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REVITALIZATION OF STEVEDORING ACTIVITIES, RISK MANAGEMENT AND RELOCATION OF LOGISTICS PROCESSES IN UKRAINIAN AGRIBUSINESS

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Summary. The article investigates risk management in the stevedoring activity and entropy provision of logistics processes in the agribusiness of Ukraine, with a focus on the critical role of stevedoring companies in ensuring sustainable development. In the context of current economic turbulence and the need for sustainable development and consumption, effective risk management in logistics processes is extremely important for maintaining the competitiveness of agribusiness, which is one of the leading export sectors of Ukraine. The importance of entropy support of logistics processes is growing due to the need for continuous development and changes in the external environment. The paper analyses the role of stevedoring companies that ensure the reliability and sustainability of logistics chains. The article also considers aspects of the regulatory framework and the need to improve it to increase the flexibility and adaptability of stevedoring companies in crisis situations. The study was conducted using a systematic approach, which includes an analysis of economic and political conditions and specific aspects of logistics processes in the agribusiness of Ukraine. The main attention is paid to the management of entropy processes and their impact on the efficiency of logistics operations. It is highlighted that the proper organization of logistics processes helps to minimize losses and increase the efficiency of supply, which is key for agribusiness in the context of constant development and change. It is shown that stevedoring companies, due to their ability to adapt to changes, have a significant impact on the efficiency of logistics operations and economic indicators of agribusiness. The study found that effective management of entropy processes is crucial for supporting the sustainable development of agribusiness in Ukraine. The need to harmonize Ukrainian legislation with international standards to improve the business environment and attract foreign investors is emphasized. Thus, the study emphasizes the importance of entropy support for logistics processes in agribusiness and the role of stevedoring companies in ensuring the sustainability and competitiveness of this sector in the context of constant change and development.

Keywords: agribusiness, risk management, support of logistics, stevedoring activity, sustainable development, economic indicators, revitalization

1. INTRODUCTION

Modern agribusiness in Ukraine operates in a highly competitive and uncertain environment, which underscores the need for effective risk management in all aspects of logistics processes. Stevedoring activities, which include handling and transshipment of agricultural cargo in ports, are a critical element of agricultural logistics. It has a significant impact on the efficiency of supplying products to both domestic and foreign markets, which, in turn, determines the economic stability of agricultural enterprises and the overall development of the country's agricultural sector. In light of global challenges, such as climate change, market volatility and political risks, Ukraine's agribusinesses need to integrate modern risk management approaches. In an environment of high uncertainty, it is important to find ways to predict and minimize the risks arising in logistics processes. One of the most promising areas is the application of the entropy approach, which allows for a more accurate assessment and management of uncertainty. Entropy, as a measure of uncertainty, can be

used to improve forecasting and risk management within stevedoring activities, in particular, in the context of agribusiness. This article discusses the main aspects of entropy support of logistics processes in the agribusiness of Ukraine, in particular in the context of stevedoring. The article analyses modern methods of risk management, identifies key factors influencing logistics processes, and proposes a model of entropy analysis to improve the efficiency of risk management. The purpose of this study is to develop practical recommendations for agricultural enterprises and stevedoring companies in order to improve their adaptive capabilities and ensure sustainable development under conditions of uncertainty.

2. LITERATURE REVIEW

Agribusiness in Ukraine faces numerous challenges and opportunities that require proper risk management, innovation and business support. The academic literature focuses on various aspects related to financial and credit infrastructure, innovation, environmental sustainability and rural enterprise development. Research in this area provides valuable insights for developing strategies for the sustainable development of Ukraine's agricultural sector. In particular, Andriushchenko et al. (2019), Sahaidak et al. (2021) investigated the prerequisites for creating a financial and credit infrastructure to support agricultural enterprises in Ukraine. They emphasize the importance of developing an infrastructure that will provide access to finance and credit for agricultural producers, which is a key factor for the growth and sustainability of the country's agricultural sector. Pittman, Nekrasenko et al. (2018; 2019) emphasize the need to improve transport infrastructure and port capacities to increase Ukraine's competitiveness in world markets. Tepliuk et al. (2022) proposed measures to increase the level of rural entrepreneurship after the COVID-19 pandemic. The researchers emphasize the importance of supporting local businesses and developing innovative approaches to restore economic activity in rural areas. The authors also propose an integrative approach to implementing sustainable management of agricultural enterprises. They emphasize the importance of sustainable development and innovation for the long-term economic efficiency of the agricultural sector.

Osaulenko et al. (2020) analyze the production potential of countries through the prism of the Sustainable Development Goals. They consider the challenges facing international economic security and competitiveness. The study highlights the importance of ensuring sustainable development to maintain economic security. Repina and Yatsenko (2024) investigate the imperatives and determinants of agri-trader behavior. They examine the factors that influence the behavior of agricultural enterprises in the market and identify the key aspects that contribute to efficient agricultural trade. Malorgio and Marangon (2021) examine the challenges of sustainable development of agricultural business. They point out the need to implement sustainable practices to ensure the long-term economic efficiency of agribusiness. Kucher and Hrechko (2021) assess and analyze the regional peculiarities of resource-saving land use for sustainable management. They consider effective approaches to land use in different regions of Ukraine. Nitsenko and Havrysh (2016) analyze the economic efficiency of grain production intensification in Ukraine. They propose theoretical and methodological approaches to increase the productivity and competitiveness of grain farms, including logistics processes. They also explore the problems and directions of increasing the competitiveness of grain producers. The authors analyze the factors that affect the productivity of grain farms and propose strategies to improve their efficiency. Holovina (2023) reveals the essence of supply chains in crisis conditions, where various aspects are

revealed. Kotenko et al. (2020; 2021; 2022) note that logistics costs, including transportation costs and delivery delays, significantly affect the export potential of Ukraine with using mathematical modelling. Shylov (2022) is devoted to the management of logistics chains in the context of global crises, such as a pandemic and economic instability. Bandura et al. (2022) offer mathematical models for predicting logistics risks in the agricultural sector. In addition to general trends development of grain logistics Shramenko et al. (2019) pay special attention to the transportation of grain by rail.

The issues of grain delivery risks at the current stage of logistics development have increased significantly. This is indicated in many Ukrainian and foreign studies. Thus, Lytiuha (2017) examines a systematic review of various risk assessment and management methods used in enterprise logistics systems. Kruk (2018) shows how effective management of warehouse and port facilities can help reduce the risks associated with delays and inefficient use of resources. In this direction, Wan et al. (2019) propose the use of an improved model for assessing maritime risks that can improve the accuracy of results in conditions of high uncertainty of risk data.

