Intellectual information system for formation of portfolio projects of motor transport enterprises

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Abstract

The improved model of portfolio formation of hybrid projects of motor transport enterprises is based on Markowitz`s theory. It provides for the optimization of the portfolio of projects for investments, which are evaluated using Sharpe`s value-risk criterion. To accelerate and improve the quality of management decisions, an intelligent information system for the formation of portfolios of hybrid projects of motor transport enterprises has been developed. The proposed intelligent information system has a three-tier architecture - presentation level, level of business logic management, and level of data access. Interaction with the user is implemented using the graphical interface of the developed software application for PC in Python 3.9, which is performed using Tkinter libraries. The information-analytical subsystem provides for the presence of three modules - risk and value assessment, project portfolio formation, and optimization. The proposed intelligent information system is tested for adequacy. Based on the use of an intelligent information system, the portfolio of hybrid projects is being optimized, which is implemented in the changing design environment of Mustang Trans LLC.

Keywords

Intelligent information system, hybrid projects, portfolio optimization, risks, value.

1. Introduction

Today, the quality of services provided by trucking companies largely depends on the efficiency of many organizations in various industries. It is impossible to provide quality transport services without managing the activities of motor transport enterprises. At the same time, it is known [1-4] that effective management in many subject areas can be ensured on the basis of a project approach. Thus for the performance of project management of activity of the enterprises and the organizations in various applied branches tools of acceptance of administrative decisions which consider the specificity of the subject branch are developed.

All trucking companies that provide freight and human transportation services, despite their daily operations, provide a variety of works that have all the hallmarks of projects called hybrids [5-8]. Such features include the timeliness of the services provided, the uniqueness, the uniqueness of the result or product of the project, which provides value to stakeholders [9-14].

Taking into account the features of hybrid projects of motor transport enterprises requires the implementation of management processes of quality planning due to the effective formation of portfolios of these projects. At the same time, the implementation of the process of forming portfolios of projects of motor transport enterprises is quite time-consuming and requires the development of an appropriate intelligent information system. The intelligent information system of project portfolios of

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motor transport enterprises should be based on methods and models that adequately reflect the specifics of hybrid projects and the project environment in which they are implemented.

2. Analysis of published data and problem setting

Problems related to the introduction of digital technologies in the production and management processes of trucking companies have been studied in scientific articles by many scientists around the world [15-21]. However, due to the dynamic development of innovations in the field of transport, it can be argued that not all tasks related to the management of trucking companies are widely reflected in scientific publications.

Many aspects of the implementation of project management, in particular in today`s conditions of trucking companies, are still being discussed, as there is a shortage of comprehensive research and development of software products that adequately ensure management decisions. This is due to the fact that publications that explore the benefits of implementing intelligent information systems in trucking companies focus on only a few aspects and, as a rule, do not provide opportunities for the formation of project portfolios of trucking companies.

Many scientific works are devoted to the development of intelligent information systems taking into account the specifics of different subject areas [22-27]. Scientists use different approaches, methods, models, and programming languages. There are also various intelligent information systems used to plan projects and their portfolios [28-34], and their authors are convinced of the importance of project management practice. Regarding the possibility of their use for the formation of project portfolios of motor transport enterprises, they do not take into account the features of the objects of management (hybrid projects for the provision of transport services), the specifics of the subject area, and its environment. This, in turn, does not allow for the qualitative formation of portfolios of projects of motor transport enterprises, as well as to quantify the risks of the value of stakeholders of hybrid projects of motor transport enterprises.

Based on the analysis of scientific works [35-40] it is established that the process of creating intelligent information systems is largely not formalized. The ability to properly create an information system to solve applied management problems requires first of all a justification of approaches that will adequately reflect the object of management and its environment, identify and correctly formulate criteria and constraints that are quite specific in trucking companies.

Existing standards, guidelines, and results of scientific work on the design of intelligent information systems determine both the organizational features of the creation of information systems and regulate the composition and content of project documentation. However, they do not reveal the essence of the process of creating information systems for the formation of project portfolios of motor transport enterprises. This led to the expediency of substantiating the approach and models of forming portfolios of hybrid projects of motor transport enterprises, which underlie the creation of an appropriate intelligent information system.

