ABSTRACT AND REFERENCES

CONTROL PROCESSES

A STUDY OF DECOMPOSITION OF A GROUP OF
SHIPS FOR PRELIMINARY FORECASTING OF
DANGEROUS APPROACHING (p. 6-12)

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The conducted studies of emerging situations of dangerous approaching of several ships revealed the existence of classification of ships that are target ships relative to the base ship. These target ships can be dangerous, safe, safe but dangerous under certain conditions. In turn, dangerous that require the maneuver of standard collision avoidance, as well as the targets that require the maneuver of emergency collision avoidance. It is proved that the specified classification of ships can be carried out using the belonging of target ships to different subsets, which depend on their motion parameters relative to the base ship.

This made it possible to view a group of several ships as a set of targets.

Experimental studies using computer simulations confirmed that decomposition of the ship approaching situation into subsets, each of which is different from the other in relative motion parameters, is possible. These parameters are relative course, bearing, maximum allowable closest point of approach for normal and emergency maneuvering, time until reaching the closest point of approach. The speed ratio between of the base and target ships, the ratio of the closest point of approach and the maximum allowable distance also affect the belonging to a certain subset.

This suggests that there is a clear dependence of the collision probability of ships on their belonging to different subsets, which can be calculated for each ship participating in the collision avoidance maneuver. It is shown that when the base ship performs the collision avoidance maneuver, there are changes in relative motion parameters, and hence the belonging of surrounding target ships to different subsets.

Thus, there are grounds to argue that using the specified classification of target ships, preliminary forecasted belonging of ships to different subsets can be calculated. The probability of dangerous approaching and/or collision of ships can also be calculated for each course alternation of the base ship relative to each of the surrounding target ships.

Keywords: navigation safety, ship collision avoidance, approaching hazard assessment, collision avoidance strategy.

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DEVELOPMENT OF A DECISIONMAKING METHOD
TO FORM THE INDICATORS FOR A UNIVERSITY
DEVELOPMENT PLAN (p. 12-21)

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The problems of decision-making support in the course of designing a university development plan have been studied. This is important because modern tendencies in the development of higher educational institution are constantly changing and getting more complicated. Organization management under modern conditions is becoming adaptive, proactive, strategic, requiring a revision of

management tools. The basis of strategic planning is indicative planning, which in turn is a form that solves the problem of imperfect information through the indicators that describe an object, a process, or a phenomenon. Effective management of the activity of a higher educational institution in the framework of planning includes the forms and the methods for creating a system of indicators that reflect the picture of the organization state.

The process of the development of a university development plan faces the problem of selecting and ranking the indicators of the development of a higher educational institution, covers both tangible and intangible sides and is a multi-criterion problem of decision making. To solve this problem, it is necessary to select a method for decision making support to form the system of indicative indicators. Evaluation of indicative indicators are carried out through the construction of a cognitive map, a priori ranking and the hierarchy analysis method, involving experts from the field of higher education management. The results obtained are compared taking into account the strengths and weaknesses of the selected methods. The decision made on the choice of the method for the formation of indicators implies the joint use of the hierarchy analysis method and the construction of a cognitive map. During the hybrid application of the methods, the mutual influence of the indicators and the compliance of the indicators with directions of the university development should be taken into account. It is not worthwhile applying a priori ranking in order to form an indicator because there are no data on the joint influence of several studied indicators on each other.

The results of the study are aimed at simplifying the decision-making process in planning: consideration of bottlenecks when designing a development plan, improvement of operation and learning quality, effective use of tangible and intangible resources.

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ANALYTICAL STUDY OF MULTIFRACTAL INVARIANT ATTRIBUTES OF TRAFFIC FLOWS (p. 22-29)

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The motor transport complex is formed by a multitude of motor traffic flows and a network of automobile roads. Transition to a new level of the motor functioning transport complex requires the development of new methods of formalizing the collective interaction of all road users. This is connected to an increase in the number of autonomous vehicles in joint traffic. We established that the transport-technological self-organization of motor transport flows is a multifractal structure. Such a structure is reliably enough described by regular hierarchical – sets of Cantor regarding the parameter of the dynamic dimension of an individual vehicle. We proved that the main multifractal attributes of road traffic flows are their fragmentation parameter and fractal dimensionality. These attributes are functionally determined by the speed, traffic density and interval of vehicles movement. Accordingly, there are three modes of vehicles movement. The absence of mutual obstacles between vehicles, low speed and low traffic intensity characterizes free movement. Such a movement determines the boundary of the collective and synchronized flows. Collective movement is characterized by a high density of traffic flow, and speed is limited by the possibilities of the road. If the indicators of the technical and operational condition of the road become decisive, we get a saturated synchronized flow. Analytical studies established a log-exponential functional relationship between the fragmentation parameter of the motor flow and the fractal dimension. We found that the combination of several road traffic flows in the case of multi-lane traffic management determines the dynamics of changes in the basic multifractal characteristics of vehicles variety. At the same time, an increase in the number of road lanes leads to an increase in the fragmentation parameter and a decrease in the fractal dimension of motor traffic flows aggregate. We considered the possibility of creating appropriate navigation algorithms for the variable optimization of the fractal attributes of road traffic. In this case, safe transport and technological modes of the motor transport complex are provided. The same applies to the conditions for increasing the part of autonomous robotic unmanned vehicles in the composition of motor vehicles.