Slavkova and Solovey (2020) studies aimed at analyzing the key risks faced by the Ukrainian agro-industrial sector in the logistics sector. Petrenko (2021) focuses on methods for optimizing logistics processes in the face of high uncertainty typical of modern agro-industrial markets. The problems hindering the development of agriculture are also indicated in the study by Russell and Nekrasenko (2018). According to them, an increase in the logistics costs of agricultural products leads to a decrease in export revenues, an increase in product prices and a slowdown in the pace of economic reforms. This thesis is supported by the findings of Fernandes et al. (2023), Mamonova et al. (2023) and Srai et al. (2023). In turn, Medvediev, Muzylyov and Montewka (2024) used a fuzzy logic model when assessing the risk management of grain logistics from Ukraine to Poland. They found that the fuzzy model was more accurate and acceptable in identifying route risk factors, could be adapted to other supply chains, and was better than linear formulas for calculating risk-adjusted transit times. In turn, KSE (2023) prepared a business case for the construction of a transshipment grain terminal on the border with Poland.

In a military situation, more risks are added, related to the relocation of agribusiness, optimization of logistics processes, management of the above-mentioned and other risks considered in the studies of Ukrainian researchers. So, for example, Neyter et al. (2022) conducted a rapid assessment of the damage to Ukraine's agricultural sector caused by the war. They examine the impact of the war on agribusiness and suggest ways to recover and develop sustainably in the post-war period. Shovkun-Zablotska et al. (2024) examined the specifics of management and marketing of agricultural exports. In turn, Rudyk et al. (2023), taking into account military actions, considered the need to support grain logistics for regional security. Kryshtal (2023) points to an increased role of logistics in the export of grain crops due to the uncertainty of the work of port operators. Holovina (2023) adds about the need to create teams in logistics companies dealing with crisis management issues, especially in military situations. At the state level, Matvieiev (2023) points out, measures were taken to resolve the issues of unblocking the work of seaports and the subsequent export of grain to international markets. Ukrainian agribusiness has received support from the EU (Corder, 2023; European Commission, 2023; Mykhalchuk, 2023) and the USA (U.S. Agency for International Development, 2023), as well as from international organizations (United Nations Industrial Development Organization, 2023; FAO, 2022, 2023; Mykhalchuk, 2023), banking structures (Himmelfarb, 2024; FMO, 2023) and other private organizations (Center for

Environmental Initiatives Ecoaction, 2023; KPMG, n.d.; WTW, 2023; GEP, 2022; UkraineInvest, 2022).

Some authors, in addition to issues related to risks and their management in conditions of uncertainty and military action, pay attention to improving logistics, including on an innovative basis. For instance, Honcharenko et al. (2023) study innovative trends in the development of agro-industrial production entities. They examine new technologies and methods that contribute to the productivity and competitiveness of agricultural enterprises. Chikov et al. (2022) analyze the economic development of agri-food enterprises on an innovation basis. They propose strategies for introducing innovations into production processes, which can increase the efficiency and sustainability of agribusinesses. Khakhula et al. (2022) considers innovative solutions in the field of supply chain management, such as automation of logistics processes, the use of big data and artificial intelligence. Taranets et al. (2022) point out the need to comply with the export of products based on the recommendations of the FAO and the EU Taxonomy, which will significantly strengthen the position of agribusiness in foreign markets. The need to reform, restore, build and modernize the logistics infrastructure is indicated in the works of The National Council for the Recovery of Ukraine from the Consequences of the War (2022), UkraineInvest (2022), Serputko (2023), Shrivastava (2023) and others.

The document from the Cabinet of Ministers of Ukraine (2013) describes the plan for the development of seaports until 2038, which is an important aspect for the country's logistics infrastructure. The World Bank (2022) assesses the current state of logistics infrastructure in Ukraine, paying special attention to transport corridors and their impact on the export of agricultural goods.

The literature review shows that risk management, innovative approaches and business support are critical for the sustainable development of agribusiness in Ukraine. Various aspects, including financial and credit infrastructure, resilience to global challenges, and the development of innovative technologies, play a key role in ensuring the economic efficiency and competitiveness of the agricultural sector. The results of these studies can be used to develop strategies aimed at increasing the welfare and economic growth of agricultural enterprises in Ukraine.

3. MATERIALS AND METHODS

For economic systems, in particular, the so-called "microsystems", which, in particular, can be understood as stevedoring companies, mathematical modeling methods using fractal theory are increasingly used as the most adaptive approach in conditions of parameter uncertainty (Seliutin et al., 2020). Variants of the mentioned methods were also developed for the use of the time dimension (Zhang, 2020). But the developed methods of using the time dimension significantly complicate the calculations, require additional computer and time resources, and therefore require a new approach. Adaptation of mathematical modeling using the theory of fractals for evaluating the effects of external factors and, in particular, evaluating the effectiveness of management tools, is also insufficiently developed. Therefore, additional attention was paid to the mathematical formalization of the assessment of regulatory influences of management factors.

To form a mathematical model (Bazaluk et al., 2021; Nitsenko et al., 2020a, 2020b) for evaluating the effectiveness of management tools, we consider a three-dimensional discrete lattice of dimension $A_1 \times A_2 \times A_3$ for which the nodes are defined by coordinates:

$x = \overline{1, A_1}$; $y = \overline{1, A_2}$; $z = \overline{1, A_3}$. The displacement of a lattice node under the influence of external factors can be found as:

$$\Delta\theta = (1 - b)\left(1 - sn^2(\theta_t - \theta_0, k)\right)/F \mid b \in [0,1] \quad (1)$$

where $\Delta\theta$ is the dimensionless displacement of a node, taking into account the complex mutual influence (F) on the displacement of other nodes, not only in one plane of the discrete lattice, but also outside it in other spatial directions, which makes it possible to assess the effect of the impact parameter on several risks simultaneously, fractally represented in separate planes; b is the fractal dimension of the lattice deformation along the time axis; θ_t, θ_0 are the positions of the node at time t and at the initial time; k is the elliptic sine modulus (sn).

We assume that the modulus of the elliptic sine k can be a variable value. This is useful given that, in general, it is necessary to study the change in the elliptic sine modulus from node to node of a discrete lattice both in the same plane and between planes. In this case, in general, equation (1) will look like the following in iterative calculations: F is the exogenous mutual influence (F) on the displacement of other nodes, not only in one plane of the discrete lattice, but also outside it in other spatial directions, which makes it possible to assess the effect of the influence parameter on several risks represented in a fractal way in separate planes; b is the fractal dimension of the lattice deformation along the time axis; θ_t, θ_0 is the position of the node at time t and at the initial time; k is the elliptic sine modulus (sn). We assume that the modulus of the elliptic sine k can be a variable value. This is useful given that in general, it is necessary to study the change in the elliptic sine modulus from node to node of a discrete lattice both in the same plane and between planes. In this case, in general, equation (1) will look like the following when iteratively calculated:

$$\Delta\theta = (1 - b)\left(1 - sn^2\left(\theta_{t+1} - \theta_t, k_j\right)\right)/F \mid b \in [0,1] \quad (2)$$

where: θ_t, θ_{t+1} – node displacement at the initial time of each iteration (t) and at each subsequent time $(t + 1)$; $j = 1,2,3 \ldots$ – iteration steps, k_j – elliptic sine modulus by $j = var$.

The variability F should take into account the interaction of the lattice nodes in a particular plane and between planes, i.e., allow formalizing both the probability of change and targeted changes due to the influence of the parameters on the system.

