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**CONTRIBUTION OF SCIENTISTS
OF THE ODESSA NATIONAL MARITIME UNIVERSITY
TO THE CREATION OF THE THEORY AND METHODS OF MANAGEMENT
THE PROCESSING OF SHIP**

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***Abstract.** The article the results of an analytical review of the achievements of scientists of the Odessa National Maritime University – ONMU (formerly the Odessa Institute of Sea Fleet Engineers – OISFE) in the field of creation and development of the theory and methods of management processing of ship (PS) within the limits of intraport operational management (IOM).*

It is shown that the mentioned scientists were involved in research work in the middle of the 20th century at the stage of formation of IOM as a science.

Her first scientific results were the methods of drawing up tape charts, hourly schedules and operational plans for processing of ship. It was noted that in the future, researchers from the OISFE took an active part in providing the methodology of IOM, first of all, the management of PS, the principles, approaches and methodological tools of the sciences born of the scientific and technical revolution, thanks to which it became possible to consider the tasks of PS management in an optimal setting.

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The methods of solving these problems developed by the scientists of OISFE-ONMU are briefly characterized, starting with the determination of the optimal distribution of port transshipment resources between ships and ending with the search for the optimal option for their use in ship operations are substantiated the main provisions of the system optimization of the PS management as a general direction of the development of IOM at the current stage.

Keywords: ship processing, management, theoretical foundations, methodological tools, system optimization.

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**ВНЕСОК ВЧЕНИХ
ОДЕСЬКОГО НАЦІОНАЛЬНОГО МОРСЬКОГО УНІВЕРСИТЕТУ
У СТВОРЕННЯ ТЕОРІЇ Й МЕТОДІВ УПРАВЛІННЯ
ПРОЦЕСОМ ОБРОБКИ СУДЕН**

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***Анотація.** Викладено результати аналітичного огляду досягнень учених Одеського національного морського університету – ОНМУ (в минулому Одеського інституту інженерів морського флоту – ОІМФ) у галузі створення й розвитку теорії й методів управління процесом обробки суден (ПОС) у межах внутрішньо-портового оперативного управління (ВОУ).*

Показано, що згадані науковці включилися в дослідну роботу в середині ХХ століття на етапі становлення ВОУ як науки.

Її першими науковими результатами стали методи складання стрічкових діаграм, годинних графіків та оперативних планів обробки суден.

Відзначено, що в подальшому дослідники з ОІМФ прийняли активну участь у забезпеченні методології ВОУ, насамперед, управління ПОС, принципами, підходами й методичним інструментарієм наук, народжених науково-технічною революцією, завдяки чому стало можливим розглядання завдань управління ПОС в оптимальній постановці.

Стисло охарактеризовано розроблені науковцями ОІМФ-ОНМУ методи розв'язання цих завдань, починаючи з визначення оптимального розподілу портових перевантажувальних ресурсів між суднами й закінчуючи пошуком оптимального варіанту їх використання на суднових роботах.

Обґрунтовано основні положення системної оптимізації управління ПОС як загального напрямку розвитку ВОУ на сучасному етапі.

***Ключові слова:** обробка суден, управління, теоретичні основи, методичний інструментарій, системна оптимізація.*

Introduction. Research into the problem of creating the scientific foundations of the management of the PS as the main object of the Higher Education Institution began in the OISFE (ONMU) in the middle of the 20th century. In this period, the issue of radically reducing the parking time of the transport fleet as a condition for increasing its carrying capacity became extremely acute. OISFE researchers decided to look for opportunities to solve this problem by improving the management of PS as the main object of IOM.

The choice of this particular direction of research was conditioned by the fact that the most important reason for the excessively long parking of ships in ports were, in the terminology of specialists of that time, the so-called «organizational defects» of IOM, the most selective of which was contained in the use of «approximate» methods of solving tasks PS management. Eliminating this «defect» through the development and further development of the theoretical foundations and methodical toolkit of PS management became then and still remains the mega-goal of port research carried out at OISFE and carried out at ONMU.

Scientists of several generations of OISFE -ONMU took part in conducting these studies. Thanks to their activity, the formation of IOM as the most important section of the general theory of management of the functioning of ports was accelerated and the formation of the scientific foundations of management of port operations began. This article is devoted to the analysis of the evolution of the latest line of research.

Presenting main material. As shown in [1], scientists from the OISFE joined the research work on creating the scientific foundations of PS management at the stage of formation of IOM, when practical knowledge acquires theoretical persuasiveness.

From postulates of practice to the beginnings of theory. This transformation of IOM took place through theoretical understanding and generalization of the accumulated practical experience of the organization of PS. This trend is most professionally reflected in the articles [2; 3], which were presented in the middle of the 20th century by scientists from the OISFE A. Sakovich and M. Tatarenko. Each of them proposed a method of

reducing the time processing of ship, which is considered independently, under the condition of rational use of technological lines (TL) in the performance of overload operations.