Keywords: traffic flow, unmanned vehicle, Cantor α-set, multifractality, fragmentation parameter.

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FORECASTING THE ESTIMATED TIME OF ARRIVAL FOR A CARGO DISPATCH DELIVERED BY A FREIGHT TRAIN ALONG A RAILWAY SECTION (p. 30-38)

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This paper reports a method for predicting the expected time of arrival (ETA) of a cargo dispatch taking into consideration determining the duration at which a freight train travels along a railroad section where trains move not complying with a departure schedule.

A characteristic feature of railroads with such a traffic system is the difficulty in predicting the stages of a transportation process, which necessitates the development of effective methods of forecasting. Based on correlation analysis, we have determined the dependence of the general macro-characteristics of train flow and individual parameters of a freight train on the duration of its movement along a section. It has been proposed to represent the dependence of predicted duration of train movement along a railroad section on the following factors: traffic intensity and density along a section, the proportion of passenger trains in total train flows, the length of a train and its gross weight. All experimental studies are based on actual data on the operation of the distance Osnova-Lyubotyn at the railroad network AO Ukrzaliznytsya.

Based on a comparative analysis, using the indicators for accuracy and adequacy of several regression methods to predict ETA of cargo dispatch, we have chosen the regression model based on an artificial neural network MLP. To derive the MLP structure, a cross-validation method has been applied, which implies the validation of a mathematical model reliability based on the criteria of accuracy MAE and adequacy – F-test. The structure of MLP has been obtained, which consists of five hidden layers. We predicted the time that it would take for a train to travel in facing direction along the Osnova-Lyubotyn section. For a given projection, the value for MAE was 0.0845, which is a rather high accuracy for this type of problems, and confirms the effectiveness of MLP application to solve the task on predicting a cargo dispatch ETA.

The current study provides a possibility to design in the future an automated system for predicting a cargo dispatch ETA for a mixed-traffic railroad system in which freight trains depart not complying with a regulatory schedule.

Keywords: railroad network, expected time of arrival, artificial neural network.

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USING THE ELEMENTS FROM A FUZZY SETS THEORY IN THE PROCESS OF DIAGNOSING THE LOYALTY OF CONSUMERS OF MOTOR TRANSPORT SERVICES (p. 39-49)

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We developed an approach to diagnosing the complex loyalty of consumer of motor transport services based on the perceptual and behavioral characteristics with application of the theory of fuzzy sets. Diagnosing the level of consumer loyalty is the basis of a cyclical process of managing the loyalty of consumers of a motor transport company (MTC) in the field of freight transportation. Formation of loyalty depends on subjective perception by a consumer; therefore, the usual quantitative methods of analysis are not effective under conditions of fuzzy (incomplete) information. Application of the results of the theory of fuzzy sets to the analysis and evaluation of the consumer loyalty makes it possible to obtain fundamentally new models and methods of analysis.

The method of data aggregation based on the fuzzy classifier makes it possible to proceed from quantitative and qualitative values of individual indicators of perception and behavior of a consumer to complex indicators of loyalty. We obtained the empirical data used in the present study by questioning consumers. The study is based on actual data on the transportation of goods for each customer of a company. We performed quantitative assessment of integral factors of perceptual (attitudinal), behavioral and complex customer loyalty according to the standard matrix assessment scheme. A three-level classification has been applied with "Low level, Middle level, High level" subset-terms of "Loyalty level" linguistic variable to recognize the level of these factors. It was found that most consumers have an average and high level of loyalty to MTC in the assessment based on results of estimating the level of customer loyalty of the motor transport company.

The use of fuzzy sets makes it possible to identify the mutual influence of perceptual and behavioral factors on formation of the complex consumer loyalty comprehensively, as well as to simulate different situations depending on the predicted indicators of interaction with a consumer. It is a prerequisite for the development of loyalty of consumers of motor transport services through the development of loyalty programs and individual strategies for interaction.

Keywords: fuzzy sets, linguistic variable, membership function, perceptual (attitudinal) loyalty, behavioral loyalty.

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STUDYING THE INFLUENCE OF PRODUCTION CONDITIONS ON THE CONTENT OF OPERATIONS IN LOGISTIC SYSTEMS OF MILK COLLECTION (p. 50–63)

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The algorithm of coordination of the content and time of operations execution in logistic systems of milk collection with manufacturing conditions was developed. The appropriateness of execution of eleven management operations ensuring coordination of collection-transport operations with daily volumes of arrival of raw milk material at its collection points was substantiated. The research was carried out based on the simulation of execution of collection-transport operations of various content, taking into consideration changing manufacturing conditions.

The prediction of the functional indicators in particular periods of the calendar year was performed based on simulation of operations execution in a logistic system of milk collection taking into account changing manufacturing conditions and possible options for the content of operations. It was substantiated that at an increase in the number of operations of milk collection, the quantitative values of the indicators of execution of these operations increase, while the quantitative values of the indicators of execution of transport operations decrease.

It was found that during the calendar year in a specified logistic system of milk collection, the content of collection and transportation operations and production conditions have a significant impact on their indicators. It was substantiated that the quantitative value of these indicators during the calendar year changes by 1.2...3 times. This is explained by a change in the volume of milk collection over a calendar year. The obtained results indicate the feasibility of daily coordination of the content of operations execution in an assigned logistic system of milk collection with production conditions.

Keywords: planning, content of operations, milk collection, logistic systems, quality of control.

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