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**AUTOMATED CONTAINER
TERMINAL MANAGEMENT
SYSTEM CTMS
IN MARINE LOGISTICS**

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Annotation. In maritime logistics, automation of seaports performs the most important functions to ensure stable high growth in international shipping volumes and strengthen competitive and price pressure in the business of shipping companies. The article provides a comprehensive assessment of the effectiveness of the automated Container Terminal Management System (CTMS), designed to automate the management of the container terminal and all operations with containers and cargo. It has been established that CTMS, in comparison with the automated container site management system (ACS MS), has a number of advantages in accelerating the turnover of containers at the terminal by optimizing storage locations and the possibility of operational control over the operation of the terminal. The possibilities of a significant increase in the speed and accuracy of container cargo handling using CTMS have been identified. The main directions of effective functioning of CTMS are defined, taking into account the fact that all operations controlled by it are carried out using mobile data collection terminals. Their use when performing operations in a warehouse allows you to reduce the number of errors, the time of operations, and provides the opportunity to obtain accurate information in real time.

Keywords: Automation of management, container terminal, containers, container turnover, storage, loading, personnel management, operational control

Introduction. In logistics, container terminals play an important role in the organization of intermodal cargo transportation. In the role of transit and distribution centers, they represent such a complex object in the information and technical sense with a large document flow that effective management is impossible without the use of new information technologies. Using the example of a complex object, container terminals can be described as an open physical flow system with two external interfaces - a land interface and a marine interface. Figure 1 shows an overview of the container terminal architecture [1-5].

The competition between shipping companies for attracting a large flow of containers has gone beyond the maritime boundaries represented by suppliers of marine transport hubs-ports for

ship accommodation. The evolution of cargo passing through container terminals, the complex nature of these platforms and the dynamic processes of port handling require the development of an effective container terminal management system. In this regard, a new class of systems has emerged among the management systems – automated container terminal management systems (Container Terminal Management System) [6,7].

Materials and methods of research. Automated container terminal management system (CTMS) is designed to automate the management of the container terminal and all container and cargo operations on the territory. It provides management of the work of loading equipment, transport and personnel, control of container movement, operational planning of tasks for personnel taking into account the current situation.

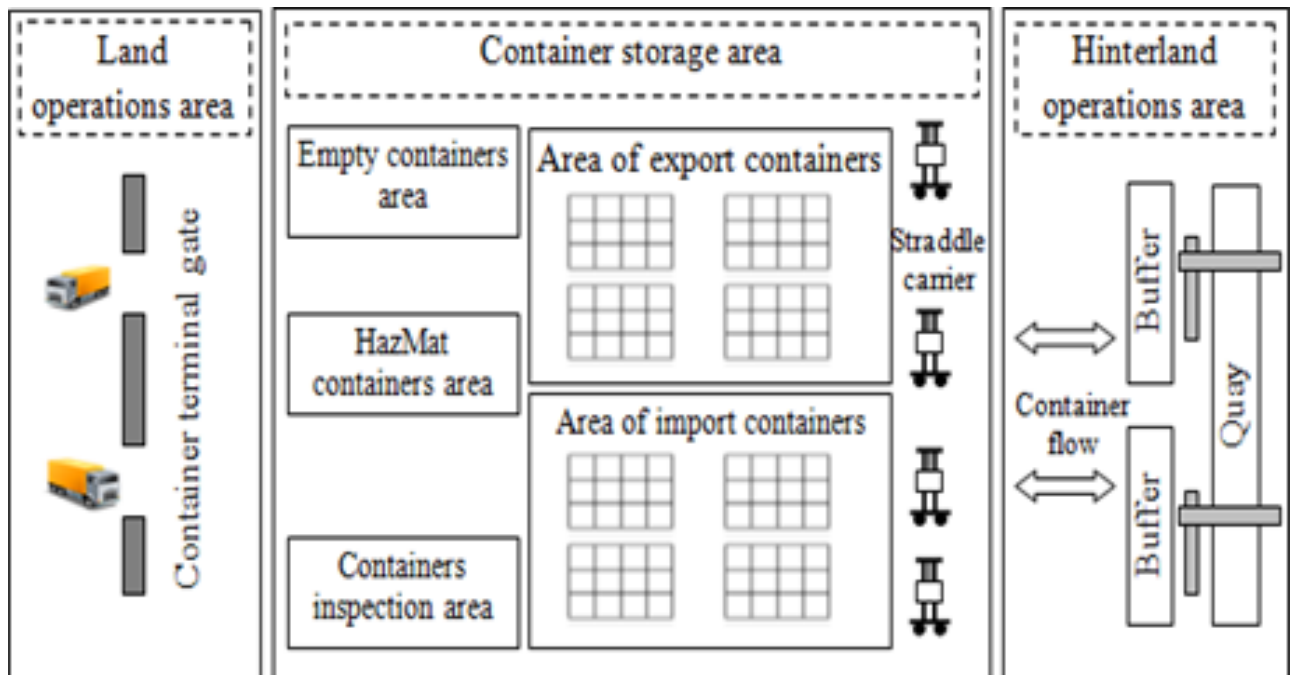


Figure 1 - The general scheme of the container terminal as a complex object in the informational and technical sense

