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SOFTWARE AND HARDWARE TOOLS FOR SEA LOGISTICS TRANSPORTATION IN UNCERTAINTY CONDITIONS

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The article considers the issues of modeling and support of management decisions on the development of maritime transport using software and hardware and tools for information support of logistics solutions. It is shown that the management of transport transportation in conditions of uncertainty requires content analysis of information on the possibility of implementing a dialogue between a consumer and a computer, creating an interactive educational environment, identifying the components of this environment, the specifics of their meaningful interpretation. A model of the educational environment of maritime transport logistics is proposed, consisting of system and application software, software and hardware solutions, elements of dynamic support of management processes. The structuring of system and application programming tasks is performed. The content of the platforms of the system software for transport logistics is considered, indicating the implementation programs. The purpose of the components of the application software is described. The means of installing and editing tasks of the application software for transport logistics are highlighted, which include adaptation to the smartphone screen, technical support of the service, adjusting the content to other versions, creating an interactive on one screen. The article describes the means of interaction with the content of the marine information architecture, providing interactive navigation through existing information resources, which include feedback forms, online recordings, interactivity buttons, interactive inserts, phone cameras, archival storage, information blocks, and visual style. Recommendations are made for creating an interactive site for the logistics of marine transport carried out under conditions of uncertainty of the influence of the external environment.

Keywords: *interactive management, structuring, knowledge organization, logistics, software and hardware solutions, interactive navigation.*

Statement of the problem

As experience shows, information is better absorbed if it is not just passively familiarized with, but also actively interacted with reference to the situation being resolved, in which the goal is achieved by information exchange of elements of this system with the computer.

In order to increase the efficiency of transport logistics management, make timely and adequate decisions for a specific situational situation, an intelligent educational environment for transport transportation in conditions of uncertainty and risk should be created, organizing knowledge at a systemic and qualitatively new level of ensuring the solution of applied problems. Achieving the set goals is possible due to the inclusion of innovative technologies and management tools in the process of knowledge organization.

The typical architecture of transport logistics includes sensors, data processing and server input operations, decision making, execution of control commands, interface of communications and interactions. A systems approach based on the integration of analysis and synthesis of different aspects of logistics systems with the need to select scientifically based tools can be used to study it. The use of a systems approach, software and hardware and tools for sea transport provides for interaction with systems of structured and functionally related elements, the organization of which requires content analysis of information on the possibilities of dialogue between the consumer and the computer. Formalization of a logistics transport system using software and hardware and tools can serve as the basis for creating an interactive website for sea transport. Service maintenance, interface platforms, query generation, consumer feedback, adaptation to external disturbances and content placement serve as the basis for system analytics of transport logistics and organizing knowledge and necessary information in offline and online modes.

Analysis of the latest achievements on the identified problem

The prospects of using system analysis tools for operational access to information on any element of transport logistics and the dynamics of transportation processes are shown in [1-4]. In the field of software, there is a growing trend to present logistics functionality using web services [5, 6]. Interactive web tools for decision support in independent platforms for web-interface management of the marine environment OCEAN System are described in [7]. The moments of building an architecture for merging analytical processing technologies of software systems with real-time modeling methods are noted.

In [8], the results of creating a distributed virtual environment simulating the behavior of a large number of

users interacting via a global network are described. Architectural solutions for several network servers are presented. A conclusion is made about the need to introduce hardware and software for an extended infrastructure of simulation tools for network servers in various scenarios. An interactive educational system for perceiving logistic information using computer-telecommunication integration of the Internet of Things application and interface technologies is presented in [9]. An application programming interface for business logistics with short messages is implemented.

In [10], describes advances in shipping data analysis and modeling with a focus on mapping maritime flows using big data. Long-term maps of current trends and cyclicality, driven by the dynamics of maritime transport and global international flows, are taken into account to support policies and strategies based on big data. In [11], an integrated software system Flex MoT for managing the visualization of marine sensors in gas production platforms and oil rigs is described, providing situational awareness and advanced decision support. The implemented solutions combine the latest web technologies and interactive presentations using the metaphor of sensory interaction.

