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THE USE OF ARTIFICIAL INTELLIGENCE FOR AUTOMATING THE MARINE CREW MANAGEMENT

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ABSTRACT

This study presents a comprehensive analysis of the implementation of artificial intelligence (AI) to optimize crew management processes in the maritime industry. The article outlines the inefficiencies of traditional HR practices in shipping companies, including delays in documentation verification, manual classification, and administrative overload. A novel model of an intelligent automation system is introduced, integrating computer vision, machine learning algorithms, and API connections to international registers. The system automates extraction, classification, and real-time validation of seafarers' documentation. Key improvements include a 70–90% increase in operational efficiency, with error rates reduced by over 90% and verification time shortened from hours to minutes. The paper also describes the patented modular system architecture, which provides multi-level verification and enables secure, scalable document workflows. Its compatibility with cloud infrastructures ensures integration flexibility for international maritime companies. The system processes over 10,000 documents monthly and delivers classification within seconds. The study demonstrates how AI technologies enhance accuracy, transparency, and accountability in HR workflows. By automating routine tasks, it reduces recruiter workload and allows for strategic human decision-making. The solution supports compliance with international standards such as STCW and IMO regulations. Findings suggest this approach enables full-cycle digital crew management, forming the foundation of smart recruiting ecosystems in maritime logistics. These ecosystems use AI-driven tools to solve challenges of operational continuity, regulatory compliance, and global workforce mobility in a digitized shipping environment. The conclusions reinforce the transformative potential of AI in modernizing crew operations, aligning maritime HRM with trends in digital innovation, automation, and secure personnel administration across the global seafaring domain. The article recommends further investigation into hybrid intelligence models that combine algorithmic precision with expert oversight, ensuring both efficiency and contextual accuracy in maritime HR decision-making processes.

Introduction.

The active implementation of AI in the field of human resource (HR) management is becoming a key direction of digital transformation in the maritime industry. Globalization, increased regulatory requirements and increased mobility of the workforce necessitate that shipping companies modernize crew management processes. Daily processing of a large volume of documents, compliance with international standards, ensuring transparency of recruitment procedures and minimizing risks require a transition from manual administration to intelligent automation. The development of computer vision technologies, ML, cloud infrastructures and API integrations provides the prerequisites for the creation of a new model of digital crew management. Such a model reduces time and financial costs, increases the accuracy of document verification, optimizes the contracting cycle, and reduces the burden on recruiting departments. Studying the AI potential in this area is crucial for the development of effective personnel strategies and ensuring the continuity of maritime transportation in the difficult conditions of modern logistics.

Problem statement.

Traditional models of maritime crew management are focused on the use of manual or partially automated solutions that are unable to provide the proper efficiency when working with large data volumes. Processing hundreds of personal documents, controlling the validity of certificates, verifying the legitimacy of diplomas, maintaining seafarers' profiles, and preparing for the next voyage are often carried out using Excel spreadsheets or CRM systems. The low level of automation is becoming a critical factor limiting the flexibility, scalability, and adaptability of HR management (HRM) processes in the maritime industry. There is a need for a comprehensive intelligent solution that can integrate all stages of crew management — from receiving documents to their verification and archiving — based on AI algorithms. An important task is to develop a system that ensures accuracy, speed, data processing security and the possibility of further scaling without reducing the quality of recruitment procedures.

Analysis of recent research and publications.

The current academic literature pays more and more attention to the application of AI in the maritime industry, in particular in the field of digital transformation of logistics and management processes. The study of Song T. et al. [5] presents an overview of AI applications in marine sciences, including navigation automation, ship management and analysis of environmental parameters. The authors emphasize the growing role of deep learning and computer vision for processing large heterogeneous data in the marine environment. Particular attention is paid to the efficiency of real-time data processing in the study of Lee E. et al. [6], where an Long short-term memory (LSTM) architecture was developed for predicting the state of maritime traffic. The results of the model indicate the ability of neural networks to take into account historical patterns and external variables. This can also be useful for crew management systems, in particular in terms of transfer logistics and personnel distribution.