All operations controlled by the automated container terminal management system are carried out using mobile data collection terminals (MDCT). Their use when performing operations in a warehouse allows you to reduce the number of errors, the time of operations, and provides the opportunity to obtain accurate information in real time.

The result obtained during each operation is entered into CTMS from the data collection terminal. The container terminal must have a deployed Wi-Fi radio network. CTMS is developed on the NET software platform and in accordance with SOA concepts.

The container terminal is managed using such equipment as:

- industrial label printers manufactured by Zebra Technologies;
- high-quality radio equipment manufactured by Motorola (Symbol);
- RFID technology.

The interaction between CTMS subsystems is based on the exchange of messages for the distribution of orders and the planning of processing operations. Agents use the Agent Interaction Language (AIL) developed by the Foundation for Intelligent Physical Agents (FIPA). CTMS modeling, by classifying into several subsystems, facilitates the stages of developing optimal interaction with transportation providers. Classification consists in grouping agents with similar goals to form consistent subsets. In addition, the classification of the system is based on criteria

for evaluating the quality of grouping agents, such as a strong relationship between agents of the same subsystem and a weak relationship between subsystems. CTMS consists of two main parts, the first of which concerns risk management decision-making and consists of three subsystems: a training subsystem, a supervision subsystem and a planning subsystem. The second part of the system concerns processing operations in CT. It consists of three subsystems: the representation subsystem, the subsystem of interaction with suppliers of road transport, the subsystem of interaction with suppliers of maritime transport (Fig. 2). Modeling of the proposed system and the definition of its functions are performed using the agent modeling language AML [7,8].

