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**DECISION MAKING MODELING IN PORT OPERATION  
MANAGEMENT**

**МОДЕЛЮВАННЯ ПРИЙНЯТТЯ РІШЕНЬ В КЕРУВАННІ РОБОТИ  
ПОРТУ**

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*Сформулированы новые подходы к улучшению системы управления и организации работы портовой инфраструктуры с применением моделирования процессов управления работой порта, направленных на повышение уровня организации и эффективности функционирования систем управления и обработки транспортных средств в морских портах.*

**The statement of the problem and its connection with the important scientific and practical tasks.** The active development of the maritime industry and insufficient knowledge about the scientific problems of modelling of the strategic decision-making in the management of the port in the addition to the technological processes of the cargo ship handling provides scientific research in this area. When performing cargo handling modelling in the ports a lot of new tasks occurs that require evaluation of quantitative and qualitative characteristics of the regularities of their functioning. Limited opportunities for experimental studies in the complex chain of the transport system makes it impossible to complete the design and implementation into operation without the using of modelling techniques, which are in the appropriate form of the processes of the port and the description of the process of these steps using a mathematical model.

If we compare the used analytical and simulation modelling techniques, each of them has its advantages and disadvantages. The first rests on the considerable challenges that require a substantial simplification of the model and give incorrect results. Therefore more often the imitating modelling is used for the researching of the transport systems.

**The analysis of the recent researching and publications on the subject.** From different perspectives, this problem was considered in the writings of the scientists: E.N. Voevudskiy, V.V. Vitlinskiy, E.P. Gromovoy, I.A. Lapkina, I.V. Morozova, A.A. Khanova and others. At the same time scientific knowledge of the organization of cargo handling operations in the ports accumulated to present time require its generalization and the further development.

**Problem definition.** Absence of a comprehensive approach and a significant degree of approximations in the solution of the individual management tasks of the port operation, as well as their settlement out of the organizational and production structure, which has recently undergone significant changes due to the Law «On the

sea ports of Ukraine» entered into force on June 14, 2013 [1]. These all allows to emphasize development of the organizational handling of the vehicles in the main objectives of the research, which are of primary importance for the following effective management of the port infrastructure:

- creating the new approaches, using the imitation modelling considering features of the transshipment complex for the optimizing the decision making in the management of the port;
- analysis of the comprehensive measures for the implementation of economic and mathematical models which optimize the use of the production base of the port;
- selection of the optimal flow sheets of the port;
- forming of the different management methods of the port using the complex of the algorithms to «play» different schemes of the port management;
- development of a technique in the solving the particular tasks of using the capacities of the port.

**The main material of the research.** Modern Trade Port – is a transport knot with the complex of structures and devices, providing moorage, fast and convenient transfer of the goods and the passengers from the land types of the transport or the inland waterways transport on the sea vessels, or from the sea to other types of transport, storage, preparation and completing of the freights [2].

The technology of the cargo operations means the combination of the ways to transfer cargos during loading and unloading of the ships and other transport vehicles, as well as to perform auxiliary works related to the transshipment process. The effectiveness of the technology used in the ports often is determined by their technical equipment, but the process of global computerization and control of the technically difficult cargo operations contradict to this. Therefore, use of the modern methods allows to model different situational models, the port services faced with, interacting with each other. In the imitating modelling used calculations are not limited, so it is possible to generate different events in the transport system with the real possibility of predicting the performance of the port work. The basic efficiency index of the port work is its cargo turnover. By cargo turnover of the port it is understood all the amount of the cargo passing through its berths, in a certain period of time [3]. For optimal using of the mooring line and time saving of the demurrage perhaps it is possible to use the imitation modelling.

Application area of the simulation models is not limited. Thus, the construction of the transport model with the simulation can be divided into the following stages:

- problem statement and defining the purpose of the research;
- development of the simulation model in the agreed frameworks;
- development or using of already existing software for computer facilities;
- testing of the model and obtaining of the results for the following conclusions and implementation.

When introducing of improved technological processes in the ports to obtain the results in their implementation they look toward a minimum possible combining of the different operations for reducing the lay days of the vessel in the port. The organizational forms of the ships operation influenced on the schedule of the port,

which are subdivided into tramp and linear schedule should be considered [2]. The work of the tramp vessels has the expressed random character and is performed at different directions, and the starting points at the conclusion of the tonnage bookings are own resources of the vessel [4]. Work of the linear ships, on the other hand, has a defined temporary pattern, which in its turn facilitates the entry of the initial conditions for a simulation model. Setting the parameters characterizing the port infrastructure using the imitating modelling the optimal solution for the basic processes of the port can be found. In this case technological process of the port work is considered by the main stages, which include such work processes:

*Preparation of the port facilities to accept vessels.* This is a long-term process, as it requires the drawing up plans for working the vessels based on the quantity of available berths for incoming vessels, roaders and the vessels at the moorage wall, the quantity of the crews for these vessels, the workload of the transshipment complex, its reserve capabilities, preparation of the auxiliary vessels of the port fleet etc. When the port is not in the intensive mode and the port capacity includes several berths it is solved by the ordinary conclusions. The complexity of scheduling of the ships working arise when the port has many berths, a large number of ship calls, a sufficient number of trucks, a wide range of overloaded cargos, and other important conditions, the analytical problem becomes unsolvable. To solve this problem it is necessary to carry out the selection of all the possible options for changing work situations using imitating modelling with the selected preset parameters which allow finding optimal schedule.