In [12], dynamic applications for vehicles integrated with a regional intelligent control and monitoring system for automatic regulation of reactions to extreme external impacts are considered. Logistic processes of combinatorial optimization formalized and implemented as a set of ontologies that allow determining the appropriate optimization method and a list of web services for their implementation are presented in [13]. In [14], an intelligent logistics transport system based on the Internet of Things and artificial intelligence technologies is presented. In [15], artificial intelligence technology is used in the analysis of ship behavior in maritime traffic.

Of interest is the study of the model of emergency planning for mixed multimodal transportation taking into account the variability of situations [16]. An interactive model of hierarchical optimization and an algorithm for decision-making in emergency situations for the planning task are constructed. The role of computerized automated systems in obtaining statistical information about fairways, managing traffic logistics, combating disasters and improving the safety of water transport is described in [17]. The human factor is replaced by a system of automated information services. Human intervention is replaced by an artificial intelligence system.

In the context of Industry 4.0, the concept of a digital twin is integrated into the construction of a logistics model for managing vehicles with a multi-distributed center [18]. The model allows minimizing transportation costs, reducing transportation time, and improving the speed of loading vehicles. The implementation algorithm is based on the cubic display mechanism. The simulation experiment was conducted in accordance with actual business data. In the same direction, the results of using an interactive multimedia computer information system should be considered [19]. The system can combine various media forms: text, image, audio, and video to implement a dynamic display of information and user experience, allows exchanging data through the interface in real time, and providing visualization and monitoring of transportation.

The presented review of recommendations and generalizations is of a navigational nature and requires studying various tools and workflows.

With the help of software, it is possible to create a step-by-step instruction for obtaining adequate software and hardware solutions, but information on the use of forms and methods for supporting the information component of maritime transport transportation is practically not found. In addition, despite the great potential of the means and tools of information on the generation of possible events for the development of maritime transport logistics in conditions of uncertainty on a regular basis does not exist. A number of significant problems are noted associated with the lack of structuring of software tools for the selected subject area, a weak educational environment for considering the content of system software platforms, installation and editing methods.

Purpose and task statement

The purpose of the work is – structuring of logistics software information, development of recommendations for choosing the format of an interactive environment website, with the help of which information about the subject area being studied can be extracted from existing knowledge under conditions of uncertainty

Tasks of the work:

- build a structuring of system software and application software and tools for maritime transport logistics;
- develop a model of intelligent educational among maritime transport under conditions of uncertainty;
- determine the means of interaction with the content of the maritime information architecture;
- determine the methods and types of installation for editing the intelligent educational environment;
- formulate provisions on the creation of an interactive site for transport logistics software.

Summary of the main material

Transport logistics, from the point of view of the systems approach, can be considered as a set of moving functionally related objects with their properties and relations, united by a common goal. Its use consists in transforming complex logistic problems into a series of tasks implemented using software and appropriate tools with the definition of a set of successive logistic steps in the conditions of changing external environment. Transport logistics software is a computer program that allows the user to interact with the computer through a touch screen, test processors, spreadsheets or other interfaces. In maritime transport logistics, this is manifested in methodological and technical solutions for intelligent educational resources of any level of complexity, functions and options of the system language, computer simulation, analysis and assessment of the

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possibility of receiving recommendations, optimization of knowledge testing, illustration of the user interface.

The structure of the logistics transport system can be represented as the interaction of three vectors:

- the vector of system inputs, which are the controlled objects of transport transportation

$$X(t)=\{X_1, X_2,..., X_n\}$$

- vectors of the state space of the system outputs, which are the resulting variables of the transport system, after the introduction of a control action into it

$$Y(t)=\{Y_1, Y_2,..., Y_m\}$$

- vectors of internal states of the transport system, which represent organizational characteristics and parameters of the transport scheme

$$S(t)=\{S_1, S_2,..., S_k\}$$

The location of the output values in relation to the inputs and internal conditions of the system can be represented in the form

$$Y(t)=F(X(t),S(t)),$$

where F - the operator of transformation of the functional parameters of the system, which can be viewed as logical, algebraic, differential, integral and other operations of transformation of coordinates of vectors $X(t)$, $S(t)$, y vector coordinates $Y(t)$ [4].

