FORMING AN AUTOMATED TECHNOLOGY TO MANAGE FREIGHT TRANSPORTATION ALONG A DIRECTION (p. 6-13)

**Tetiana Butko**
Ukrainian State University of Railway Transport, Kharkiv, Ukraine
**ORCID**: http://orcid.org/0000-0003-1082-599X

**Oleksii Kostiennikov**
Ukrainian State University of Railway Transport, Kharkiv, Ukraine
**ORCID**: http://orcid.org/0000-0001-9626-0859

**Larysa Parkhomenko**
Ukrainian State University of Railway Transport, Kharkiv, Ukraine
**ORCID**: http://orcid.org/0000-0003-1647-7746

**Viktor Prokhorov**
Ukrainian State University of Railway Transport, Kharkiv, Ukraine
**ORCID**: http://orcid.org/0000-0001-8963-6467

**Ganna Bogomazova**
Ukrainian State University of Railway Transport, Kharkiv, Ukraine
**ORCID**: http://orcid.org/0000-0002-8042-0624

The study investigated the process of rolling stock movement along a direction and took into consideration possible risks during transportation of freight. It revealed the main reasons, which cause effects of the first and last mile. They include, namely, the lack of the required number of technically sound rolling stock on scheduled time and significant difficulties with the passage of trains, specifically through port and border stations.

The study formalized the technological process of transportation of freight along a direction in the form of an optimization mathematical model of the process of movement of freight wagons. The objective function of the model represented total operation costs. Its basis was the Lebesgue-Stieltjes integral, which took into consideration the effect of the first and last mile. The model also took into consideration possible risks, which arise in the process of wagon operation. It is expedient to refer the built optimization model to the problems of stochastic programming.

The analysis of statistical data showed that the time required for wagons to move from an initial station of a route to a port station and the time required for movement of wagons from a port station directly to a port conform to normal distribution. The presence of a positive correlation between these two values gave reason to consider the corresponding parameters within a single probabilistic field. This approach made possible to determine probability of untimely arrival of wagons to a port more accurately and, accordingly, to determine a value of financial risk.

The modeling proved that there was an extremum of the objective function of the minimum type, which made possible to form a procedure for optimal control of transport parameters. Thus, the generated model is universal in nature. It gives possibility to manage the transportation process with the lowest operational costs for the railway in the presence of feedback. Calculations showed a decrease in railway costs approximately by 10 % comparing with the costs calculated according to the existing method of determination of the actual cost of transportation of freight. The optimization model is the basis for formation of an automated technology for the management of freight traffic. We propose to implement it in the form of a system of decision support for the dispatcher staff.

**Keywords**: railway transport, first and last miles, operation costs, risk function.

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## AN ALGORITHM OF SELECTING THE PRICING MODEL FOR A CONSTRUCTION CONTRACT (p. 13-21)

**Olexander Bugrov**
Kyiv National University of Construction and Architecture,
Kyiv, Ukraine
**ORCID**: http://orcid.org/0000-0002-2325-1545

**Olena Bugrova**
National University of Kyiv-Mohyla Academy, Kyiv, Ukraine
**ORCID**: http://orcid.org/0000-0001-8447-282X

An algorithm has been developed for selecting a price model for a construction contract. This is important because price is one of the key parameters of a contract. It is this parameter that determines how much of the value created in the framework of the contract in a monetary form goes to the contractor and what remains to the client. The study has found that the contract drivers of pricing are the initial price, control, incentives (moral hazard), and the final price. This interpretation coincides with the fundamentals of contract theory and is a prerequisite for the fundamental credibility of the developed system. The basic input components of the decision-making algorithm on the most appropriate pricing strategy are the matrix of properties of contract price models and a metric of questions for evaluating the client's respective priorities for the project.

The system helps choose one of five key pricing strategies: CRC, MC, TC, LS or GMP, which are used in international practice. Applying the system of choosing the pricing model of a contract in conjunction with the system of selecting the organizational profile of the project provides an opportunity to choose the most appropriate strategy from 130 paired alternatives. The proposed approach in a cumulative way contributes to the success of construction projects and has a unified character. The formalized toolkit for benchmarking alternatives is the digital content of the strategic COMP – Contract Organizational Mechanisms: Pricing. The algorithm is built on estimating the priority vectors of pricing factors for a project (based on certain sets of ranks and ratings) with a further grading of the feasibility of using each of the alternative price models in the project. Approbation of the COMP system in the construction project of the Ice Arena in Kyiv has shown that the created conceptual model (the proposed algorithm) makes it possible to take an expedient decision on the pricing strategy for a contract with mathematical, high theoretical and practical argumentation.

