ABSTRACT AND REFERENCES

CONTROL PROCESSES

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DEVELOPMENT OF VEHICLE SPEED FORECASTING METHOD FOR INTELLIGENT HIGHWAY TRANSPORT SYSTEM (p. 6–14)

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Interaction of vehicles on an intercity highway is considered. The vehicle control model here is idealized, close to the 4th generation automated intelligent transport system. Each vehicle has the desired motion program, independent of the driver's motives, which is justified by minimum resource consumption and compliance with the desired schedule. The diversity of programs affects their unwanted change. The aim was to identify the dependence of the actual vehicle speed on traffic flow parameters. The main task was to reveal a direct parameter for changing the motion program. The use of simulation models based on cellular automata is substantiated. A new cellular automaton, which is a sliding window with a reference point, which is the observer vehicle is developed. The number of objects in the field increases periodically and is constant. All cells on the left and right of the reference point of the automaton form the information field, or the total length of the automaton. The automaton height, which depends on the type of highway, is modeled. The rules of objects movement in the automaton grid at each iteration are finite, established and similar to the Schreckenberg automaton, except for randomization, which is minimized in this model. Such an automaton reflects relative speeds of vehicles relative to the observer vehicle, as well as the ability to reproduce accelerations. At each iteration, the change in vehicle speeds is calculated. The simulation algorithm is programmed in the Delphi language. Simulation of the vehicle movement on the E-471 international highway is performed. On the 20 km section of this route, traffic flows with different density and speed distribution are modeled. The quadratic correlation dependences of the forced change in the desired speed of the observer vehicle on changes in the average speed of the flow vehicles are revealed. The degree of agreement between the theoretical dependence and empirical data is very high. On the basis of the dependencies obtained, the choice of the direct diagnostic parameter of the traffic flow is justified.

Keywords: traffic flow, highway, cellular automaton, sliding window, relative speed, intelligent transport system.

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MODELING OF RELIABILITY OF LOGISTIC SYSTEMS OF URBAN FREIGHT TRANSPORTATION TAKING INTO ACCOUNT STREET CONGESTION (p. 15–21)

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Mathematical formulation of the problem of forming urban freight transportation is performed. The structure of the system information model is developed, which takes into account material, energy and information flows. Mathematical expressions for calculating the criterion for choosing rational routes – route quality factor are presented. The criterion takes into account the capabilities of the logistics center (information content), cargo weight, congestion (traffic jams), transportation distance and actual delivery time. A distinguishing feature is that it is determined online and takes into account the congestion dynamics of routes during a work shift.

The dynamic model of delays in decision making in the logistics chains of urban freight transportation is developed. The model allows calculating the processing time of transportation requests and transportation time itself. It is shown that the total time of freight delivery consists of the travelling time of the vehicle, taking into account route resistance and delay time in all logistic chains of the system.

The mathematical model is developed for assessing the reliability of urban freight transportation, taking into account street congestion. The model operates online and allows determining the parameters of the transport process, including traffic jams on city streets.

The reliability criterion of the logistics system of urban freight transportation – reliability coefficient is proposed. The criterion takes into account the travelling time of the vehicle and the delay time of receipt of transportation requests at the logistics center, and the time of delays at the transport company. It is shown that in the absence of delays in logistics chains, the reliability coefficient is equal to unity, and if there is a delay, the reliability coefficient is less than unity. The physical significance of the reliability criterion is determined. It is the share of non-fulfillment of transportation requests on time.

Keywords: freight transportation, reliability coefficient, route quality factor, urban traffic jams, urban street network.

