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MODERN SYSTEMS OF PLANNED MAINTENANCE OF VESSEL EQUIPMENT

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Abstract. *Modern approaches to building planned maintenance system for ship equipment are analyzed, as well as the features of such systems used by leading ship management companies. Management companies are faced with a growing administrative burden associated with inventory, assessment of regulatory requirements and risks, as well as a growing need for data analysis to assess efficiency.*

The purpose of the work is to analyze and summarize the acquired experience in using planned maintenance system, approaches to building a structure of the tasks to be solved and their features.

Key words: *maintenance, technical management, planned maintenance systems, software.*

Introduction.

A planned maintenance system (PMS) on ships is mandatory according to the International Safety Management Code. As part of technical management, the ship manager provides services such as budgeting, PMS, periodic inspections, dry docking, procurement, documentation, safety management system and many others [1-3]. Management companies are faced with an increasing administrative burden associated with inventory, assessment of regulatory requirements and risks, as well as an increasing need for data analysis to assess effectiveness. Given the huge amount of data used today to solve the problems of effective management of the PMS process, a whole range of different business intelligence tools are needed, specialists with specialized knowledge in the field of data mining to conduct analytics and focus on critical areas that are constantly difficult to maintain. Ship management companies use PMS software, which allows you to track the numerous tasks that need to be performed.

Main text.

Let us consider several examples of PMS systems offered in the maritime transportation market. In the field of providing the above services, performers use various terminology to describe the services and works offered.

Det Norske Veritas (DNV) has developed a large-scale complex called the Planned maintenance system for technical ship management – ShipManager Technical. The system is approved by the DNV classification society [4].

ShipManager Technical is a technical ship management system for scheduled and unscheduled maintenance, defect reporting, and technical asset and data management.

The software provides an opportunity to obtain a set of important information, solve a number of tasks, namely:

• optimization of ship maintenance management;

• centralized management of equipment and maintenance work of all ship equipment;

• provision of information for effective reporting on the management of the entire fleet using the business analytics subsystem (ShipManager Analyzer);

• has an easy-to-use common user interface between ship and shore, which improves communication;

• enables preparation and documentation of all planned and unplanned maintenance tasks;

• identifies and schedules tasks based on counters/calendar and conditions;

• categorizes work and items according to relevant safety-critical criteria;

• automatically updates inventory data with spare parts used to perform maintenance tasks;

• maintains life cycle records for each piece of equipment;

• efficiently manages hazardous materials inventory;

• manages defects;

• exchanges equipment for maintenance and repair without losing critical information;

• has centralized task lists for shipboard engineers and office technical staff;

• integrates with other Ship Manager software modules.

SHIPMATE Planned Ship Maintenance System by SBN Technologies Pvt. Ltd. (India) is a software that enables ship owners and operators to maintain their ships at intervals specified by manufacturers and class/classification society requirements [5].

SHIPMATE PMS provides maintenance and replenishment scheduling, plays an important role in reducing the risk of accidents through regular preventive maintenance, and helps ensure that various ship seaworthiness parameters meet the standards set by regulatory authorities and manufacturers.

The Computerized Maintenance Management System (CMMS) helps to reduce the overall workload and increase management efficiency, including specialized software for the Planned Maintenance System Software (PMSS). Features of this system:

• Bureau Veritas certified software class;

• maintains maintenance schedules;

• maintains maintenance history;

• provides automatic creation of future maintenance tasks based on established rules;

• graphical user interface to facilitate the work planning process;

• tracks maintenance work history, including images of equipment/work;

• tracks critical spare parts and equipment; the system updates all transactions related to the purchase and use of stocks and notifies all stakeholders on board and ashore (this feature ensures that all stakeholders are provided with the necessary information, which increases transparency and efficiency);

• maintains detailed and structured documentation of the work, such as work procedures, drawings, spare parts to be used;

• data transfer “Shipping Company – Vessel – Shipping Company” (data and images) for synchronization;

• inventory management; requests are generated based on inventory levels and criticality of spare parts; link to the procurement system;

• monitoring of certificate expiration dates and creation of appropriate alerts.

Let's consider a few more examples of such systems.

Pacific Tug (Aust) Pty Ltd - (Australia) - uses the system Technical Services in Marine Operations [6]. The list of offered services is based on the following provisions, which the company defines as the main ones:

• mechanical systems - this includes maintenance and repair of engines, generators and other mechanical components that are crucial for the operation of the vessel;

• electrical systems - ensuring the correct operation of electrical systems, such as power distribution, lighting and electronic equipment;

• navigation equipment - regular checks and updates of navigational aids such as GPS, radars and compasses to ensure accurate and safe navigation.

• software and data management - implementation of software updates and management of data systems to optimize operational efficiency and improve decision-making processes.

Shipnet (Norway) uses a comprehensive technical marine software, Shipnet Technical, which optimizes maintenance procedures [7]. The core of the technical solution is based on the Shipnet ONE platform, including applications: scheduled maintenance, a technical defect module, analysis of components for repair or disposal, inventory management, etc. The system provides tracking of maintenance and repair history in such forms as, for example, crankshaft deflection data, tank inspection readings and others, which helps to identify critical areas to focus on in the future.