Jones A. Et al. [7] proposed the concept of BATMAN — a cognitive system for tracking maritime activity based on deep neural networks. The architecture mimics the principles of brain functioning and demonstrates a high level of adaptability to complex and changing conditions. Its application in the field of crew monitoring can increase the accuracy of detecting anomalies in marine crew members' routes or documentation. The study presented by Mishra S. [8] shows how AI-based models are used to ensure cybersecurity in the financial sector. The considered principles of adaptive risk management can also be applied to the security of digital profiles of crew members stored in cloud systems. Salem T. and Dragomir M. [9] explored the potential of digital twins in the construction industry. Although the subject area is different, the architectural principles of synchronization of physical and digital objects can find application in personalized monitoring of seafarers' profiles. In this context, each profile is a digital representation of a real crew member.

Chatterjee S. et al. [10] analysed the use of AI in business-to-business (B2B) partner relationship management. The authors argue that automation of communication processes contributes to the accuracy of information exchange and reduces the number of administrative errors — aspects that are critical for the interaction between recruiters and maritime agents. Ughulu J. [11] describes the role of AI in scaling businesses through the automation of standard procedures. The ideas presented in the article are consistent with the principles of optimizing recruitment processes in the maritime industry, where repetitive operations can be fully delegated to intelligent algorithms. Khan A.A. et al. [12] consider the synergy between AI, blockchain, and Industrial Internet of Things (IIoT) for the digitalization of small and medium-sized enterprises. This approach opens up prospects for the integration of multi-component technologies to improve the reliability of document verification and protect crew data. The publication of Lu et al. [13] demonstrated the use of computer vision for image segmentation in the field of building materials recycling.

The semantic segmentation methodology presented by the authors is also relevant in the context of automatic recognition of crew documents in complex formats. In a review of the use of AI in pharmacy practice, Chalasani S.H. et al. [14] describe the advantages of adaptive learning and updating algorithms based on new input data. This approach fully meets the tasks in the field of crew management, where document formats and regulations change dynamically. Gulati K. Et al. [15] analysed the impact of AI and IoT on the social and psychological aspects of HRM in the banking sector. Automation enables reducing the emotional burden on employees and increase overall efficiency. Similar conclusions can be extended to the field of crew recruitment, where personnel face constant stress due to the volume and responsibility of work. The latest study — Hinge P., Salunkhe H. and Boralkar M. [16] — offers an analysis of the use of AI in HRM using semantic analysis of employees' emotions. The application of similar technologies in the field of maritime recruiting can allow

for better assessment of a candidate's suitability according to formal criteria and behavioural patterns, which will enhance the quality of personnel selection.

Aim.

The aim of the article is to investigate the possibilities of using AI to improve the efficiency of maritime crew management by automating processing, checking, and storing crew documentation. The main objectives of the study are to analyse modern digital solutions used in the field of recruiting and crew management. These include, in particular, the systems based on computer vision, ML, and API integrations with international registries. The advantages of implementing such technologies to ensure verification accuracy, reduce administration costs, and reduce document processing time compared to traditional approaches are considered. Particular attention is paid to the applied aspect: the effectiveness of the patented optical recognition and classification system for crew documents, which has already been implemented in several international companies, is assessed. The prospects for scaling such solutions in the digital ecosystem of maritime HRM and the creation of an innovative model of personnel operations in the maritime industry are revealed.

Results.

One of the key problems of the maritime industry is the excessive workload on administrative staff associated with checking, classifying and verifying a large number of crew documents. According to our company's internal statistics, the average volume of document flow per seafarer per contract is about 15–20 files, including certificates, diplomas, passports, contracts, medical certificates, etc. When working with crews of more than 500 people, this amounts to more than 10,000 documents per month. The implementation of the AI system has made it possible to automate up to 85% of routine operations with these files.