**Keywords**: contract theory, multi-criteria analysis, pricing mechanisms, strategic decision-making.

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## DEVELOPMENT OF A METHOD TO CALCULATE THE PROBABILITY OF A BERTH FAILURE UNDER VERTICAL STOCHASTIC LOAD (p. 21-27)

**Denys Bezushko**
Odessa National Maritime University, Odessa, Ukraine
**ORCID**: http://orcid.org/0000-0003-2215-1136

**Konstantin Egupov**
Odessa National Maritime University, Odessa, Ukraine
**ORCID**: http://orcid.org/0000-0002-8342-820X

**Mykhaylo Postan**
Odessa National Maritime University, Odessa, Ukraine
**ORCID**: http://orcid.org/0000-0003-4891-3063

We developed the method for determining the probability of achieving the maximum value of loads from the cargo that is stored at the port terminal warehouse on the front wall of the berth under conditions of uncertainty of the moments of vessel approach and their loading. The method is based on the construction and analysis of the stochastic model of operation of a port terminal, consisting of a single berth and a warehouse together with the reloading equipment. The process of the arrival of vessels with cargo is supposed to be described by the model of a complex Poisson process; the whole cargo unloaded from the vessels arrives at a warehouse and is transported

from a warehouse by the land transport in a uniform way at constant intensity. The probabilistic model of the operation of the system "a warehouse – a berth" at the port terminal was constructed with the help of the mathematical theory of risk. We formulated the criterion of safe operation of a berth at its structural elements being influenced by the random load of the cargo, stored in a warehouse in the rear of the berth, as the probability of not exceeding the maximum admissible value of the pressure on the front wall of the berth (according to the Coulomb law). To find the probability of a berth failure, the linear integral equation of the convolution type, the solution to which was found for a series of particular cases, was derived. Based on the found probability for a berth failure, two practically important problems were stated and solved. First, the values of intensity of cargo transporting from a warehouse, which ensures the absence of a failure with the small enough assigned probability, were determined. Second, we stated the criterion of the economic viability of insuring the port losses as a result of elimination of consequences of a berth failure due to the maximum admissible value being exceeded by loads over the assigned period of time. The numerical illustration of the specified problems was presented.

**Keywords**: port terminal, vessels with cargo, maximum pressure, front wall of a berth, risk of berth failure, risk insurance.

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### A METHOD TO FORM CONTROL OVER QUEUING SYSTEMS TAKING INTO CONSIDERATION THE PROBABILISTIC CHARACTER OF DEMAND (p. 28-36)

**Igor Lutsenko**
Kremenchuk Mykhailo Ostrohradskyi National University, Kremenchuk, Ukraine
**ORCID**: http://orcid.org/0000-0002-1959-4684

**Illia Dmytriiev**
Kharkiv National Automobile and Highway University, Kharkiv, Ukraine
**ORCID**: http://orcid.org/0000-0001-8693-3706

**Nina Avanesova**
Kharkiv National University of Civil Engineering and Architecture, Kharkiv, Ukraine
**ORCID**: http://orcid.org/0000-0003-3636-9769

**Iryna Semenyshyna**
State Agrarian and Engineering University in Podilia, Kamianets-Podilskyi, Ukraine
**ORCID**: http://orcid.org/0000-0001-9300-8914

**Zhanna Rozhnenko**
Kryvyi Rih National University, Kryvyi Rih, Ukraine
**ORCID**: http://orcid.org/0000-0002-3906-4728

**Oleg Danileyko**
Kryvyi Rih National University, Kryvyi Rih, Ukraine
**ORCID**: http://orcid.org/0000-0002-9011-2318

Queueing systems (QS) belong to the class of systems the quality of control over which cannot be assessed in real time. In other words, it is impossible to apply methods of classic search optimization at the stage of control design.

The current practice of control design implies the acquisition of historical data required to model an operational process in order to choose its best control parameters. These parameters include: determining the size of the planning horizon, forecasting interval, the type of a forecasting model. All these parameters represent the degrees of freedom of search optimization. Upon defining these parameters, modeling process is repeated for different values of shift in the demand forecasted value towards the region of large positive values. Such a shift leads to an increase in the QS inventory levels and a decrease in the likelihood of a product deficit occurrence.

