DEVELOPMENT OF AN APPROACH FOR OPERATIVE CONTROL OVER RAILWAY TRANSPORT TECHNOLOGICAL SAFETY BASED ON THE IDENTIFICATION OF RISKS IN THE INDICATORS OF ITS OPERATION (p. 6-14)

Valerii Samsonkin
State University of Infrastructure and Technologies, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-1521-2263

Oleksii Goretzkyi
State University of Infrastructure and Technologies, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-2566-6120

Viacheslav Matisuk
State University of Infrastructure and Technologies, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0003-2355-2564

Viktor Myronenko
State University of Infrastructure and Technologies, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-5888-3867

Anatoliy Boinik
Ukrainian State University of Railway Transport, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0001-7773-9055

Viktor Merkulov
Ukrainian State University of Railway Transport, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0003-3898-6445

The paper addresses the mechanism of ensuring and management of traffic safety in railway traffic. It uses the actual statistics on the cases of violations of traffic safety along the railways of Ukraine over recent years. We have selected three departments for empirical research and along the railways of Ukraine over recent years. We have actual statistics on the cases of violations of traffic safety management of traffic safety in railway traffic. It uses the 

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of measures to prevent escalation into an emergency. We defined a risk as the most significant prerequisite for traffic accidents. Prerequisites are in the plane of ensuring of a transportation process, and they are systemic in nature.

The developed algorithm for operative management of technological safety and a procedure for support of making operative management decisions reduce the impact of risks. The algorithm is formalized and ready for automation. Automation involves application of 4.0 digital technologies. Application of the proposed approach will help to reduce an impact of the human factor, to increase efficiency and objectivity of management decisions for ensuring of safety, and to make safety financing targeted and effective. It is possible to apply the proposed approach to other modes of transportation.

Keywords: systematic approach, technological safety, management decision, detection of statistical pattern.

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IMPROVEMENT OF THE ANTI-COLLISION METHOD “VELOCITY OBSTACLE” BY TAKING INTO CONSIDERATION THE DYNAMICS OF AN OPERATING VESSEL (p. 14-19)

Andriy Aleksishin
National University “Odessa Maritime Academy”, Odessa, Ukraine
ORCID: http://orcid.org/0000-0002-7629-9411

Aleksandr Vagushchenko
LLC Nordic Hamburg Shipmanagement Ltd., Odessa, Ukraine
ORCID: http://orcid.org/0000-0003-2389-4305

Oleksandr Vagushchenko
National University “Odessa Maritime Academy”, Odessa, Ukraine
ORCID: http://orcid.org/0000-0002-0776-8595

Yevgeniy Kalinichenko
National University “Odessa Maritime Academy”, Odessa, Ukraine
ORCID: http://orcid.org/0000-0003-2898-7313

This paper has proposed an algorithm that accounts for the dynamics of an operating vessel within the Velocity Obstacle collision prevention method. This algorithm provides the basis for selecting joint maneuvers by course and speed with the assigned start for divergence with multiple “targets” by determining, applying a sorting method, a representative set of acceptable maneuver options. In order to employ the method of sorting, we have selected the ranges of change in the maneuver parameters (course and speed) and performed their sampling at a small enough step. One finds, for all pairs of discrete values of change in the course and speed, taking into consideration the dynamics of an operating vessel, a trajectory and duration of a maneuver, with determining, at the time it ends, the location of an operating vessel and “targets”, as well as it is to be established if it is accompanied by the intersection of “target” danger domains. If none of these domains is crossed, the maneuver option is considered acceptable. The totality of such joint changes in course and speed, derived from sorting, creates a set of permissible maneuver options. When finding this set, the dynamics of an operating vessel is taken into consideration simplistically. It is believed that the turns are performed at a constant angular speed, a change in the linear speed at braking can be represented by a power polynomial of second order, and changes in course and speed in the joint maneuver are independent. The “targets” involve circular danger domains whose center is shifted, from a “target”’s center of mass to the stern, by 1/3 of the domain’s radius. This radius has been amended to include the size of a “target” and an operating vessel.