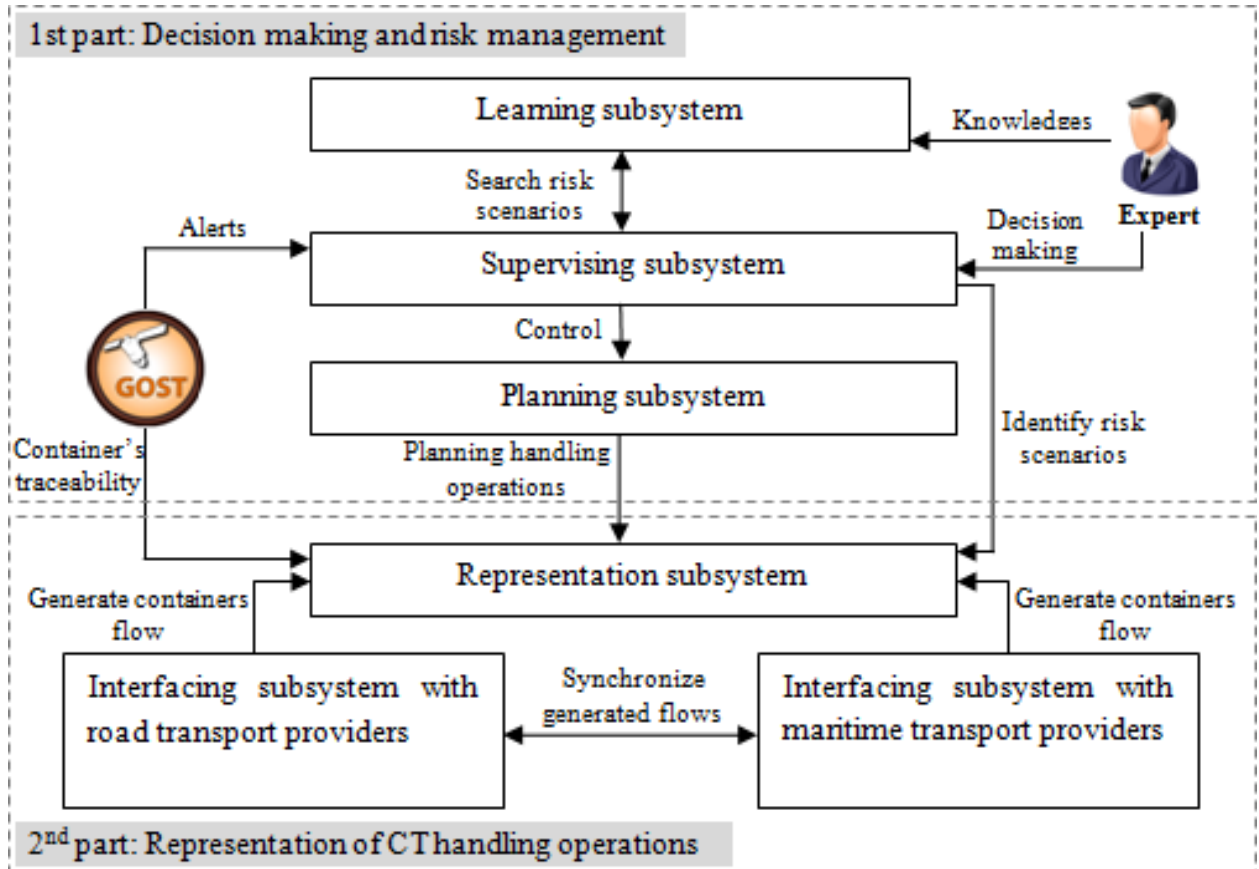


Figure 2 - Classification of the CTMS into subsystems

The results of the study. Compared with the automated container site management system (automated control system), CTMS has a number of advantages in accelerating container turnover at the terminal by optimizing storage locations and the ability to quickly monitor the operation of the terminal.

Let's analyze the tasks and functions of CTMS systems that differ from the tasks and functions of the automated container site management system.

The tasks of CTMS systems include a set of solutions aimed at optimizing the operation of container terminals:

1. Optimal use of resources:
 - increasing the turnover of the container terminal by optimizing storage locations;
 - optimization of container storage;
 - automatic search for optimal storage locations;
 - carrying out inventories without stopping the container terminal.

2. Real-time warehouse management:

- accounting of all relevant information about the container;
- real-time reflection of all operations;
- the possibility of operational control over the operation of the terminal;
- up-to-date reflection of stocks and operations in the enterprise management system.

3. Personnel management:

- increasing the turnover of the terminal without increasing the number of staff;
- real-time management of warehouse equipment and personnel by issuing tasks by the system;
- operation management of reloading equipment;
- formation of production reports;
- quick training of new personnel to work in the system;
- the possibility of using employee motivation schemes;
- user experience monitor.

Managing seaports and cargo terminals using CTMS TOS (Terminal Operation System) helps to increase the economy and transparency of all logistics facility processes. The port/cargo terminal management system comprehensively automates all operations and business processes: from the planning of acceptance to the final shipment of cargo. Control of operations in the port or at the cargo terminal is provided even at the stage of work planning: a scheme of a ship or a train is created in order to effectively organize loading and unloading operations; registration of car visits is automated in order to avoid queues from trucks at the entrance to the logistics facility. The control of operations in the port and at the cargo terminal includes a rational approach to the processing and placement of goods: container, general, bulk and bulk. Each category has its own rules for processing, placement and storage. Many parameters are taken into account to minimize the number of unnecessary operations and adjustments. The "profile" of each cargo contains a complete history of all operations performed with it [9.10].

The port/cargo terminal management system integrates with ERP, as well as other software and equipment of the logistics facility, which allows it to receive data and analyze all current processes, increase the productivity of loading and unloading equipment, and effectively distribute tasks among personnel. CTMS TOS Cargo (Fig.3.) monitors the operations of both container rastark and container sealing. As part of the container processing process, operations are monitored as container rastark (with a seal of the rastark act, further accounting of goods leaving the container is not conducted in the system), or container rastark into a vehicle (cross-docking), with the seal of the act of rastarki and container sealing, including sealing from the vehicle (cross-docking).

The functions of CTMS systems include operations:

- maintaining reference books of the system: container directory, cargo directory, container owners directory, counterparty directory, loading equipment directory;
- planning of container placement areas;
- management of container operations: acceptance, shipment, inspection, weighing, repair, etc.;
- management of container movement strategies at the container terminal;
- managing the grouping of containers according to various criteria;
- operation management of reloading equipment;
- transport handling management;
- formation of production reports;
- billing.(collection of information on the use of telecommunication services).