Fleet Management Limited (Hong Kong) uses the Planning and Reporting Infrastructure for Ship (PARIS) platform [8]. The system allows for real-time vessel performance monitoring, predictive maintenance, and seamless communication between shore-based teams and crews at sea.

Analysis of the above systems allows us to identify the following main categories of ship management services implemented using integrated marine software systems. The main components of PMS software can be identified as

follows.

Budgeting. Efficient use of resources to reduce operating costs. Having a large fleet under its care allows ship management companies to work on economies of scale and provide discounts on commissions to their clients, keeping operating costs within an acceptable limit.

Maintenance. Effective execution of predictive, preventive and emergency maintenance to ensure the long service life of all equipment on board. Ship management systems can provide a timely maintenance schedule that extends the life of equipment by ensuring that the vessel receives all the necessary spare parts, supplies and bunkers.

Inspections and Surveys. Inspections are carried out by various organisations such as flag states, classification societies, port state control authorities and shipping companies.

Survey inspections are special types of inspections carried out at the request of shipowners. The surveyor provides a ship assessment that helps owners offer the ship for cargo transport through charterers. This is because charterers rely on survey assessments to determine the suitability of a ship to carry their cargo when there are several similar ships. The organizations that most frequently carry out ship inspections include OCIMF (SIRE), Rightship, CDI and P&I clubs [9-12].

Docking. Successfully planning the necessary drydocking operations takes several months and must take into account factors such as budget, repair needs, size, age and condition of the vessel. The goal is to complete all necessary repairs at the best possible cost. Ship management companies can ensure that the docking plan is systematically planned and executed smoothly, while remaining within the allocated budget.

Procurement. Procurement is the process of purchasing and delivering the goods requested by the vessel's crew. In order for the vessel to operate smoothly, purchases must be made on time, within budget and to the recommended quality. Logistics can be a major challenge when heavy or volume-limited cargo (batteries, medical equipment, etc.) must be transported over long distances in a timely manner, while

adhering to local and international regulations. This also includes the timely supply of various technical consumables, such as fasteners (bolts, nuts, washers), lumber, welding rods, steel brushes, gases, cutting and grinding wheels, etc.

Documentation. Maintaining up-to-date documentation on board is essential to prevent delays and accidents. A vessel requires a variety of permits and relevant certificates from the flag state, classification society, insurance company, MLC, etc. MLC 2006 – Maritime Labour Convention – is an important international document that sets standards for labor rights for seafarers [13].

All equipment must have certificates of approval and regular maintenance. Even if a piece of equipment is in perfect condition, it has no status without the appropriate certificate.

Safety management system. Accidents, incidents and hazardous situations pose a risk to life, the ship and the environment. The International safety management code (ISM code), issued by the IMO, describes an safety management system as "a structured and documented system that enables company personnel to effectively implement the company's safety and environmental protection policies." The Code is based on common principles and objectives, which include assessing all identified risks to a company's ships, personnel and environment, and establishing appropriate safety measures.

These technical services play a crucial role in maintaining the operational capability and efficiency of ships and equipment. These services help prevent mechanical breakdowns, shipboard equipment failures, ensure regulatory compliance and extend the service life of maritime assets. Without effective technical support, maritime operations can experience significant disruptions, leading to costly delays and potential safety threats.

Summary and conclusions.

Specialized computer platforms of the planned structure of ship maintenance management increase productivity, reduce costs and allow more effective use of important information regarding the condition of equipment, work plans, predictive maintenance, other work procedures, etc. Existing and promising complexes make it

possible to effectively manage the hierarchy of components, centralized work procedures and other modules of ship processes.

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METHODS OF INTELLIGENT ELECTROENCEPHALOGRAM DATA ANALYSIS FOR CLASSIFYING HUMAN EMOTIONAL STATES

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Abstract. *The paper presents a method for classifying human psycho-emotional states (positive and negative) based on the intelligent analysis of electroencephalogram (EEG) data. The proposed approach is an extension of the k-nearest neighbors method and is based on calculating the geometric distance from the analyzed signal to the barycenters of the formed clusters. Unlike direct comparison with individual reference samples, the use of barycenters mitigates the impact of random outliers and artifacts within the training set, ensuring the signal is compared against the most typical "integral portrait" of the emotion. Input EEG data are pre-processed to convert the dynamic amplitude series into stationary integral metrics over a time interval of 1000–3000 ms to filter out reaction noise. It has been experimentally confirmed that the method demonstrated 100% classification accuracy within the constructed test sample.*

Keywords: *artificial intelligence, data analysis, knowledge bases, clustering, EEG.*

Introduction

The rapid development of Brain-Computer Interfaces (BCI) and artificial intelligence systems underscores the critical need for objective instrumental monitoring of human emotional states. One of the main obstacles to creating reliable classifiers is the nature of emotional responses, which is characterized by fuzzy logic, signal non-stationarity, and high noise levels in electroencephalogram (EEG) recordings [1-2].

Classical frequency analysis methods, such as the Fast Fourier Transform (FFT), often prove ineffective for isolating the useful signal from the superposition of electromagnetic oscillations, as they do not allow for the classification of harmonics according to their origin. In previous studies, the authors proposed an approach for transitioning from dynamic parameters to stationary statistical data by calculating integral metrics of brain activity. However, classification using the classical nearest