To test the resulting algorithm, the software has been developed in the Borland Delphi programming language. Employing it for calculations has confirmed the operability of the algorithm. That enables the derivation, in real time, of a set of velocity vectors for divergence taking into consideration the dynamics of own vessel, which makes it possible to improve the accuracy of forecasting and the safety of calculated maneuvers. The use of displaced circular danger domains for “targets” makes it possible to take into account the unequal degree of risk when crossing their course along the bow and stern.

Keywords: collision prevention, sorting method, set of valid options, dynamics accounting algorithm.

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This paper proposes a Boolean mathematical model of integer linear programming, which takes into consideration the structural features of containers, of a vessel, as well as rules for placing hazardous cargoes according to the IMDG Code (International Maritime Dangerous Cargoes Code), as well as a modified additive algorithm for solving a problem on compiling a load plan for a containership. To validate the mathematical model, we have chosen a classic algorithm that relies on the ideas from the general method of branches and boundaries. Given that the derived mathematical model for a problem on loading a containership by dangerous cargoes has a specific form, this algorithm was complemented with tests, which make it possible to reject some solutions without direct check.

The paper gives an example of solving the problem on placing cargoes in the hold taking into consideration the structural constraints for containers and the rules for placing dangerous cargoes in accordance with the IMDG Code, which was obtained through the modified additive algorithm.

**Keywords:** containerships, load plan, Boolean mathematical model, dangerous cargoes, additive algorithm.

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**CONSTRUCTION OF A MATHEMATICAL MODEL AND A METHOD FOR ARRANGING HAZARDOUS CARGOES ON A CONTAINERSHIP**

(p. 20-27)

Kyrylo Kamieniev  
National University “Odessa Maritime Academy”, Odessa, Ukraine  
ORCID: http://orcid.org/0000-0002-9200-9496

Alla Kamienieva  
National University “Odessa Maritime Academy”, Odessa, Ukraine  
ORCID: http://orcid.org/0000-0002-9970-9081

Mykola Tsybmal  
National University “Odessa Maritime Academy”, Odessa, Ukraine  
ORCID: http://orcid.org/0000-0003-1398-9279

Compiling a load plan for a containership, which takes into account the maximum number of factors, requires consideration of the structural constraints for containers and a vessel, restrictions on placement, as well as segregation rules for cases of dangerous cargoes.

Accounting for restrictions on placing containers with hazardous cargoes, the so-called IMO containers (IMO – International Maritime Organization), appears important given the current tendency towards the increased volumes of hazardous cargo transportation.

The proposed approach for solving the task on automating the compilation of a load plan aboard a containership implies dividing the task into two stages. At the first stage, one calculates the permissible arrangement of containers taking into consideration the structural limitations and compatibility of dangerous cargoes, at the second stage – one calculates safety parameters (stability, durability, etc.).
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One of the essential, yet insufficiently studied, issues related to the implementation of onboard capacitive energy accumulators in the subway is determining their rational parameters (power and energy intensity). We have analyzed existing methods and approaches to choosing the parameters for onboard capacitive energy accumulators. Disadvantages for each method and approach have been defined. We have substantiated the need to devise an approach that would make it possible to fully account for the factors influencing actual conditions of a subway train operation. Existing methods and approaches to selecting rational parameters have deficiencies and do not take into consideration the factors of real operating conditions of a subway train. This paper has proposed a comprehensive approach that takes into account the specified factors of influence and makes it possible to choose rational parameters for an onboard capacitive energy accumulator based on two indicators: the weight and cost of an accumulation system. We have determined the rational parameters for an onboard capacitive energy accumulator for the predefined operating conditions of a subway train using a comprehensive approach. The amount of saved electric power due to the implementation of an onboard accumulator with rational parameters has been calculated. The research results could be used when designing, constructing, and introducing the subway rolling stock with an onboard capacitive energy accumulator, as well as during an expert estimation of the amount of energy saved.