*Cargo receiving for transportation and management of the depot acreage.* These two processes are often interrelated and include the preparation of the depot acreage and different parts of the port, weighing, placement and storage of the cargos in the port, marking and documentation preparation. The complex of these actions combines all the resources used for the storage and delivery of the goods to the ship. This complex logistics chain can be solved only by making a simulation model of the intraport infrastructure, which will provide a combined solution based on the proper use of the vehicles and the routes of the cargo in the port area. Without taking into account features of the depot resources, dynamics of the goods movement is impossible to effectively manage by all the supply chain. The effectiveness of the functioning of the whole chain, and as a result, quick vessel loading depends on the efficiency of the warehouse, the frequency of use of its space and resources.

*Loading the vessels in the port.* Cargo operations are usually carried out by the port facilities characterizing outloading capacity of the port. The outloading capacity of the port, in its turn, depends on the length and number of the berths of the given cargo specialization, determining the number of the simultaneously worked vessels, and their technical operational characteristics [5]. The effective vessels handling should be provided taking into account the available port resources and the design features of the vessels, other mobile transport means, type and location of the transshipment means, depots and incoming roads, kind of the processed goods for the formation of the optimal process models of the cargo operations, which allows to set way and use of the special cargo facilities, places for cargos movement with the selecting of the optimal scheme of the cargo operation process. Requirements for the model can be established with a maximum load capacity or cost minimization. Thus,

the possibility of considering the peculiarities of all the components of the intraport system and their relationships allow reduce costs and risks when making management decisions.

*Preparation of the port to sailing the vessel.* This stage of the handling the vessel requires with minimum expense from the port's side, but it plays a very important role in the processing vessel as a whole and includes the inspection of the vessel and departure clearance, clearance of the cargo documents, preparation of the necessary tools, including tugs to leave port. This process also requires the attention of the port authorities, because the delay of the vessel due untimely provision of the port services to sail the vessel in voyage causes financial losses. This stage of handling is modelled on the basis of the temporary monitoring of the cargo operations and the collection of this data for input into the imitation model and its timely correction.

Studying the technological processes of the port work and considering their main stages it is possible to draw a model scheme on decision making in the management of the port, shown on the picture 1.

