

FORMAL-LOGICAL APPROACHES TO BUILDING INFORMATION MODEL OF NAVIGATOR IN THE FORM OF A DYNAMIC TRAJECTORY

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Abstract: Current trends in the development of the water transport industry are increasingly faced with the need to predict its dynamics over time. The main driving forces are not only material and technical factors, but also the resources of professionals of the industry. The large amount of information and the possibility to choose career advancement of navigators in many cases force them to make decisions intuitively, guided by their own assessments. Instead, it is essential to follow the trends in the formation of stakeholder requirements, which are directly shaped by the labor market. The paper presents formal-analytical approaches to the formation of the model of the navigator in the form of stages of the decision-making trajectory, the corresponding risks during the transition from one state to another. There are described approaches to the use of automated systems for identifying the parameters of the model of the navigator, taking into account the needs of stakeholders in the maritime industry.

Keywords: automated identification systems, transport systems, information model of the navigator, the trajectory of management decisions, navigation safety, the human factor.

ФОРМАЛЬНО-ЛОГІЧНІ ПІДХОДИ ДЛЯ ПОБУДОВИ ІНФОРМАЦІЙНОЇ МОДЕЛІ СУДНОВОДІЯ У ВИГЛЯДІ ДИНАМІЧНОЇ ТРАЄКТОРІЇ

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Анотація: Сучасні тенденції розвитку галузі водного транспорту все частіше зіштовхується із потребою прогнозування її динаміки у часі. Головними рушійними силами є не тільки матеріально-технічні чинники, а і ресурси фахівців галузі. Великий обсяг інформації та можливість вибору просування по кар'єрі фахівців судноводіїв змушують у багатьох випадках приймати рішення інтуїтивно, керуючись власними оцінками. Натомість вкрай необхідно слідувати за тенденціями формування вимог стейкхолдерів, що безпосередньо формує ринок праці. У роботі приведені формально-аналітичні підходи щодо формування моделі судноводія у вигляді етапів траєкторії прийняття рішень, наведено відповідні ризики під час переходу від одного стану до іншого. Приведено підходи щодо застосування автоматизованих систем ідентифікації параметрів моделі судноводія з урахуванням потреб стейкхолдерів морської галузі.

Ключові слова: автоматизовані системи ідентифікації, транспортні системи, інформаційна модель судноводія, траєкторія прийняття управлінських рішень, навігаційна безпека, людський фактор.

Introduction. The modern global environment is constantly in the process of transformation and making appropriate adjustments that would meet the requirements and standards of today. The transport sector was no exception, in particular the training of crew for modern ships. The maritime industry has undergone many

changes over the years of its existence, becoming a complex critical infrastructure in many countries around the world, which requires significant changes in the professional selection of highly qualified crews [1].

In turn, crewing centers and modern maritime training focus on the development of professional, business and analytical skills of future maritime professionals, including navigators [2, 3]. A large amount of data and knowledge, probabilistic directions of formation and evolution of the information model of modern navigators leads to non-standard approaches to defining strategies and objectives to improve the safety and reliability of maritime transport [4–8].

Literature analysis. One of the main factors of modern organizational and technical systems of maritime transport is the level of competitiveness, which directly depends on the effectiveness of navigators' actions in the performance of official duties. Instead, the requirements of stakeholders have a clear framework [9].

That is why the areas of research are:

- analysis and formalization of basic requirements and criteria by stakeholders;
- formal definition of dominated sets of alternatives in the navigator's decision-making processes;
- determination of the risks of information uncertainty in the development of the information model of navigator.

In order to build the trajectory of the professional development of the future navigator firstly it is necessary to designate the main structural elements of the informational model of the navigator according to the requirements of the current market practice. These requirements, in turn, are formed by the basic needs of stakeholders [10].

In 2013, Adam Weintrit and Tomasz Neumann in their book Marine Navigation and Safety of Sea Transportation: STCW, Maritime Education and Training (MET), Human Resources and Crew Manning, Maritime Policy, Logistics and Economic Matters [11] conducted an assessment of evaluation and satisfaction of stakeholders on maritime higher education institutions graduates.

The list of the main significant parameters of the model includes: communication, professionalism and trustworthiness, discipline, loyalty, consistency of performance, leadership skills, honesty, industry, social responsibility, initiative. All respondents were divided into four levels: Management Level, Operational Level, Ratings, Cadets (Table 1).

Table 1 – Levels of respondents

Level	Number	%
Management Level	6	12
Operational Level	6	12
Ratings	20	38

Cadets	20	38
Total	52	100

The rank of stakeholders' satisfaction in all competencies according to the level of respondents is shown in the following table (Table 2).

Table 2 – Rank of stakeholders' satisfaction

Level	Mean	Description	Rank
Management Level	7.48	Satisfied	2.0
Operational Level	7.38	Satisfied	4.0
Ratings	7.55	Satisfied	1.0
Cadets	7.47	Satisfied	3.0

Satisfaction levels were determined as follows:

7.76–10.00 – Very Satisfied

4.51–7.75 – Satisfied

2.26–4.50 – Dissatisfied

1.00–2.25 – Very Dissatisfied

From the results of the study we can conclude that the level of stakeholders' satisfaction is quite high, but not the highest one. This, in turn, was the impetus for defining systemic principles for the formation of the information model of the subject (navigator) undergoing training [12–15]. It is determined that for the optimal formation of the main parameters of the model it is necessary to develop an automated system for collecting and processing data on the activities of the navigator (educational and professional), as well as data on dynamically changing conditions of stakeholders of leading world maritime companies.