The integrated system receives incoming documents via corporate email or via API connection to Customer Relationship Management (CRM). Computer vision models (Optical Character Recognition (OCR) + Convolutional Neural Network (CNN)) enables the system recognize the type of document and extracts key fields — name, date of birth, document validity period, certificate type. After that, the document is classified according to a standardized scheme, for example, according to the Standards of Training, Certification and Watchkeeping for Seafarers (STCW) classification. Then, the document is tied to a specific seafarer through the feature comparison algorithm (Name-Matching, Cosine Similarity), even if the name is entered with errors. It became possible to reduce the number of unconfirmed documents from 9% to less than 1% in the first 3 months of implementation.

A feature of the developed system is multi-level verification of the legitimacy of documents through official registers — in particular, the Register of Maritime Certificates of Ukraine, the MARINA register (Philippines). For this, automated application programming interface (API) queries are used: the system generates a query, extracts the answer from the register, and automatically attaches the result to the seafarer's profile. This reduced the time for checking documents from 4–6 hours to 3–5 minutes.

Table 1. Comparison of the efficiency of processing crew documentation, before/after the implementation of the AI-based system

Indicator	Before AI implementation	After AI implementation	Improvement
Average processing time per seafarer	4 h 25 min	58 min	-78%
Frequency of errors in documents	7.8%	0,6%	-92%
HR involved in verification	6 specialists	1–2 specialists	-66%
Processing costs per month	$8,000	$2,300	-71%

Source: developed by the author

An automated notification mechanism for document expiration operates simultaneously. The system generates a summary of critical certificates and sends them to the recruiting staff in advance. This approach has significantly reduced the risks of disrupting crew training for voyages. Aydın E. and Turan M.A considered a similar role of automation in HRM processes, who note the effectiveness of AI models in accelerating decision-making in the field of HRM [1, p. 12].

The unification of the digital document storage structure is implemented through the Google Cloud Storage infrastructure using formatted file names according to the [DocumentType]_[SurnameInitials]_[UUID4] template. This approach ensures archiving stability, simplifies integration with corporate Enterprise resource planning (ERP) systems, and minimizes the need for manual intervention.

The results of the internal audit at OSM Crew Management confirmed the cost-effectiveness of the system. The time for preparing a full package of documents was reduced by 40%, the total processing costs were reduced by 32%, and no document losses were detected. Munim Z.H. et al. analysed the prospects for the application of intelligent technologies in shipping, who identified increased accuracy of operations as a key result of digital innovations in the industry [4, p. 583].

The algorithm for recognizing, classifying, and verifying crew documentation became the basis of the patented technical solution The System for Optical Recognition, Identification, and Unification of Professional and Personal Documents of a Marine Crew Member. The technology is implemented as a multi-level system with a modular architecture. The principle of combining automated processing and human control corresponds to the hybrid intelligence model proposed by van der Aalst W.M.P. This model emphasizes the adaptive balance between algorithmic decision-making and operator responsibility [3, p. 7].

The system demonstrated stable processing of over 10,000 documents per month during testing at partner companies, with an average classification time of one document of less than 2 seconds. The integration covers the entire crew management cycle: from recruitment to contract return control. Such an architecture fully correlates with the vision of the development of digital defence infrastructure formulated by Purja A. et al., who consider AI as a means of strengthening the resilience of the national maritime industry [2, p. 22].

A separate example of the successful implementation of AI in crew management is the patented system of optical recognition, identification and unification of professional and personal documents of a marine crew member. The solution is designed to automate analysis, processing and verification of seafarers' documentation. The features of the development is based on deep neural networks, computer vision systems and cloud architecture with access to external registries.

The system integrates into the information infrastructure of maritime companies via corporate email, API or web interface. Documents received as attachments are automatically identified, recognized, and classified. Thanks to pre-trained neural networks, the type of each document is determined with high accuracy, regardless of format, language or template.