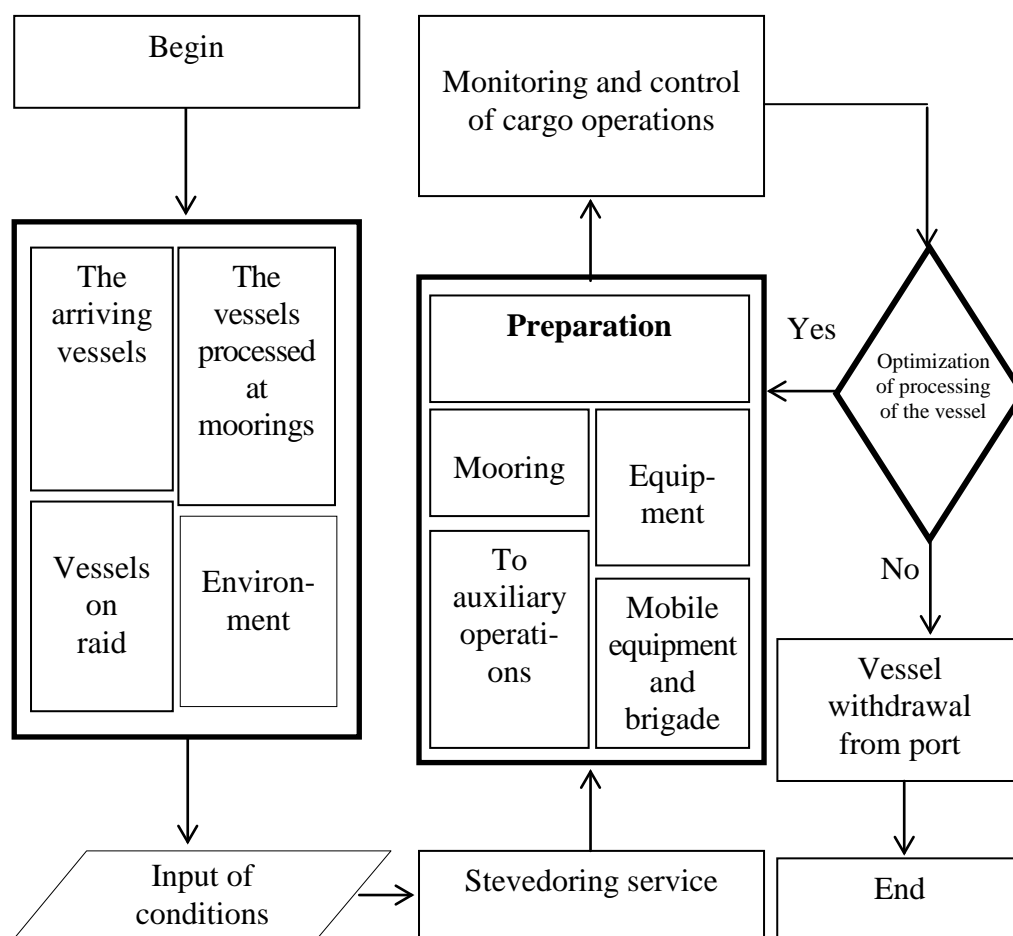


Fig. 1. Model of management of decision-making of work of port

**The conclusions from this research and the prospects for further scientific elaboration in this direction.** Imitating modelling allows developing new technological schemes of processing the cargo, the corrections of already used technological schemes and studying the peculiarities of handling services on the specific port transshipment complexes. Imitating models provide an opportunity to predict the management process by the port operation from the decisions making to monitoring of their implementation and documentation drawing up. The imitating models reveal the necessity of completing of the truck park, the purchase of new cargo devices, time scheme of maintenance works and human resource management. This allows to "play" different management schemes based on the current location of the cargo and vessels, to analyze different scenarios and choose the most effective solution at a given time. The use of the imitating modelling allows the maximum possible reduction in the number of the methods and operations in seaports workflows. Besides the implementation of combining at the same time with the cargo works, namely the preparation of the cargo spaces and the hatches to the loading/unloading of bunker fuel, supply by food and water, materials, tools, documentation drawing up and other auxiliary operations.

#### *References*

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#### *Анотація*

В даній статті розглянута проблема ефективності функціонування систем керування і обробки транспортних засобів в морських портах, та вживання методів моделювання для їх вирішення. Запропоновано комплексні підходи до удосконалення діючих систем керування портом, основу яких на аналізі окремих ситуаційно-технологічних чинників, що виникають в кожному процесі під час обробки суден в порту.

Проаналізувавши будову транспортної моделі, що включає обробку судна в порту, виявляються ключові її елементи, що так чи інакше залежать від якісної організації вантажних операцій в порту. Через те, від вирішення проблем в керуванні технологічними процесами портів залежить своєчасне виконання перевезення вантажів. Поглиблене вивчення технологічних процесів дає змогу стверджувати, що одним з шляхів вирішення проблем в прийнятті рішень в керуванні роботи порту є імітаційне моделювання, яке дає змогу заздалегідь обрати оптимальнішу схему роботи порту в кожній окремій ситуації, з урахуванням усіх чинників, навіть організаційну форму роботи суден.

Результатом роботи є аналіз доцільності вживання імітаційної моделі, що базується на різних умовах та враховує багато факторів впливу на модель роботи порту. До таких умов можна віднести: кількість причалів, їх особливості та оснащеність, кількість та технічні особливості перевантажного обладнання, внутрішню організацію порту, взаємодію підрозділів, кількість суден та їх техніко-експлуатаційні характеристики, що обробляються, очікують обробки та прибувають до порту, та багато інших факторів.

Розроблено засади на яких працює імітаційна модель, які враховують основні етапи технологічного процесу порту, що пов'язані між собою та виконуються по чергово. До них відносять: підготовку портових об'єктів до прийому суден, прийом вантажів до перевезення та керування складськими територіями, завантаження суден, підготовку порту до виходу судна в рейс.

Досліджена тема має не аби яку область втілення у портовій галузі. Це пов'язано з тим, що її втілення не потребує великих кладень, а ефект від втілення відчувається практично зразу. Особливе значення вона отримує через інтенсивну конкуренцію серед портів за вантажі та появу нових більш великих за розмірами суден з великою вантажопідйомністю. Не менш важливо ще й те, що імітаційне моделювання може використовуватись в великих та малих існуючих портах, а також для портів, які щойно побудовані, що робить імітаційні моделі універсальними засобами в прийнятті рішень в керуванні роботи портом. Гнучка система дозволяє обирати модель з максимальним завантаженням або мінімізацією вартості обслуговування в порту, що дозволить судновласникам обирати для себе вигідніший варіант.

Нові підходи, що сформовані в статті дозволять покращити систему управління та організації роботи портової інфраструктури і підвищити обсяг вантажопотоку та залучити нові. Окрім цього імітаційне моделювання дозволяє відшукати слабкі ланки в існуючих технологічних схемах обробки суден та розробляти на їх основі нові, що врахують проблеми попередніх.