3. The purpose and objectives of the study

The purpose of the work is to improve the model, as well as on its basis to create an intelligent information system for the formation of portfolios of hybrid projects of motor transport enterprises, taking into account the specifics of the subject area and changing characteristics of the project environment.

To achieve this goal should solve the following tasks:

- to substantiate the model of formation of portfolios of hybrid projects of motor transport enterprises;
- to develop an intelligent information system and on the basis of its use to optimize the portfolio of hybrid projects taking into account the changing characteristics of the project environment.

4. Model of formation of portfolio of hybrid projects of motor transport enterprises

Hybrid projects of motor transport enterprises are projects that arise during the operational activities of motor transport enterprises, involve a limited number of actions aimed at providing transport services with signs of uniqueness, limited resources, clarity of requirements for duration and quality of product.

The improved model of optimization of portfolios of hybrid projects of motor transport enterprises is based on Markowitz`s theory [35], which takes into account the peculiarities of their implementation and the changing design environment. In particular, the proposed model provides for the selection of an effective portfolio of hybrid projects of trucking companies, taking into account the requirements of stakeholders to risk and value (transport services provided and profits), as well as the number of resources, spent and project budget. The choice of a rational portfolio of hybrid projects of motor transport enterprises is based on the criterion of "value-risk". It is assumed that both the value and risks of individual hybrid projects of trucking companies included in the portfolio for a given design environment are variable and can be described by the relevant theoretical laws of distribution.

According to the classical theory of Markowitz, the portfolio of hybrid projects of motor transport enterprises can be represented by a number of components that characterize its features:

$$PP = \left\langle P,\ V_{pp},\ \sigma_{pp} \right\rangle, \tag{1}$$

where P – the set of i-th hybrid projects of motor transport enterprises, which are part of the portfolio; V_{pp} – the value of the portfolio of hybrid projects of motor transport enterprises; σ_{pp} – the variance of the value of the portfolio of hybrid projects of motor transport enterprises.

The set of i-th hybrid projects of motor transport enterprises, which are part of the portfolio is:

$$P = \left\{ P_1, P_2, ... P_i \right\}, \tag{2}$$

where $P_1, P_2, ... P_i$ – the set of hybrid projects of the motor transport enterprises which are included in a portfolio is set.

The value of the portfolio of hybrid projects of motor transport enterprises is:

$$V_{pp} = \left\{ M\left[V_{p1} \right], M\left[V_{p2} \right], ... M\left[V_{pi} \right] \right\}, \tag{3}$$

where $M\left[V_{p1} \right], M\left[V_{p2} \right], ... M\left[V_{pi} \right]$ – the mathematical expectation of the variable value of individual hybrid projects of motor transport enterprises included in the portfolio during a given period $\left(T \right)$ of resource use (vehicles and contractors).

To quantify the risks of stakeholders of hybrid projects of motor transport enterprises, we propose to use a known model [5, 13]. It involves a combination of individual normal laws of distribution of random variables in order to predict their value and quantify risk. Random value of predicted value $\left(V_{pi} \right)$ from the implementation of hybrid projects of motor transport enterprises is estimated taking into account the changing market and production conditions, which are described by the laws of Gaussian distribution. Mathematical expectation of value $\left(V_{pi} \right)$ from the implementation of hybrid projects of motor transport enterprises is determined by the formula:

$$M\left(V_{pi} \right) = M\left(M_v \right) - M\left(V_i \right), \tag{4}$$

where $M\left(M_v \right), M\left(V_i \right)$ – accordingly, the mathematical expectation of the specific market value of transport services provided on the basis of the implementation of hybrid projects of motor transport enterprises and the volume of investment in them, Euro/km.

Provided that there is a close correlation between the specific market value of transport services provided on the basis of the implementation of hybrid projects of motor transport enterprises and the volume of investment in them during a given period, the standard deviation of profit $\sigma\left(V_{pi} \right)$ from hybrid projects of motor transport enterprises is determined by the formula:

$$\sigma\left(V_{pi}\right)=\sqrt{\sigma^2\left(M_v\right)+\sigma^2\left(V_i\right)-2\cdot r\cdot\sigma\left(M_v\right)+\sigma\left(V_i\right)}, \quad (5)$$

where r – the correlation coefficient between the mathematical expectation of the specific market value of transport services provided on the basis of the implementation of hybrid projects of motor transport enterprises, and the amount of investment in them in a particular calendar year.