It is necessary to directly monitor and select from the permissible multiplicity the solution of the single most effective solution $x^0 \in X$. In a formal setting, this means that it is necessary to know the underlying problem

$$x^0 = \arg \underset{x \in X}{extr}\ E(x)$$

where $E(x)$ – generalized scalar indicator of decision quality.

Managing alternatives are selected depending on the situation, the assessment of which requires diagnostics. The process of changing the state of the system over time is determined by the dynamics of the transport system, which is characterized by a multidimensional quantity that can take on a number of values at hierarchical levels $y \in Y$.

Denoting the parameter of the process dynamics by t, and the set of its values by T, we have $t \in T$, де $y = y(t)$. The process of the system transitioning from a state with a time parameter value t_0 in the state S with meaning $t > t_0$ we have

$$S_{t_0 t}(y(t_0)) = y(t), \qquad y \in Y, \quad t \in T$$

Having designated the controlling influence on the course of the transport process from the entire possible set of controls through U we have

$$S^u_{t_0 t}(y(t,u)) = y(t,u), \qquad y \in Y, \quad t \in T, \quad u \in U$$

To describe the variability of the process with an indication of the goal, it is necessary to introduce decision-making criteria. Then each individual management alternative can be evaluated by a certain number or value of the corresponding criterion. Then the comparison of alternatives will be reduced to comparing their corresponding numbers.

A model of the educational environment of transport logistics under uncertainty is proposed, which includes elements of dynamic support of the transportation process, system software for transport logistics, application software for transport logistics, software and hardware solutions, tools and features of model settings, interaction with the content of the information architecture. Such a structure of the model is explained by the fact that the interaction of its elements can be described either using a system of equations, constraints and inequalities, which determines its complexity and analysis of structural components, or by introducing various simplifications and exceptions, which reduces its value. Therefore, the model of the educational environment of transport logistics under uncertainty is presented in the form of separate functional blocks (Fig. 1).

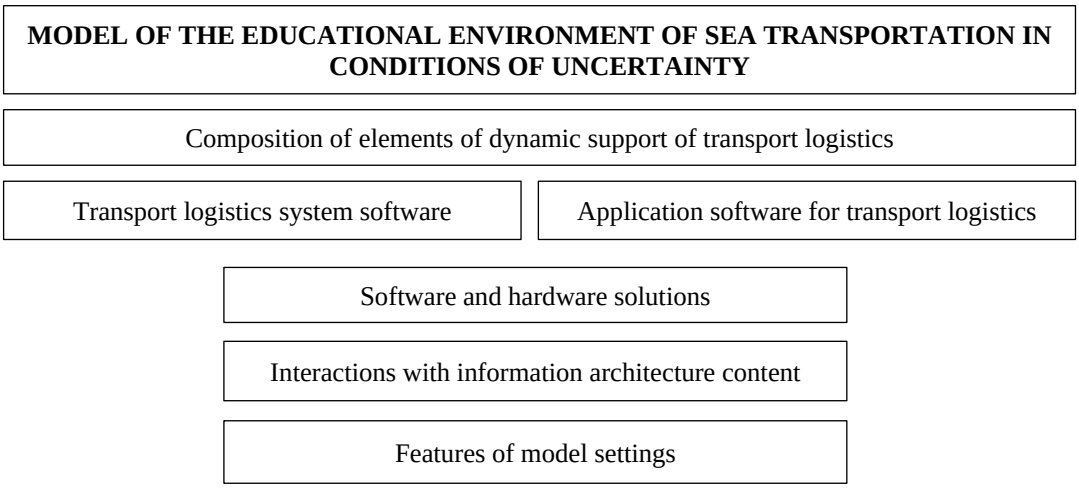

Fig. 1 – Model of educational among sea transport transportation under conditions of uncertainty

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One of the requirements of the system approach of maritime transport logistics is to ensure the reliability of management in real time.

The main component block of the construction of the model of the intelligent educational environment is the system software of transport logistics. System programming is the process of creating software that manages the hardware resources of a computer, working with large volumes of data. The advantages of system programming are the creation of effective and stable software. System software, unlike application software, can work independently.