CTMS functions include the management of the following factors:

- the address space of the container site, the territorial limitation of the container site;

- container operations: acceptance, shipment, inspection, repair, etc.;
- the course of container movement at the container terminal;
- combining containers into stacks according to certain criteria;
- operation of reloading equipment;
- handling of transport: road and rail

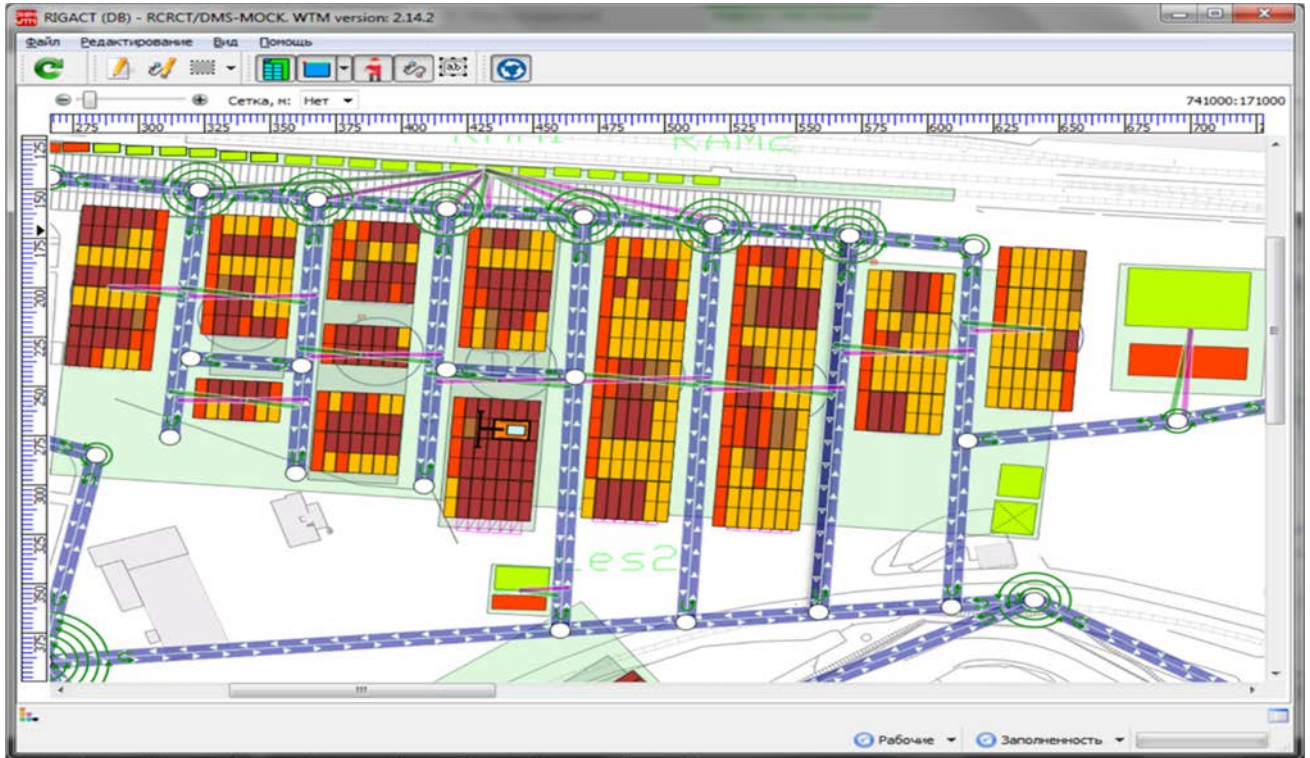


Figure 3 - TOS.Cargo - ship loading/unloading management

The functions of this system also include:

- maintenance of production reports;
- printing of a package of documents (acts, etc.);
- billing, collection of billing data and transfer them to the CIS in order to process and generate an invoice for the services provided;
- integration of the container terminal management system with CIS;
- creation of system directories: container directory, cargo directory, container owners directory, counterparty directory, loading equipment directory.

The terminal graphic display module includes a system that makes it possible to monitor the terminal in a 2-dimensional graphical display mode. The graphical representation screen shows the terminal areas, storage locations and equipment locations. Upon request for information about the storage location, the system provides a list of containers available in it and detailed information on them. Dispatchers' places of work are located on client workstations connected to the application server and the database server. The dispatcher is provided with a set of graphical tools with which he can monitor the operational situation at the terminal, make the necessary decisions in case of emergency situations, carry out appropriate planning of work on the movement of containers at the terminal, configure the parameters of the planning system. Let's analyze the advantages of CTMS systems other than the automated container site management system.