Process efficiency is compromised by both the insurance stocks and a shortage of products. However, experience has shown that a certain shift in control towards an increase in the inventory levels improves the efficiency of their functioning.

Thus, the task on QS inventory control implies the substantiation of choice of control parameters in the process of cyclic simulation of the operational process based on the set of historical data.

Despite the long history of the subject, there is no method at present whose application would make it possible to obtain control, the parameters of which could be considered justified. This relates to that the best control parameters are determined not by examining the quality of economic models of an operational process but rather by studying the quality of quantitative models of this process.

In order to further advance the theory and methods of control, we have constructed an economic-mathematical model of uncoordi-

nated operation. The model proposed takes into consideration the result of interaction between processes in the buffering channel and processes in the client channel that aims to meet customer demand considering a factor of information impact from marketing technologies on the internal and external consumer.

The structure of the constructed mathematical model has passed the validation procedure for consistency, in the process of comparing the redundant and deficient operations.

A procedure for estimation optimization of the simulated process has showed a possibility to determine the optimal control parameters based on the criterion for a maximum criterion of efficiency of operational process.

**Keywords**: optimal control, demand forecasting, prediction, insurance stock, effectiveness formula.

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**DETERMINATION OF PARAMETERS OF THE STOCHASTIC INVENTORY MANAGEMENT SYSTEM IN THE CONDITIONS OF ECONOMICALLY-BASED SHORTAGE (p. 37-46)**

**Lidiia Savchenko**
National Aviation University, Kyiv, Ukraine
**ORCID**: http://orcid.org/0000-0003-3581-6942

**Mariya Grygorak**
National Aviation University, Kyiv, Ukraine
**ORCID**: http://orcid.org/0000-0002-5023-8602

A methodical approach to determining the optimal parameters of a stochastic inventory management system in the context of an economically justified deficit that allows responding quickly to fluctuations in demand and the dynamics of changes in inventory status is proposed and tested on real data. This approach relates, in particular, the shortage costs and the corresponding service level with the values of safety stock, order quantity and the threshold stock level. The technique is applicable to the normal distribution of inventory consumption and delivery time.

Determining the optimal parameters of the inventory management system in the conditions of unstable consumption and replenishment allows you to prevent an overestimation of the volume of inventories in the warehouses of industrial and commercial enterprises. At the same time, the need for working capital (the value of investments in stocks) and the total value added in the supply chains of goods decline, the risks of illiquid stocks decrease.

As a result of the study, a causal relationship was established between the level of customer service, the shortage level, order quantity and safety stock volume. It is proved that the procedure for determining the parameters of the stochastic inventory management system should be preceded by determining the economically feasible shortage level, which will determine the optimal level of customer service and the optimal size of safety stock by the criterion of total costs.

The proposed approach allows processing the accumulated statistical data on the dynamics of changes in stock status in real time using statistical methods and finding a compromise between the size of safety stock, the shortage level and the level of customer service by the criterion of minimum total costs.

**Keywords**: safety stock, stochastic models of inventory management, shortage level, customer service level.

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**Olena Slavinska**
National Transport University, Kyiv, Ukraine
**ORCID**: http://orcid.org/0000-0002-9709-0078

**Vitalii Stozhka**
Ltd. GRANBUD LEADER, Kyiv, Ukraine
**ORCID**: http://orcid.org/0000-0002-5039-9852

**Anna Kharchenko**
National Transport University, Kyiv, Ukraine
**ORCID**: http://orcid.org/0000-0001-8166-6389

**Andrey Bubela**
National Transport University, Kyiv, Ukraine
**ORCID**: http://orcid.org/0000-0002-5619-003X

**Alina Kvatadze**
M. P. Shulgin State Road Research Institute State Enterprise, Kyiv, Ukraine
**ORCID**: http://orcid.org/0000-0003-3320-3798

The article deals with the approaches to the construction of a multi-level hierarchical system of indicators for evaluation of the quality state of a motor road section. The model of the weight of parameters and characteristics of motor roads as a road-transport asset included in the information and management system of monetary evaluation was developed. The need for the research was caused by the necessity to develop a unified qualimetric model of monetary evaluation of a motor road section. As a result, the parameters and structural elements of motor roads were analyzed, which made it possible to consider the evaluation object – a road section – from the standpoint of the methodology of constructing complex multilevel hierarchical systems. Based on the proposed approach, a complete qualimetric model for the cost evaluation of a motor road was constructed, which is based on the method of decomposition of the object's properties and includes the maximum number of possible parameters, characteristics, structural elements, and indicators of transport operational state.