System software of transport logistics includes the management of complex software systems that automate and optimize the logistics processes of route building, cargo tracking, optimization of transport flows (Fig. 2)

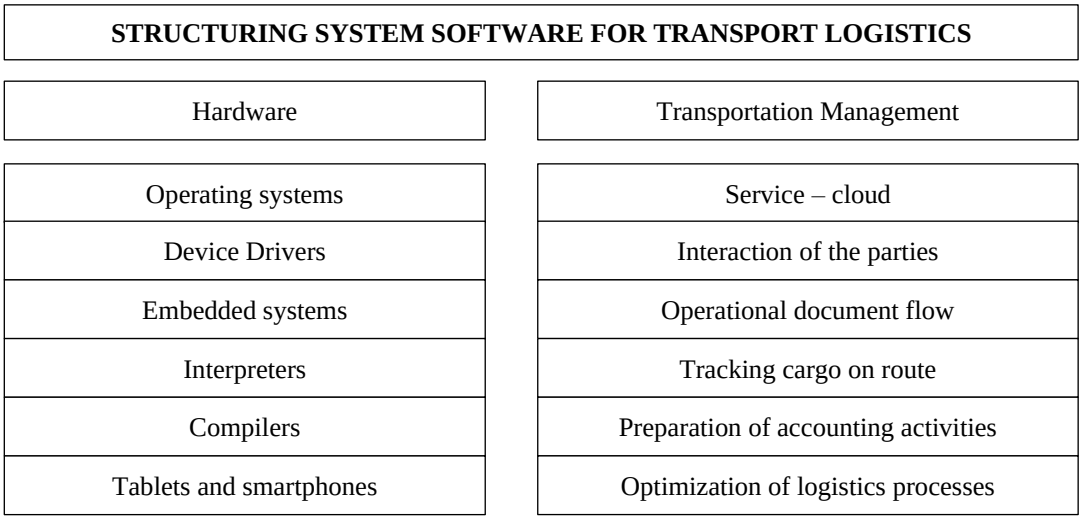

Fig. 2 – Maritime transport logistics system software

Elements of the system software of maritime transport logistics are hardware tools such as operating systems, device drivers, embedded systems, interpreters, compilers. Windows, Linux, MacOS operating systems represent an interface between the computer hardware and other applications. A device driver is a program that allows the operating system to interact with the computer hardware, which includes printers, scanners, sound cards. A compiler is a program that allows the source code of a program to be translated into machine code that can be used on a computer. Embedded systems are used to automate transport management.

Another component of the construction of the intellectual model educational environment is the application software of sea transport.

The application software performs the task of managing sea transport under conditions of uncertainty based on user requests. This allows the user to import and export files, take the necessary resources from the Internet, work with text documents.

As means of application software, we can highlight such programs as: Google Jamboard, Open Board, AWWAPP, Ziteboard, BitPaper. The application software can be installed on a computer and mobile phone for work in offline and online mode. The main elements of the application software of sea transport logistics are platforms, services, test processors, mobile applications, adaptive layouts, interactive task templates (Fig. 3).

Receiving complete information, the application software calculates route optimization with the transfer of information to the vessel server via web services and a web portal. In the presented model of the intelligent educational environment of sea transport, a block of software and hardware solutions is separately allocated that provide technical support for the system and application software. Software and hardware solutions are the main fundamental block for building a model of the intelligent educational environment of sea transport in conditions of uncertainty. Software and hardware solutions in sea transport are aimed at increasing the efficiency, safety and automation of various logistics processes. They allow remote control of ship mechanisms and include a vessel control system, remote equipment diagnostics, automated control and forecasting systems, communications, real-time data tracking and optimization of ship operations. Risk reduction in management is achieved by identifying any emergency situations.