The main economic results obtained from the introduction of CTMS systems:

- rational placement of containers;

- elimination of container losses;
- acceleration of container handling;
- reduction of terminal operating costs, their optimization and transparency;
- optimization of the use of equipment and loading equipment;
- increasing the processing speed of motor vehicles, railway transport, ships;
- reducing the cost of operating loading equipment;
- reduction of idle mileage due to the use of optimization algorithms for the issuance of works;
- reduction of the mileage of empty vehicles;
- improving the efficiency of personnel management;
- increase of staff productivity;
- reducing the cost of inappropriate use of personnel;
- saving time on registration of accompanying documents;
- access to the necessary documents in real time.

Conclusion. Thus, in comparison with the traditional container site management system, the efficiency of using the STMS system for container terminal management ensures savings and transparency of all processes of the logistics facility, comprehensively automates all operations and business processes of the container terminal. In combination with the acceleration of container turnover and the possibility of operational control over the operation of the terminal, this ensures a reduction in terminal operating costs and an increase in the efficiency of personnel management.

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ТЕҢІЗ ЛОГИСТИКАСЫНДАҒЫ СТМС КОНТЕЙНЕРЛІК ТЕРМИНАЛДЫ БАСҚАРУДЫҢ АВТОМАТТАНДЫРЫЛҒАН ЖҮЙЕСІ

Аңдатпа. Теңіз логистикасында-теңіз порттарын автоматтандыру халықаралық теңіз тасымалы көлемінің тұрақты жоғары өсуін қамтамасыз ету және кеме қатынасы компанияларының бизнесі саласындағы бәсекелестік және баға қысымын күшейту бойынша аса маңызды функцияларды орындайды.

Мақалада контейнер терминалын және барлық контейнер және жүк операцияларын басқаруды автоматтандыруға арналған автоматтандырылған контейнер терминалын басқару жүйесінің (контейнер терминалын басқару жүйесі - КТБЖ) тиімділігіне кешенді баға берілген. Контейнерлік аланды басқарудың автоматтандырылған жүйесімен (КА БAJ) салыстырғанда сақтау орындарын оңтайландыру және терминал жұмысын жедел бақылау мүмкіндігі есебінен терминалдағы контейнерлер айналымын жеделдету бойынша бірқатар артықшылықтарға ие екендігі анықталды. Контейнер терминалын басқару жүйесі пайдалану кезінде контейнерлік жүктерді өңдеу жылдамдығы мен дәлдігін айтарлықтай арттыру мүмкіндіктері анықталды. Контейнер терминалын басқару жүйесі тиімді жұмыс істеуінің негізгі бағыттары оның бақылауындағы барлық операциялар мобильді деректер жинау терминалдарының көмегімен жүзеге асырылатындығын ескере отырып анықталды. Оларды қоймадағы операцияларды орындау кезінде пайдалану қателер санын, операциялардың орындалу уақытын азайтуға мүмкіндік береді, нақты уақыт режимінде нақты ақпарат алуға мүмкіндік береді.

Кілт сөздер: Басқаруды автоматтандыру, контейнер терминалы, контейнерлер, контейнер айналымы, сақтау, тиеу, персоналды басқару, жедел бақылау

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АВТОМАТИЗИРОВАННАЯ СИСТЕМА УПРАВЛЕНИЯ КОНТЕЙНЕРНЫМ ТЕРМИНАЛОМ СТМС В МОРСКОЙ ЛОГИСТИКЕ

Аннотация. В морской логистике - автоматизация морских портов выполняет важнейшие функции по обеспечению стабильного высокого роста объемов международных морских перевозок и усилению конкурентного и ценового давление в сфере бизнеса судоходных компаний.

В статье дана комплексная оценка эффективности автоматизированной системы управления контейнерным терминалом (Container Terminal Management System - СТМС), предназначенной для автоматизации управления контейнерным терминалом и всеми операциями с контейнерами и грузами. Установлено, что СТМС по сравнению с автоматизированной системой управления контейнерной площадкой (АСУ КП) обладает рядом преимуществ по ускорению оборота контейнеров на терминале за счёт оптимизации мест хранения и возможностью оперативного контроля за работой терминала. Выявлены возможности значительного повышения скорости и точности обработки контейнерных грузов при использовании СТМС. Определены основные направления эффективного функционирования СТМС с учетом того, что все операции, контролируемые

ею осуществляются с помощью мобильных терминалов сбора данных. Их использование при выполнении операций на складе позволяет сократить число ошибок, время выполнения операций, предоставляет возможность получения точной информации в режиме реального времени.

Ключевые слова. Автоматизация управления, контейнерный терминал, контейнеры, оборот контейнеров, хранение, погрузка, управление персоналом, оперативный контроль