ABSTRACT AND REFERENCES

CONTROL PROCESSES

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## OPTIMIZATION OF INVENTORY MANAGEMENT MODELS WITH VARIABLE INPUT PARAMETERS BY PERTURBATION METHODS (p. 6–15)

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Lines of optimization of the model of the economic order quantity (EOQ) under a condition of insignificant changes of input parameters by perturbation methods were offered.

To achieve the objective, analytical formulas of the EOQ model based on the asymptotic approach under conditions of minor changes in the input parameters were obtained. The discrete increase in the order fulfillment costs and the inventory storage costs which depend on the "small parameter" as well as periodic fluctuations in demand for products were taken as variable parameters of the system.

Based on the asymptotic method of perturbations, a convenient-to-use formula for determining EOQ under the condition of an insignificant increase in the order fulfillment costs was derived. The percentage deviation of the "perturbed" order quantity from that of Wilson's formula was also determined. Evaluation of the sensitivity of the EOQ model has revealed that the relative deviation of the "perturbed" order quantity from the optimal one at insignificantly changing costs of the order fulfillment varied from 1 % to 15 % depending on the period. Comparative analysis of the total costs calculated using the asymptotic formula and Wilson's formula has found that taking into account changes in order quantities leads to a reduction in the company's expenditures.

A two-parameter model of optimal order quantity was constructed. It takes into account both minor changes in the order fulfillment costs and inventory storage costs. Two-parameter asymptotic formulas were derived to determine optimal order quantity and total costs which correspond to the "perturbed" order quantity.

The proposed asymptotic model which takes into account a discrete insignificant increase in the order fulfillment costs and periodic nature of fluctuations in demand for products has practical significance. This model can be used to optimize the logistics management system of the enterprise due to its proximity to realities and the ease of use.

**Keywords:** inventory management model, small parameter, perturbation method, asymptotic expansion, order quantity.

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## TRANSPORT CONSTRUCTION COST MANAGEMENT BY RATIONAL ORGANIZATIONAL AND TECHNOLOGICAL SOLUTIONS (p. 16–24)

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Special conditions of implementation of construction projects of transport facilities show that cost management requires appropriate optimization of organizational and technological solutions. The computer model and method for selecting optimal management by the criterion of construction cost minimization are developed. The model shows the organizational and technological variability of the enterprise, characteristic of transport construction. The method allows to carry out variant modeling, according to which the patterns of changes in the construction cost, the ratio of direct and general production costs are compiled under the influence of the following factors: average complexity of the project totality, average relocation distance, attribution of resources, industrialization of applied solutions.

The numerical experimental studies quantitatively proved that organizational and technological solutions characteristic of the enterprise as a whole affect the solutions of individual construction projects of transport facilities. In particular, it was found that with a decrease in the average complexity of the project totality, the influence of industrialization of applied solutions is reversed and begins to increase the cost of works.

The lowest value of cost change (–13.6 %) was found, characterized by the most effective organizational and technological solutions: the average complexity of the project totality $X_1$=2.2 thousand hours, the average relocation distance $X_2$=100 km, using only own equipment and labor resources ($X_3$=0 %), minimal industrialization of applied solutions ($X_4$=0 %).

It was revealed that contracting organizations building relatively small transport facilities should use traditional methods of work. The cost efficiency of solutions, according to which enterprises constructing geographically dispersed facilities should use contracted resources with local material and technical base was also determined.

**Keywords:** construction of transport facilities, organizational and technological solutions, numerical optimization.

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## CHOOSING THE RATIONAL MANAGEMENT OF HIGH-RISE BUILDING CONSTRUCTION PROJECTS (p. 24–33)

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The approach to the choice of rational management of high-rise building construction, which ensures the effective use of resources, was developed. This approach is aimed at ensuring cost-effectiveness, energy-saving, quality, safety, and environmental friendliness of high-rise buildings.

It was proposed to solve such tasks based on the search for rational decisions that correspond most to desirable (assigned) technical and economic characteristics (indicators), based on the application of statistical modeling of projects as manageable processes. At the same time, it is advisable to take into consideration the influence of determining organizational-technological, technical, and managerial factors. To assess decisions regarding these factors, it is necessary to

find a rational value of management efficiency criterion. From the customer's (investor's) position, it is advisable to consider the minimum cost of high-rise building construction.

It was proposed to consider the impact of the factors of quality, safety, energy efficiency, environmental friendliness, optimal maintenance of a high-rise building. The sufficiency and essence of the impact of these factors on making rational decisions in the management of high-rise building construction projects were substantiated by the results of the expert questioning.

Mathematical models, based on the consideration of the systemic influence of determining factors, were obtained. These models provide an opportunity to assess numerically the level of achievement of the assigned results, in particular, by the criterion of high-rise building construction, at various stages of project management.

The obtained results are relevant because they make it possible to reach the rational values of the desired indicators under specific conditions of execution of construction and mounting works within specified resource restrictions. By operating predictive estimates of the expected results, investors have the opportunity to adjust their goals and choose the most rational variant of the investment-construction project.

