ABSTRACT AND REFERENCES

CONTROL PROCESSES

DOI: 10.15587/1729-4061.2019.184162

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 Goretskyi
State University of Infrastructure and Technologies, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-2656-6120

Viacheslav Matsiuk
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/0000-0002-6088-3867

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 justification of the need for a systematic approach. The departments account for 60 % of traffic accidents a year. The departments include a locomotive department, tracks department and carriages department. A systematic approach to technological safety management has been proposed. It uses safety violation statistics as input information. It systematizes each safety violation accident according to eight parameters that characterize location, time, type of case, its cause, guilty party, circumstances, motivation, and targeted damage. It creates the appropriate database with systematization parameters. The analysis of dynamics of traffic accidents in the one-, two-, and three-dimensional space of systematization parameters detected hidden patterns, which pose a threat of deterioration of safety and occurrence of emergency. We interpreted this as a bottleneck, which requires increased attention and development 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.

References

1. Festag, A. (2014). Cooperative intelligent transport systems standards in europe. IEEE Communications Magazine, 52 (12), 166–172. doi: https://doi.org/10.1109/mcom.2014.6979970
2. Sjoberg, K., Andres, P., Buburuzan, T., Brakemeier, A. (2017). Cooperative Intelligent Transport Systems in Europe: Current Deployment Status and Outlook. IEEE Vehicular Technology Magazine, 12 (2), 89–97. doi: https://doi.org/10.1109/mvt.2017.2670018
3. Li, Z., Dao, H., Patel, H., Liu, Y., Zhou, B. (2017). Incorporating Traffic Control and Safety Hardware Performance Functions into Risk-based Highway Safety Analysis. PROMET - Traffic&Transportation, 29 (2), 143–153. doi: https://doi.org/10.7307/ptt.v29i2.2041
4. Young, W., Sobhani, A., Lenné, M. G., Sarvi, M. (2014). Simulation of safety: A review of the state of the art in road safety simulation modelling. Accident Analysis & Prevention, 66, 89–103. doi: https://doi.org/10.1016/j.aap.2014.01.008
5. Astarita, V., Giofré, V. P. (2019). From traffic conflict simulation to traffic crash simulation: Introducing traffic safety indicators based on the explicit simulation of potential driver errors. Simulation Modelling Practice and Theory, 94, 215–236. doi: https://doi.org/10.1016/j.simpat.2019.03.003
6. Pešić, D., Vujanić, M., Lipovac, K., Antić, B. (2013). New method for benchmarking traffic safety level for the territory. Transport, 28 (1), 69–80. doi: https://doi.org/10.3846/16484142.2013.781539
7. Johnsson, C., Laureshyn, A., De Ceunynck, T. (2018). In search of surrogate safety indicators for vulnerable road users: a review of surrogate safety indicators. Transport Reviews, 38 (6), 765–785. doi: https://doi.org/10.1080/01441647.2018.1442888
8. Kamaluddin, N. A., Andersen, C. S., Larsen, M. K., Meltofte, K. R., Várhelyi, A. (2018). Self-reporting traffic crashes – a systematic literature review. European Trans-