To determine the efficiency of the portfolio of hybrid projects of trucking companies, it is proposed to use the Sharpe coefficient [41], which is defined as the ratio of the average increase in value for risk reduction to the average deviation of the portfolio of hybrid projects of trucking companies:

$$S=\frac{M\left[P\left(V_{pp}\right)-P\left(V_{pf}\right)\right]}{\sigma_{pp}}=\frac{M\left[P\left(V_{pp}\right)-P\left(V_{pf}\right)\right]}{\sqrt{Var\left[P\left(V_{pp}\right)-P\left(V_{pf}\right)\right]}}, \quad (6)$$

where S – Sharpe`s ratio; $M\left[P\left(V_{pp}\right)-P\left(V_{pf}\right)\right]$ – the value growth due to the fact that the mathematical expectation of the value of the portfolio of hybrid projects of motor transport enterprises exceeds its value in the absence of risks; $P\left(V_{pp}\right)$ – projected value of the portfolio of hybrid projects of motor transport enterprises; $P\left(V_{pf}\right)$ – the value of the portfolio of hybrid projects of motor transport enterprises in the absence of risks; σ_{pp} – the average deviation of the value of the portfolio of hybrid projects of motor transport enterprises.

Such a portfolio of hybrid projects of motor transport enterprises is considered to be effective, which provides a condition for obtaining the maximum predicted value of the portfolio with the same average deviations of the value of other formed portfolios. In general, a portfolio of hybrid projects of motor transport enterprises is considered effective if there is a high quantitative value for a given benefit and the allowable value of risk.

5. Results of development and use of intellectual information system for optimization of hybrid project portfolio

In order to accelerate and improve the quality of portfolio formation of hybrid projects of motor transport enterprises, an appropriate intelligent information system has been developed. The proposed architecture of the intelligent information system consists of a set of software modules, which are identical in content to the architectural components presented in Figure 1.

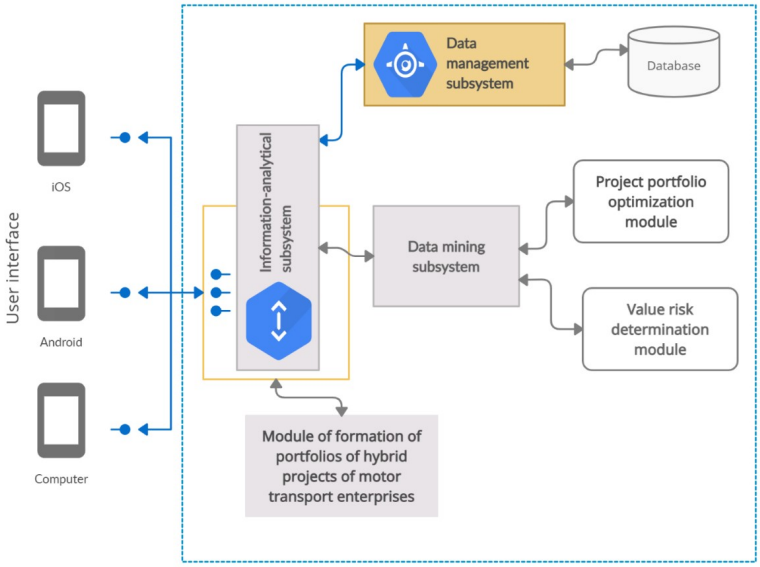

Figure 1: Model of the architecture of intelligent information system of formation of portfolios of hybrid projects of motor transport enterprises

The modules of the proposed intelligent information system for the formation of portfolios of hybrid projects of trucking companies have a three-tier architecture, which provides a presentation level, i.e. a client program, which is an application for mobile platforms or personal computer, level of business logic management and data access level to database management systems. For high-quality management of objects during the development of an intelligent information system, in accordance with the proposed architecture model, three namespaces were allocated – Data_Set_Table_Adapters and Portfolio_formation. Data_Set_Table_Adapters contains Table_Adapters objects, which provide communication between the modules of individual subsystems of the intelligent information system and the database. The Portfolio_formation namespace implements two levels of architecture that provide data processing and user interaction. Interaction with the user is implemented using the graphical interface of the developed software application for PC in Python 3.9, the working window of which is shown in Figure 2. The development of the user interface is performed using the Tkinter library, and the information-analytical subsystem involves the use of libraries Numpy, Pandas, Scipy.stats, Matplotlib with open source for the Python programming language.

