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Methodology of Effective Application of Economic-Mathematical Modeling

as the Key Component of the Multi-Crisis Adaptive Management

Abstract. Introduction. The modern economy is characterized not only by processes of increasing globalization and competition in markets, mobility and internationalization of resources, rapid development of innovative information technologies, but also by rapid spread of crisis phenomena in the middle and between national economies - all these factors put forward new requirements for effective corporate management [1, 2].

Purpose. Thus, for the sake of stability, not only in the current global market competition, but especially in the context of multi-level crisis phenomena [3], all efficient companies (including logistic) should be able to adapt quickly and efficiently to changes, i.e., they must be systemically adaptive with using economic and mathematical modeling of crisis program, forecasting the results of crisis management.

Results. The two main groups of results will provide an adequate, systemic multi-modal response to a variety of crisis events and situations. The process of assembling and configuring the elements of the crisis program (plan) is inherently an open, heuristic, intellectual process of making managerial decisions and scenarios. The intellectual and professional abilities of the manager (specialist, auditor, controller) performing this task play a significant role in the development and implementation of effective crisis management plans and programs. This determines the importance of the personal factor and experience in preparing for decision-making in open problems, determines the requirements for the selection and organization of work in the ad-hoc mode of internal and external experts (auditors, controllers). However, a study of the management practice of logistics companies in emerging markets (especially in the context of the current global pandemic) showed a significant and negative potential impact of subjective factors on decisions of the management of logistics companies, their auditors and controllers (cheating, corruption, raiding, inattention, industrial espionage, etc.). To limit the influence of the above subjective factors, the authors conducted research in the field of economic and mathematical modeling on two main tasks: development of a methodology and model for the formation of a crisis plan for a logistics company in the context of a possible multi-level crisis and development of methodology and improvement of models for predicting the results of a possible implementation of an crisis three-level adaptive program for a logistics company, taking into account the influence of the current multi-level crisis features and conditions.

The results obtained can be used by logistics companies on emerging markets of developing countries and under the influence of similar political, macroeconomic and pandemic crisis phenomena (for example, including many countries in Africa, most countries in Eastern Europe, some countries of Latin America, some countries in the Middle East, and some countries in Southeast Asia).

Conclusions. The obtained results are relevant and applicable not only for local logistic companies, but also for international applications in the context of projected glo bal macroeconomic and current national crisis phenomena.

Keywords: crisis management; logistics company; economic and mathematical modeling of crisis program; forecasting the results of crisis management.

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УДК 004.94:005.7/656/338.1

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Методологія ефективного застосування економічно-математичного моделювання як ключовий компонент багаторівневого адаптивного антикризового управління

Анотація. Сучасна економіка характеризується не тільки процесами посилення глобалізації та конкуренції на ринках, мобільністю та інтернаціоналізацією ресурсів, швидким розвитком інноваційних інформаційних технологій, а й швидким поширенням кризових явищ у середині та між національними економіками – усі ці фактори впливають на нові вимоги до ефективного корпоративного управління.

З'ясовано, що процес складання та налаштування елементів антикризової програми (плану) є відкритим, евристичним, інтелектуальним процесом прийняття управлінських рішень та сценаріїв. Доведено, що інтелектуальні та професійні здібності керівника (спеціаліста, аудитора, контролера) відіграють значну роль у розробці та впровадженні ефективних антикризових планів та програм управління. Це визначає важливість особистісного фактора та досвіду підготовки до прийняття рішень у відкритих проблемах, формує вимоги до відбору та організації роботи в режимі ad-hoc внутрішніх та зовнішніх експертів (аудиторів, контролерів). У процесі дослідження з'ясовано, що практика управління логістичними компаніями на ринках, що розвиваються (особливо в контексті поточної глобальної пандемії) показала значний та негативний потенційний вплив суб'єктивних факторів на рішення керівництва логістичних компаній, їх аудиторів та контролерів (шахрайство, корупція, рейдерство, неуважність, промислове шпигунство тощо).