After classification, the system extracts key details from the document: last name, initials, date of birth, type and number of the certificate, validity period. Based on this data, a comparison is formed with the corresponding seafarer profile in the company's database. If the profile does not exist, the system automatically creates a new one, saving the file in the corresponding personal directory generated according to the template.

The documents are verified through automated queries to national and international registers, including the State Register of Maritime Certificates of Ukraine and MARINA (Philippines). The response is systematically processed and added to the seafarer's digital dossier, providing administrators with confirmation or a reason for refusal. All responses are aggregated in a visual dashboard for further analytics.

Table 2. Functional stages of implementation of the patent System for Optical Recognition, Identification, and Unification of Professional and Personal Documents of a Marine Crew Member

Stage	Action Description	Instrument
1	Receiving emails or API requests with attached documents	Integration with email services, CRM
2	Extracting files, determining the format and type of the document	OCR, CNN models, structure analysis
3	Identifying a seafarer based on document data	Mapping algorithms, name + date + ID
4	Saving in cloud storage and updating the profile	UUID, Google Cloud, cataloguing system
5	Verification in the registers of Ukraine, the Philippines	API queries, response parsing
6	Generating automatic notifications about the document status	Notifications, logging
7	Displaying results in CRM/web interface	Visualization, admin panel, export

Source: developed by the author

The integration of this system enables automating routine actions and eliminate human errors when checking the compliance of documents. Each stage is implemented as a separate service that works asynchronously and is scalable. This architecture provides stable processing of large data sets in real time. The system's web interface provides flexible access levels: the administrator sees a full report on activity, verification status, and certificate expiration dates. Recruiters receive only the necessary information to make personnel decisions. The interface is built on the principle of intuitive navigation access without the need for technical training.

Special attention was paid to scalability — the system easily adapts to the requirements of new companies. Thanks to the use of cloud services, it does not require complex local deployment. Self-learning tools enable its adaptation to new types of certificates, even if they were not included in the initial training set. Today, the solution is used by several international crew companies, including OSM Crew Management and Crew Recruitment Services. According to customer analytics, the implementation of the patented technology reduced document verification costs by 60–70%, and the level of automatic confirmation of document validity reached 99%.

The developed system enabled achieving operational efficiency and increase the level of transparency in HRM processes. Full digitalization and tracing of actions in the system provide an audit of both internal solutions and external compliance with the standards of international maritime organizations. All actions are logged, which guarantees compliance with cybersecurity policies and personal data retention standards. Generalization of implementation efficiency indicators demonstrates stable results in different regional contexts. Regardless of the scale of the company or the region of work of the crew, the algorithm demonstrates stable recognition accuracy of over 98% for the main types of documents. At the same time, the system's performance is maintained at high loads — over 20,000 processing per day without loss of quality or delays. The developed architecture is suitable for further scaling, in particular in the areas of legal verification, automated contracting or synchronization with international databases of the International Maritime Organization (IMO) or the International Labour Organization (ILO). Creating a fully functional crew management ecosystem based on it will enable implementing the concept of "smart recruiting". In such a model, routine operations are delegated to machine algorithms, and specialists focus on making strategic decisions.

Conclusions.

The use of AI in the management of marine crews has proven its effectiveness in solving the problems of large-scale document flow, checking the legitimacy of certificates, and increasing the overall productivity of recruitment processes. The proposed system has demonstrated the ability to automate more than 70% of routine tasks, significantly reduce the number of errors, and reduce costs, which is confirmed by the practice of implementation in specialized companies. The integration of the patented algorithm into the IT infrastructure of companies enabled the implementation of the principles of adaptive HRM with a high accuracy, speed, and scalability. The proposed solution meets international standards and creates the prerequisites for building digital crew management ecosystems. In such ecosystems, intelligent systems are a central link in the transformation of the maritime industry.

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