The mechanism of substantiation of the weights of parameters and characteristics of the evaluation object – a motor road section – through the rational combination of the cost method, the expert method and the method of equivalent relationships was proposed. The adequacy of the proposed model is proved by the analysis of standard errors that make up about 5 %, which that does not significantly affect reliability of the results of analytical calculations.

The results of the conducted studies will be the further development of the information and management system for the monetary evaluation of a road-transport complex, the operation purpose of which is substantiation of rational managerial decisions on road assets in general and on motor roads in particular.

The developed model of weights of motor road parameters can be used by enterprises and organizations of the road industry and can be a basis for making effective well-grounded managerial decisions on road-transport assets.

**Keywords**: weight of parameters, motor roads, level of quality state, qualimetry, hierarchical model, information and management system.

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**PROCESSES OF MANAGING INFORMATION INFRASTRUCTURE OF A DIGITAL ENTERPRISE IN THE FRAMEWORK OF THE «INDUSTRY 4.0» CONCEPT (p. 60-72)**

**Kateryna Andriushchenko**
Kyiv National Economic University named after Vadym Hetman, Kyiv, Ukraine
**ORCID**: http://orcid.org/0000-0002-6274-5310

**Volodymyr Rudyk**
State Agrarian and Engineering University in Podilia, Kamianets-Podilsky, Ukraine
**ORCID**: http://orcid.org/0000-0001-9011-4543

**Olena Riabchenko**
National University of the State Fiscal Service of Ukraine, Irpin, Ukraine
**ORCID**: http://orcid.org/0000-0001-6631-2830

**Maryana Kachynska**
Kharkiv National University of Internal Affairs, Kharkiv, Ukraine
**ORCID**: http://orcid.org/0000-0002-7319-4470

**Nataliia Marynenko**
Ternopil Ivan Puluj National Technical University, Ternopil, Ukraine
**ORCID**: http://orcid.org/0000-0002-6645-8167

**Lidiya Shergina**
Kyiv National Economic University named after Vadym Hetman, Kyiv, Ukraine
**ORCID**: http://orcid.org/0000-0001-9031-0616

**Vita Kovtun**
Kyiv National Economic University named after Vadym Hetman, Kyiv, Ukraine
**ORCID**: http://orcid.org/0000-0001-7212-6700

**Mariia Tepliuk**
Kyiv National Economic University named after Vadym Hetman, Kyiv, Ukraine
**ORCID**: http://orcid.org/0000-0001-6823-336X

**Alla Zhemba**
National University of Water and Environmental Engineering, Rivne, Ukraine
**ORCID**: http://orcid.org/0000-0003-0268-3258

**Oksana Kuchai**
Kyiv National Linguistic University, Kyiv, Ukraine
**ORCID**: http://orcid.org/0000-0002-4201-7236

A study of the management of the information infrastructure of a digital enterprise is conducted within the framework of the "Industry 4.0" concept. It is determined that modern digital technologies cause an exponential growth of data flows, for the effective functioning of which the need arises to transform a classic enterprise into digital. There are new business models, network structures based on collective methods of production and consumption, which transform traditional market relations and require the development of new solutions in the field of digital enterprise management. It is noted that the use of all elements (mobility; sociality; BPM, electronic document management system ERP finance and accounting; Big Data Analytics, business analytics) of modern information and communication technologies will increase the productivity and value of enterprises. It is determined that information and communication technologies allow to effectively interact with each other in certain sectors of production and ensure the optimization of any business processes using consumerization. Modern trends in the development of digital enterprises are identified and the prerequisites for the introduction of digitalization in the business space are marked. The constituent elements of the management process of the information infrastructure of a digital enterprise are structured, on the basis of which a model of the information infrastructure management process is proposed. The objectives of the digital infrastructure are substantiated, which are indicated: to increase the speed of decision-making, to increase the variability of processes depending on the needs and characteristics of the client, to reduce the number of employees involved in the process. The methodological foundations of the process of managing the information infrastructure of a digital enterprise are deepened in the context of the "Industry 4.0" concept.

**Keywords**: management processes, information infrastructure, digital enterprise, digital economy, Industry 4.0.

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