Щоб обмежити вплив вищезазначених суб'єктивних факторів, проведено дослідження в галузі економіко-математичного моделювання щодо двох основних задач: розробка методології та моделі формування антикризового плану логістичної компанії в контексті можливої багаторівневої кризи та методології й вдосконалення моделей прогнозування результатів впровадження антикризової багаторівневої адаптивної програми для логістичної компанії з урахуванням впливу нинішніх багаторівневих кризових особливостей та умов.

Отримані результати є актуальними та практичними не лише для місцевих логістичних компаній, а й для міжнародного застосування у контексті прогнозованих глобальних макроекономічних та поточних національних кризових явищ.

Ключові слова: антикризовий менеджмент; логістична компанія; економіко-математичне моделювання антикризової програми; прогнозування результату антикризового управління.

JEL Classification: C18; C61; G01; O21; C54; C61, L9.

Formulation of the problem. So, the modern global economy is characterized not only by processes such as the globalization of markets, the internationalization of enterprises, the rapid development of innovative information technologies, but also the rapid spread of crisis phenomena between cooperative economies, increasing global demands for total business efficiency, and they all put forward new demands for corporate management. Therefore, to ensure stability not so much in a competitive global market, but especially in the context of microeconomic and macroeconomic crises, given the impact of the current pandemic, all competitive enterprises and companies (including logistics [5]) must be able to quickly and effectively adapt to crisis factors, risks and threats [6].

Given the above, it should be noted that crisis management is a special, constantly organized management aimed at the most rapid and effective identification of the signs of a crisis state and the creation of appropriate prerequisites for its timely overcoming to ensure the restoration of the viability of a company, preventing the emergence of a situation of its bankruptcy. The optimal crisis strategy of a company and its effective configuration for getting out of a crisis state are determined by a multi-level set of different factors, restrictions and conditions. At the same time, the speed of overcoming the crisis depends on the quality and timeliness of scenario management decisions aimed at overcoming it. It should be noted separately that the formation of a crisis management system for a company should be based not only on measures to overcome the crisis, but also on preventive measures aimed at preventing the occurrence of possible future crisis situations [7].

Taking into account the above analyzed theoretical prerequisites, the formation of an effective crisis program for a logistics company in the current conditions (global macroeconomic crisis, global crisis caused by the

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coronavirus pandemic, industry and national specifics) is one of the most responsible, significant and difficult tasks, since the optimal and timely choice, the iterative configuration of the crisis program scenario (based on predictive modeling of its possible implementation results) - ensures the withdrawal of the logistics company from the crisis state with the least losses in the shortest possible time. So, the first part of the results of the author's research (devoted to the construction of formal math. models) on solving these topical problems is presented in this publication.

Analysis of recent research and publications. Although common theoretical studies of crisis management are sufficiently substantiated in the works of V. I. Fuchegy, T. V. Gavrilenko, N. O. Kovalchuk, L. S. Kravchuk, A. O. Pavluk, Ye. A. Pryaduna O. S. Voroninoyi, K. I. Voennoyi. However, an up-to-date analysis of the aforementioned publications shows that the tasks of formalization of an effective and optimal crisis program for a logistics company in the current conditions: global macroeconomic crisis, global crisis caused by the coronavirus pandemic, industry and national specifics, different stages and scales of crisis phenomena - is a very urgent task.

As a rule, most authors offer certain, limited by the author, set of crisis measures in accordance with the degree of depth of one already existing crisis of the same scale and only one goal / stage of the company's financial stabilization. Moreover, in existing publications, an unambiguous and substantiated point of view on the sequence (priority) of the application of certain crisis procedures and methods, the optimal ratio between them and their parameters has not been achieved, the methodological tools for each stage of crisis transformations are formed empirically without proper substantiation of the expediency of these particular measures with these are their parameters [8].