**Keywords:** project, rational project management, management efficiency criterion, high-rise construction, efficient use of resources, organizational and technological, technical, and managerial factors.

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## DEVELOPMENT OF AN ECONOMICMATHEMATICAL MODEL TO DETERMINE THE OPTIMAL DURATION OF PROJECT OPERATIONS (p. 34–42)

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Planning the duration of works in order to optimize the implementation time is an important component of an efficient company's project management. The optimization economic-mathematical model for determining the duration of implementation of project stages was created in the research. The objective function is the maximization of the probability of successful project implementation and generation of new organizational knowledge at each stage. The model assumes that the sum of the duration of project stages should not exceed the specified project duration. The model assumes that the following stage can begin after the previous one at the probability of task implementation and generation of new knowledge of the previous one at the level that is not below the established one. The model takes into account that the combination with the minimal total project duration and with minimal costs for realization are chosen from the possible combinations of the durations of project stages. The model involves the use of combinatorics elements to determine the possible combinations of the duration of stages. In addition, the experts' knowledge and the direct estimation method were used to determine the weight factors of the project stages. The total probability of successful project implementation was determined as the sum of probabilities of successful realization of tasks and generation of new knowledge at each project stage, taking into consideration the corresponding weight factors. Practical implementation of the model was carried out for the project of development, content creation, and implementation of the information system and the database for the management of activity of the regional center of physical education of school youth lasting 10 months. The project consists of three stages: designing, development and testing, and implementation. It was established that the following duration of the project stages will be optimal: stage 1 – 4 months, stage 2 – 5 months, stage 3 – 1 month. At this distribution of time, the probability of successful project implementation is 0.81, costs are USD 5,440. The created model can be used for any enterprise with the purpose of planning the duration of the project works and its successful implementation within the set period.

**Keywords:** project duration, optimization model, economic-mathematical model, company knowledge management.

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## SUBSTANTIATING THE CRITERIA OF CHOOSING PROJECT SOLUTIONS FOR CLIMATE CONTROL SYSTEMS BASED ON RENEWABLE ENERGY SOURCES (p. 42–50)

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The choice of project solutions for systems of providing climatic conditions in premises, based on different types of renewable energy sources, was substantiated. The means proposed to solve project tasks, imply the use of the interaction between different stakeholders, the number of subsystems necessary for effective functioning in the open system, that is taking into account the synergetic effect. It was proved that the introduction of complex climate control and energy supply system will allow uniting the functions inherent to disparate engineering systems, and ensure the transformation and redistribution of various types of energy flows, which will minimize operating costs. The hierarchical structure of the problem of approval of alternative project solutions of the climatic systems based on the Analytic Hierarchy Process method was constructed, which allows obtaining a set of optimal variants. The application of the corresponding tool apparatus of Data Envelopment Analysis enables constructing a system of evaluation of the energy efficiency of projects of complex climatic control and power supply systems using different types of renewable energy sources. The functional intended to select the optimum variant of a project solution of the climate control and energy supply system was constructed. The proposed project solutions were examined from the position of determining the minimization of the total consumption of energy resources and operating costs of three alpha-stakeholders. The proposed indicator of relative integrated energy efficiency allows making an optimum choice of complex systems with disparate input and output characteristics.

**Keywords:** climate control systems, renewable energy sources, project solutions, energy efficiency, ranking.

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## CONSTRUCTING AND INVESTIGATING A MODEL OF THE ENERGY ENTROPY DYNAMICS OF ORGANIZATIONS (p. 50–56)

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Energy entropy is the "highest" indicator of the state of an organization, developing the ideas of efficiency and value. The integrity of energy entropy implies taking into consideration the level of order in an organization (information entropy) along with the ability to "release" effectively the energy for useful work. Versatility is ensured by the independence on a kind of activity of an organization. The formalization of energy entropy of organizations was proposed. According to the proposed approach, energy entropy is determined by an increase in total energy and its comparison with the "ideal" option; the level of free energy and information entropy that reflects the ability of the organization's structure to ensure certain results. Incoming and outgoing (free) energy are considered as the main parameters of the organization's state. Their combination determines the growth of energy, a set of possible combinations – information entropy. The scheme of changes in time of the main "energy parameters" of an organization (total energy, free energy, incoming energy) was identified.

Two main variants of energy increase dynamics – uniform growth and growth with acceleration (slowdown) were represented. Experimental studies, which involved considering the most possible variants of dynamics of influencing parameters, were carried out. The effect of different combinations of their dynamics (simultaneous growth/decrease, growth/decrease at different rates) on the dynamics of energy entropy was analyzed. It was established that an increase in a share of free energy does not provide an outflow of energy entropy without reducing a degree of uncertainty of the results expressed in a decrease in information entropy. Conclusions about the necessary dynamics of influencing parameters to ensure the vital activity of an organization according to the energy entropy concept were made.