For example, a critical analysis of the situation in maritime transport has shown that the level of education is not always the key to high achievements in maritime practice. All this indicates the nonlinear nature of the formation and development of the information model of the navigator and requires the formation and use of complex mathematical and algorithmic models and methods, development of appropriate automated systems for identification and management of these processes.

The results of this study became the basis for determining the main significant identifiers and criteria for the professionalism of navigators. The authors of this study plan to conduct an in-depth analysis of data from official sources and databases of the maritime industry (data about graduates, data from Crewing and Shipping Companies), using Data Mining Tools, to develop and build mathematical models, which in turn aims to perform the following tasks:

- taking into account the individual information model of the navigator, in accordance with his management level and professional experience;

- definition of the main significant criteria for model analysis;
- construction of the trajectory of evolution of the information model of the navigator in time.

The use of modern technologies will allow not only to analyze existing data, to establish the interconnection between them, but also to develop a plan to create an automated decision support system that will take into account the individual characteristics of each navigator.

Thus, the main goal of the developed system is to help choose the best and most effective way of professional development of the navigator, taking into account the basic requirements and needs of stakeholders, which ultimately should increase its competitiveness in today's labor market, successful employment and further professional development.

Main research material. Thus, the primary task arises of creating a model of the behaviour of a navigator at the time of choosing a decision-making strategy when choosing a trajectory of professional growth. The development of a decision support system in a multifactorial space of probable states will increase the competitiveness of the organisational and technical systems of water transport in Ukraine. At the same time, the trajectory of the formation of the navigator's model actually separates those sets of situations of its development, the parameters of which were not priority at the initial stages. Thus, within the framework of building a trajectory development management system, a class of tasks is considered due to strict separation within the framework of a single development space. For a formal description of this space and processes requiring automation, we use the mathematical apparatus, which is based on non-Archimedean principles, where tree-like sets of states are strictly separable [16, 17]. This fully fits into the specifics of this study and has grounds for application.

Let's consider the sequence of states of the navigator's model in the transition from x to y , such that: $y = f(x)$, $x_{n+1} = f(x_n)$. The choice of a new state (selection of a company, position, growth prospects, financial opportunities) conditionally depends on the navigator himself within the context of a set of planned events of the form $K_{\{\tau/T\}} = (G, M, I)$, $I \subseteq G \times M$, $\Omega_i \in G$ [18]. At the same time, the composition of identifiers for decision-making is based on the experience of the navigator and the formed priorities $\Omega = \{\alpha(\{\tau / T_0\})\}$. These priorities are based on the knowledge model $\{S\}$, $\Omega_z = \{\alpha(\{S\}_\alpha, z / Z)\}$, which is correlated the context transition sets $A \rightarrow B$, containing the logic of substantiation of the choice by the navigator of the type $K^* = K([G_A] \& [M_B])$, then the evolution of the context during the transition will look like: $B = f(A) = \{y = f(x) : x \in A\}$.

It should also be taken into account that the dynamics of the trajectory develops according to the display area $\varphi(\delta)$ for $A \rightarrow B$, due to accompanying perturbations. Taking into account that there is always a probability of transition to at least two close

sets, then there is a duality of the transition $B, \bar{B}$. Then the correlation of sets will be possible if there is a perturbation d , such as: $d(B, \bar{B}) \rightarrow \varphi(d), \delta(d)$ and contributing to display if $\forall d \in D: \psi(\langle \varphi(d), \delta(d) \rangle) \in B, \bar{B}$. Then, in order to form the trajectory of the development of the navigator model, it is necessary to designate the points of the metric space within the indicated sets $B, \bar{B}$ where the distance between them is defined as: $\rho(a, B(\bar{B})) = \inf_{b \in B(\bar{B})} \rho(a, B(\bar{B})) \Rightarrow \rho(a, B(\bar{B})) = \min_{b \in B(\bar{B})} (a, B(\bar{B}))$. The perception of the nearest points of the development trajectory enables the navigator to determine the further course of the trajectory. In this case, the context $K_{\{b/B\} \cup \{a/A\}}$, will be stored in each of the sets.

Then $\{A\} \subseteq \{B\}, \{A\} \cap \{B\} \neq \emptyset$, however, if the distinguishability of the sets is not essential $\{A\} \neq \{B\}$, there is possible manifestations of the refusal of the transition in search of a new stage in the development of the trajectory. In another case, there may be a situation where the transition is difficult for the navigator for a number of reasons $\{A\} \ll \{B\}$. In both cases, the pre-planned development trajectory fails. During the transition phase, this is the most significant internal risk for navigator [19-22]. Assessment of the situation, one's capabilities and resources can be very subjective, which causes a negative manifestation of the human factor and unpredictably affects the entire process. This greatly disrupts global planning and forecasting on the part of management structures and drastically reduces the reliability of the entire system.

Conclusions. As part of the study, it is necessary to develop a methodology for collecting information within the framework of a systematic approach, which allows identifying the parameters and their evolution at all stages of the life cycle of the subject - the navigator. In this case, it is important to determine not only the state vector of the system, but the individual factors of the navigator that affect the weights, priorities and interconnection of these parameters in the system. The obtained results will allow approaching the problem of identification of the navigator's model as a subject of the organisational and technical system of water transport at a qualitatively new level.

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