As follows from the above analysis of publications, the issues of scenario modeling of the results of the implementation of the adaptive crisis strategy of logistics companies in the current conditions (global macroeconomic crisis, global crisis caused by the coronavirus pandemic, industry and national specifics, different stages and scales of crisis phenomena) - have not been disclosed.

Thus, taking into account the above, the purpose of this article is divided into two, sequential and related stages (in turn, each stage of research is divided into two sub stages) [9]:

1. development of a methodology and model for the formation of a crisis plan for a logistics company in the context of a possible multi-level multi-crisis (global macroeconomic crisis, crisis caused by the coronavirus pandemic, crisis in the transport industry, possible crisis phenomena at the state or regional levels (for example: political and economic crises and revolutions etc.);

1.1. formal statement of the problem of generating a set of alternative scenarios and options for three-level

crisis programs for a logistics company, taking into account global and regional conditions, industry impacts and specific corporate features of the logistics company (taking into account the strategic goals of the owners and / or top management); taking into account the stages and scale of crisis phenomena;

1.2. formalization of the search model for the choice of the optimal scenario of the crisis program of the logistics company and the detailed adjustment of its optimal structural parameters;

2. development of methodology and improvement of models for predicting the results of a possible implementation of an crisis three-level adaptive program for a logistics company, taking into account the influence of the features and conditions mentioned in paragraphs 1. and 1.1. of this rubric;

2.1. improvement the model for assessing changes in the results of the cumulative influence of objective external crisis factors and possible subjective internal risks and influences on the integrated result of the company's logistics activities;

2.2. improvement of the assessment model for optimizing the total formed reserves / assets / stocks / funds of the logistics company as part of the implementation of crisis measures of risk management (which will lead to an improvement in its financial stability through the possibility of releasing a part of the formed reserves).

The object of the research is the optimal and effective crisis management of a logistics company in the context of multi-modal crisis phenomena.

The subject of the research is economic and mathematical modeling of the optimal crisis program of a logistics company and forecasting the results of its implementation.

The basic terminology and theoretical foundations of this study are presented in previous publications of the authors over the past 4 years (see the list of used literature at the end of this publication), in addition, the latest theoretical background is given in this publication.

Used methods: critical analysis of existing literature, analysis of the empirical professional experience of the authors of the study, systemic structural-logical and functional analysis of logistics systems, economic and mathematical modeling and forecasting.

Formulation of research goals. As mentioned above, the purpose of this research is divided into two sequential and related phases.

Outline of the main research material. Based on the traditional typology of decision-making tasks, the formation of a company's crisis program should be viewed as a possible, dynamic, complex, open and risky task [10].

The assignment of the problem of forming an crisis program to the class of open problems is due to the fact that before making a decision, the set of admissible alternatives, hypotheses and consequences is empty.

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The inclusion of a task to the class of tasks with risk is determined by the probability of obtaining a negative result, certain losses that may occur [11]. Therefore, in the decision-making process, the possible consequences of a particular configuration of the crisis program should be taken into account (the formal solution to this problem is given in the second part of the main section of this article).

Therefore, a necessary condition for solving such a complex problem is the search for the fundamental and optimal structure of the problem to be solved, that is, its main elements and the existing relationships between them, taking into account their possible combinations.

Suppose that the main (basic) elements of the task of forming a management crisis program are:

The set of alternative configurations of crisis management AM = (am1, am2, … aml)b

represents a set of l possible alternatives for configuring a multi-level system of crisis measures for a logistic company, taking into account the results of analysis / forecasting of the financial condition of the company regarding the likelihood of bankruptcy / its financial stability and the corresponding target discrete decision of shareholders / owners (b):

- bankruptcy of a logistic company;
- official liquidation of the company;
- effective sales of the company to new owners;
- legal withdrawal of liquid assets and formal sale / re-registration of the company;
- recovery and reorganization of the company in order to continue further work without re-profiling.