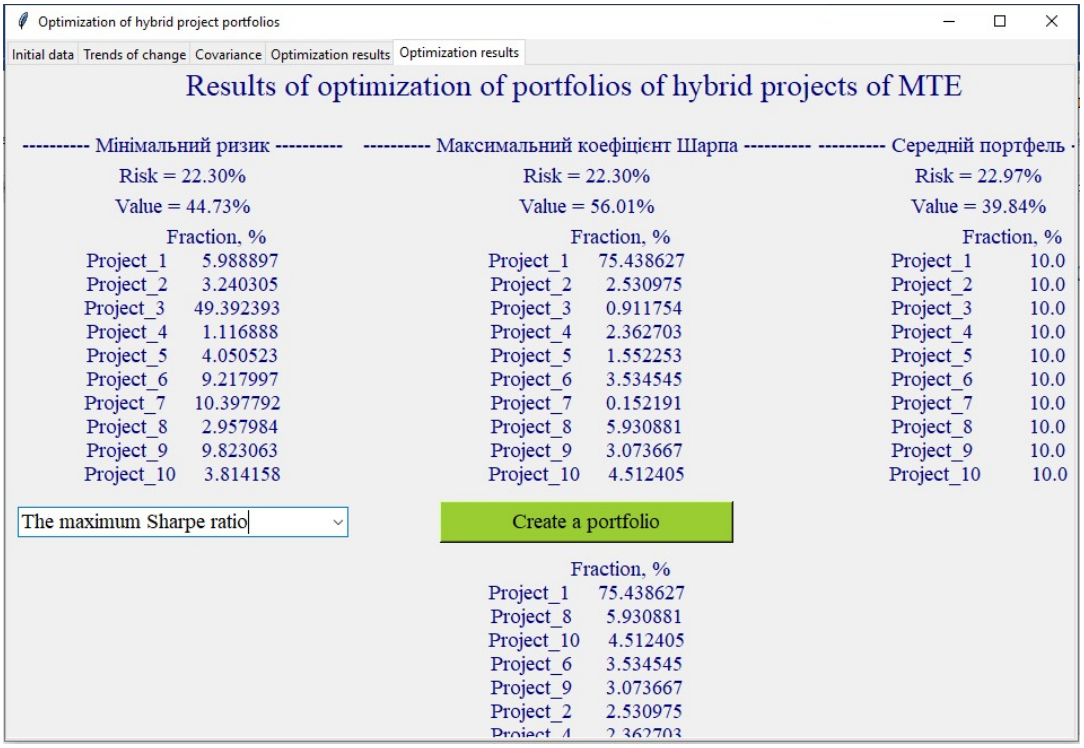

Figure 2: The window of the software application of the intelligent information system with the initial data for optimization of the portfolio of hybrid projects of the motor transport enterprise

The proposed intelligent information system for forming portfolios of hybrid projects of a motor transport enterprise has been tested for adequacy according to the Mann-Whitney test. For this purpose, the real indicators of the value of hybrid projects were compared, which were implemented in the project environment of Mustang Trans LLC (Ustyluh, Volyn region) and obtained as a result of using an intelligent information system. The deviations did not exceed 3.5%, which indicates the adequacy of the proposed intelligent information system for the formation of portfolios of hybrid projects of the trucking company.

Optimization of the portfolio of hybrid projects was performed for the conditions of Mustang Trans LLC. This company mainly provides transport services in Ukraine, so consider hybrid projects at the state level. It is accepted that the implementation of such projects involved vehicles (truck tractors DAF XF 105.460), available in the base company.