Keywords: onboard capacitive energy accumulator, subway train, regenerative braking, accumulation system.

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COSTEFFECTIVENESS IN MATHEMATICAL MODELLING OF THE POWER UNIT CONTROL
(p. 39–48)

Oleksandr Popov
Kharkiv State Academy of Physical Culture,
Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0003-0550-7890

Nataliia Shmatko
National Technical University “Kharkiv Polytechnic Institute”, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-4969-252X

Pavlo Budanov
Ukrainian Engineering Pedagogics Academy, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-1542-9390

Iryna Pantielieieva
Ukrainian Engineering Pedagogies Academy, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0003-2960-2358

Kostiantyn Brovko
Kharkiv Petro Vasyleenko National Technical University of Agriculture, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-9669-9316

The authors of the study have analysed the criteria for increasing cost-effectiveness in the operation of power-generating equipment of power units at TPPs and NPPs. The existing methods of calculating the cost-effectiveness generating equipment of power units at TPPs and NPPs. The existing methods of calculating the cost-effectiveness generating equipment of power units at TPPs and NPPs.
plant is the compulsory checking to detect a low level of information reliability. It is proved that reliability of the power unit technological equipment substantially depends on the effectiveness of emergency automated control when an unpermitted shutdown of a power unit occurs due to false positives. It is shown that the cause of false positives is low reliability of the data on the power unit technological process parameters. It is revealed that unforeseen unpermitted shutdown of a power unit and a decrease in the energy consumer load leads to significant economic and material losses, and, consequently, to a decrease in economic efficiency of automated control of a power unit. It is shown that the existing economic models do not take into account the financial and material costs that occur due to unpermitted shutdown of the power unit and decrease in the energy consumer load in case of false positives in real time. The authors of the study have devised a unified integrated economic and mathematical model, which allows calculating the economic effect taking into account changes in the reliability of the technological equipment, due to the timely prompt detection of false positives and low-reliability data. The proposed emergency modular unit coupled with modules for detecting and control of false alarms, which takes into account static and operational economic components, allows calculating the economic effect based on the devised unified integrated economic and mathematical model. The authors of the study give practical recommendations for applying the economic module in the hardware and software complex of the power unit, which allows calculating the economic effect on the basis of static data coming from the data memory and current data from the power unit.

**Keywords:** power unit abnormal mode, efficiency criteria, methods for calculating the economic effect.

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DEVELOPMENT OF A METHOD FOR DETERMINATION OF SHIP’S LOADING TIME DISTRIBUTION UNDER IRREGULAR CARGO ARRIVAL (p. 49-56)

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

Iryna Saveleva
Odessa National Maritime University, Odessa, Ukraine
ORCID: http://orcid.org/0000-0002-6492-2130

Victoria Stadnik
Odessa National Maritime University, Odessa, Ukraine
ORCID: http://orcid.org/0000-0003-2930-6532

A method for determining the time distribution function of ship berthing under loading under the direct option of loading operations (i.e., without the warehouse) in conditions of irregular cargo delivery by rail is developed. In order to take into account uncertainty and risk factors (random arrivals of loaded cars at the terminal and loading volume of cars), it is proposed to use linear Markov processes that describe the dynamics of train arrival and cargo loading on the ship. It is assumed that the intervals between adjacent arrivals of loaded cars at the terminal are exponential random variables. Cargo transshipment from cars on the ship is carried out at a constant rate. The cases when the volume of cargo in cars is a random or constant variable are considered in detail. To find the probability densities and state probabilities of the corresponding Markov process, a system of linear differential equations is derived. A solution to this system of equations in terms of the Laplace transform is found, in particular, the distribution function of the ship berthing time, taking into account possible interruptions while waiting for cargo delivery by cars. For the case of a constant volume of cargo on cars, the corresponding distribution function of the ship berthing time and its asymptotics for a large deadweight tonnage are also found using the central limit theorem. Based on the results obtained, the problem of finding a criterion of expediency of insuring the risk of exceeding the laytime (contractual) of the ship is formulated. It is proved that the results obtained are important for the theory, as well as for the practice of the port operator and shipping companies, since they can reduce the risk of exceeding the ship berthing time under loading operations. A numerical illustration of the proposed method is given.