Of course, for each of the b goals, a specific set of performance indicators (EFb) of crisis management must be determined and the weighting coefficients w_b^p of each indicator p must be expertly determined. That is, it is proposed to evaluate the integral effectiveness of option l of the amlb crisis policy for the b goal of shareholders:

$$EF_b^l = \sum_p \left| ef(aml)_b^p \right| \times w_b^p \qquad (1)$$

The module operator is applied taking into account the multi-directionality of the utility function of various indicators of the effectiveness of crisis management.

In turn, taking into account the goal b of the shareholders, each l alternative crisis policy of am_b^l will be formed at three levels: 1) strategic measures taking into account the state of the industry; 2) tactical measures taking into account the state of the region; 3) operational and special crisis measures, taking into account the diagnostics of a specific logistic company.

It is important to detail the configuration of these levels:

A) $(ams_i, t_i, r_i, dg)_b^l$ - configuration of strategic crisis management,
   where,

ams_i - the selected strategic i component of strategic crisis management, from the list determined by the authors, which is given below:

1) implementation of constant monitoring of the external environment of the enterprise with the diagnosis of crisis factors, deviations of parameters from to the crisis norm;

2) forecasting the probability, scale, timing, type of future crisis at the enterprise, assessing the potential consequences;

3) diagnostics (analysis and assessment) of the financial condition of the enterprise, the study of production and marketing potential;

4) development and implementation of a strategic set of measures to reduce the external vulnerability of the enterprise and risk management policy;

5) development of a strategy for managing the process of liquidation \ sale \ bankruptcy of an enterprise and liquidation of the damage caused (in the case of such a decision after diagnostics);

6) planned development of a complex of variable plans for management actions in the face of unexpected, external crisis phenomena;

7) development of a plan for the financial recovery of the enterprise and maintenance of its financial long- and medium-term liquidity (including the search for financial investors);

8) search for new production partners and development of new production programs;

9) formation of a new sales marketing policy with the involvement of related and completely new sales markets;

10) policy formation for the implementation of innovations (including achievements in the field of IT);

11) optimization of transit multi-modal transportation;

12) increasing economic security by developing a methodology and technology for managing relevant risks;

13) intensification of participation in new forms of cooperation and specialization i.e. logistics networks (alliances);

14) restructuring and reorientation of cargo flows, taking into account the current political and militaristic risks;

15) audit, restructuring and further development of international transport corridors and others, based on the specifics of current situation and tasks.

t_i - a set of time parameters of the i strategic component of crisis management (sequence, duration of its application)

r_i - planned resources, taking into account resource constraints for the implementation of the i strategic crisis measure;

dg - a selective set of prerequisites / results of diagnosing a crisis state at the industry level (including but not limited to data on the depth of the crisis, the cause of the crisis, the stage of the crisis, the degree of

its complexity, shareholder attitudes, historical prerequisites, the mode of application of crisis measures (preventive / reactive), other industry characteristics and parameters).

B) *(amt$_j$, t$_j$, r$_j$,dg)* $_b{}^l$ - configuration of tactical crisis management

where,

amt$_j$ - the selected tactical *j* component of tactical crisis management, from the list specified by the author, presented below:

1. Analysis, optimization and reorganization of operational business processes.

2. Analysis, structuring, optimization and regulation of costs with the introduction of hard budgeting.

3. Identification, analysis and diversification of risks.

4. Optimization of the organizational structure.

5. Closure of unprofitable production facilities.

6. Change in pricing policy (increase in prices, change in terms of delivery and payment, expansion of service packages, etc.).

7. Activation of sales of goods and services using new approaches and technologies (crisis low-budget marketing).

8. Rotation of management personnel, ensuring the development of qualifications.

9. Strengthening of persistence, interest of managers and workers in the final results of their activities.

10. Use of "hidden reserves" of the organization (reserves for operating activities, reserves for investment activities, reserves for financial activities).

11. Operational support of financial or material liquidity (bank overdrafts, receipt of goods for sale, etc.).

12. "Gaining experience" and the formation of an effective investment policy of enterprises.