port Research Review, 10 (2). doi: https://doi.org/10.1186/s12544-018-0301-0
9. Sokolovskij, E., Prentkovskis, O. (2013). Investigating traffic accidents: the interaction between a motor vehicle and a pedestrian. Transport, 28 (3), 302–312. doi: https://doi.org/10.3846/16484142.2013.831771
10. Clitan, A.-F. (2014). Sustainable Transport in Romania vs. European Union. Analysis of Road Transport System from the Sustainable Transport Perspective. Romanian Journal of Transport Infrastructure, 3 (2), 37–45. doi: https://doi.org/10.1515/rjti-2015-0026
11. Bureika, G., Gaidamauskas, E., Kupinas, J., Bogdevičius, M., Steišūnas, S. (2016). Modelling the assessment of traffic risk at level crossings of lithuanian railways. Transport, 32 (3), 282–290. doi: https://doi.org/10.3846/16484142.2016.1244114
12. Dezhkam, B., Mehrdad Eslami, S. (2017). A review of methods for highway-railway crossings safety management process. International electronic journal of mathematics education, 12 (3), 561–568.
13. Sever, D. (1970). New Approach to Determining Visibility Length on Passive Protected Level Railroad Crossings. PROMET - Traffic&Transportation, 24 (6), 479–486. doi: https://doi.org/10.7307/ptt.v24i6.1203
14. Matsiuk, V. (2017). A study of the technological reliability of railway stations by an example of transit trains processing. Eastern-European Journal of Enterprise Technologies, 1 (3 (85)), 18–24. doi: https://doi.org/10.15587/1729-4061.2017.91074
15. Santarremigia, F. E., Molero, G. D., Poveda-Reyes, S., Aguilar-Herrando, J. (2018). Railway safety by designing the layout of inland terminals with dangerous goods connected with the rail transport system. Safety Science, 110, 206–216. doi: https://doi.org/10.1016/j.ssci.2018.03.001
16. Mironenko, V. K., Kacman, M. D., Macyuk, V. I. (2016). Creation pre-conditions of decision support system on of consequences liquidation of railway emergency on the basis of network-centric control methods. Systemy obrobky informatsiyi: zbirnyk naukovykh prats, 5 (142), 182–188.
17. Katsman, M. D., Myronenko, V. K., Matsiuk, V. I. (2015). Mathematical models of ecologically hazardous rail traffic accidents. Reliability: theory & applications, 10 (1), 28–39.
18. Chruzik, K., Wiśniewska, K., Fellner, R. (2017). Analysis of internal sources of hazards in civil air operations. Scientific Journal of Silesian University of Technology. Series Transport, 94, 27–35. doi: https://doi.org/10.20858/sjsutst.2017.94.3
19. Di Gravio, G., Patriarca, R., Costantino, F., Sikora, I. (2017). Safety Assessment for an ATM System Change: A Methodology for the ANSPs. PROMET - Traffic&Transportation, 29 (1), 99–107. doi: https://doi.org/10.7307/ptt.v29i1.2121
20. Skorupski, J. (2011). Dynamic methods of air traffic flow management. Transport Problems, 6 (1), 21–28.
21. Rios Insua, D., Alfaro, C., Gomez, J., Hernandez-Coronado, P., Bernal, F. (2019). Forecasting and assessing consequences of aviation safety occurrences. Safety Science, 111, 243–252. doi: https://doi.org/10.1016/j.ssci.2018.07.018
22. Corrigan, S., Kay, A., Ryan, M., Ward, M. E., Brazil, B. (2019). Human factors and safety culture: Challenges and opportunities for the port environment. Safety Science, 119, 252–265. doi: https://doi.org/10.1016/j.ssci.2018.03.008
23. Velychko, O., Gordiyenko, T. (2018). A comparative analysis of the assessment results of the competence of technical experts by methods of analytic hierarchy process and with using the Rasch model. Eastern-European Journal of Enterprise Technologies, 3 (3 (93)), 14–21. doi: https://doi.org/10.15587/1729-4061.2018.131459
24. Bochkovskii, **A.,** Gogunskii, V. (2018). Development of the method for the optimal management of occupational risks. Eastern-European Journal of Enterprise Technologies, 3 (3 (93)), 6–13. doi: https://doi.org/10.15587/1729-4061.2018.132596
25. The European Parliament. Directive 2004/49/EU (Railway Safety Directive) (2004). European Union: Official Journal of the European Union, 24.
26. Polozhennia pro Systemu upravlinnia bezpekoiu rukhu poizdiv u Derzhavniy administratsiyi zaliznychnoho transportu (2011). Zbirnyk normatyvnykh aktiv z bezpeky rukhu ha zaliznychnomu transporti. Kyiv: DAZTU, 32–130.
27. International Electrotechnical Commission. IEC 61508-1: 2010. Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements (2010). International Electrotechnical Commission, 132.
28. Zoeteman, A., van Zelm, R. (2001). Developing a Cost-Effective Renewal Strategy for Railway Track on Conventional Networks. A practical example of a policy revision at Netherlands Railways. Proceedings of the 5-th World conference on Railway Research. Cologne.
29. Butko, T. V., Prokhorov, V. M., Chekhunov, D. M. (2018). Intelligent control of marshalling yards at transportation of dangerous goods based on multiobjective optimization. Science and Transport Progress. Bulletin of Dnipropetrovsk National University of Railway Transport, 5, 41–52. doi: https://doi.org/10.15802/stp2018/145470
30. Butko, T., Prokhorov, V., Chekhunov, D. (2017). Devising a method for the automated calculation of train formation plan by employing genetic algorithms. Eastern-European Journal of Enterprise Technologies, 1 (3 (85)), 55–61. doi: https://doi.org/10.15587/1729-4061.2017.93276
31. Analiz stanu bezpeky rukhu, polotiv, sudnoplavstva v Ukraini za 2012 rik (2013). Ministerstvo infrastruktury Ukrainy. Kyiv: Ministerstvo infrastruktury Ukrainy, 52. Available at: https://mtu.gov.ua/files/Avar_analiz_2012.Pdf
32. Analiz stanu bezpeky rukhu, polotiv, sudnoplavstva v Ukraini za 2013 rik (2014). Ministerstvo infrastruktury Ukrainy. Kyiv: Ministerstvo infrastruktury Ukrainy, 117. Available at: https://mtu.gov.ua/files/Avar_analiz_2013.Pdf
33. Analiz stanu bezpeky rukhu, polotiv, sudnoplavstva ta avariynosti na transporti v Ukraini za 2014 rik (2015). Departament bezpeky na transporti Ministerstva infrastruktury Ukrainy. Kyiv: Ministerstvo infrastruktury Ukrainy, 124. Available at: https://mtu.gov.ua/files/АНАЛІЗ%20за%202014%20рік.pdf

34. Analiz stanu bezpeky rukhu, polotiv, sudnoplavstva ta avariynosti na transporti v Ukraini za 2015 rik (2015). Kyiv: Ministerstvo infrastruktury Ukrainy, 150. Available at: https://mtu.gov.ua/files/АНАЛІЗ%20-%202015.pdf
35. Analiz stanu bezpeky rukhu, sudnoplavstva ta avariinosti na transporti v Ukraini za 2016 rik. Available at: http://dsbt.gov.ua/sites/default/files/imce/Bezpeka_DTP/analiz_2017/analiz_avariynosti_2016.pdf
36. Analiz stanu bezpeky rukhu, sudnoplavstva ta avariinosti na transporti v Ukraini za 2017 rik. Available at: http://dsbt.gov.ua/sites/default/files/imce/Bezpeka_DTP/2018/analiz_avariynosti_2017.compressed.pdf
37. Dovidnyk osnovnykh pokaznykiv roboty Rehionalnykh filiy PAT «Ukrainska zaliznytsia» (2005–2015 roky) (2016). Ukrainska zaliznytsia, Upravlinnia statystyky. Kyiv: VTs «Prydniprovia», 60.
38. Samsonkin, V. M., Martyshko, A. M. (2015). Praktychne zastosuvannia vyznachennia «vuzkykh mists» v ubezpechenni rukhu na pidpryiemstvakh zaliznychnoho transportu dlia profilaktyky transportnykh podii. Zaliznychnyi transport Ukrainy, 1, 3–10.
39. Samsonkin, V., Druz', V., Feldman, A. (2018). Applying of activities management based on self-learning. EUREKA: Physics and Engineering, 1, 29–38. doi: https://doi.org/10.21303/2461-4262.2018.00530

DOI: 10.15587/1729-4061.2019.185319

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/0000-0003-2389-4505

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.

References

1. Statheros, T., Howells, G., Maier, K. M. (2007). Autonomous Ship Collision Avoidance Navigation Concepts, Technologies and Techniques. Journal of Navigation, 61 (1), 129–142. doi: https://doi.org/10.1017/s037346330700447x
2. Kuwata, Y., Wolf, M. T., Zarzhitsky, D., Huntsberger, T. L. (2014). Safe Maritime Autonomous Navigation With COLREGS, Using Velocity Obstacles. IEEE Journal of Oceanic Engineering, 39 (1), 110–119. doi: https://doi.org/10.1109/joe.2013.2254214
3. Damas, B., Santos-Victor, J. (2009). Avoiding moving obstacles: the forbidden velocity map. 2009 IEEE/RSJ International Conference on Intelligent Robots and Systems. doi: https://doi.org/10.1109/iros.2009.5354210
4. Wilkie, D., van den Berg, J., Manocha, D. (2009). Generalized velocity obstacles. 2009 IEEE/RSJ International Conference on Intelligent Robots and Systems. doi: https://doi.org/10.1109/iros.2009.5354175
5. Pietrzykowski, Z., Borkowski, P., Wołejsza, P. (2012). NAVDEC - navigational decision support system on a seagoing vessel. Maritime University of Szczecin, 30 (102), 102–108.
6. Yong, X., Yixiong, H., Liwen, H. (2015). Multi-ship automatic collision avoidance control method based on speed obstacle. China maritime, 38 (3), 144–153.