Based on the use of an intelligent information system with initial data, which is presented in Figure 3, the optimization of the portfolio of hybrid projects of the specified motor transport enterprise is executed. This made it possible to form an optimal portfolio of 10 hybrid projects. There

is a maximum Sharpe ratio (characterizes the efficiency of investment in the portfolio compared to the risk-free portfolio), which provides a probability of obtaining the projected value of the portfolio – 0.67, and a risk probability of 0.23, which corresponds to the minimum portfolio risk.

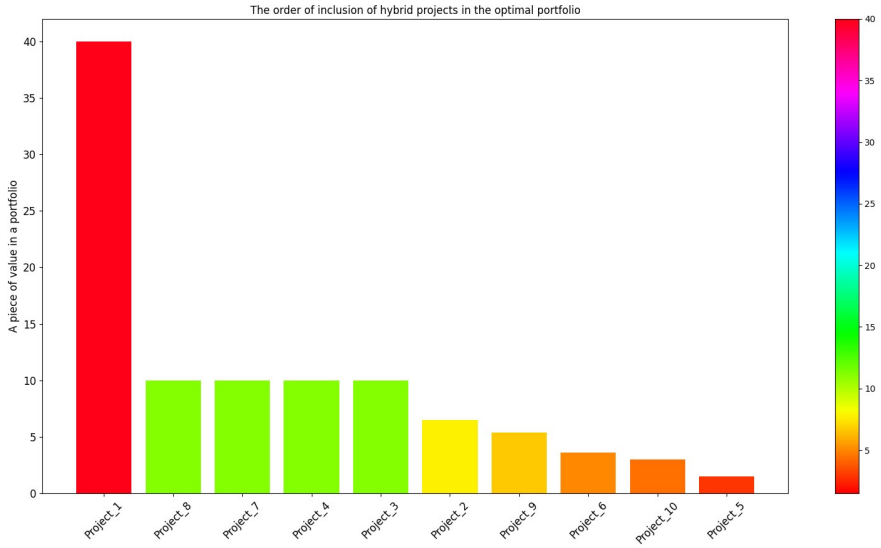

Figure 3: The order of inclusion of hybrid projects in the optimal portfolio

It was found that project Nr1 has a maximum value of 40% of the value of the entire portfolio, projects Nr8, Nr7, Nr4, and Nr3 have a value exceeding 10% of the value of the portfolio for Mustang Trans LLC. They are included in the portfolio in descending order of value and available risk.

The obtained research results are intended for use by project managers during the initiation and planning of portfolios of hybrid projects of a trucking company. The use of this system will significantly speed up and improve the quality of management decisions, as well as the effectiveness of CPMTE.

6. Conclusions

The improved model of formation of portfolios of hybrid projects of motor transport enterprises is based on Markowitz`s theory that provides optimization of the specified portfolio on the invested investments which are estimated with the use of Sharp`s criterion “value-risk”. The proposed model provides for systematic consideration of changing characteristics of the design environment and provides qualitative forecasting of quantitative values of stakeholders at a given benefit and acceptable value of risk.

To accelerate and improve the quality of management decisions, an intelligent information system for the formation of portfolios of hybrid projects of motor transport enterprises has been developed. The proposed intelligent information system has a three-tier architecture (presentation level, level of business logic management, and level of data access). Interaction with the user is implemented using the graphical interface of the developed software application for PC in Python 3.9, which is performed using Tkinter libraries. The information-analytical subsystem includes three modules (risk and value assessment, project portfolio formation, and its optimization), which are created using the libraries Numpy, Pandas, Scipy.stats, Matplotlib with open source code for the Python programming language. The proposed intelligent information system was tested for adequacy and on the basis of its use the portfolio of hybrid projects, which is implemented in the changing design environment of Mustang Trans LLC, was optimized.

7. References

[1] P. Leviäkangas, S. Michaelides, Transport system management under extreme weather risks: views to project appraisal, asset value protection and risk-aware system management, Natural Hazards 72(1) (2014) 263–286.

