ARTIFICIAL INTELLIGENCE APPLICATIONS IN MARITIME VESSELS

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Abstract. This article examines the application of artificial intelligence (AI) technologies in maritime vessels, focusing on navigation, autonomous control, technical diagnostics, and energy efficiency. The study also analyzes the advantages and challenges associated with AI implementation. The importance of these technologies for the future development of maritime transport in Azerbaijan is highlighted.

Keywords: shipping, maritime transport, automation, safety, unmanned vessels

Introduction. In recent years, rapid technological advancements have significantly influenced the maritime transport sector. As a strategically important field, maritime navigation requires innovative solutions to improve safety, efficiency, and sustainability. Artificial Intelligence (AI), defined as systems capable of learning, reasoning, and decision-making, plays a key role in this transformation.

The application of AI in maritime vessels contributes not only to the automation of technical processes but also to the reduction of risks related to human factors. This study aims to analyze the main areas of AI application, evaluate its advantages, and identify the challenges associated with its implementation.

Main Body. Applications of AI in Maritime Vessels. Artificial intelligence is widely applied in navigation and route planning. AI-based systems process real-time data such as weather conditions, sea currents, vessel traffic, and potential hazards to determine optimal routes. By integrating GPS and AIS data, these systems significantly reduce the risk of collisions and improve operational efficiency. In addition, machine learning algorithms can continuously analyze historical voyage data to improve route optimization over time, leading to more accurate and reliable decision-making.Modern AI technologies enable ships to operate with a high level of automation. For example, autonomous vessels such as *Yara Birkeland* demonstrate the capability of AI systems to perform route planning and vessel control without human intervention. These systems can also generate alternative routes in critical situations, thereby increasing safety. Furthermore, AI-based decision support systems assist ship operators by providing real-time recommendations, reducing workload and enhancing situational awareness.In addition, AI is used in autonomous control systems to optimize vessel speed, direction, and stability. These systems rely on sensor data, radar inputs, and predictive models to maintain optimal performance under varying environmental

conditions. AI also plays a crucial role in technical maintenance by predicting equipment failures through the analysis of engine vibration, temperature, and other performance indicators. This predictive maintenance approach helps to prevent unexpected breakdowns and reduces maintenance costs.Furthermore, artificial intelligence improves crew safety by monitoring operational conditions and detecting potential risks in advance. At the same time, AI enhances energy efficiency by optimizing fuel consumption and engine performance, which contributes to reducing operational costs and minimizing the environmental impact of maritime transport. As a result, AI technologies are becoming an essential component of modern maritime systems, supporting safer, more efficient, and sustainable ship operations.

Research Methodology. This study is based on analytical and comparative methods. The analytical approach is used to examine the functional capabilities of AI systems in maritime operations, while comparative analysis evaluates differences between traditional and AI-based navigation systems. The research also incorporates conceptual modeling to assess the impact of AI on risk reduction and operational efficiency.

Comparative Analysis and Risk Model. Traditional navigation depends largely on human experience and manual data interpretation, whereas AI-based systems rely on real-time data processing and automated decision-making. This leads to improved accuracy, reduced fuel consumption, and enhanced safety.

To evaluate the effectiveness of AI in maritime safety, a simplified risk model can be expressed as:$\boldsymbol{R = P \times C}$

where *R* represents risk level, *P* is the probability of an incident, and *C* is its consequences. AI reduces both probability and impact by improving situational awareness and enabling preventive actions, thus lowering overall maritime risk.

Advantages and Challenges. The use of AI offers several advantages, including reduced human errors, improved operational efficiency, early hazard detection, and decreased environmental impact. However, challenges such as high implementation costs, cybersecurity risks, insufficient crew training, and unresolved legal and ethical issues remain significant barriers.

Conclusion. Artificial intelligence is becoming a key factor in the transformation of maritime transport. It enhances safety, improves efficiency, and supports environmental sustainability. However, its successful implementation requires strong regulatory frameworks, advanced infrastructure, and skilled personnel. The results indicate that AI integration can significantly reduce operational risks while improving overall performance. Azerbaijan can benefit from adopting these technologies and aligning with global maritime innovations.

References

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