7. Kim, D.-G., Hirayama, K., Park, G.-K. (2014). Collision Avoidance in Multiple-Ship Situations by Distributed Local Search. Journal of Advanced Computational Intelligence and Intelligent Informatics, 18 (5), 839–848. doi: https://doi.org/10.12716/1001.09.01.03
8. Hayama, I. (2014). Computation of OZT by using Collision Course. Navigation, 188, 78–81. doi: https://doi.org/10.18949/jinnavi.188.0_78
9. Vagushchenko, A. A., Vagushchenko, A. L. (2017). Definition of safe z-maneuvers areas for collision avoidance in confined waters. Ekspluatatsiya morskogo transporta, 2 (83), 73–75.
10. Banas, P., Breitsprecher, M. (2011). Knowledge Base in the Interpretation Process of the Collision Regulations at Sea. International Journal on Marine Navigation and Safety of Sea Transportation, 5 (3), 359–364.
11. Burmeister, H., Bruhn, W. (2014). Designing an autonomous collision avoidance controller respecting COLREG. Maritime-Port Technology and Development, 83–88. doi: https://doi.org/10.1201/b17517-11

DOI: 10.15587/1729-4061.2019.183385

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 Tsymbal
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.).

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.

Reference

1. Galierikova, A., Sosedova, J. (2018). Intermodalni prijevoz opasnih tereta. Naše More, 65 (3), 8–11. doi: https://doi.org/10.17818/nm/2018/3.8
2. Krupneyshie vladel’tsy “megamaksov” v mire. Available at: https://ports.com.ua/articles/krupneyshie-vladeltsy-megamaksov-v-mire
3. Ambrosino, D., Sciomachen, A., Tanfani, E. (2004). Stowing a containership: the master bay plan problem. Transportation Research Part A: Policy and Practice, 38 (2), 81–99. doi: https://doi.org/10.1016/j.tra.2003.09.002
4. Wang, L., Ni, M., Gao, J., Shen, Q., Jia, Y., Yao, C. (2019). The Loading Optimization: A Novel Integer Linear Programming Model. Enterprise Information Systems, 13 (10), 1471–1482. doi: https://doi.org/10.1080/17517575.2019.1631964
5. Parreño-Torres, C., Alvarez-Valdes, R., Parreño, F. (2019). Solution Strategies for a Multiport Container Ship Stowage Problem. Mathematical Problems in Engineering, 2019, 1–12. doi: https://doi.org/10.1155/2019/9029267
6. Kebedow, K. G., Oppen, J. (2018). Including Containers with Dangerous Goods in the Multi-Port Master Bay Planning Problem. MENDEL, 24 (2). doi: https://doi.org/10.13164/mendel.2018.2.023
7. Zeng, M., Low, M. Y. H., Hsu, W. J., Huang, S. Y., Liu, F., Win, C. A. (2010). Automated stowage planning for large containerships with improved safety and stability. Proceedings of the 2010 Winter Simulation Conference. doi: https://doi.org/10.1109/wsc.2010.5678873
8. Ambrosino, D., Sciomachen, A. (2015). Using a Bin Packing Approach for Stowing Hazardous Containers into Containerships. Springer Optimization and Its Applications, 1–18. doi: https://doi.org/10.1007/978-3-319-18899-7_1
9. Kamieniev, K. I., Kamienieva, A. V. (2018). Vykopystannia adytyvnoho alhopytmu dlia rozmishchennia nebezpechnykh

vantazhiv na konteinernomu sudni. Sudovozhdenie: sbornik nauchnyh tpudov, 28, 70–77.
10. Yaagoubi, A. E., El Hilali Alaoui, A., Boukachour, J. (2018). Multi-objective river-sea-going container barge stowage planning problem with container fragility and barge stability factors. 2018 4th International Conference on Logistics Operations Management (GOL). doi: https://doi.org/10.1109/gol.2018.8378102
11. Ambrosino, D., Anghinolfi, D., Paolucci, M., Sciomachen, A. (2010). An Experimental Comparison of Different Heuristics for the Master Bay Plan Problem. Lecture Notes in Computer Science, 314–325. doi: https://doi.org/10.1007/978-3-642-13193-6_27
12. On Transportation of Dangerous Cargos. Available at: https://zakon.rada.gov.ua/laws/show/1644-14?lang=en
13. IMDG Code (2012). Vol. 1. CPI Group (UK) Ltd, Croydon, 486.
14. Taha, H. (2018). Issledovanie operatsiy. Sankt-Peterburg: OOO «Dialektika», 1056.
15. Taha, H. (1985). Vvedenie v issledovanie operatsiy. Kn. 1. Moscow: Mir, 479.
16. Neygel, K., Iv'en, B., Glinn, D., Uotson, K., Skinner, M. (2011). C#4.0 i platforma.NET 4 dlya professionalov. Moscow: Dialektika, Vil'yams, 1440.

DOI: 10.15587/1729-4061.2019.183304

DEVELOPMENT OF A COMPREHENSIVE APPROACH TO DETERMINING THE RATIONAL PARAMETERS OF AN ONBOARD CAPACITIVE ENERGY ACCUMULATOR FOR A SUBWAY TRAIN (p. 28-38)

Andriy Sulym
State Enterprise «Ukrainian Scientific Railway Car Building Research Institute», Kremenchuk, Ukraine
ORCID: http://orcid.org/0000-0001-8144-8971

Oleksij Fomin
State University of Infrastructure and Technologies, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0003-2387-9946

Pavlo Khozia
State Enterprise «Ukrainian Scientific Railway Car Building Research Institute», Kremenchuk, Ukraine
ORCID: http://orcid.org/0000-0001-8948-6032

Oleksii Palant
O. M. Beketov National University of Urban Economy in Kharkiv, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0001-8178-6874

Vyacheslav Stamatin
O. M. Beketov National University of Urban Economy in Kharkiv, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0003-3441-567X

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.