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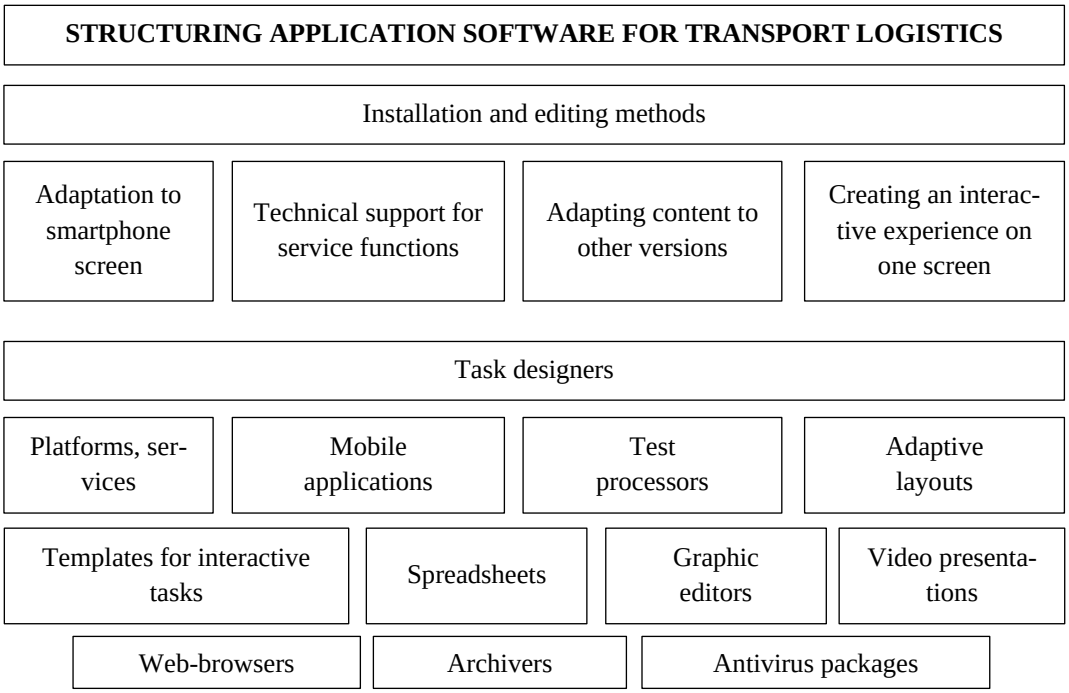

Fig. 3 – Application software for transport logistics

Examples of software and hardware solutions for high-speed vessels of the new generation include semi-naturalistic modeling complexes in the field of software, integrated bridge systems with remote diagnostics of equipment, means of fighting for the survivability of the vessel, equipment for external and internal ship communications, allowing to organize the control of the vessel by one watchman. The predictive analytics system for continuous monitoring of vibrations and elastic deformations with signaling of deviations via a digital communication channel combines ship software hardware complexes based on satellite data and forecasts of the hydrometeorological situation. The emergency warning signaling system for operational monitoring of the technical condition with control from the wheelhouse and central control of the Grapix Gate software and hardware complex automates control and optimizes logistics. Distributed registry technologies and the use of cloud forms in the creation of services for the automation of business processes are formed on blockchain platforms for storing and exchanging information using online applications for the formation and maintenance of a digital registry of transactions in several places simultaneously. IBM Corporation has launched an application for shipping companies specializing in the automation of maritime trade, which takes advantage of the possibilities of introducing elements of artificial intelligence and the Internet of Things.

A separate block in the model of the interactive educational environment of maritime transport logistics presents the means of interaction with the content of the information architecture (Fig. 4).

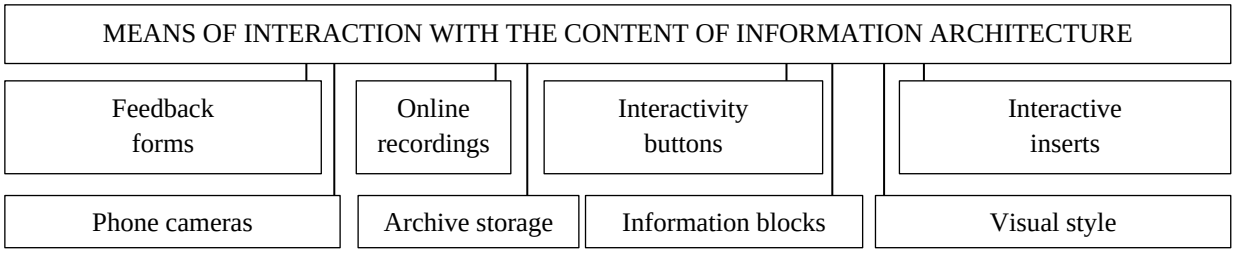

Fig. 4 – Means of interaction with the content of information architecture

Intelligentization of maritime transport operations in conditions of uncertainty requires continuous replenishment of input information from various sources hidden by a large amount of poorly structured information. This requires content creation. Content, according to its main purpose, is the content of web pages, channels, various