In the general case:

$$F = p_0 - p_1 x - p_2 y - p_3 z \quad (3)$$

where: p_0, p_1, p_2, p_3 – parameters included in the linear form. Parameter p_0 does not depend on x, y, z.

In the case of a linear fractal shift, the function F has the form:

$$F = p_0 - p_1 x - p_2 y - p_3 j - d_1(x - x_0)^2/x_c^2 - d_2(y - y_0)^2/y_c^2 - d_1(z - z_0)^2/z_c^2 \quad (4)$$

where: $d_1, d_2, d_3, x_0, x_c, y_0, y_c, z_0, z_c$ – the parameters included in the quadratic form and x_c, y_c, z_c are simultaneously semi-axes of volumetric fractal structures for the displacement due to the effects.

When fractal structures move due to external influence, in particular, the influence of a regulating factor, there is a transition from the initial coordinate system O_{xyz}, the nodes of

the discrete lattice in which are described by the variables *x, y, z*, to a new coordinate system $O/x/y/z/$ are the nodes of a discrete lattice in which the variables are respectively described by $x^{|}, y^{|}, z^{|}$ that is, there is a need to form equations of relationship between variables x, y, z та $x^{|}, y^{|}, z^{|}$. The following equations are proposed:

$$x^{|} = xk_1^{|}cn(\theta_{1\alpha}, k_1) - y\,sn(\theta_{1\alpha}, k_1) + zk_1^{|}cn(\theta_{1\alpha}, k_1) \quad (5)$$

$$m^{|} = xk_1^{|}sn(\theta_{1\alpha}, k_1) + y\,cn(\theta_{1\alpha}, k_1) + zk_1 cn(\theta_{1\alpha}, k_1) \quad (6)$$

$$z^{|} = -xk_1 + zk_1^{|}\,;\; k_1 = \sin\omega_1;\; k_1^{|} = \cos\omega_1;\; k_1 + k_1^{|} = 1 \quad (7)$$

where: ω_1 – effective angle, which depends on the choice of the target function of the process of introducing regulatory impacts and financial and technological capabilities for the gradual implementation of these impacts ; k_1, $k_1^{|}$ – elliptic function modules; $\theta_{1\alpha}$ – displacement, which is a function of angle α in a two-dimensional plane Oxy and the module k_1, which determine the mechanisms of re-forming the volumetric fractal structure. An iterative approach in the case of regulatory impacts for successive periods, for example, financing of regulatory measures on a weekly, monthly or quarterly basis, requires the development of an additional mathematical formalization. We propose the following approach. A response surface is formed in the state space (coordinate axes: objective function, individual risks). The ratio of the stevedoring company's costs for risk neutralization to the monetary consequences of risks is proposed as the objective function. This approach also makes it possible to assess the cost-effectiveness of risk mitigation measures.

The following approach is proposed. A response surface is formed in the state space (coordinate axes: objective function, individual risks). As an objective function, the ratio of costs of the stevedoring company for risk neutralization to the consequences of risks in monetary form is proposed. This approach also makes it possible to assess the economic efficiency of measures to neutralize risks. Points with coordinates (x, y, z); $(x^{|}, y^{|}, z^{|})$; $(x^{||}, y^{||}, z^{||})$ etc. form an attractor (Lazarenko and Makarenko, 2013) on the response surface. It should be noted that each of these points corresponds to an implicitly expressed time of regulatory impact. That is, this approach allows not only to identify the general vector of movement along the response surface under the implementation of successive regulatory measures and to predict the prospects of the risk neutralization process, but also to simplify calculations by excluding time as a variable from the fractal mathematical model.

Thus, the model algorithm can be formalized as a sequence of the following blocks:

- studying the impact of risks on the company's activities;
- identification of the main risks for the stevedoring company's operation in terms of the level of impact;
- determining the feasibility of using specific economic instruments to neutralize each risk;
- determining the mutual influence of factors and the possibility of their application to neutralize more than one of the risks;
- structural fractal formalization, which includes: allocation of structural elements: processes, positions, divisions, locations, etc.;
- determination of functional fractal determinants (levels, features, fractal dimension, etc.);
- forming the objective function of the mathematical model and providing the possibility of its replacement;

- detailed formulation of the task, in particular, priorities in neutralizing risks, determination of the need to activate specific fractal elements to implement the task;
- analysis of the effectiveness of the use of economic instruments of risk management in stevedoring activities, which allows justifying the choice of a specific set of these instruments for the task.

This mathematical approach has been applied in the study of a new transshipment complex deployed near Izmail (Odesa region) with a design capacity of bulk cargo handling of ~185-200 thousand tons/month and the prospect of further increasing the volume of cargo transshipment.

Taking into account the main objective of stevedoring activities - the implementation of loading and unloading operations, economic factors of risk neutralization can be divided into the following areas

- technical and technological - aimed at ensuring the uninterrupted operation of equipment and information systems, with minimization of their downtime due to the impact of risks;
- external and organizational - aimed at ensuring a stable level of the required intensity of the flow of goods for processing and, accordingly, stable shipment of goods;
- functional - aimed at ensuring the rhythmicity of the process technology and the formation of an appropriate level of labor productivity in the face of risks; organization of cargo flow on the port territory and adjacent roads, in particular, to help reduce queues of related vehicles, for example, by forming additional mobile working teams, which, in particular, will reduce the risk of damage to cargo in the event of air attacks.

Adaptive - capable of reducing or even neutralizing significant negative dynamic impacts on stevedoring activities, especially in times of war.

One of the main economic instruments for managing the complex of risks, which includes financial, corporate risks, and negative macroeconomic impacts on stevedoring activities, is the tariff policy of the enterprise. Given that dynamic changes in tariffs have negative consequences, such as a decrease in customer confidence, changes in the level of cargo turnover at the port operator's berths, and, in general, may lead to a decrease in the company's competitiveness, it is worthwhile to implement a discount policy at a relatively stable level of service tariffs. The discount policy will help to increase the level of corporate interaction with key partners and customers.

Currently, the increasing risks for port operators when handling bulk cargo have led to a significant increase in the cost of handling one ton of cargo. If in 2021 the price was about $10 per ton, then in 2022 it increased to $25-30 per ton. Such a sharp increase in cost is due to increased external and internal risks affecting logistics processes, which poses challenges for operators to optimize costs and improve efficiency in order to remain competitive in the global market.

With a certain level of stabilization of prices for bulk cargo in foreign markets, this reduces the profitability of production for Ukrainian exporters, reducing their interest in transshipment of cargo by water, which may, with further growth of risks and, accordingly, an increase in tariffs, affect the volume of cargo transshipment by individual stevedoring companies. This limits the increase in tariffs for stevedoring companies' services as a source of providing the necessary financial resources for risk mitigation measures, even in the face of an increasing level of risk. At the same time, providing a system of benefits and discounts for individual customers, for example, to form logistics flows of cargo arrivals for handling by stevedoring companies, at the right time, at the right transshipment points from related transport, etc. can be an effective economic tool to reduce the impact of certain types of risks. The use of relevant regulation and cost control can be one of the tools to neutralize financial risks and

not only, as is often claimed, to assess the cost of port operator services. Given the dynamic change in external influences, it is advisable to use a combined method, one of the components of which may be the ABC method. This method is advisable to use, in particular, because it has been tested for reengineering business processes in flexible organizational structures, which is typical for the modern implementation of activities by Ukrainian port operators. This determines the specifics of the stevedoring company's tariffs for its services.