References

1. Sablin, O. (2014). Study of the efficiency of the electric energy recovery process in the subway. Eastern-European Journal of Enterprise Technologies, 6 (8 (72)), 9–13. doi: https://doi.org/10.15587/1729-4061.2014.30483
2. Zhemerov, G. G., Ilyina, N. O., Tugay, D. V. (2014). Reduction of energy losses in subway rolling-stock energy supply systems using energy-consuming storages. Tekhnichna elektrodynamika, 5, 137–138.
3. Shevlyugin, M. V., Zheltov, K. S. (2008). On reduction of electric power consumption in Moscow underground by application of capacitive energy storage devices. Nauka i tehnika transporta, 1, 15–20.
4. Ciccarelli, F., Iannuzzi, D., Tricoli, P. (2012). Control of metro-trains equipped with onboard supercapacitors for energy saving and reduction of power peak demand. Transportation Research Part C: Emerging Technologies, 24, 36–49. doi: https://doi.org/10.1016/j.trc.2012.02.001
5. Allegre, A.-L., Bouscayrol, A., Delarue, P., Barrade, P., Chattot, E., El-Fassi, S. (2010). Energy Storage System With Supercapacitor for an Innovative Subway. IEEE Transactions on Industrial Electronics, 57 (12), 4001–4012. doi: https://doi.org/10.1109/tie.2010.2044124
6. Ciccarelli, F. (2014). Energy management and control strategies for the use of supercapacitors storage technologies in urban railway traction systems. PHD School in Industrial Engineering, 330.
7. Szênâsy, I. (2009). New energy management of capacitive energy storage in metro railcar by simulation. Acta Technica Jaurinensis, 2 (1), 117–131.
8. Mensah-Darkwa, K., Zequine, C., Kahol, P., Gupta, R. (2019). Supercapacitor Energy Storage Device Using Biowastes:

A Sustainable Approach to Green Energy. Sustainability, 11 (2), 414. doi: https://doi.org/10.3390/su11020414
9. Limanskiy, S. S. (2010). Pat. No. RU 2436690 C2 RF. Sposob dvizheniya elektricheskogo transportnogo sredstva na rekuperirovannoy elektroenergii i ustroystvo dlya ego osushchestvleniya. MPK B60L 7/12. No. 2010104636/11; declareted: 11.02.2010; published: 20.12.2011. Bul. No. 35, 18.
10. Eliseev, A. D., Fursov, S. A. (2015). Superkondensatory Nesscap povyshayut energoeffektivnost' elektroprivodov. Elektronnye komponenty, 2, 80–83.
11. Kossov, E. E., Nikipelyy, S. O. (2010). Primenenie nakopiteley maloy energoemkosti v silovoy tsepi teplovoza. Visnyk Skhidnoukrainskoho nats. un-tu im. V. Dalia, 5 (147), 246–248.
12. Shchurov, N. I., Shcheglov, K. V., Shtang, A. A. (2008). Primenenie nakopiteley energii v sistemah elektricheskoy tyagi. Sbornik nauchnyh trudov NGTU, 1 (51), 99–104.
13. Riabov, E. S. (2015). Defining the parameters of an energy storage for an electrorolling stock with asynchronous traction drive under the limited current in the traction network. Visnyk Natsionalnoho tekhnichnoho universytetu «Kharkivskyi politekhnichnyi instytut», 6 (1115), 132–137.
14. Rybalko, A. Ya., Dybrin, S. V. (2008). Vybor emkosti nakopitelya energii dlya obespecheniya snizheniya maksimuma potreblyaemoy moshchnosti. Gorniy informatsionno-analiticheskiy byulleten' (nauchno-tehnicheskiy zhurnal), 8, 356–361.
15. Kostin, N. A., Nikitenko, A. V. (2014). Avtonomnost' rekuperativnogo tormozheniya – osnova nadezhnoy energoeffektivnoy rekuperatsii na elektropodvizhnom sostave postoyannogo toka. Zaliznychnyi transport Ukrainy, 3, 15–23.
16. Sulym, A. O., Fomin, O. V., Khozia, P. O., Mastepan, A. G. (2018). Theoretical and practical determination of parameters of on-board capacitive energy storage of the rolling stock. Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu, 5, 79–87. doi: https://doi.org/10.29202/nvngu/2018-5/8
17. Mukha, A. M., Kostin, M. O., Kurylenko, O. Y., Tsyplia, H. V. (2017). Enhancing the operational efficiency of direct current drive based on use of supercondenser power storage units. Science and Transport Progress. Bulletin of Dnipropetrovsk National University of Railway Transport, 5 (71), 48–60. doi: https://doi.org/10.15802/stp2017/114624
18. Gorobchenko, O., Fomin, O., Fomin, V., Kovalenko, V. (2018). Study of the influence of electric transmission parameters on the efficiency of freight rolling stock of direct current. Eastern-European Journal of Enterprise Technologies, 1 (3 (91)), 60–67. doi: https://doi.org/10.15587/1729-4061.2018.121713
19. Myatezh, A. V., Yaroslavtsev, M. V. (2013). Opredelenie energoemkosti bortovogo bufernogo kondensatornogo nakopitelya energii dlya gorodskogo elektricheskogo transporta. Transport Rossiyskoy Federatsii, 4 (47), 62–65.
20. Fomin, O., Sulym, A., Kulbovskyi, I., Khozia, P., Ishchenko, V. (2018). Determining rational parameters of the capacitive energy storage system for the underground railway rolling stock. Eastern-European Journal of Enterprise Technologies, 2 (1 (92)), 63–71. doi: https://doi.org/10.15587/1729-4061.2018.126080
21. Bayryeva, L. S., Prokopovich, A. V. (2004). Teoriya elektricheskoy tyagi. Moscow: Izdatel'stvo MEI, 40.
22. Rozenfel'd, V. E., Isaev, I. P., Sidorov, N. N., Ozerov, M. I.; Isaev, I. P. (Ed.) (1995). Teoriya elektricheskoy tyagi. Moscow: Transport, 294.
23. Sulim, A. A. (2015). Povyshenie effektivnosti energoobespecheniya podvizhnogo sostava metropolitena s sistemami rekuperatsii putem primeneniya emkostnyh nakopiteley energii. Kyiv, 188.
24. SOU MPP 45.060-253:2008. Vahony metropolitenu. Zahalni tekhnichni vymohy (2008). Kyiv: Ministerstvo promyslovoi polityky Ukrainy, 29.
25. Tkachenko, V., Sapronova, S., Kulbovskiy, I., Fomin, O. (2017). Research into resistance to the motion of railroad undercarriages related to directing the wheelsets by a rail track. Eastern-European Journal of Enterprise Technologies, 5 (7 (89)), 65–72. doi: https://doi.org/10.15587/1729-4061.2017.109791