[2] A. Tryhuba, I. Tryhuba, O. Bashynsky, I. Kondysiuk, N. Koval, L. Bondarchuk, Conceptual Model of Management of Technologically Integrated Industry Development Projects, in: IEEE 15th International Conference on Computer Sciences and Information Technologies, CSIT-2020, IEEE, Lviv, 2020, pp. 155–158. doi: 10.1109/CSIT49958.2020.9321903.

[3] R. Ratushny, O. Bashynsky, O. Shcherbachenko, Identification of firefighting system configuration of rural settlements, in: MATEC Web of Conferences 247. International Conference on Fire and Environmental Safety Engineering, FESE 2018, Lviv, 2018. doi: 10.1051/matecconf/201824700035.

[4] P. Lub, A. Sharybura, L. Sydorchuk, A. Tatomyr, V. Pukas and M. Cupial, Information-analytical system of plants harvesting project management, in: I International Workshop IT Project Management, ITPM 2020, CEUR Workshop Proceedings 2565, Slavsko, Lviv region, 2020, pp. 244–253.

[5] A. Tryhuba, I. Tryhuba, O. Ftoma, O. Boyarchuk, Method of quantitative evaluation of the risk of benefits for investors of fodder-producing cooperatives, in: 14th International Scientific and Technical Conference on Computer Sciences and Information Technologies, CSIT-2019, IEEE, Lviv, 2019, pp. 55–58.

[6] A. Tryhuba, V. Boyarchuk, I. Tryhuba, O. Boyarchuk, O. Ftoma, Evaluation of Risk Value of Investors of Projects for the Creation of Crop Protection of Family Daily Farms, Acta universitatis agriculturae et silviculturae mendelianae brunensis 67(5) (2019) 1357–1367.

[7] M. Salehi, S. Farhadi, A. Moieni, N. Safaie, M. Hesami, A hybrid model based on general regression neural network and fruit fly optimization algorithm for forecasting and optimizing paclitaxel biosynthesis in Corylus avellana cell culture, Plant Methods 17(13) (2021). doi: 10.1186/s13007-021-00714-9.

[8] A. Tryhuba, M. Rudynets, N. Pavlikha, I. Tryhuba, I. Kytsyuk, O. Komeliuk, V. Fedorchuk-Moroz, I. Androshchuk, I. Skorokhod, D. Seleznov, Establishing patterns of change in the indicators of using milk processing shops at a community territory, Eastern-European Journal of Enterprise Technologies: Control processes 102 (2019) 57–65.

[9] A. Tryhuba, V. Boyarchuk, I. Tryhuba, O. Boiarchuk, N. Pavlikha, N. Kovalchuk, Study of the impact of the volume of investments in agrarian projects on the risk of their value, in: II International Workshop IT Project Management, ITPM 2021, CEUR Workshop Proceedings 2851, Slavsko, Lviv region, 2021, pp. 303–315.

[10] P. Lub, A. Sharybura, V. Pukas, Modelling of the technological systems projects of harvesting agricultural crops, in: 14th International Scientific and Technical Conference on Computer Sciences and Information Technologies, CSIT-2019, IEEE, Lviv, 2019, pp. 19–22.

[11] L. Pankratova, T. Paientko, Y. Lysenko, Using Trading System Consolidated Models in Stock Exchange Price Forecasting, in: 8th International Workshop Information Technology in Economic Research, ICTERI 2019, CCIS 1175, Kherson, pp. 1–28, 2020. doi: 10.1007/978-3-030-39459-2_17.

[12] A. Tryhuba, V. Boyarchuk, I. Tryhuba, O. Ftoma, S. Francik, M. Rudynets, Method and Software of Planning of the Substantial Risks in the Projects of Production of raw Material for Biofuel, in: I International Workshop IT Project Management, ITPM 2020, CEUR Workshop Proceedings 2565, Slavsko, Lviv region, 2020, pp. 116–129.

[13] A. Tryhuba, V. Boyarchuk, I. Tryhuba, O. Ftoma, V. Tymochko, S. Bondarchuk, Model of assessment of the risk of investing in the projects of production of biofuel raw materials, in: 15th International Scientific and Technical Conference on Computer Sciences and Information Technologies, CSIT, IEEE, Lviv, 2020, pp. 151–154. doi: 10.1109/CSIT49958.2020.9322024.