In the first of these publications, a rule is postulated, according to which the placement of TL during ship processing is rational, if one of the following conditions is met: on all hatches of the ship, cargo operations are completed at approximately the same time (when the number of TL is greater than or equal to the number of hatches); all TLs complete work at the same time when all hatches are fully processed (when the number of TLs is less than the number of hatches).

The so-called «ribbon diagram method» proposed in [2] is based on this rule, which determines the sequence of processing the ship's hatches, as well as the relationship between the work of transshipment machines on the pier and loaders in the hold.

The approach used in [2] to building tape charts of ship handling was developed in [3] when developing a method for drawing up hourly ship loading/unloading schedules. This method is based on the postulate, which asserts that the minimum time for processing a ship during cargo operations can be achieved if the TLs participating in the processing of the ship are maximally used both in terms of productivity and time.

The methods outlined in [2; 3] are considered using numerical examples, while algorithms for their implementation as formalized procedures are not available. This incompleteness was eliminated by O. Mahamadov, a scientist from the OISFE, at the end of the 1960s through the development of a graph-analytical method of drawing up operational plans for processing of ships with the help of an algorithm that simulates the processes of loading/unloading the ship's hatches and the work of TL.

Summarizing the above, we note that the development of the method of drawing up operational plans for loading/unloading ships marked the end of the formation stage and, at the same time, the beginning of the stage of creation of the management methodology of PS and IOM as a whole.

From rational to optimal. As shown in [1], the stage of creating the IOM methodology took place in a difficult environment. The research work developed in his first five years was interrupted by the Second World War. Work in this direction resumed only in the early 1950s, on the eve of the scientific and technological revolution. And yet, despite the transitional nature of the stage, its results can be considered as the beginning of the development of the theoretical provisions and methodological arsenal of IOM.

Thus, during the initial part of the development stage of IOM, which is characterized, a point of view was established, which noted that effective management of the process of handling ships can be ensured by developing the following types of plans:

- dislocation (decadal, weekly, five-day) schedule processing of ships that have already arrived at the port or are on the approach to it;
- operational plans for loading/unloading individual vessels;
- shift-daily port work plans (section «Ship operations»).

Let us emphasize that this three-link system of plans remains relevant to the present time due to its theoretical persuasiveness and practical possibility to be implemented.

Another fundamentally important result of a methodological nature, obtained at the beginning of the considered stage, related to the justification of the legality of setting two interrelated tasks – on the distribution of port transshipment resources among ships accepted for processing and on the use of resources on ships during loading and unloading operations. And this provision remains relevant as a fundamental basis for the management of PS.

The second part of the stage of creation of the methodology of management of the PS within the framework of the IOM developed rapidly and efficiently. During this period, the methodology of the IOM was intensively enriched with the principles, approaches and methods of the sciences born of the scientific and technical revolution – cybernetics, systems engineering, system analysis, the theory of optimization of planning and management, economic and mathematical modeling, calendar planning, operations research. Under the influence of this, instead of the concept of «rational», the concept of «optimal» was established in the methodology of the IOM, as a result of which the tasks of the management of public transport began to be considered in an optimal setting.

In those years, the greatest attention was paid to the tasks of distribution of TL between ships and their use in ship works. Scientists from the OISFE took an active part in the research of these tasks, the scientific results of which are briefly described below.

So, L. Derevykh proposed to solve the first of the selected tasks by establishing the optimal sequence of processing vessels with the maximum concentration of TL on each vessel. This approach, as shown in his articles [4,5], is based on the rule that says: first of all, TL should be directed to the vessel with the maximum numerical rating, which is determined by the ratio of the cost of the vessel at the parking lot to the labor intensity of its processing. Experimental verification of this rule based on the reported data of the Odesa port showed that it is strict when the number of TL does not exceed the limit of their concentration on each vessel, and guarantees satisfactory accuracy for practice, if the specified condition is not observed.

V. Ananyina was the first Ukrainian scientist to use the representation of linear programming to solve the problem of TL distribution between ships during shift-day planning of ship processing [6]. It is appropriate to emphasize that other researchers, who also turned to the ideas of linear programming, considered the considered task under the condition that the number of ships and TL remain constant during the control interval. V. Ananyina eliminated this limitation and proposed a linear model of the ship processing process, which takes into account the possibility of changes in the composition of ships and the amount of TL over time.

O. Mahamadov, investigating the problem of optimizing the operational planning of the PS, raised the issue of the distribution between ships not only of TL, but also of other transshipment resources (berths and storage containers) and proposed to separate the distribution of sets (M-distribution) and quantities (K-distribution) of the mentioned resources [7]. At the same time, in the case of M-distribution of resources, managed decisions should be made based on the mutual compatibility of ships (cargo) and resources. At the same time, the K-distribution of resources is based on the observance of restrictions related to the parameters and characteristics of both ships and resources.

At the same time, O. Mahamadov was engaged in the creation of mathematical

models of tasks on the distribution and use of TL in the operational planning of the PS. He has priority in the development of the first correct models of the specified tasks, which were published in the early 1970s [7]. These models are also distinguished by a frank orientation towards compliance with practically current conditions for the organization processing of ships.