DOI: 10.15587/1729-4061.2019.183422

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/0000-0002-4909-252X

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

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

Kostiantyn Brovko
Kharkiv Petro Vasylenko 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 disregard factors that lead to economic costs during shutdowns of the power unit and reduce the energy consumer load. A significant factor in increasing cost-effectiveness of the automated control systems at a power unit of a power 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.

References

1. Duel', M. A., Duel', A. L. (2007). Avtomatizatsiya analiza tehniko-ekonomicheskih pokazateley (TEP) energooborudovaniya TES. Energetika i elektrifikatsiya, 12, 35–41.
2. Duel', M. A., Shchur, Yu. A. (2009). Kriterii optimal'nogo upravleniya energoblokom TES v nestatsionarnyh rezhimah. Enerhetyka ta elektryfikatsiya, 4, 3–8.
3. Duel, M. O., Kanjuk, G. I., Fursova, T. N., Bliznitshenko, E. N. (2013). Automation of determination of energy features of energy equipment. Energosberezhenie. Energetika. Energoaudit, 2, 13–19.
4. Duel', M. A. (2009). Kriterii effektivnosti sistem avtomatizirovannogo upravleniya energoblokami TES i AES. Enerhetyka ta elektryfikatsiya, 12, 45–51.
5. Budanov, P. F., Brovko, K. Yu., Vasuchenko, P. V. (2016). Improve the reliability of power facilities functioning based on improvements software and hardware complex automated subsystem of emergency and preventative protection. Zbirnyk naukovykh prats Kharkivskoho universytetu Povitrianykh Syl, 3 (48), 161–167.
6. Stoppato, A., Mirandola, A., Meneghetti, G., Lo Casto, E. (2012). On the operation strategy of steam power plants working at variable load: Technical and economic issues. Energy, 37 (1), 228–236. doi: https://doi.org/10.1016/j.energy.2011.11.042
7. Le Duy, T. D., Vasseur, D. (2018). A practical methodology for modeling and estimation of common cause failure parameters in multi-unit nuclear PSA model. Reliability Engineering & System Safety, 170, 159–174. doi: https://doi.org/10.1016/j.ress.2017.10.018
8. Budanov, P. F., Brovko, K. Yu. (2016). Improving the reliability of process control of power facilities emergency way to identify features in non-standard modes functioning on the basis of fractal method of detection. Information Processing Systems, 7 (144), 175–180.
9. Kuchorenko, A. N. (2015). Economic efficiency calculation procedure for the automatic water-level regulating invariant system in the boiler shell. Energetika. Izvestiya vysshih uchebnyh zavedeniy i energeticheskih obedineniy SNG, 6, 62–73.
10. Duel', M. A., Kanyuk, G. I. (2011). Automation process and its impact on efficiency and CHP power generation nuclear power plant. Eastern-European Journal of Enterprise Technologies 5 (8 (53)), 15–22. Available at: http://journals.uran.ua/eejet/article/view/1272/1173
11. Tøndel, I. A., Foros, J., Kilskar, S. S., Hokstad, P., Jaatun, M. G. (2018). Interdependencies and reliability in the combined ICT and power system: An overview of current research. Applied Computing and Informatics, 14 (1), 17–27. doi: https://doi.org/10.1016/j.aci.2017.01.001
12. Alobaid, F., Mertens, N., Starkloff, R., Lanz, T., Heinze, C., Epple, B. (2017). Progress in dynamic simulation of thermal power plants. Progress in Energy and Combustion Science, 59, 79–162. doi: https://doi.org/10.1016/j.pecs.2016.11.001
13. Wahlström, B. (2018). Systemic thinking in support of safety management in nuclear power plants. Safety Science, 109, 201–218. doi: https://doi.org/10.1016/j.ssci.2018.06.001
14. Kulakov, G. T., Kravchenko, V. V., Makosko, Yu. V. (2013). Methodology for calculation of economic efficiency in implementation of TPP automatic control innovation systems (Part 2). Nauka i tehnika, 2, 77–82.
15. Aslanyan, A. Sh., Arakalyan, E. K., Pan'ko, M. A. (2009). K otsenke tehniko-ekonomicheskoy effektivnosti razrabotki i vnedreniya ASUTP TES, realizovannyh na baze programmno-tehnicheskih kompleksov. Vestnik MEI, 1, 99–106.
16. Bortoni, E. C., Bastos, G. S., Souza, L. E. (2007). Optimal load distribution between units in a power plant. ISA Transactions, 46 (4), 533–539. doi: https://doi.org/10.1016/j.isatra.2007.03.003
17. Bao, T., Liu, S. (2016). Quality evaluation and analysis for domain software: Application to management information system of power plant. Information and Software Technology, 78, 53–65. doi: https://doi.org/10.1016/j.infsof.2016.05.007
18. De Oliveira-De Jesus, P. M., Antunes, C. H. (2018). Economic valuation of smart grid investments on electricity markets. Sustainable Energy, Grids and Networks, 16, 70–90. doi: https://doi.org/10.1016/j.segan.2018.05.003

19. Budanov, P. F., Brovko, K. Yu. (2016). Dynamic spatial-temporal model of information-control systems program-technical complexes PCS power unit. Zbirnyk naukovykh prats Kharkivskoho natsionalnoho universytetu Povitrianykh Syl, 4 (49), 80–85.