**Keywords:** information entropy, free energy, efficiency of energy turnover, organization structure, formation of neg-entropy.

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## OPTIMIZATION OF VEHICLE SPEED FORECASTING HORIZONT ON THE INTERCITY HIGHWAY (p. 57–68)

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The movement of the car in the traffic on intercity routes was investigated. Traffic should be energy efficient, safe and comply with the desired schedule. A method for analyzing the input data flow based on a simulation model has been developed. The proposed simulation algorithm is based on the use of available information resources for driving a car. Traffic control involves choosing a speed with known road and traffic restrictions. The presented algorithm allows to consider the expediency of each of speed increase opportunities over the forecast horizon. The content of the algorithm is the optimal redistribution of time resources. Indicators of control quality are absolute deviations from the optimal energy-saving program of free movement and from the planned schedule. The movement of a freight road train on the long-distance highway E–371 was performed. It was found that the total amount of information increases with increasing distance of scanned traffic. However, the share of reliable information is reduced. It was found that the dependence of the quality of vehicle traffic control on the size of the forecast horizon is piecewise-continuous. The dependence has an extreme value of the horizon in each continuous section, at which the deviation from the optimal program is minimal. The obtained results can be applied in modern intelligent transport systems. The research results make it possible to develop and adhere to optimal long-term traffic programs on highways. It solves the problem of managing large data streams. Large amounts of information for forecasting can be submitted in parts with reasonable frequency using the developed methodology.

**Keywords:** intelligent transport systems, speed forecasting, data flow analysis, optimal movement program, main transportation.

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**DEVELOPMENT OF A MULTINOMIAL LOGITMODEL TO CHOOSE A TRANSPORTATION MODE FOR INTERCITY TRAVEL (p. 69–77)**

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Reducing the share of the use of automobiles in intercity passenger transportation is one of the ways to achieve the goals of sustainable development in transport that could positively affect the environment. The purpose of this work is to determine, based on the analysis of the results of polling conducted in the city of Lviv, Ukraine, trends in the selection of an external transport hub (ETH) by the transportation system users for a subsequent intercity trip. To this end, a multinomial logit model of ETH selection has been constructed, based on calculating the utility of students' choice of a railway and a bus hub. Multi-nominal logit models (MLM) are widely used to simulate the behavior of users, as evidenced by numerous studies. Their correct application requires that a set of factors should be defined that influence making a choice and the MLM coefficients should be calculated, based on studying users' behavior within a specific design area. The factors affecting the choice of a type of an external transport hub are the characteristics of an ETH (the throughput and the number of dispatches in a certain direction) and the duration and cost of a trip. The impact of these factors differs depending on the trip length: we have calculated the MLM coefficients for selecting an ETH type separately for travel up to 100 km in length, from 100 to 200 km, and more than 200 km. In addition, such indicators as the duration of a city trip and the time interval of dispatching were introduced in the model; however, the process of calculating the significance of the logit-model parameters revealed that these indicators did not exert significant influence on the users within the studied group. The result of this study is the defined characteristics of the performed trips with the hub-based distribution. The data obtained would contribute to a better understanding of the behavior of users of this class when they choose the mode of intercity travel and could be used to optimize the functioning of external transport hubs.

**Keywords:** multi-nominal logit-model, movement mode, utility of choice, external transport hub.

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## FORMING AN AUTOMATED TECHNOLOGY TO ACTIVELY MONITOR THE TRANSPORTATION OF DANGEROUS CARGOES BY RAILROAD (p. 78–85)

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The approach has been proposed to form automated technology in order to actively monitor the transportation of dangerous goods by railroad. The reported approach to the dynamic description of trains' status has been developed on the basis of modifying the language of trains' status in the form of abstract modeling of operational processes. This will ensure the fastest implementation of decision-making algorithms by the operational personnel at the powerful support from the automated complex of dispatching control. It has been determined that the maximum effect of the implementation of the proposed approach could be obtained by synthesizing it with a system of active monitoring of moving units' traffic.

Modeling an arbitrary case involving a train, which can occur in real operational circumstances, has made it possible to predict the violation of a normative train schedule and to simulate the cognitive process of decision-making by a train dispatcher to rationally resolve a complicated train situation under changing operational conditions while accounting for a significant number of factors. Modifying the language of train-related cases could adequately produce the spatial-time description of train situations along a simulated section, whereby it is the closest to the language of the dispatching personnel.

The advantages of the proposed approach are that it makes it possible to form a database and a knowledge base as quickly as possible in order to form a working model of the system of dispatching control. A given system has been developed on the basis of the imitation of the cognitive activity of the human operator, thereby providing an opportunity to deepen the implementation of artificial intelligence systems on railroads. These innovations could help achieve the maximum level of safety in the transportation of dangerous goods while simultaneously and unconditionally reducing operating costs and gaining higher profits.

**Keywords:** dangerous cargoes, language of train situations, abstract modeling of operational processes.

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