[14] T. Neskorodieva and E. Fedorov, Method for automatic analysis of compliance of expenses data and the enterprise income by neural network model of forecast, in: 2nd International Workshop

on Modern Machine Learning Technologies and Data Science, MoMLeT+DS 2020, CEUR Workshop Proceedings 2631, Lviv-Shatsk, 2020, pp. 145–158.
[15] P. Willumsen, J. Oehmen, V. Stingl, J. Geraldi, Value creation through project risk management, International Journal of Project Management 37(5) (2019) 731–749.
[16] A. K. Bandeh Lou, A. Parvishi, R. Taghifam, M. Lotfi, A. Taleei, Integrating earned value management with risk management to control the time-cost of the project, IIOAB Journal 7 (2016) 114–119.
[17] A. Tryhuba, V. Boyarchuk, I. Tryhuba, O. Ftoma, R. Padyuka, M. Rudynets, Forecasting the risk of the resource demand for dairy farms basing on machine learning, in: 2nd International Workshop on Modern Machine Learning Technologies and Data Science, MoMLeT+DS 2020, CEUR Workshop Proceedings 2631, Lviv-Shatsk, 2020, pp. 327–340.
[18] H. R. Maier, G. C. Dandy, Neural networks for the prediction and forecasting of water resources variables: A review of modelling issues and applications, Environmental Modelling and Software 15(1) (2000) 101–124.
[19] R. Ratushnyi, A. Tryhuba, O. Bashynsky, V. Ptashnyk, Development and Usage of a Computer Model of Evaluating the Scenarios of Projects for the Creation of Fire Fighting Systems of Rural Communities, in: Xlth International Scientific and Practical Conference on Electronics and Information Technologies, ELIT-2019, IEEE, Lviv, pp. 34–39, 2019. doi: 10.1109/ELIT.2019.8892320.
[20] A. Tryhuba, V. Boyarchuk, I. Tryhuba, O. Ftoma, Forecasting of a lifecycle of the projects of production of biofuel raw materials with consideration of risks, in: International Conference on Advanced Trends in Information Theory, ATIT, IEEE, Kyiv, 2019, pp. 420–425. doi: 10.1109/ATIT49449.2019.9030492.
[21] G. Zhang, B. Eddy Patuwo, M. Y. Hu, Forecasting with artificial neural networks: The state of the art, International Journal of Forecasting 14(1) (1998) 35–62.
[22] A. Saiyad, A. Patel, Y. Fulpagare, A. Bhargav, Predictive modeling of thermal parameters inside the raised floor plenum data center using Artificial Neural Networks, Journal of Building Engineering 42 (2021).
[23] A. Tryhuba, R. Ratushny, I. Tryhuba, N. Koval, I. Androshchuk, The Model of Projects Creation of the Fire Extinguishing Systems in Community Territories, Acta universitatis agriculturae et silviculturae mendelianae brunensis 68(2) (2020) 419–431.
[24] L. I. Quemada-Villagómez, R. Miranda-López, M. Calderón-Ramírez, J. L. Navarrete-Bolaños, G. M. Martínez-González, H. Jiménez-Islas, A simple and accurate mathematical model for estimating maximum and minimum daily environmental temperatures in a year, Building and Environment 197 (2021). doi:10.1016/j.buildenv.2021.107822.
[25] M. Kornaszewski, M. Chrzan, J. Wojciechowski, Intelligent transportation systems example of modern eco-transport solutions in Europe, in: Medzinárodná vedecká konferencia: Globalizácia a jej sociálno-ekonomické, DÔSLEDKY 10, Žilinská Univerzita v Žiline, Slovak Republic, 2010, pp. 247–251.
[26] A. Nagy, J.Tick, Review of predictive analytics vendors for transport management systems, in: 15th International Symposium on Intelligent Systems and Informatics, SISY-2017, IEEE, Subotica, 2017, pp. 225–230.
[27] Y. Vyklyuk, N. Kunanets, V. Pasichnyk, O. Husak, O. Kunanets, Y. Kryvenchuk, An Information System Prototype for Monitoring and Modeling the Spread of Viral Infections, in: 2nd International Workshop on Modern Machine Learning Technologies and Data Science, MoMLeT+DS 2020, CEUR Workshop Proceedings 2631, Lviv-Shatsk, 2020, pp. 351–366.
[28] L. Buiak, O. Bashutska, K. Pryshliak, V. Hryhorkiv, M. Hryhorkiv, V. Kobets, Models of Rental Payments Formation for Agricultural Land Plots Taking into Account the Ecological Level of Economy, in: 10th International Conference on Advanced Computer Information Technologies, ACIT 2020, IEEE, Germany, 2020, pp. 204–208.
[29] N. Komleva, V. Liubchenko, S. Zinovatna, V. Kobets, Risk management with lean methodology, in: 1st International Workshop on Computational & Information Technologies for Risk-Informed Systems, CITRisk 2020, CEUR Workshop Proceedings 2805, Kherson, 2020, pp. 266–281.
[30] T. Verezubova, T. Paientko, Modeling input financial flows of insurance companies as a component of financial strategy, in: 12th International Conference on ICT in Education,