13. Application of logistics outsourcing.

14. Adaptive logistics controlling.

t$_j$ - a set of time parameters of the *j* tactical component of crisis management (sequence, duration of its application)

r$_j$ - planned resources, taking into account resource constraints for the implementation of the *j* tactical crisis measure;

dr - a selective set of prerequisites / results of diagnosing a crisis state at the regional level (including, but not limited to data on the depth of the crisis, the cause of the crisis, the stage of the crisis, the degree of its complexity, shareholder attitudes, historical prerequisites, the regime for applying crisis measures (preventive / reactive), other regional characteristics and parameters).

C) *(amu$_y$, t$_y$, r$_y$,dc)* $_b{}^l$ - configuration of crisis management, taking into account the specifics of a logistic company in specific crisis conditions

where,

amu$_y$ - the selected *y* component of the specific crisis management of the logistic company, from the list determined by the auditors of a logistic company in specific conditions;

t$_y$ - a set of time parameters of the *y* specific component of crisis management of a logistic company (sequence, duration of its application)

r$_y$ - planned resources, taking into account resource constraints for the implementation of the *y* specific crisis measure for a specific logistic company;

dc - a selective set of prerequisites / results of diagnosing a crisis state at the level of a specific logistic company (including, but not limited to data on the depth of the crisis, the cause of the crisis, the stage of the crisis, the degree of its complexity, the attitudes of shareholders, historical prerequisites, the mode of application of crisis measures (warning / reactive), other specific characteristics and logistic company parameters).

The function of results *R* is a function of results that characterizes the immediate results of the implementation of the components of the crisis policy.

In particular,

r$_i$ (ams$_i$, t$_i$, r$_i$, dg) $_b{}^l$ - the heuristic function of the set of the results of the strategic components of the crisis policy;

r$_j$ (amt$_j$, t$_j$, r$_j$ dg) $_b{}^l$ - the heuristic function of the set of the results of the tactical components of the crisis policy;

r$_y$ (amu$_y$, t$_y$, r$_y$,dc) $_b{}^l$ - the heuristic function of the set of the results of specific components of the crisis policy of a logistic company.

Thus, the task of finding the optimal configuration of the crisis management policy of logistic company is formalized as follows:

$$EF_b{}^l (r_i \ (ams_i, t_i, r_i, dg), \ r_j \ (amt_j, t_j, r_j, dg), \ r_y \ (amu_y, t_y, r_y, dc)) \quad \rightarrow opt(l) \quad (2),$$

taking into account the formula

$$EF_b{}^l = \sum_p \left| ef(am^l)_b^p \right| \times w_b^p, \quad (3)$$

it is clear to obtain the following formalization:

$$\sum_p \left| ef((r_i \ (ams_i, t_i, r_i, dg), r_j \ (amt_j, t_j, r_j, dg), r_y \ (amu_y, t_y, r_y, dg)) \ {}^l)_b^p \right| \times w_b^p \rightarrow opt(l) \quad (4)$$

An important component of the crisis strategy of logistics activities is the ability to plan (through preliminary modeling) the result of changes in the resulting integrated indicators of logistics activities, depending on the action of crisis factors, both in the microenvironment and in the external macro environment.

Therefore, it is proposed to model the change in the results ΔINF of the cumulative objective influence of external crisis factors and components of the subjective crisis policy on the integrated result of the enterprise's logistics activities. And as a result of crisis management, one should consider not just a change in income, profit, profitability, but a change in the forecast indicator of

integrated financial stability through the following improved model:

$$\Delta INF = \sum_{i=1}^{m} k_i\, ext_i + \sum_{j=1}^{n} k_j int_j + \sum_{i=1}^{m} \sum_{j=1}^{n} k_{ij}\, cum_{ij} \quad (5)$$

where:

int_j - change of the effective indicator of the logistics activity of the enterprise due to the i crisis factor of the microenvironment;

ext_i - change of the effective indicator of the logistics activity of the enterprise due to the j crisis factor of the external macro environment;

cum_{ij} - change of the effective indicator of the logistics activity of the enterprise due to the indirect influence of the i factor of the microenvironment through the j factor of the external microenvironment;

moreover, k = [0, 1], k = 0 - if the influence of the crisis factor can be neglected in modeling, and k = 1 - when the influence of the crisis factor should be taken into account when modeling in full. Its specific value for modeling a specific action of risk factors is proposed to be determined according to the fuzzy inference methodology within the framework of expert analysis using the knowledge base and / or fuzzy ad-hoc cases.