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ORGANIZED MANAGEMENT OF DECENTRALIZED ECONOMIC PRODUCTION SYSTEMS WITH JOINT IMPLEMENTATION OF DEVELOPMENT PROJECTS (p. 22–35)

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Since integration and cooperation of enterprises have become important preconditions for the success of their operation, the organization of management of integrated economic production systems must thus take into account the features of decentralized decision-making by locally optimized economic entities. In this regard, the aim of the work was to establish a theoretical basis for the organization of management of joint implementation of development projects by participants of decentralized economic production systems based on business engineering technology. The hypothesis of the study is that such organizational regulation of interaction can be implemented through the creation of a set of business rules distributed among the participants of an economic production system. The regulation of business rules and the organization of communications between economic agents are implemented using the Design and Engineering Methodology for Organizations, DEMO. Within the framework of applying the DEMO methodology, a set of key roles of the stakeholders is defined. The set of top-level communication models of the participants of economic production systems has been developed, and groups of rules for maintaining the sustainability of the economic production system have been identified. The resulting models can be correlated with the standards of architectural modelling of complex systems. The logic of this correlation is represented by the example of the ArchiMate architectural modelling language. The relevance of this correlation is due to the creation of a basis for the deployment of a corporate information system and optimization of business processes of the economic production system.

Keywords: decentralization, economic production system, organizational sustainability, business engineering, enterprise ontology.

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DEVISING A FUZZY STAKEHOLDER MODEL FOR OPTIMIZING THE PORTFOLIO OF PROJECTS AT A FISHING INDUSTRIAL ENTERPRISE TAKING RISKS INTO ACCOUNT (p. 36–45)

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The method for portfolio investment, allowing the formation of the optimal portfolio structure considering degrees of satisfaction of requirements of stakeholder groups, risks and uncertainty of external and internal environment, was proposed. The model that represents a fuzzy nonlinear programming problem was considered. The weighted average of project utility is used as objective function. The utilities of projects are multiplicative Cobb-Douglas type functions using, along with financial indicators, expert verbal evaluations of qualitative indicators of satisfaction of stakeholder requirements, converted into fuzzy numbers. Exponents in this function reflect the significance of stakeholders for the organization in terms of the existing resource sharing between a company and a stakeholder and the degree of mutual influence. Quantitative accounting of risks is implemented based on the H. Markowitz approach and the scenario-based method. Uncertainty and lack of information for the indicator of economic efficiency of projects is modeled through the use of the fuzzy approach. Constraints in the model are also fuzzy. The transforming from a fuzzy optimization problem into a crisp problem is performed by assigning the satisfaction degrees for an objective function and the constraints. The choice of a certain satisfaction degree also makes it possible to some extent to take into account uncertainty, which, in turn, affects the composition of the portfolio. The solution to the model is found numerically using the proposed method, which allows, based on fuzzy utilities, finding fuzzy objective function and constraints, and transforming a fuzzy model into a crisp quadratic programming problem at specified satisfaction degrees. The example of the formation of an optimal portfolio of investment projects of a fishing industrial enterprise was explored.

Keywords: project portfolio optimization, accounting of stakeholder requirements, utility function, fuzzy model.

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SUBSTANTIATING THE EFFECTIVENESS OF PROJECTS FOR THE CONSTRUCTION OF DUAL SYSTEMS OF FIRE SUPPRESSION (p. 46–53)

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The expediency of the systemic activity of cross-border operational rescue units due to the creation of dual systems of cross-border fire suppression was substantiated. Dual fire suppression systems are temporarily created systems (for the period of liquidation of fires at the borders) from the resources of two neighboring countries in

order to restrict the development and suppress fires, as well as to protect people and wealth from them. The objects of configuration of such systems are the number and composition of technical means for fire suppression, the number and speciality of firefighters-rescuers, as well as supplies for the liquidation of fires. The analysis of the relationships between the objects of configuration of dual systems of cross-border firefighting was performed and the feasibility of developing the toolsets to determine the effectiveness of the projects the dual system creation was substantiated.

Three variants for determining the effectiveness of the projects of creating dual systems of cross-border fire-suppression were proposed. They are the basis for the developed geometric model of substantiation of the configuration of the projects of creation of dual systems of cross-border fire suppression. It was found that the range of a change of the parameters of firefighting-rescue units of two states varies from 0 to 1, which affects the effectiveness of the projects of creation of dual systems of cross-border fire-suppression.