In accordance with the Report on Strategic Port Pricing of the United Nations Conference on Trade and Development in 1995, the methods of determining tariffs for stevedoring companies' services may be based on: costing of the company's expenses; assessment of its performance and cost-based tariffs. Often, in the Ukrainian context, these tariffs are set based on the level of the main competitors, rather than on costs or their use as economic instruments for risk management. Also, in a time of war, it is problematic to use, as stevedoring companies do in foreign ports, average costs for six months or even longer. Given the dynamism of the main risks in the Ukrainian environment, marginal costs should be used to set tariffs. An effective tariff setting policy is also an economic tool to reduce the level of threats from industry competition to a stevedoring company's business and to mitigate the corporate risk of non-market methods of competition used by its main competitors.

The level of competitiveness of Ukrainian stevedoring companies is significantly lower than that of port operators in other countries. The economic indicator of this level of competitiveness can be the specific indicator of cargo transshipment per linear meter of berth. This indicator for port operators in other countries is currently around 8 million tons per year (for containerized cargo ~ 2 thousand TEU). For domestic stevedoring companies, it varies depending on their specialization in the type of cargo handled, but is generally almost three times less than this figure (almost four times less for containerized cargo). The main economic incentive to remedy this situation may be the threat of losing transshipment volumes due to external and internal competition.

Ukrainian employers are limited by economic, tax pressure, and legislative regulations in providing salaries that are in line with those paid to stevedoring companies, for example, in the EU. The mobility of stevedoring company personnel, even during mobilization bans on cross-border movement, is insignificantly limited, and differences in wages on different sides of the interstate border encourage employees to change their place of work. A social package, which may include health insurance, transportation to and from work, housing, etc., is also an economic tool to encourage employees. But, in our opinion, it is also effective to create a differentiated set of economic factors for personal motivation of each employee. This, in particular, requires forming an employee's psychological and motivational profile. The formation of such a profile requires the cost of software and hardware, as well as the cost of remuneration of personnel who implement these profiles and analyze the trajectory of changes in personal motivation under the variability of risks.

This approach is fundamentally different from the traditional organization of the production process of the pre-war period, when it was required to minimize the area of the port operator's production facilities to reduce time and resources spent on moving personnel and cargo within the enterprise.

The approach shown schematically in Figure 1 also leads to the expansion of the port operator's business and the stevedoring company's acquisition of the functions of a logistics center (hub), which is a tool for ensuring the volume of cargo for its further processing, gaining economic results by expanding the scope of services, which in turn reduces the impact of risk groups, in particular financial risks, and the stevedoring company's sustainable operation, which is important for staff retention.

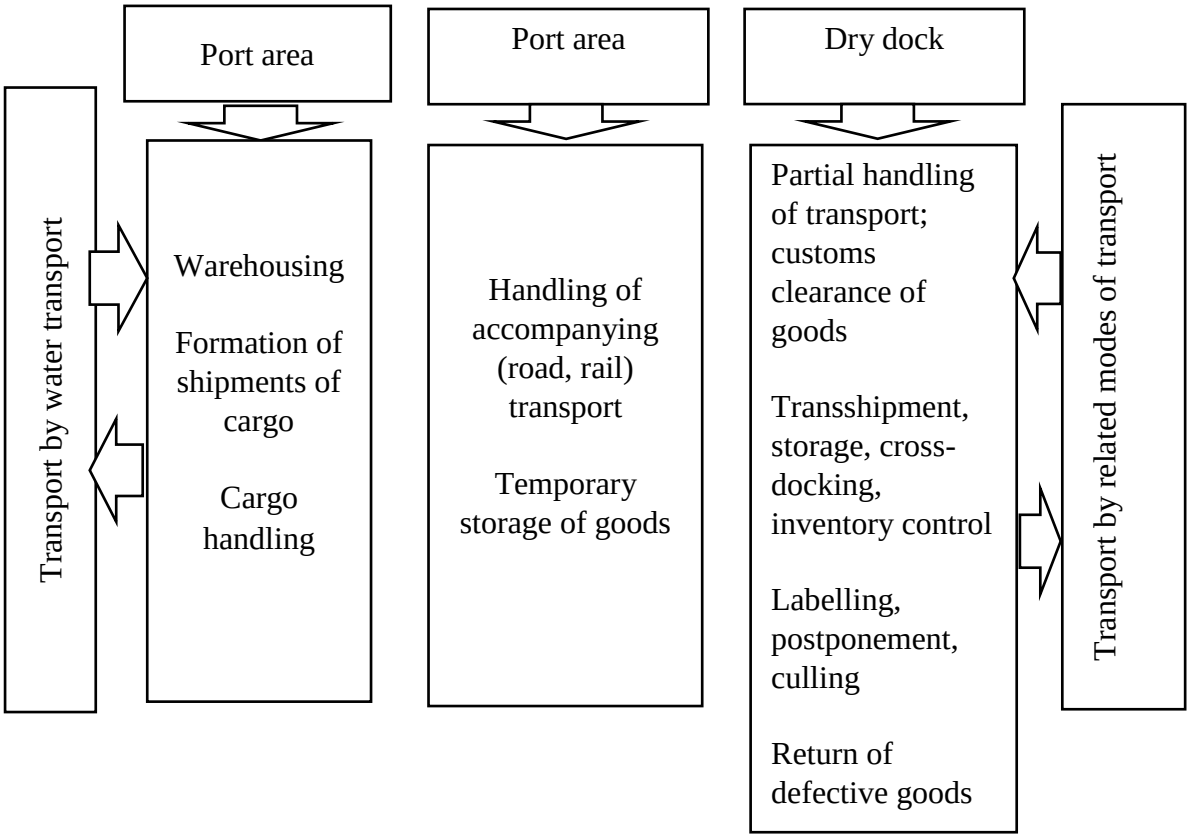

Fig. 1. Scheme of spatial segmentation of stevedoring company's production processes and production integration of selected segments on the basis of economic feasibility and implementation of a risk-oriented approach
Source: developed by the author

The following tool can be used as an example of integrating the above risk mitigation areas. First of all, in the Danube ports, together with stevedoring companies from other countries, it is worth expanding the raid scheme for transshipment of bulk cargo, in particular, grain cargo, which the aggressor considers one of the main targets for missile and bomb attacks. The novelty of introducing this economic tool is that it changes the purpose of using raid transshipment. Until now, the construction of raid terminals has been seen primarily as an extension of port operators' services. Therefore, the comprehensive, integral nature of this instrument also means that it has a distinct economic component. At the same time, the introduction of a raid scheme for transshipment of cargo outside the Ukrainian border radically mitigates military risks, in particular the risks of damage to land-based infrastructure, and this outweighs the likely increase in organizational, technical, technological, production and other risks, the significance of which is significantly lower than military risks.