Steps to reduce economic risk as part of the crisis policy of a transport company can ultimately lead to an improvement in its financial stability through the possibility of releasing parts of formed reserves (stocks):

$$\Delta REZ = REZ_t - REZ_{t+1} = \left(\sum_{i=1}^{I} \Delta p_{it} rez_i km_i + \sum_{j=1}^{j} \Delta p_{jt} rez_j \right) - \left(\sum_{i=1}^{I} \Delta p_{it+1} rez_i km_i + \sum_{j=1}^{j} \Delta p_{jt+1} rez_j \right) \quad (6)$$

where:

km_i - the multiplier coefficient of the formed reserves for the i type of economic risk, which significantly depends on the audit results, the specifics of a particular transport company and the goals of the adopted crisis strategy, and which is proposed to be determined in an expert manner;

REZ_t - the sum of the total formed reserves / stocks within the framework of the risk management policy in the time period t;

Δp_{it} - the change in the probability of occurrence of a single risk i within the time period t;

Δp_{jt} - the change in the probability of the onset of the group (synergistic) risk j within the time period t.

The following explanations should be added to the above model:

- the grouping of risks into synergistic groups j is carried out by expert advice (by the established crisis committee) based on the results of the audit and financial analysis of the transport company and taking into account the adopted crisis strategy;

- the initialization of indicators p, rez and km, which occurs at the third stage of the crisis policy, is carried out by expert means (by the established crisis committee) based on the results of the audit and financial analysis of the transport company and taking into account the adopted crisis strategy;

- in the case of a significant and / or systematic change in Δrez during the period t + 1 - the necessary change in the initially established values of rez and km by expert judgment based on the statistical analysis performed.

Conclusions. The above two main groups of results will provide an adequate, systemic multi-modal response to a variety of crisis events and situations. Taking into account the above, it is clear that the process of assembling and configuring the elements of the crisis program / plan is inherently an open, heuristic, intellectual process of making managerial decisions and scenarios. The intellectual and professional abilities of the manager / specialist / auditor / controller performing this task play a significant role in the development and implementation of effective crisis management plans and programs. This determines the importance of the personal factor and experience in preparing for decision-making in open problems, determines the requirements for the selection and organization of work in the ad-hoc mode of internal and external experts / auditors / controllers. However, a study of the management practice of logistics companies in emerging markets (especially in the context of the current global pandemic) showed a significant and negative potential impact of subjective factors on managerial (including crisis) decisions of the management of logistics companies, their auditors and controllers (cheating, corruption, raiding, inattention, industrial espionage, etc.). To limit the influence of the aforementioned subjective factors, the authors carried out additional research in the field of effective automation of anomaly and fraud detection mood of Data Mining activity for Big logistic Data, as an important crisis factor for the management system of a logistics company in emerging markets [12, 13].

The results obtained can be used by logistics companies on emerging markets of developing countries and under the influence of similar multi-level political, macroeconomic and pandemic crisis phenomena (for example, including many countries in Africa, most countries in Eastern Europe, some countries of Latin America, some countries in the Middle East, and some countries in Southeast Asia).

References:

1. Krasniuk, M. T. & Kustarovskyi, O. D. (2017). Problems and prospects of development of Ukrainian logistics and information systems in the conditions of a globalized economy and macroeconomic crisis phenomena. *Investytsii : praktyka ta dosvid.* Kyiv. 10. 34-39 [in Ukrainian].