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programs and networks that make up an information package. Therefore, it can also be expressed as the reason why a user visits a website. Content serves as a means of orientation and searching for necessary information in the entire labyrinth of source information. Information architecture and the content of its provision are the basis of the logistics of maritime transport. They serve as a means of maintaining the immutability of transport flow parameters and coordinating the actions of all transport links on interactive maps. Together, they form a set of processes for organizing structured information for navigation on websites with the distribution of cognitive load through appropriate interfaces and dialog boxes. Their use gives the user a reference point in the diversity of existing resources, specifying the meaning of their use and the search system.

Editing of the model of the intelligent educational environment can be achieved using graphic editors, video presentations, web browsers, archivers, antivirus packages. The search engine itself selects the site according to the relevant content.

Features of the setup and implementation of the model of the intelligent educational environment of maritime transport logistics are presented in Fig. 5.

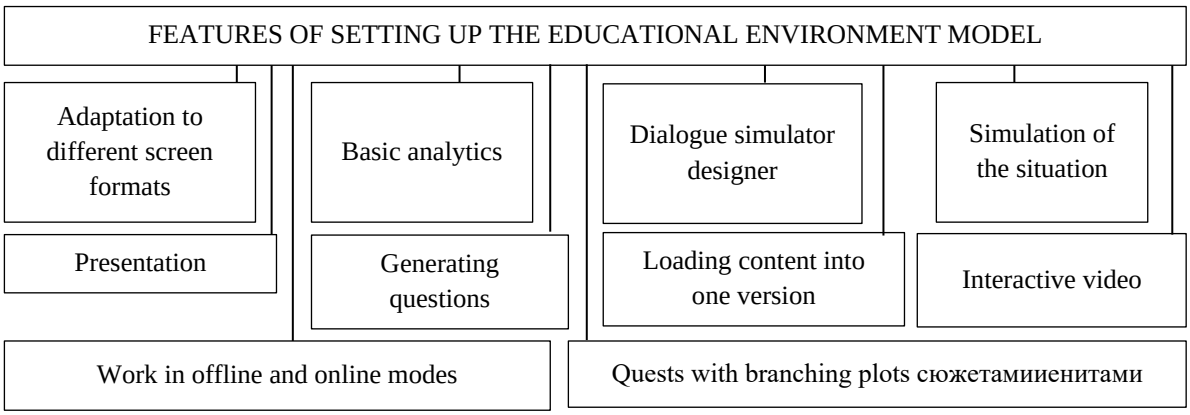

Fig. 5 – Features of setting up the educational environment model

The presented structuring reveals the capabilities of the educational environment model, manifested in the processing of requests, receiving responses and storing data.

Interactive sites are platforms for interaction with content in a non-standard format. In interactive sites, thanks to the built-in web browser, access to any content is provided. Interactive site-architect of user behavior.

When opening a search browser to form a request, a well-organized site is needed. With the organization of information, its structuring and the creation of appropriate web resources, convenient for the user. Structuring information helps to take into account the interests of the user and serves as a way to facilitate the search for the necessary information in the entire labyrinth of existing information.

The semantic content of the interactive site is to optimize technical applications for obtaining information by any user agent, such as a smartphone. Multimedia presentations allow interactive interaction with existing educational resources. Such interactive navigation is reliably provided by means of interaction with content, which include feedback forms, online recordings, interactivity buttons, interactive inserts, phone cameras, archive storage, information blocks, visual style. To create an interactive site for maritime transport logistics, it is necessary to decide on the solution to the issue of what is achieved by introducing a non-standard format for interacting with content and why information cannot be packaged in a regular text format. In addition to the values achieved in this case, obtaining an information product of user interaction with possible changes in the external environment and prompt response to emerging situations, financial constraints and technical capabilities of the platform being presented must be taken into account, which can be achieved through software and hardware solutions for transport transitions in conditions of uncertainty.