Keywords: port terminal, ship, loaded cars, laytime exceeding risk, risk insurance.

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ESTABLISHING PATTERNS OF CHANGE IN THE INDICATORS OF USING MILK PROCESSING SHOPS AT A COMMUNITY TERRITORY
(p. 57-65)

Anatoliy Tryhuba
Lviv National Agrarian University, Dublyany, Ukraine
ORCID: http://orcid.org/0000-0001-8014-5661

Mykola Rudynets
Lviv National Technical University, Lutsk, Ukraine
ORCID: http://orcid.org/0000-0002-0793-5963
It was established that there are two periods of milk processing – intensive one (from day 119 to day 301 within a calendar year) and non-intensive one (from day 1 to day 118 and from day 302 to day 365 within a calendar year) based on forecasting daily volumes of milk supplied for processing from communities’ farms over a calendar year. It is necessary to organize operation of shops in two shifts during the intensive period of milk processing, and in one shift during the non-intensive one. It was established that the laws of Weibull distribution describe daily volumes of milk processing. Their statistical characteristics during the intensive and non-intensive periods are: coefficient of variation is 0.65 and 0.62; shape parameter is 1.56 and 1.64, respectively. The confidence interval is within 509...6,995 liters.

We studied changing production conditions and identified trends in changes in the parameters of using milk processing shops at community territories. They underlie the determination of cost indicators. The results of this study will be useful for the identification of a configuration of projects to create milk production shops at a community territory.

Keywords: functioning, shop, milk processing, efficiency, planning, modeling, stochasticity, production conditions.

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DEVELOPMENT OF A COMPUTER MODEL FOR EVALUATING THE ALTERNATIVE OPTIONS OF AN INVESTMENT AND CONSTRUCTION PROJECT UNDER CONDITIONS OF UNCERTAINTY AND RISK (p. 66-76)

Natalia Sizova
Kharkiv National University of Civil Engineering and Architecture, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-8950-8200

Olha Starkova
Kharkiv National University of Civil Engineering and Architecture, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-9034-8830

Ganna Solodovnik
Kharkiv National University of Civil Engineering and Architecture, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0001-6323-5083

Natalya Dolgova
Kharkiv National University of Civil Engineering and Architecture, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-8950-8200
The paper reports the proposed method of quantitative analysis of risks in investment construction projects, which uses a probabilistic approach. The specific feature of this approach is a multistage evaluation process and complex accounting of indicators for decision making regarding the investment attractiveness of sites under conditions of uncertainty.

Based on this approach, an automated computer model for evaluating investment attractiveness of construction projects was developed. The indicators of investment efficiency and risks for various options of construction project implementation were explored, the alternative for a project development was selected and the best investment project was determined with the use of the computer model.

The reliability of the results was proved by studying the stability of decisions and by their errors.

The results were obtained in order to improve the efficiency of managerial decisions in the sector of investment in construction sector of economy. The developed computer model makes it possible, based on statistical data of demand for residential real estate, to perform a quantitative analysis of risks of investment in construction projects, to make a choice of a construction project by profitability and risk indicators, as well as by the criteria of decision making under conditions of risk and uncertainty.

Numerical experiments with a computer model showed the need to invest in additional research in order to clarify the environmental parameters and to invest in the construction of a multi-storey building.

The obtained results are relevant due to a high degree of turbulence in the environment in the construction sector, as well as in connection with the importance of attracting investments from the position of competitiveness. The computer model developed in the process of research is universal regarding the type of a residential real estate construction object.

**Keywords**: quantitative analysis of risks, decision tree, investment project, decision making under conditions of risk.

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