

## ABSTRACT AND REFERENCES

## CONTROL PROCESSES

DOI: 10.15587/1729-4061.2020.195071

**DEVISING AN AUTOMATED TECHNOLOGY TO ORGANIZE THE RAILROAD TRANSPORTATION OF CONTAINERS FOR INTERMODAL DELIVERIES BASED ON THE THEORY OF POINT PROCESSES (p. 6–12)****Tetiana Butko**Ukrainian State University of Railway Transport,  
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A significant number of problems and associated additional expenses emerge for operators due to imperfections in the existing technology of operational planning of the functioning of railroad transport as a part of the intermodal transportation system. The source of problems is not only the process of transportation of containers by rail but also the processes that occur immediately before and after it. These processes are uncertain because of their probabilistic nature. Their random nature provokes additional idle time of rolling stock, causes additional operator expenses, and reduces the quality of customer service. However, the direct influence on them is very difficult or economically inexpedient.

The study shows that taking into account the probabilistic nature of these processes to reduce their negative impact is most effective precisely at the stage of operational planning of the functioning of railroad enterprises involved in the intermodal transportation process. One should note that it is necessary to take into account random factors of processes of formation and processing of container trains at stations, their movement along sections and transfer to a port simultaneously in order to improve the quality of such planning. However, the arrival of containers at terminal railroad stations requires special attention.

It has been proven that the key to the solution to the problem of synchronization of the processes is the formation of automated technology for the organization of the transportation of containers by railroad.

We have formalized the technological process of formation and movement of container trains to seaports in the form

of a model of stochastic optimization using a mathematical apparatus from the theory of point processes for this purpose. The optimization criterion for this model represents the operating expenses of an operator for the organization of the railroad part of intermodal transportation. The stochastic nature of the model gives a possibility to find the optimal parameters of the operational plan for the organization of container transportation while controlling a level of certainty in the possibility of implementation of the plan taking into account the probabilistic nature of the constituent processes.

Based on the developed model, software was created in the MATLAB programming environment and an automated technology for moving container trains was formed. The application of the proposed model in the formation of railroad container transportation technology could reduce operating expenses of a railroad part of intermodal container transportation by at least 10 %.

**Keywords:** intermodal container transportation, random point processes, stochastic optimization, railroad container transportation.

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DOI: 10.15587/1729-4061.2020.194155

**DEVISING A METHOD TO OPTIMIZE THE INVESTMENT STRUCTURE AIMED TO ACHIEVE STRATEGIC TARGETS IN THE SOCIOECONOMIC DEVELOPMENT OF REGIONS (p. 13–24)**

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A method has been proposed to form the optimal structure of regional state investments, which contributes to the strategic goals and objectives of the socio-economic development of a region through the advanced development of human capital. The dynamic model has been considered representing a mathematical programming problem, which describes in the form of recurrent dependences the chain of channels of influence: “the structure and volume of investments→the indicators of the regional human capital→the indicators for the socio-economic development of a region”. The weighted average of degrees in achieving the target values of resulting indicators of socio-economic development of a region on the considered horizon of planning has been used as the objective function. Recurrent dependences are the lag econometric models of panel data involving the main components. To construct three types of models (the through models, those with the deterministic and random spatial effects) using the Best Subset method,

the open-source software R was employed. The best models were chosen with the help of tests by Wald, Hausman, and Breusch–Pagan. The limitations within the model are a series of assumptions about the processes of the development of human capital and the socio-economic development considering the uncertainties. The optimization variables are shares of the distribution of investment resources based on the investment directions and years. Based on the results of modeling and numerical calculations on the example of several regions of Russia in dynamics over the years, the optimal investment structure has been proposed. A given structure enables making the maximum progress towards achieving the target values of strategic indicators of the development of a region through the development of human capital.

**Keywords:** socio-economic development of a region, human capital of a region, optimization of investment structure, multi-period economic-mathematical model.