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2. Kulynych, Y. (2012). Genesis of planning theories from the standpoint of determining the prospects of economic development of the enterprise. *Ekonomichny`j analiz.* 11(2). 304-307 [in Ukrainian].

3. Crisis Management : Multi-Dimensional Typologies (2020). Retrieved from : https://www.futurelearn.com/info/courses/high-stakes-leadership-leading-in-times-of-crisis/0/steps/171225 [in English].

4. Krasnyuk, M., Tkalenko, A. & Krasniuk, S. (2021). Development of the fintech industry and fintech technologies under covid-19. Grail of Science, (4), 68-70. DOI: https://doi.org/10.36074/grail-of-science.07.05.2021.009 [in Ukrainian].

5. Krasnyuk, M. T. & Kustarovskiy, O. D. (2017). Research, adaptation of methods and perfection of models of financial analysis of enterprises of transport industry in the current crisis conditions of Ukraine. *Modeliuvannia ta inform. systemy v ekonomitsi* : Zb. Nauk. Pr. / Vidp. Red. V.K. Halitsyn. 93. 175 – 195 [in Ukrainian].

6. Krasnyuk, M., Hrashchenko, I., Krasniuk, S. & Kustarovskiy, O. Reengineering of a Logistic Company and its Information System Taking into Account Macroeconomic Crisis (2019). *Modern Economics*. 13. 141-153. DOI: https://doi.org/10.31521/modecon.V13(2019)-23 [in English].

7. Krasnyuk, M. & Kustarovskiy O. (2017). The development of the concept and set of practical measures of crisis logistics management in the current Ukraine conditions. *Management theory & practice.* Publisher : Warsaw Management University. 19 (1). 31-38 [in English].

8. Hrashchenko, I. & Krasnyuk, M. & Krasniuk, S. (2020). Iterative methodology of bankruptcy forecast of logistic companies in emerging markets, taking into account global/regional crisis. *Problems of systemic approach in the economy*. 1(75). 138–147. DOI: https://doi.org/10.32782/2520-2200/2020-1-43 [in English].

9. Herashchenko, I. S., Krasniuk, M. T. & Kustarovskyi, O. D. (2018). Improvement of the economic and mathematical modeling of the results of implementation of individual elements of the adaptive crisis policy of the transport industry companies of Ukraine. *Naukovyi visnyk Uzhhorodskoho universytetu Seriia «Ekonomika».* 1 (51). 205 – 211 [in Ukrainian]

10. Krasnyuk, M., Tkalenko, A. & Krasniuk, S. (2021). Results of analysis of machine learning practice for training effective model of bankruptcy forecasting in emerging markets. *Collection of scientific works ΛΌΓΟΣ.* DOI: https://doi.org/10.36074/logos-09.04.2021.v1.07[in English].

11. Zholonko T., Grebinchuk, O., Bielikova, M., Kulynych, Y., & Oviechkina, O. (2021). Methodological Tools for Investment Risk Assessment for the Companies of Real Economy Sector. *Risk Financial Managment.* 14 (2). 78 [in English].

12. Krasnyuk, M. T., Hrashchenko, I. S., Kustarovskiy, O. D. & Krasniuk, S. O. (2018). Methodology of effective application of Big Data and Data Mining technologies as an important crisis component of the complex policy of logistic business optimization. *Economies' Horizons.* 3(6). 121–136, DOI: https://doi.org/10.31499/2616-5236.3(6).2018.156317 [in English].

13. Krasnyuk, M. & Krasniuk, S. (2020). Comparative characteristics of machine learning for predicative financial modelling. *Collection of scientific works ΛΌΓΟΣ*, 55-57. DOI: https://doi.org/10.36074/26.06.2020.v1.21 [in English].

14. Claire Meyer (2020). Multi-Crisis Management. Retrieved from : https://www.asisonline.org/security-management-magazine/articles/2020/03/multi-crisis-management/ [in English].