Another important issue that needs to be addressed when creating interactive sites is key information and presentation of management principles. Key information is obtained by using a large set of ready-made libraries, with the help of which it is possible to develop almost any functionality of a vehicle in the format of an endless picture of situational interactions with possible accompanying effects and interrelations. Scrolling goes not only in breadth, covering all new aspects of transportation, but also in depth, covering the history of possible disasters and failures.

Orientation to the dialog mode of operation provides that all management procedures in the time and space domain are detailed on a set of elements, taking into account the limitations and resource capabilities in the range of change of the target function and elements of technical implementation.

The developed interactive environment of sea transportation under uncertainty, which organizes knowledge at a systemic and qualitative level, will contribute to increasing the efficiency of the management process.

By collecting and processing huge amounts of data, building forecasts, and accelerating information exchange, intelligent interactive solutions are becoming the main tool for optimizing management decisions and dynamically processing available information on the development of maritime transport in conditions of uncertainty, capable of adapting to changes in external situations using simulations and software components of the content specific to freight transport

Conclusions

1. Interactive sites for optimizing technical applications for functional applications of maritime transport logistics allow searching for possible interactions with the consumer not only in a regular text format, but also in the form of an information product indicating ongoing changes in the conditions of the transport transition. The described software and hardware solutions of the intelligent educational environment will provide a presentation of management principles in a non-standard form using elements of interaction with content and possible connections and interactions in the dialog mode of operation.

2. Structuring of system software and tools with division into interfaces of hardware and transportation management can serve as a tool for automating management of technological applications for optimizing logistics processes. Structuring of application software designed to solve problems of transport management based on consumer requests allows working with text documents, receiving requests from Internet resources.

3. The proposed model of the educational environment of transport logistics under uncertainty in the form of functional blocks of system and application software with hardware and software solutions contributes to the speed and reliability of managing maritime transport in real time. Hardware and software solutions allow remote control of ship mechanisms, tracking data in real time, and optimizing logistics. Risk reduction in management is achieved by identifying any abnormal situations.

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ПРОГРАМНІ ТА АПАРАТНІ ЗАСОБИ ДЛЯ МОРСЬКИХ ЛОГІСТИЧНИХ ПЕРЕВЕЗЕНЬ В УМОВАХ НЕВИЗНАЧЕНОСТІ

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Розглянуто питання моделювання та підтримки прийняття управлінських рішень щодо розвитку морських транспортних перевезень з використанням програмно-апаратних засобів та інструментарію інформаційного супроводу логістичних рішень. Показано, що керування транспортними перевезеннями в умовах невизна-ченості вимагає контент-аналізу інформації про можливість здійснення діалогу споживача з комп'ютером, створення інтерактивного освітнього середовища, виявлення компонентів цього середовища, специфіки змістовної інтерпретації. Запропоновано модель освітнього середовища морської транспортної логістики, що складається із системного та прикладного програмного забезпечення, програмно-апаратних рішень, елементів динамічного супроводу процесів управління. Виконано структуризацію завдань системного та прикладного програмування. Структурування прикладного програмного забезпечення, призначеного для вирішення задач управління транспортом на основі запитів споживачів, дозволяє працювати з текстовими документами, отримувати запити з інтернет-ресурсів. Розглянуто зміст платформ системного програмного забезпечення транспортної логістики із зазначенням реалізаційних програм. Описано призначення компо-нентів прикладного програмного забезпечення. Виділено засоби встановлення та редагування завдань при-кладного програмного забезпечення транспортної логістики, в якості яких обрані адаптація під екран смар-тфона, технічна підтримка сервісу, підстроювання контенту під інші версії, створення інтерактиву на одно-му екрані. Наводиться опис засобів взаємодії з контентом морської інформаційної архітектури, що забезпе-чують інтерактивну навігацію по існуючим інформаційним ресурсам, в якості яких вибрані форми зворот-ного зв'язку, онлайн-записи, кнопки інтерактивності, вставки, камери телефону, архівні сховища, інформа-ційні блоки, візуальна. Складено рекомендації щодо створення інтерактивного сайту логістики морських транспортних перевезень, які здійснюються в умовах невизначеності впливу зовнішнього середовища.

Ключові слова: *інтерактивне керування, структуризація, організація знань, логістика, програмно-апаратні рішення, інтерактивна навігація.*

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