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DOI: 10.15587/1729-4061.2020.194449

**DEVELOPMENT OF MODELS FOR ASSESSING A DRIVER'S FAILURE-FREE OPERATION IN A TRANSPORTATION SYSTEM UNDER CONDITIONS OF TRAFFIC CONGESTION (p. 24–38)**

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This paper has considered the task on determining a driver's failure-free operation in the transportation system of a city taking into account traffic jams. A driver's time of

stay in traffic jams leads to an increase in his/her psycho-emotional condition, an increase in the level of fatigue, and, therefore, to a decrease in failure-free operation. The level of a driver's failure-free operation directly affects road safety. The driver's failure-free operation within the elements of a transport system determines the probability of a traffic accident, which depends not only on the network parameters and traffic flows but, first of all, on the response time of the driver.

We have developed models for assessing a driver's failure-free operation along the sections of a transport network and transport nodal points taking into account traffic jams. They have made it possible to assess the probability of a traffic accident for the average driver. The models take into consideration the impact of a traffic jam by changing the response time of a driver, which is a function of changing the level of fatigue.

To determine by how many times the probability of a traffic accident for the average driver along the sections of a transport network and in traffic nodes with a traffic jam exceeds the same probability along the same elements of the transport system without traffic jams, we considered the ratio of the probabilities.

The adequacy of the models has been verified by comparing the ratio of the probabilities of a traffic accident with the traffic jam along the sections of a transport network and without it to the corresponding ratio of the number of traffic accidents along the same sections of a transport network and at intersections.

The developed models that take into account traffic jams for assessing a driver's failure-free operation along the elements of a transport network make it possible to compare and evaluate various project solutions to improve road safety.

**Keywords:** driver failure-free operation, traffic accident, transport system, traffic jam, response time.

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DOI: 10.15587/1729-4061.2020.195327

**SELECTION OF A TRAFFIC MANAGEMENT SCHEME AT AN INTERSECTION TAKING INTO CONSIDERATION THE TRAFFIC FLOW COMPOSITION (p. 39–46)**

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Traffic flows in large cities have a non-uniformed character of origin and changes. The main parameters are often sensitive to the changes in the environmental conditions, specifically, the time of the day, season, etc. The magnitudes that characterize traffic flows have a stochastic nature and therefore they are difficult to predict. According to this, indicators such as intensity, density and traffic speed over time and space are uneven. Taking this into consideration, during the development of traffic management schemes, there arises a necessity to take into consideration additional factors which are of probabilistic nature. This approach provides more opportunities in the traffic management process and makes it possible to use appropriate ways to choose traffic management methods in certain cases. This process involves detailed studies of traffic indicators. The approaches and methods for studying the main indicators of traffic flows were given. They include both field methods and simulation, which involves accounting of mathematical and physical patterns of traffic flows. It also makes it possible to predict the situation when choosing a traffic management scheme with the use of computer equipment. The results of the studies, which were conducted according to the described methods, were analyzed. These results indicate a close relationship between the relative traffic composition for the types of vehicles and the indicators of queuing and delays within the intersections. According to the results, mathematical dependences characterizing this relationship were obtained. It was established that the choice of a road traffic scheme at intersections should be made taking into consideration the traffic flow composition, as each regulation type is effective for a particular case.

**Keywords:** traffic composition, traffic flow, traffic management scheme, traffic delay.

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**DOI: 10.15587/1729-4061.2020.193935**  
**CONSTRUCTION OF A PORTFOLIO**  
**FORMATION METHOD BY CONFIGURING**  
**PROJECTCANDIDATES BASED ON FLOW**  
**CHARACTERISTICS (p. 47–61)**

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A method for portfolio formation, based on the logical methodological technique for configuring projects-candidates, which are represented by the S-curves of a cost flow and expected results, has been proposed. The application of the technique makes it possible to present a portfolio as continuously going processes of accumulation of potential attractiveness of different combinations of projects rather than a static totality of projects. Configuring has been shown to allow finding such a sequence of the mutual location of projects within a portfolio, in which the criterion, taking into account different types of the flow, reaches a maximum value. Using the S-curves makes it possible to account for changes in the indicators of flows that depend on the time of starting a project in the portfolio and affect its attractiveness.