The introduction of a roadside bulk cargo transshipment scheme also helps to solve the problem of insufficient water depth near berths for large ships.

The economic tool of port land lease allows not only to solve the problem of expanding the volume of cargo handling, in particular, by attracting additional land plots for the construction of new berths, but also to reduce the level of military risks by relocating port infrastructure on the ground, which reduces the likelihood of its destruction by a single missile and bomb attack. However, when port infrastructure facilities are put into operation, it is extremely

difficult to change project documentation after the fact and rebuild infrastructure elements, so this approach should be implemented at the project preparation stage or during the planned renewal of stevedoring companies' fixed assets, and for this reason, this approach was not considered in this case.

To evaluate the effectiveness of the impact of a particular economic risk management tool, the angle of change of the attractor along the response surface was estimated at each subsequent step of calculating the coordinates of the lattice node displacement, and changes in the coordinates of the discrete lattice nodes were studied not only in one plane but also in other spatial directions, which made it possible to assess the effect of the impact parameter on several risks simultaneously. Comparison of the $\Delta\theta$ value in different planes made it possible to compare the impact of a particular economic management tool on different types of risks and, accordingly, to assess the effectiveness of its use. The implementation of the iterations is shown in Figure 2.

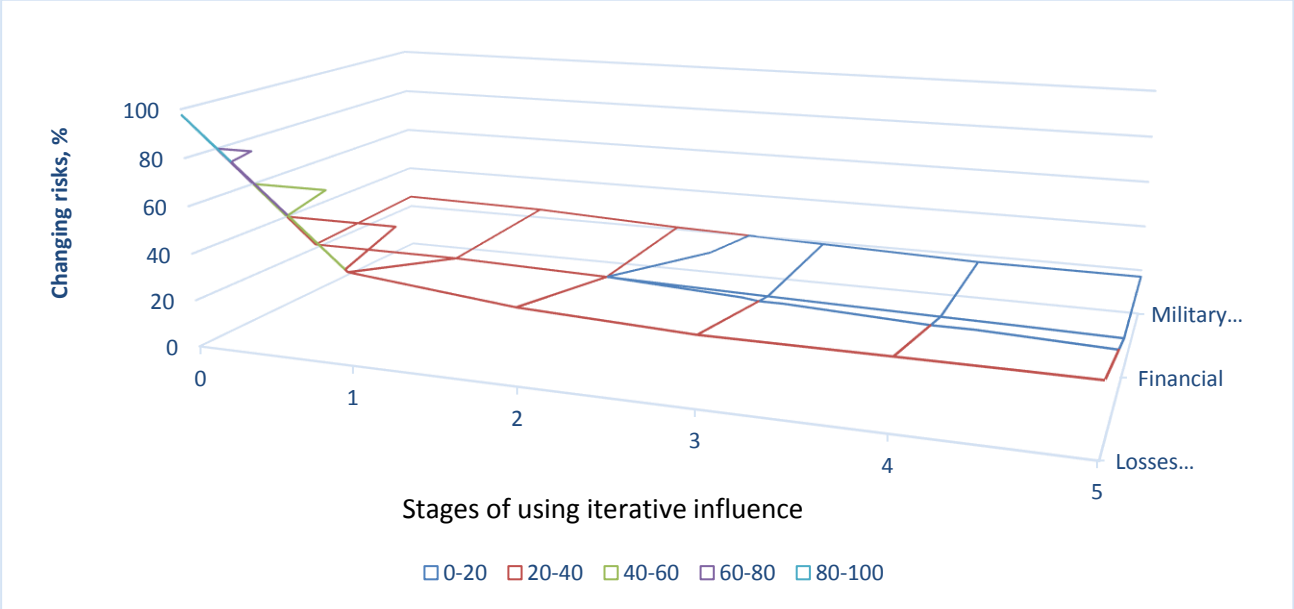

Fig. 2. Use of economic tools to reduce the level of exposure to risks for each of the iterations
Source: developed by the author

On Fig. 2 colors highlight the zones of change in the number of risks for each iteration. Five iterations are considered (see Fig. 2 and Table 1), the first of which uses an economic tool for influencing risk - financing the construction and commissioning of the raid terminal (estimated cost - 245 million UAH (~ $6 million), the internal rate of return is taken as ~13.4, the payback period is estimated at ~7 years), the second uses an economic tool to influence the risk - financing and putting into operation a backup high-voltage cable line (cost – UAH 36,000 (~ $860), including VAT – UAH 43,000 (~ $1030)), which reduces the risk blackout of enterprises due to a rocket-bomb attack. The next iterations are the application of financial instruments for the use of revenues received from the operation of the raid terminal to reduce financial risks for the enterprise and the risk of loss of labor potential.

As can be seen from those shown in Fig. 2 and in Table. 1 of the data after the third iteration, there are no significant changes in risks for items No. 1-6. This means that the limit of regulatory influence on the specified risks has been reached. The length of time for the implementation of changes for each iteration is determined by the effectiveness of the organization of regulatory measures and time limits for technological operations.

Tab. 1

Risk change scheme

№/№	Risk	Stages of using iterative influence					
		Null	First	Second	Third	Fourth	Fifth
1	Military	97.75	39.00	32.00	29.00	29.00	29.00
2	Financial	21.67	21.67	20.00	18.50	17.20	16.10
3	Losses of personnel potential	25.00	24.00	21.00	19.00	17.00	17.00
4	Macroeconomic	9.083	8.92	8.94	8.91	8.92	8.92
5	Fiscal	7.92	7.92	7.92	7.92	7.92	7.92
6	Geopolitical	9.167	9.167	9.167	9.167	9.167	9.167

Given the significant dispersion of components of macroeconomic, fiscal, and geopolitical risks, the impact of these regulatory measures on macroeconomic risk is not significant. Also, as can be seen from Table. 1, intra-corporate economic tools for managing fiscal and geopolitical risks are not significant. The proposed approach made it possible to stop the choice on the above-mentioned economic tools for managing military, financial risks and the risk of losing personnel potential.

In today's conditions of global challenges, such as climate change, political and economic instability, the agricultural sector of Ukraine faces a high level of uncertainty, which significantly affects logistics processes. One of the key aspects that requires detailed analysis is the impact of these risks on the efficiency of stevedoring activities that ensure the handling and transshipment of agricultural cargo at ports. Stevedoring activity is a critical element of agricultural logistics, as it directly affects the supply of products to both domestic and foreign markets, which determines the economic stability of agricultural enterprises and the overall development of the country's agricultural sector.

In the context of modern conditions, the revitalization of stevedore activity appears as an important strategic initiative. The introduction of modern technologies and innovations can significantly increase the efficiency of transshipment of agricultural cargo, reduce delays and optimize processes. Revitalizing infrastructure and processes are key to improving productivity and reducing costs.

However, for effective risk management in logistics processes, it is important to apply innovative approaches. One such approach is entropy analysis. The concept of entropy, which is a measure of uncertainty, allows more accurate assessment and management of uncertainty within logistics processes. Using an entropy approach can provide improved risk prediction and management in stevedoring operations.