Research and Industrial Applications. Integration, Harmonization and Knowledge Transfer, CEUR Workshop Proceedings 1614, Kyiv, 2016, pp. 566–574.
[31] N. Smith, S. Male, Risk, value, uncertainty and requirements management in projects, in: Conference-Construction Management and Economics, CME 2007, Past, Present and Future, University of Reading, 2007, pp. 385–394.
[32] S. Koch, Value-at-risk for e-business project and portfolio appraisal and risk management, in: International Conference on Electronic Business, ICEB, Taipei, Taiwan, 2007, pp. 765–768.
[33] M. N. Ibrahim, D. Thorpe, M. N. Mahmood, Risk factors affecting the ability for earned value management to accurately assess the performance of infrastructure projects in Australia, Construction Innovation 19(4) (2019) 550–569.
[34] E. McConnell, Project Management Methodology: Definition, Types, Examples, (2019). URL: http://www.mymanagementguide.com/basics/project-methodology-definition/.
[35] K. Georgalos, I. Paya, D. A. Peel, On the contribution of the Markowitz model of utility to explain risky choice in experimental research, Journal of Economic Behavior & Organization 182 (2021) 527–543. doi:10.1016/j.jebo.2018.11.010.
[36] R. Ratushny, O. Bashynsky, V. Ptashnyk, R. Chubyk, I. Bordun, Planning of Territorial Location of Fire-Rescue Formations in Administrative Territory Development Projects, in: I International Workshop IT Project Management, ITPM 2020, CEUR Workshop Proceedings 2565, Slavsko, Lviv region, 2020, pp. 93–105.
[37] O. Bashynsky, T. Hutsol, A. Rozkosz, O. Prokopova, Justification of Parameters of the Energy Supply System of Agricultural Enterprises with Using Wind Power Installations, in: 6th International Conference Renewable Energy Sources, ICoRES 2019, E3S Web of Conferences 154, Krynica, Poland, 2019. doi: 10.1051/e3sconf/202015406001.
[38] R. Ratushny, I. Horodetskyy, Y. Molchak, V. Grabovets, The configurations coordination of the projects products of development of the community fire extinguishing systems with the project environment, in: II International Workshop IT Project Management, ITPM 2021, CEUR Workshop Proceedings 2851, Slavsko, Lviv region, 2021, pp. 238–248.
[39] B. Batyuk, M. Dyndyn, Coordination of Configurations of Complex Organizational and Technical Systems for Development of Agricultural Sector Branches, Journal of Automation and Information Sciences 52(2) (2020) 63–76.
[40] A. Tryhuba, O. Bashynsky, I. Garasymchuk, O. Gorbovy, D. Vilchinska, V. Dubik, Research of the variable natural potential of the wind and energy energy in the northern strip of the Ukrainian carpathians, in: 6th International Conference – Renewable Energy Sources, ICoRES 2019, E3S Web of Conferences 154, Krynica, Poland, 2019. doi: 10.1051/e3sconf/202015406002.
[41] F. Kircher, D. Rösch, A shrinkage approach for Sharpe ratio optimal portfolios with estimation, Journal of Banking & Finance 133 (2021). doi: 10.1016/j.jbankfin.2021.106281.