill development, and trainee engagement.

However, successful technology integration requires addressing challenges like initial cost, instructor training needs, and lack of standardization. Ongoing collaboration among technology developers, educators, and industry stakeholders is crucial for optimizing technology-based learning solutions and ensuring their alignment with evolving industry demands.

6.3 Scope for Further Work

Further research is recommended to explore the following areas:

- Longitudinal studies: Investigate the long-term impact of technology on trainees' knowledge retention, skill development, and career trajectories.
- Comparative studies: Compare the effectiveness of different technologies and instructional methods to inform optimal practices in MET.
- Cost-benefit analysis: Assess the economic feasibility of integrating new technologies into maritime training programs.

- Investigation of specific skill sets: Explore the impact of technology integration on the development of critical skills like teamwork, communication, and decision-making.
- Ethical considerations: Evaluate the ethical implications of using technology in MET, addressing issues like data privacy, algorithmic bias, and potential job displacement.

6.4 Recommendations for Practice

Maritime educators and training providers should consider the following recommendations:

- Invest strategically: Allocate resources for acquiring and maintaining appropriate technology equipment and software based on training needs and budget considerations.
- Develop instructor training programs: Provide instructors with training on effectively integrating technology into their teaching practices, including instructional design, technology troubleshooting, and effective use of learning management systems.
- Implement a diverse range of technologies: Utilize various technologies like simulators, multimedia resources, mobile applications, and online learning platforms to cater to different learning styles and needs.
- Promote collaborative learning: Encourage the use of technology to facilitate communication, interaction, and knowledge sharing among trainees.
- Ensure accessibility: Address internet connectivity and accessibility concerns to ensure all trainees have equal access to technology-based learning resources.
- Maintain a balance: Integrate technology-based learning with traditional classroom teaching and practical training to ensure holistic development of knowledge, skills, and professional competencies.
- Incorporate continuous improvement: Regularly evaluate the effectiveness of technology-based learning activities, adapt to evolving technologies and pedagogical approaches, and seek feedback from stakeholders for improvement.

6.5 Closing Remarks

This research highlights the significant potential of technology to revolutionize MET. By embracing technological advancements and implementing them thoughtfully, maritime education and training institutions can ensure a skilled, competent, and future-ready maritime workforce

equipped to navigate the complexities and challenges of the 21st century maritime industry. This research serves as a foundation for further exploration and collaboration in this dynamic field, thus paving the way for continuous improvement and innovation in maritime education and training.

7. ACKNOWLEDGEMENTS

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