Relocation of logistics processes or infrastructure is also an important aspect of strategic management. Relocation can significantly affect the adaptability of agribusinesses and stevedoring companies, ensuring a more efficient location of resources and optimization of processes. However, the implementation of relocation requires careful planning and consideration of numerous factors to ensure its effectiveness.

The integration of modern approaches to risk management is a necessary condition for increasing the stability of agricultural logistics in conditions of uncertainty. It is necessary to consider which methods of risk management are the most effective and how their implementation can affect the overall sustainability and efficiency of the agricultural sector. Practical recommendations for agribusinesses and stevedoring companies based on the results of the study should include strategies and measures aimed at increasing adaptability and

resilience in the face of uncertainty. The implementation of these recommendations can significantly affect the long-term development and competitiveness of the agricultural sector of Ukraine.

4. CONCLUSIONS

The study demonstrated the effectiveness of various economic tools for risk management in stevedoring activities, especially in the conditions of agribusiness in Ukraine. The impact of these tools on reducing the risks of loss of personnel potential, financial and military risks was considered, which allowed the following conclusions to be formulated. First, wage increases and investments in technological processes. As tools for reducing the risk of loss of personnel potential, not only raising the level of staff wages, but also investments in improving the technological process, in particular, the laying of a backup power supply line, which contributes to solving the issue of labor resources, increasing the psychological balance of the staff and reducing the risks of losses, were considered. Secondly, it is precisely the economic tool "port-lend-lease" that is able to solve the problem of expanding the volume of cargo handling by attracting additional land plots for the construction of new berths, but also reduces the level of military risks due to the relocation of port infrastructure to safer areas. That is, a comprehensive approach to financial and corporate risk management. Financial and corporate risks were considered as a single complex related to the tariff policy of the enterprise and the level of competition. The unblocking of the Great Odesa seaports created a systemic competitive threat for the river terminals of the Danube region, which led to a reduction in the volume of cargo handling for some companies in the Danube region. Evaluation of the effectiveness of economic instruments. To evaluate the effectiveness of the impact of economic tools on risks, the estimation of the angle of change of the attractor along the response surface was used for each subsequent step of calculating the displacement coordinates of the grid node. This made it possible to study changes in the coordinates of nodes of a discrete grid in different spatial directions and simultaneously assess the impact on several risks.

The given review of the economic factors of risk neutralization indicates that their action is often not limited to the impact on one risk, but changes a larger number of risks. At the same time, due to the effects of economic factors of risk neutralization on different groups of risks at once, the possibility of their multi-vector impact on individual risks cannot be ruled out. This requires the introduction of mathematical formalization for evaluating the impact of economic factors of risk neutralization. As a tool for reducing the risk of loss of personnel potential, not only raising the level of staff salaries, but also, for example, investments in improving the technological process (in particular, the laying of a backup power supply line), which will contribute to solving the issue of labor resources, were considered. It is also considered that the reduction of the level of military threats will contribute to the reduction of the risk of loss of personnel potential, as it leads to an increase in the psychological balance of the personnel.

The study confirms that innovative approaches to risk management can significantly increase the efficiency of logistics processes in Ukrainian agribusiness, reducing losses and increasing the resilience of enterprises to external threats.

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References

1. Andriushchenko Kateryna, Mykola Ishchenko, Mykhailo Sahaidak, Mariia Tepliuk, Oksana Domina. 2019. "Prerequisites for the creation of financial and credit infrastructure of support for agricultural enterprises in Ukraine". *Banks and Bank Systems* 14(2): 63-75. ISSN: 1816-7403. DOI: 10.21511/bbs.14(2).2019.06.
2. Bandura Romina, Janina Staguhn, Benjamin Jensen. 2022. "Modernizing Ukraine's Transport and Logistics Infrastructure". *Center for Strategic & International Studies.* Available at: https://www.csis.org/analysis/modernizing-ukraines-transport-and-logistics-infrastructure.
3. Bazaluk Oleg, Sergiy Kotenko, Vitalii Nitsenko. 2021. "Entropy as an Objective Function of Optimization Multimodal Transportations". *Entropy* 23(8): 946. ISSN: 1099-4300. DOI: 10.3390/e23080946.
4. Cabinet of Ministers of Ukraine. 2013. On the approval of the Strategy for the Development of Seaports of Ukraine for the period until 2038: Order No. 548 of July 11, 2013. Available at: https://zakon.rada.gov.ua/laws/show/548-2013-p?lang=en#Text.
5. Center for Environmental Initiatives Ecoaction. 2023. "Agriculture: priorities for sustainable investments to aid Ukraine's recovery". Available at: https://en.ecoaction.org.ua/agri-priorities-sustainable-ukraine.html.
6. Chikov I., V. Radko, M. Marshalok, M. Tepliuk, O. Petrenko, I. Sharko, A. Sitkovska. 2022. "Economic development of agricultural food enterprises on an innovative basis". *Financial and Credit Activity: Problems of Theory and Practice* 1(42): 98-106. ISSN: 2306-4994. DOI: 10.55643/fcaptp.1.42.2022.3672.
7. Corder Mike. 2023. "EU agriculture officials work on ways to move Ukrainian grain to the world". *The Associated Press*. Available at: https://apnews.com/article/european-union-grain-exports-ukraine-poland-russia-49fd3c52f9c90b97ac3d3e90b247c1d6.
8. European Commission. 2023. "Ukraine 2023 Report: Commission Staff Working Document. Accompanying the document: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. 2023 Communication on EU Enlargement policy". Available at: https://neighbourhood-enlargement.ec.europa.eu/system/files/2023-11/SWD_2023_699%20Ukraine%20report.pdf.
9. FAO. 2022. "Ukraine: Strategic priorities for 2023". Available at: https://openknowledge.fao.org/server/api/core/bitstreams/e323dbca-25b2-4736-98fb-a6e20dacae76/content.
10. FAO. 2023. "Ukraine: Response programme - January–December 2023 - Restoring food systems and protecting food security in Ukraine". DOI: 10.4060/cc4655en.
11. Fernandes Gabriel, Pedro Teixeira, Tiago A. Santos. 2023. "The impact of the Ukraine conflict in internal and external grain transport costs". *Transportation Research Interdisciplinary Perspectives* 19: 100803. ISSN: 2590-1982. DOI: 10.1016/j.trip.2023.100803.