The creation of the methodology of the IOM was facilitated by the research of other scientists of the OISFE, namely O. Malaksiano's (operational analysis of PS indicators), H. Stolyarov's (operational regulation of PS), V. Borovsky's (substantiation of operational bandwidth), O. Kotlubay's (coordination and interaction of enterprises of transport hubs), P. Makushev's (establishment of operational specialization of wharves and port warehouses), S. Ostrovsky's (methodology for agreeing the conditions of PS).

Thanks to the above-mentioned achievements of Ukrainian scientists, in the early 1970s, work on the implementation of IOM as part of the automated port management system (AMS «Port»), and as part of the complex of tasks «Operational planning of port operation in optimal mode» (OPORT) and «Optimal technical plan-schedule processing of ship» (OTPSPS), which were later combined into one set of tasks called «Continuous plan-schedule of port work» (CPSPW).

Scientists from OISFE L. Derevich, T. Smolyankin and M. Tatarenko took part in the development of the OPORT and CPSPW task sets. They worked on issues of scientific support for the distribution of TL on other transshipment resources between ships. At the same time, their colleagues Mahamadov O., Makushev P., Moskvichev V. and Todorova E. carried out technical and operational design of the set of tasks of OTPGOS and its implementation in major ports of Ukraine.

If we consider the results obtained during the development of the AMS «Port» as a whole, we can conclude that they definitely contributed to the identification of directions for further improvement of the IOM methodology. Unfortunately, the cessation of work on the design of the AMS «Port» in 1981 resulted in the loss of activity of researchers regarding the issues of further development of IOM, as a result of which, during the next quarter of a century, no publications with truly new results on the specified issues appeared.

The situation of stagnation in IOM research persisted until the beginning of the current century, when the orientation of researchers towards solving the theoretical problems of IOM improvement in a systemic setting was outlined. This direction is most clearly reflected in the articles of O. Mahamadov [8; 9].

Along with this, during 2014-2017, a series of articles was presented by a graduate student of the ONMU Yu. Kruk. He summarized his scientific results in a dissertation [10], where he laid out methodological foundations and practical recommendations for improving the efficiency of port terminal operators based on adaptive management methods and the logistics concept. In the «Ship Works» section of the IOM, the dissertation student returned to the tasks of distribution and use of TL in the processing of ships using linear models in combination with heuristic rules.

Fundamentally important at the current stage is the return of IOM researchers to the problem of port management automation. Such a step was taken by Yu. Ovsyannikov, a graduate of OISFE, vice president of the stevedoring company «Novotech-Terminal»,

operating in the Odesa port. Under his leadership and with the direct participation of the CYVIS company, an analogue of the Port AMS called «Digital Dispatch» was created and put into production [11]. This system is able to provide «on-line» implementation of all general management functions applied to the production process of the company as a whole, cargo handling machines, means of intraport transport and their operators. The experience of operating the «Digital Dispatch» confirmed its efficiency, reliability and high efficiency.

From the above, it follows that at the current stage research and project work on the automation of the IOM should be carried out in accordance with the ideology of the development of automated control systems, which are similar to the «Digital Dispatch». Under such a condition, the creation of the theory and methods of system optimization of PS acquires the greatest relevance, as was emphasized above.

From local to system optimization. The issue of the need to ensure system optimization of PS management was considered in the original formulation in [12], where it is shown that its solution is possible if the condition of agreement of the indicators determined as a result of solving tasks on the distribution and use of overloading resources in unity with the preparation of processing plans is met ships for different planning periods. The generalization of this question was carried out by modern scientists of ONMU O. Kirillova's, O. Magamadov's, V. Kirillova's, N. Pavlova's and B. Shurin's and published in [13] in the form of a concept that assumes:

- consideration of PS in the setting «from mooring of ships to berths to from mooring them from berths»;
- development of the mechanism of management of the port starting from the justification of its organizational and functional structure as the unity of the composition and the order of producing controlled influences on the port in order to ensure the maximum benefit for the port and the interests of the port clientele;
- development of a methodical toolkit for forming aggregated cycles of ship processing, fixing intervals of ship operation management, implementation of a functional model of adaptive management of PS in the modes of situational «sliding» planning when combining software management with monitoring and stabilizing management.

In [13] it is also shown that the tactics of managing the loading/unloading of ships within the framework of aggregated cycles allows to exclude the occurrence of the problem of the «tail» of the process beyond the limit of the planned period, and with «sliding» planning it becomes possible to use information about ships, cargo and transshipment resources of ports, which is constantly updated.

Conclusion. Proceeding from the above, it is legitimate to claim that scientists of several generations from the OISFE-ONMU have determined the general direction of the formation and development of the theory and methods of optimal management of PS within the IOM. We would like to believe that the next generations of ONMU researchers will continue the work of their predecessors and achieve even more significant scientific results.

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