The developed model of portfolio formation, the system-creating factor of which is the configuring technique, revealed the relations between its structural elements, which made it possible to identify the essence of the criterial attractiveness indicator and a portfolio configuration criterion. In calculating attractiveness, the proposed technique for the S-curve coagulation procedure, which implies the discounting of cumulative flows, was used. This coagulation enables obtaining an integral indicator that takes into account the specific features of particular S-curves and opens up the possibility of using any type of flows in the problems of assessing and comparing projects and portfolios.

Based on the attractiveness indicator and the use of a procedure for rationing the discounted cumulative flows, a portfolio-forming criterion has been developed. It was established that the criterion adequately reflects a greater attractiveness of projects with a decreasing character of costs and less funding time at the same parameters for the expected results. This fact has been proven by the results of computer simulation. In addition, it was confirmed that the constructed method makes it possible to take into account the strategic importance of a project, the specificity of a portfolio financing schedule, as well as the specific features in the character of changes in a project cost and the expected project result.

**Keywords:** project attractiveness, feasibility, result attainability, S-curves, discounting of a cumulative flow, rationing.

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«Математичне моделювання процесів в економіці та управлінні проєктами і програмами (MMP-2019)». Kharkiv: KhNURE, 136–137.

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DOI: 10.15587/1729-4061.2020.195455

**DEVELOPMENT OF INFORMATION TECHNOLOGY FOR PLANNING ORDER FULFILLMENT AT A FOOD ENTERPRISE (p. 62–73)**

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An information technology has been proposed that aims to resolve the task of planning the fulfillment of orders for manufacturing products at food enterprises under conditions of uncertainty and risk. The information technology is based on combining the ant colony, gray wolves, and genetic algorithms, as well as the constructed mathematical model of the operative execution of orders. The advantages of algorithm combination include the formation of alternative variants of plans and the avoidance of local optima. The proposed mathematical model includes the partial criteria, constraints, as well as an evaluation function, for determining the effectiveness of the compiled plan of order execution. The application of a petal diagram and an additive convolution of partial criteria has been suggested to illustrate the clarity of a variant of order fulfillment. The mathematical model makes it possible for a DM to define any set of partial criteria to take into consideration the patterns of order execution.

The information technology ensures rapid reconfiguration of the current plan of order execution in the event of emergencies or the need to urgently fulfill a certain order.

**Keywords:** mathematical model, scheduling order execution, combined algorithm.

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DOI: 10.15587/1729-4061.2020.194531

**DEVELOPMENT OF A MODEL FOR DECISION SUPPORT SYSTEMS TO CONTROL THE PROCESS OF INVESTING IN INFORMATION TECHNOLOGIES (p. 74–81)**

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A model for managing the investment process has been proposed, using an example of investing in information technologies (IT) taking into consideration that a given process is multifactorial in character. The difference between our model and those constructed previously is that, firstly, it considers the investment process as a complex structure, for which it is not enough to model it as a one-factor category. Secondly, our model is based on solving a bilinear multi-step quality play with several terminal surfaces. The solution has been derived within a new class of bilinear multi-step games that describe the interaction of objects in multidimensional space. Consideration of the investment process in such a statement provides an opportunity to adequately describe the process of finding rational strategies of players in the course of investing in information technologies. The study conducted has made it possible to implement the model's programming code in the MATLAB simulation environment. Software product, the decision support system "IT INVESTMENT", has been developed. The mathematical core of the DSS is based on the application of a new class of bilinear differential games. The proposed solution makes it possible to find the optimal investment strategies for potential investors; its application enabled to reduce the discrepancies between forecasting data and actual return on investment, for example, in IT projects. The resulting solution has made it possible to represent graphically the sets of preferences of investors in the process of investing in IT projects, taking into consideration the multifactor character in multidimensional space. It has been shown that such an approach, combined with the application of computer simulation and DSS, would provide an investor with wider opportunities to analyze and choose rational financial strategies.

**Keywords:** optimal investment strategies, decision support, multi-step game, software product.

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