12. FMO. 2023. “FMO supports Ukraine’s grain exports and global food security through USD 31mln loan to agribusiness company Trans-Oil Group”. Available at: https://www.fmo.nl/news-detail/80f933dd-6011-4f3f-b1f5-72c018497fc2/fmo-supports-ukraine-s-grain-exports-and-global-food-security-through-usd-31mln-loan-to-agribusiness-company-trans-oil-group
13. GEP. 2022. “Russia-Ukraine War: Global Impact on Logistics”. Available at: https://www.gep.com/blog/mind/russia-ukraine-war-logistics-impact.
14. Himmelfarb, Anne. 2024. “Ukraine: Third Rapid Damage and Needs Assessment (RDNA3)”. February 2022 – December 2023. *The World Bank Group*. Available at: https://ukraine.un.org/sites/default/files/2024-02/UA%20RDNA3%20report%20EN.pdf.
15. Holovina O. 2023. “The role of the crisis management team in managing supply chains during war”. In *Logistics of the future: effective solutions for trade: theses add. International science and practice Internet Conf.* (Kyiv, April 20, 2023) / resp. ed. N.B. Ilchenko. Kyiv: State trade and economy University, 2023. 28-30. DOI: 10.31617/k.knute.2023-04-20.
16. Honcharenko Oksana, Myroslava Nenakhova, Oleksandr Bokoch, Ivan Vladimirov. 2023. “Innovative trends in the development of subjects of agro-industrial production”. *Food Industry Economics* 15(2). ISSN: 2411-4111. DOI: 10.15673/fie.v15i2.2676.
17. Khakhula Bohdan, Oksana Kostyuk, Oleksii Lanchenko, Hanna Antonyuk, Oleksandr Homon. 2024. “Innovative tools for risk management of the production activities of agricultural enterprises in an institutional environment”. *Scientific Horizons* 27(2): 136-153. ISSN: 2663-2144. DOI: 10.48077/scihor2.2024.136.
18. Kotenko S., V. Nitsenko, I. Hanzhurenko, M. Vasylyuk, Y. Lavrushchenko, I. Kucher. 2021. “The Economic Crisis as a Factor in Changing the Structure of Multimodal Transportation Routes”. *Financial and Credit Activity: Problems of Theory and Practice* 6(41): 277-284. ISSN: 2306-4994. DOI: 10.18371/fcaptp.v6i41.251454.
19. Kotenko Sergiy, Svitlana Ilchenko, Valeriia Kasianova, Vitalii Diakov, Svitlana Mashkantseva, Vitalii Nitsenko. 2022. “Determination of the Expected Value of Losses Caused by the Cargo Transportation Insurance Risks by Water Transport”. *Inventions* 7(3): 81. ISSN: 2411-5134. DOI: 10.3390/inventions7030081.
20. Kotenko Sergiy, Vitalii Nitsenko, Iryna Hanzhurenko, Valerii Havrysh. 2020. “The Mathematical Modeling Stages of Combining the Carriage of Goods for Indefinite, Fuzzy and Stochastic Parameters”. *International Journal of Integrated Engineering* 12(7): 173-180. ISSN: 2229-838X. DOI: 10.30880/ijie.2020.12.07.019.
21. KPMG. n.d. “KPMG in Ukraine offers audit, tax and advisory services geared to the unique needs of the agriculture business”. Available at: https://kpmg.com/ua/en/home/industries/agriculture.html.
22. Kruk Yu. Yu. 2018. “Economic justification of stevedoring activity development in Ukraine on the basis of queuing and storage theories”. *Economic Innovations* 20(3(68): 115-125. ISSN: 2524-003X. DOI: 10.31520/ei.2018.20.3(68).115-125.
23. Kryshtal H. 2023. “Role of Logistics in the Development of Agriculture of Ukraine in the War Conditions”. *Science and Innovation* 19(2): 73-82. DOI: 10.15407/scine19.02.073.
24. KSE. 2023. “Greenfield grain transshipment terminal on the border of Ukraine and Poland: a prefeasibility study: Analytical report”. Available at: https://kse.ua/wp-content/uploads/2023/07/D3_Greenfield_grain_transshipment_terminal_on_the_border_of_Ukraine.pdf.

25. Kucher Anatolii, Alina Hrechko. 2021. “Assessment and analysis of regional features of resource-saving land use for sustainable management”. *Management, Economic Engineering in Agriculture and Rural Development* 21(1): 431-441. ISSN: 2284-7995. Available at: https://managementjournal.usamv.ro/pdf/vol.21_1/Art49.pdf.
26. Lazarenko S.V., O.S. Makarenko. 2013. On estimates of the dimensions of attractors of discrete dynamical systems with anti-dissipation. *Mathematical machines and systems*, 4: 161-168. ISSN: 1028-9763. Available at: http://jnas.nbuv.gov.ua/j-pdf/MMS_2013_4_19.pdf.
27. Lytiuha Y.V. 2017. “Risk Management of Logistics System of The Enterprise: Essence, Evaluation, Methods”. *Efektyvna ekonomika* 6. ISSN: 2307-2105. Available at: http://www.economy.nayka.com.ua/?op=1&z=5646.
28. Malorgio Giulio, Francesco Marangon. 2021. “Agricultural business economics: the challenge of sustainability”. *Agric Econ* 9: 6. ISSN: 2193-7532. DOI: 10.1186/s40100-021-00179-3.
29. Mamonova Natalia, Olena Borodina, Brian Kuns. 2023. “Ukrainian agriculture in wartime: Resilience, reforms, and markets”. *Transnational Institute*. Available at: https://www.tni.org/en/article/ukrainian-agriculture-in-wartime.
30. Matvieiev Mykhailo. 2023. “Ukraine’s agriculture and farmland market: the impact of war”. *VoxUkraine*. Available at: https://voxukraine.org/en/ukraines-agriculture-and-farmland-market-the-impact-of-war.
31. Medvediev Ievgen, Dmitriy Muzylyov, Jakub Montewka. 2024. “A model for agribusiness supply chain risk management using fuzzy logic. Case study: Grain route from Ukraine to Poland”. *Transport. Res. Part E: Logist. Transportat. Rev.* 190: 10369. ISSN: 1366-5545. DOI: 10.1016/j.tre.2024.103691.
32. Mykhalchuk Viktoriia. 2023. “FAO and the EU support relocation of Ukraine’s national seed collection to a secure site”. *FAO*. Available at: https://ukraine.un.org/en/229333-fao-and-eu-support-relocation-ukraine’s-national-seed-collection-secure-site.
33. Nekrasenko, Larysa, Russell Pittman, Olga Doroshenko, Valentyna Chumak, Andrii Doroshenko. 2019. “Grain logistics in Ukraine: the main challenges and effective ways to reach sustainability”. *Economic Annals-XXI* 178(7-8): 70-83. ISSN: 1728-6220. DOI: 10.21003/ea.V178-06.
34. Neyter Roman, Hryhorii Stolnikovych, Oleg Nivievskyi. 2022. “Agricultural War Damages Review Ukraine. Rapid Damage Assessment”. *KSE Center for Food and Land Use Research*. Available at: https://kse.ua/wp-content/uploads/2022/06/Damages_report_issue1-1.pdf#page=1.
35. Nitsenko Vitalii, Sergiy Kotenko, Iryna Hanzhurenko, Abbas Mardani, Ihor Stashkevych, Maksym Karakai. 2020a. “Mathematical Modeling of Multimodal Transportation Risks”. (pp. 439-447). In: *Ghazali R., Nawi N., Deris M., Abawajy J. (eds) Recent Advances on Soft Computing and Data Mining. SCDM 2020. Advances in Intelligent Systems and Computing*, 978. Springer, Cham. ISBN: 978-3-030-36055-9. DOI: 10.1007/978-3-030-36056-6_41.
36. Nitsenko Vitalii, Sergiy Kotenko, Iryna Hanzhurenko, Keisha LaRaine Ingram. 2020. “Determination of Weight Coefficients for Stochastic and Fuzzy Risks for Multimodal Transportation”. *Journal of Physics: Conference Series* 1529: 032007. ISSN: 1742-6596. DOI: 10.1088/1742-6596/1529/3/032007.