The absence of the extremum of dependence of effectiveness of the projects of creating dual systems of cross-border fire-suppression on the number of forces and facilities of two neighboring states was found. The dependence of the maximum value of effectiveness of the projects of create of dual systems of cross-border fire suppression on its parameters indicates the need for taking into account the characteristics of the changing project environment, as well as organizational components of these projects.

According to the results of geometric modeling, the mutual influence of five indicators on effectiveness of the projects of creation of dual systems of cross-border fire suppression was substantiated.

Keywords: project, effectiveness, dual system of fire suppression, cross-border rescue unit.

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DEVELOPMENT OF A METHOD OF COMPLETING EMERGENCY RESCUE UNITS WITH EMERGENCY VEHICLES (p. 54–62)

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The study considers the process of response of emergency rescue units to emergencies and hazardous events occurring on the territory of a city with a population of more than one million people. It has been determined that the flow of calls to the departments of emergency rescue units has a certain structure, and their number correlates with the size of the total area of the housing stock of a settlement. This dependence was described by a polynomial trendline, for which an appropriate equation was composed to determine the number of calls that could be made to the emergency rescue units in the future. These data can also be used to determine the number of emergency vehicles that emergency response units must provide to carry out their intended operations effectively. A method of completing the departments of emergency rescue units with emergency vehicles is proposed taking into account the operational situation in the areas of their on-site visits, and it consists in performing four consecutive stages. The first stage involves the selection of the necessary factors on the basis of analysing statistical data that characterize the process of response of departments of emergency rescue units to various destructive events and the construction of a predictive model. The second stage involves the calculation of the indicator of the specific number of emergency vehicles per call, taking into account the different groups of call flows. The third stage involves determining the total number of emergency vehicles at the emergency rescue units of a settlement. As the mathematical models applied at this stage are based on the Poisson distribution law, there is a limitation in using the proposed method, entailing that the flow of calls must be Poisson. The fourth stage of the calculations involves the redistribution of the previously determined total number of emergency vehicles between the departments of the emergency rescue units, taking into account the peculiarities of the operational situation in the areas of their on-site visits.

Keywords: emergency rescue unit, call flow, methods of completing, emergency vehicle.

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DEVISING METHODOLOGICAL PROVISIONS FOR THE COMPARATIVE EVALUATION OF VARIANTS FOR AN ARMAMENT SAMPLE IN TERMS OF MILITARY-TECHNICAL LEVEL (p. 63–72)

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When setting a tactical-technical task on constructing a sample of armament, not only its characteristics related to purpose are considered, but its operational and technical, technological, economic, and other characteristics as well. The totality of characteristics defines the military-technical level of the armament sample. Typically, such variants of armament sample are considered that differ by the set of characteristics. For comparative estimation of armament sample variants in terms of military-technical level, it is necessary to apply appropriate methodical provisions.

Resolving the task on comparative evaluation of armament sample options was made possible by consistently solving four problems.

In solving the first problem, the decomposition of the totality of characteristics of an armament sample into the following three levels has been performed: properties, properties' components, indicators. The scientific result from the first problem is a methodological approach to comparative evaluation of armament sample options based on the consideration of the characteristics' significance when ranking the variants of an armament sample using a method of multi-criteria analysis.

Solving the second problem helped establish the order of staged expert estimation of coefficients for the properties' significance, properties' components, and indicators, using a pairwise comparison method, which makes it possible to take into consideration their impact on the military-technical level of an armament sample.

The result from solving the third problem of the current study is the algorithm for comparative evaluation of an armament sample using a taxonomy method. The reported algorithm makes it possible to rank the variants of an armament sample taking into consideration the significance of indicators that define their military-technical level.

Our decomposition of characteristics, using a pairwise comparison method for expert estimation of their significance, as well as a taxonomy method, has made it possible to obtain an integrated procedure for the comparative evaluation of an armament sample variants in terms of the military-technical level.

When solving the fourth task of this study, we have considered the order of application of the devised procedure using an example of comparative estimation of the military-technical level of variants for an anti-aircraft missile system.

The methodology could be used in substantiating a tactical-technical task on the development of armament samples.

Keywords: armament sample, military-technical level, pairwise comparison, taxonomy method, comparative evaluation procedure.

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