DOI: 10.15587/1729-4061.2019.183828

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 Savelieva
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 and initial conditions 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.

References

1. Postan, M. Ya., Korniyets, T. E., Moskalyuk, L. V. (2013). On some of the port logistics problems related to optimization of spare parts supply for handling equipment stock. Vestnik Astrahanskogo gosudarstvennogo tehnicheskogo universiteta. Seriya: Morskaya tehnika i tehnologiya, 2, 174–183.
2. Postan, M., Kushnir, L. (2016). A method of determination of port terminal capacity under irregular cargo delivery and pickup. Eastern-European Journal of Enterprise Technologies, 4 (3 (82)), 30–37. doi: https://doi.org/10.15587/1729-4061.2016.76285
3. Mathisen, T. A., Hanssen, T.-E. S. (2014). The Academic Literature on Intermodal Freight Transport. Transportation Research Procedia, 3, 611–620. doi: https://doi.org/10.1016/j.trpro.2014.10.040
4. SteadieSeifi, M., Dellaert, N. P., Nuijten, W., Van Woensel, T., Raoufi, R. (2014). Multimodal freight transportation planning: A literature review. European Journal of Operational Research, 233 (1), 1–15. doi: https://doi.org/10.1016/j.ejor.2013.06.055
5. Kruk, Y., Postan, M. (2016). Development and analysis of dynamic optimization model of transport flows interaction at port terminal. Eastern-European Journal of Enterprise Technologies, 1 (3 (79)), 19–23. doi: https://doi.org/10.15587/1729-4061.2016.61154
6. Rodrigues, R., Rangel, J. J. de A. (2016). Analysis of ship arrival functions in discrete event simulation models of an iron ore export terminal. Pesquisa Operacional, 36 (1), 45–66. doi: https://doi.org/10.1590/0101-7438.2016.036.01.0045
7. Wanke, P. (2011). Ship-berth link and demurrage costs: evaluating different allocation policies and queue priorities via simulation. Pesquisa Operacional, 31 (1), 113–134. doi: https://doi.org/10.1590/s0101-74382011000100008
8. Gasnikov, A. V., Klepov, S. L., Nurminskiy, E. A., Holodov, Ya. A., Shamray, N. B. (2010). Vvedenie v modelirovanie transportnyh potokov. Moscow: Izd-vo MFTI, 363.
9. Gnedenko, B. V., Kovalenko, I. N. (2005). Vedenie v teoriyu massovogo obsluzhivaniya. Moscow: KomKniga, 400.
10. Feller, V. (1984). Vvedenie v teoriyu veroyatnostey i ee prilozheniya. Vol. 2. Moscow: Mir, 738.
11. Shiff, J. L. (1999). The Laplace Transform. Springer, 236. doi: https://doi.org/10.1007/978-0-387-22757-3

DOI: 10.15587/1729-4061.2019.184508

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
Lutsk National Technical University, Lutsk, Ukraine
ORCID: http://orcid.org/0000-0002-0793-5963

Nataliia Pavlikha
Lesya Ukrainka Eastern European National University, Lutsk, Ukraine
ORCID: http://orcid.org/0000-0001-5191-242X

Inna Tryhuba
Lviv National Agrarian University, Dublyany, Ukraine
ORCID: http://orcid.org/0000-0002-5239-5951

Iryna Kytsyuk
Lesya Ukrainka Eastern European National University, Lutsk, Ukraine
ORCID: http://orcid.org/0000-0002-1519-5993

Olha Korneliuk
Lesya Ukrainka Eastern European National University, Lutsk, Ukraine
ORCID: http://orcid.org/0000-0001-6620-1073

Valentyna Fedorchuk-Moroz
Lutsk National Technical University, Lutsk, Ukraine
ORCID: http://orcid.org/0000-0002-0941-1215

Igor Androshchuk
Lutsk National Technical University, Lutsk, Ukraine
ORCID: http://orcid.org/0000-0002-3779-6896

Iryna Skorokhod
Lesya Ukrainka Eastern European National University, Lutsk, Ukraine
ORCID: http://orcid.org/0000-0001-8628-3715

Dmytro Seleznov
Lutsk National Technical University, Lutsk, Ukraine
ORCID: http://orcid.org/0000-0002-7729-9851

An approach has been proposed to the justification of patterns in the changes of indicators related to using milk processing shops at their various parameters at a community territory, taking into account changes in production conditions. The basis of the approach is a series of experimental studies on components of production conditions, taking into consideration their characteristics in each individual community. The study implied modeling of work at processing shops.

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 and 46...634 liters.

We carried out a study to justify regularities of change in the indicators of using milk processing shops at their various parameters at a community territory, taking into account changes in production conditions using an example of production conditions in the Brodivsky region of Lviv oblast (Ukraine). It was found that an increase in the productivity of milk processing shops from 0.5 to 20 t/day leads to the proportional decrease in specific energy consumption from 116 to 10 kW/t, specific water consumption from 10 to 0.3 m^3/t and the specific demand (N_u) in human labor from 0 to 0.3 people/t in the production of various types of dairy products.

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.

References

1. Tryhuba, A., Boyarchuk, V., Tryhuba, I., Boyarchuk, O., Ftoma, O. (2019). Evaluation of Risk Value of Investors of Projects for the Creation of Crop Protection of Family Dairy Farms. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 67 (5), 1357–1367. doi: https://doi.org/10.11118/actaun201967051357
2. Aleksejevs, R., Guseinovs, R., Medvedev, A. N., Guseynov, S. E. (2016). Groupage Cargo Transportation Model. Transport and Telecommunication Journal, 17 (1), 60–72. doi: https://doi.org/10.1515/ttj-2016-0007
3. Liotta, G., Stecca, G., Kaihara, T. (2015). Optimisation of freight flows and sourcing in sustainable production and transportation networks. International Journal of Production Economics, 164, 351–365. doi: https://doi.org/10.1016/j.ijpe.2014.12.016
4. Petraška, A., Čižiūnienė, K., Prentkovskis, O., Jarašūnienė, A. (2018). Methodology of Selection of Heavy and Oversized Freight Transportation System. Transport and Telecommunication Journal, 19 (1), 45–58. doi: https://doi.org/10.2478/ttj-2018-0005
5. Bazaras, D., Batarlienė, N., Palšaitis, R., Petraška, A. (2013). Optimal road route selection criteria system for oversize goods transportation. The Baltic Journal of Road and Bridge Engineering, 8 (1), 19–24. doi: https://doi.org/10.3846/bjrbe.2013.03
6. Bula, G. A., Prodhon, C., Gonzalez, F. A., Afsar, H. M., Velasco, N. (2017). Variable neighborhood search to solve the vehicle routing problem for hazardous materials transportation. Journal of Hazardous Materials, 324, 472–480. doi: https://doi.org/10.1016/j.jhazmat.2016.11.015
7. Doumiati, M., Erhart, S., Martinez, J., Sename, O., Dugard, L. (2014). Adaptive control scheme for road profile estimation: application to vehicle dynamics. IFAC Proceedings Volumes, 47 (3), 8445–8450. doi: https://doi.org/10.3182/20140824-6-za-1003.00986