37. Pittman Russell, Larysa Nekrasenko. 2018. “Grain, Export, and Logistics in Ukraine”.
38. Sahaidak Mykhailo, Mariia Tepliuk, Victoria Zhurylo, Natalia Rudenko, Olesia Samko. 2021. “Integrative Viewpoint for Implementing Sustainable Management Agricultural Business Excellence”. *TEM Journal* 10(1): 303-309. ISSN: 2217-8309. DOI: 10.18421/TEM101-38.
39. Seliutin Viktor, Oleksandr Olshanskiy, Sergii Seliutin. 2020. Conceptual model of the restaurant enterprise strategic management system. *Scientific notes of Taurida National V.I. Vernadsky University Series: Economy and Management* 31(70/4): 1-7. ISSN: 2523-4803. DOI: 10.32838/2523-4803/70-4-27.
40. Serputko Iaroslav. 2023. “A working investment model: On what conditions business is ready to invest in the agricultural sector”. *Deloitte*. Available at: https://www2.deloitte.com/ua/en/pages/press-room/deloitte-press/2023/06-05.html.
41. Shovkun-Zablotska Lyudmila, Volodymyr Pysarenko, Liudmila Sierova, Sergiy Tegipko. 2024. “Management and Marketing of the Wartime Agribusiness in Ukraine”. *Economics Ecology Socium* 8: 64-77. ISSN: 2616-7107. DOI: 10.61954/2616-7107/2024.8.1-6.
42. Shramenko N., D. Muzylyov, A. Manukian. 2020. “Analysis of the grain market in Ukraine and directions for the development of logistics for the transportation of grain cargo”. *Technical service of agriculture, forestry and transport systems* 18: 70-79. ISSN: 2311-441X. Available at: https://repo.btu.kharkov.ua/bitstream/123456789/3127/1/9.pdf.
43. Shrivastava Mohit. 2023. “Logistics Risk Management: Mitigating Disruptions and Ensuring Business Continuity”. *Global Trade*. Available at: https://www.globaltrademag.com/logistics-risk-management-mitigating-disruptions-and-ensuring-business-continuity/.
44. Shylov Maksym. 2022. “Supply Chain Risk Management in the Food and Agriculture Sector – Keeping Flexibility and Financial Resilience”. *Greco Risk and Insurance Management.* Available at: https://greco.services/supply-chain-risk-management-in-the-food-and-agriculture-sector-keeping-flexibility-and-financial-resilience/.
45. Slavkova Olena, Maryna Solovey. 2016. “The role of logistics in agricultural development in Ukraine”. *Ekonomika i Organizacja Logistyki* 1(2): 67-77.
46. Srai Jagjit Singh, Gary Graham, Remko Van Hoek, Nitin Joglekar, Harri Lorentz. 2023. “Impact pathways: unhooking supply chains from conflict zones – reconfiguration and fragmentation lessons from the Ukraine–Russia war”. *International Journal of Operations & Production Management* 43(13): 289-301. ISSN: 0144-3577. DOI: 10.1108/IJOPM-08-2022-0529.
47. Synytsyna Halyna A., Serhii O. Zubkov. 2020. “Theoretical Aspects of the Food Sphere Enterprises Functioning on the Basis of Sustainable Development”. *Business Inform* 3: 208-216. ISSN: 2222-4459. DOI: 10.32983/2222-4459-2020-3-208-216.
48. Taranets Kostiantyn, Oleh Krasniuk, Serhii Zimenko. 2023. “The criterion of sustainability for Ukrainian agribusiness products based on the guidelines of FAO and the EU Taxonomy as a driver for strengthening the country’s position on commodity markets”. *EY Ukraine*. Available at: https://www.ey.com/en_ua/climate-change-sustainability-services/the-criterion-of-sustainability-for-ukrainian-agribusiness.
49. Tepliuk Mariia, Mykhailo Sahaidak, Svitlana Petrovska, Natalia Rudenko, Mykhailo Matsola. 2022. “Proposal to Increase the Level of Rural Business Activity after COVID-19.” *TEM Journal* 10(2): 656-662. ISSN: 2217-8309. Available at: 10.18421/TEM102-21.

50. The National Council for the Recovery of Ukraine from the Consequences of the War. 2022. “Draft Ukraine Recovery Plan: Materials of the “New agrarian policy” working group”. Available at: https://www.kmu.gov.ua/storage/app/sites/1/recoveryrada/eng/new-agrarian-policy-eng.pdf.
51. U.S. Agency for International Development (USAID). 2023. “AGRI-Ukraine Export Logistics Support”. Available at: https://era-ukraine.org.ua/en/agri-ukraine-export-logistics-support/.
52. UkraineInvest. 2022. “Rebuilding Ukraine with the Private Sector: International Investment Fair”. Available at: https://ukraineinvest.gov.ua/en/events/investment-fair/.
53. United Nations Industrial Development Organization (UNIDO). 2023. “Survey of Supply Chains in Post-Conflict Conditions in Ukraine”. Available at: https://www.unido.org/sites/default/files/unido-publications/2023-11/20230811_Supply%20Chain_Ukraine.pdf.
54. Vitalii Nitsenko, Havrysh Valerii. 2016. “Enhancing the stability of a vertically integrated agro-industrial companies in the conditions of uncertainty”. *Actual problems of economics* 10(184): 167-172. ISSN: 1993-6788.
55. Wan, C., Yan, X., Zhang, D., Qu, Z., Yang, Z. 2019. “An advanced fuzzy Bayesian-based FMEA approach for assessing maritime supply chain risks”. *Transport. Res. Part E: Logist. Transportat. Rev.* 125: 222-240. ISSN: 1366-5545. DOI: 10.1016/j.tre.2019.03.011.
56. WTW. 2023. Food, Beverage and Agriculture Supply Chain Risk Report 2023”. Available at: https://www.wtwco.com/en-sg/insights/2023/03/2023-food-beverage-and-agriculture-supply-chain-risk-report.
57. Yatsenko Olha, Vitalii Nitsenko, Tetiana Tananaiko, Beata Szetela, Alla Kobylianska. 2019. “Trade and economic integration dominants in North America countries’ interaction”. *Journal of International Studies* 12(3): 277-293. ISSN: 2071-8330. DOI: 10.14254/2071-8330.2019/12-3/22.
58. Zamlynskyi Viktor, Rostislav Heretskiy, Daria Firsa, Sergii Stepanenko. 2023. “Strengthening economic security through the zero waste concept in sustainable business”. *Ukrainian Journal of Applied Economics and Technology* 8(4): 139-149. ISSN: 2415-8453. DOI: 10.36887/2415-8453-2023-4-22.
59. Zhang John Hongguang. 2020. *Fractal Properties and Characterizations*. Cornel University. DOI: 10.48550/arXiv.2006.03888

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