8. Gardziejczyk, W., Zabicki, P. (2017). Normalization and variant assessment methods in selection of road alignment variants – case study. Journal of civil engineering and management, 23 (4), 510–523. doi: https://doi.org/10.3846/13923730.2016.1210223
9. Tryhuba, A., Ftoma, O., Tryhuba, I., Boyarchuk, O. (2019). Method of quantitative evaluation of the risk of benefits for investors of fodder-producing cooperatives. 14th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT), 55–58.
10. Ratushny, R., Tryhuba, A., Bashynsky, O., Ptashnyk, V. (2019). Development and Usage of a Computer Model of Evaluating the Scenarios of Projects for the Creation of Fire Fighting Systems of Rural Communities. 2019 XIth International Scientific and Practical Conference on Electronics and Information Technologies (ELIT). doi: https://doi.org/10.1109/elit.2019.8892320
11. Andrés, L., Padilla, E. (2015). Energy intensity in road freight transport of heavy goods vehicles in Spain. Energy Policy, 85, 309–321. doi: https://doi.org/10.1016/j.enpol.2015.06.018
12. Ratushnyi, R., Khmel, P., Tryhuba, A., Martyn, E., Prydatko, O. (2019). Substantiating the effectiveness of projects for the construction of dual systems of fire suppression. Eastern-European Journal of Enterprise Technologies, 4 (3 (100)), 46–53. doi: https://doi.org/10.15587/1729-4061.2019.175275
13. Tryhuba, A., Pavlikha, N., Rudynets, M., Tryhuba, I., Grabovets, V., Skalyga, M. et. al. (2019). Studying the influence of production conditions on the content of operations in logistic systems of milk collection. Eastern-European Journal of Enterprise Technologies, 3 (3 (99)), 50–63. doi: https://doi.org/10.15587/1729-4061.2019.171052
14. Benekos, I., Diamantidis, D. (2017). On risk assessment and risk acceptance of dangerous goods transportation through road tunnels in Greece. Safety Science, 91, 1–10. doi: https://doi.org/10.1016/j.ssci.2016.07.013
15. Newnam, S., Goode, N., Salmon, P., Stevenson, M. (2017). Reforming the road freight transportation system using systems thinking: An investigation of Coronial inquests in Australia. Accident Analysis & Prevention, 101, 28–36. doi: https://doi.org/10.1016/j.aap.2017.01.016
16. Tryhuba, A., Zachko, O., Grabovets, V., Berladyn, O., Pavlova, I., Rudynets, M. (2018). Examining the effect of production conditions at territorial logistic systems of milk harvesting on the parameters of a fleet of specialized road tanks. Eastern-European Journal of Enterprise Technologies, 5 (3 (95)), 59–70. doi: https://doi.org/10.15587/1729-4061.2018.142227
17. Park, S.-W. (2004). Modeling of deformational characteristics in unbound granular geomaterials. KSCE Journal of Civil Engineering, 8 (3), 281–285. doi: https://doi.org/10.1007/bf02836010
18. Pauer, G. (2017). Development Potentials and Strategic Objectives of Intelligent Transport Systems Improving Road Safety. Transport and Telecommunication Journal, 18 (1), 15–24. doi: https://doi.org/10.1515/ttj-2017-0002
19. Petraška, A., Čižiūnienė, K., Jarašūnienė, A., Maruschak, P., Prentkovskis, O. (2017). Algorithm for the assessment of heavyweight and oversize cargo transportation routes. Journal of Business Economics and Management, 18 (6), 1098–1114. doi: https://doi.org/10.3846/16111699.2017.1334229
20. Tryhuba, A., Bashynsky, O. (2019). Coordination of dairy workshops projects on the community territory and their project environment. 14th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT), 51–54.
21. Bartuška, L., Biba, V., Jeřábek, K. (2016). Verification of Methodical Procedure for Determining the Traffic Volumes Using Short-term Traffic Surveys. Procedia Engineering, 161, 275–281. doi: https://doi.org/10.1016/j.proeng.2016.08.553
22. Maitah, M., Hodrab, R., Malec, K., Shanab, S. A. (2015). Exploring the Determinants of Consumer Behavior in West Bank, Towards Domestic and Imported Dairy Products. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 63 (1), 355–368. doi: https://doi.org/10.11118/actaun201563010355
23. Barłowska, J., Litwińczuk, Z., Kowal, M. (2014). Influence of Production Season and Lactation Stage on the Technological Suitability of Milk from Cows of Various Breeds Fed in the TMR System. Annals of Animal Science, 14 (3), 649–661. doi: https://doi.org/10.2478/aoas-2014-0039
24. Bandyopadhyay, P., Khamrui, K. (2007). Technological advancement on traditional indian desiccated and heat-acid coagulated dairy products. Australian Journal of Dairy Technology, 62 (2), 4–10.

DOI: 10.15587/1729-4061.2019.184376

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/0000-0002-0103-1939

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.

References

1. Vitlinskyi, V. V. (2004). Ryzykolohiya v ekonomitsi ta pidpryiemnytstvi. Kyiv: KNEU, 480.
2. Vitlinskyi, V. V., Verchenko, P. S. et. al. (2000). Ekonomichnyi ryzyk, ihrovi modeli. Kyiv: KNEU, 120.
3. Yaremko, I. Y. (2005). Metody otsinky budivelnykh kontraktiv v umovakh ekonomichnoi intehratsiyi. Naukovi zapysky, 8, 34–39.
4. Bartashevska, Yu. M. (2014). Otsinka ryzyku investytsiynykh proektiv pidpryiemstva v protsesi yikh realizatsiyi. Yevropeiskyi vektor ekonomichnoho rozvytku. Ekonomichni nauky, 2 (17), 15–21.
5. Koshechkin, S. A. Kontseptsiya riska investitsionnogo proekta. Korporativnyy menedzhment. Available at: http://www.cfin.ru/finanalysis/koshechkin.shtml
6. Kazak, A. Yu., Slepuhina, Yu. E. (2013). Sovremennye metody otsenki proektnyh riskov: traditsii i innovatsii. Vestnik UrFu. Seriya ekonomika i upravlenie, 2, 13–36.
7. Doroshenko, M. (2012). Peculiarities of investment project risk calculation. Visnyk Kyivskoho natsionalnoho torhovelno-ekonomichnoho universytetu, 5, 66–75.
8. Bernoulli, D. (1954). Exposition of a New Theory on the Measurement of Risk. Econometrica, 22 (1), 23–36. doi: https://doi.org/10.2307/1909829
9. Molins, J., Vives, E. (2016). Model risk on credit risk. Risk and Decision Analysis, 6 (1), 65–78. doi: https://doi.org/10.3233/rda-150115
10. Guégan, D., Hassani, B., Li, K. (2017). Measuring risks in the tail: The extreme VaR and its confidence interval. Risk and Decision Analysis, 6 (3), 213–224. doi: https://doi.org/10.3233/rda-170128
11. Osadchaya, N. A., Murzin A. M., Torgayan, E. E. (2017). Assessment of Risks of Investment and Construction Activities: Russian Practice. Journal of advanced research in law and economics, 8 (2), 529–544.
12. Shelepov, A. (2018). MDBs' Approaches to Mobilizing Private Investment for SDGs: Opportunities and Risks. International Organisations Research Journal, 13 (4), 144–159. doi: https://doi.org/10.17323/1996-7845-2018-04-07
13. Olkhov, V. (2017). Quantitative description of financial transactions and risks. ACRN Oxford Journal of Finance and Risk Perspectives, 6 (2), 41–54.
14. Mohamed Ihab, K. I. R. A. (2017). Pricing implications of assessing risk of relative wealth outcomes. ACRN Oxford Journal of Finance and Risk Perspectives, 6 (2), 55–76.
15. Garnier, J., Papanicolaou, G., Yang, T.-W. (2017). A risk analysis for a system stabilized by a central agent. Risk and Decision Analysis, 6 (2), 97–120. doi: https://doi.org/10.3233/rda-160117
16. Belás, J., Vojtovič, S., Ključnikov, A. (2016). Microenterprises and Significant Risk Factors in Loan Process. Economics & Sociology, 9 (1), 43–59. doi: https://doi.org/10.14254/2071-789x.2016/9-1/3
17. Aliu, F., Pavelkova, D., Dehning, B. (2017). Portfolio risk-return analysis: The case of the automotive industry in the Czech Republic. Journal of International Studies, 10 (4), 72–83. doi: https://doi.org/10.14254/2071-8330.2017/10-4/5
18. Karas, M., Srbová, P. (2019). Predicting bankruptcy in construction business: Traditional model validation and formulation of a new model. Journal of International Studies, 12 (1), 283–296. doi: https://doi.org/10.14254/2071-8330.2019/12-1/19
19. Solodovnyk, H. V. (2018). Modeliuvannia pryiniattia bahatoetapnykh rishen. Yevropeiskyi vektor modernizatsiyi: kreatyvnist, prozorist ta stalyi rozvytok, 207–220.
20. Novozhylova, M. V., Solodovnyk, H. V. (2016). Modeliuvannia upravlinnia komertsiynym ryzykom. Kharkiv: KhNUBA, 81.
21. Rynok pervichnogo zhil'ya Har'kova v 2018 godu. Available at: http://idcmproject.com.ua/novostrojki_itogi_2018/

22. Vitlinskyi, V. V. (2010). Quantitative measurement of the level of economic risk. Visnyk ZhDTU. Seriya: Ekonomichni nauky, 1 (51), 159–162. Available at: http://ven.ztu.edu.ua/article/view/69230/64976
23. Vysochina, M. V. (2009). Analiz metodiv otsiniuvannia efektyvnosti upravlinnia diyalnistiu pidpryiemstva. Kul'tura narodov Prichernomor'ya, 161, 86–89.
24. Sizova, N. D., Solodovnik, G. V., Perun, M. U. (2016). Analysis of the methods of assessment of investment appeal of construction objects in term of uncertainty and risk. Young Scientist, 10 (37), 417–420.
25. Labsker, L. G., Yanovskaya, E. V. (2002). Obshchaya metodika konstruirovaniya kriteriev optimal'nosti resheniy v usloviyah riska i neopredelennosti. Finansoviy menedzhment, 5, 58–74.
26. Brumnik, R., Klebanova, T., Guryanova, L., Kavun, S., Trydid, O. (2014). Simulation of Territorial Development Based on Fiscal Policy Tools. Mathematical Problems in Engineering, 2014, 1–14. doi: https://doi.org/10.1155/2014/843976
27. Sizova, N. D., Petrova, O. O., Solodovnik, G. V., Perun, M. U. (2017). Evaluation of investment attractiveness using information system. Young Scientist, 4.4, 90–93.
28. Guryanova, L., Klebanova, T., Trunova, T. (2017). Modeling the financial strategy of the enterprise in an unstable environment. Economic Studies journal, 3, 91–109.
29. Guryanova, L. S., Klebanova, T. S., Gvozdytskiy, V. S. (2015). Econometric modelling of the financial regulation mechanism in regional development. Actual Problems of Economics, 11, 408–421.
30. Piskun, O. I., Klebanova, T. S. (2014). Analysis of current organizational forms of integrated structures. Actual Problems of Economics, 2, 201–210.
31. Daradkeh, Y., Guryanova, L., Kavun, S., Klebanova, T. (2012). Forecasting the cyclical dynamics of the development territories: Conceptual approaches, models, experiments. European Journal of Scientific Research, 74 (1), 5–20.