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ВПРОВАДЖЕННЯ ІНСТИТУЦІОНАЛЬНОЇ АНТИКРИЗОВОЇ ПОЛІТИКИ В ТРАНСПОРТНІЙ СФЕРІ

Актуальність роботи визначається зростаючим впливом факторів ризику для транспортної галузі та небезпеки криз в сфері перевантаження, транспортування, обробки вантажів, зростаючою роллю регіональних та корпоративних структур в керуванні та організації транспортних потоків. Це входить в протиріччя з застарілою системою керування транспортною галуззю, спроможністю ефективно та своєчасно реагувати на нові виклики, що обумовлює необхідність формування нових теоретико-методологічних аспектів уникнення та нейтралізації наслідків ризиків в процесі перевезень вантажів. Реформування системи управління транспортною галуззю передбачає формування нових відносин на всіх рівнях, починаючи з рівня державні інституції – корпоративні структури.

Мета та завдання наукового дослідження полягає у розробці теоретичних та методологічних засад інституціональної антикризової політики і практичних рекомендацій щодо нових підходів у запобіганні кризам та нейтралізації їх наслідків для підвищення ефективності та стійкості транспортної галузі.

Завданням наукового дослідження є розробка теоретичних положень та методологічних принципів нової структури антикризового управління транспортною системою та практичних рекомендацій щодо створення відповідних взаємовідносин з державними інститутами, формулювання вимог до нормативної бази регуляторної інституціональної політики, яка б створювала умови для ефективного функціонування транспортної галузі.

Результати базуються на формуванні нових методологічних засад впровадження інституціональної антикризової політики в транспортній сфері. Основою нового підходу є поєднання макро та мікро-пруденціних регуляторних впливів для запобігання кризам в транспортній галузі та нейтралізації їх наслідків, забезпечення стійкості та ефективності системи обробки, перевантаження та транспортування, в першу чергу, мультимодальних та інтермодальних вантажів. Як інструмент впровадження нової регуляторної пруденційної політики запропоновано використати систему антикризових центрів, що базуються на існуючих регіональних, консолідованих корпоративних структурах та центрах управління за видами транспорту. Основним принципом антикризової діяльності вказаних центрів є гра за ненульовою сумою.

Висновки. Ризики настання криз різного рівня для транспортної галузі зростають за об'єктивних факторів. Для запобігання кризам запропоновано провадити збалансовану та компромісну пруденційну регуляторну політику, сформувати систему антикризових центрів. Методом компромісної пруденційної політики обрано індикаторний аналіз. Розроблено структуру аналітичних служб вказаних центрів. Створено математичну модель прогнозування криз та впровадження регуляторних впливів для запобігання кризам та мінімізації їх наслідків. Деталізовано схему ідентифікації та визначення ступеня інституційних та інституціональних чинників на формування регуляторних впливів мультимодальних та інтермодальних перевезень. З огляду на розроблені методичні та методологічні новації запропоновано схему організації пруденційного регулювання та нагляду в транспортній сфері.

Ключові слова: макро-пруденційний аналіз, мікро-пруденційний аналіз, криза, мультимодальні перевезення, інтермодальні перевезення, ризики

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IMPLEMENTATION OF THE INSTITUTIONAL ANTI-CRISIS POLICY IN THE TRANSPORT AREA

Topicality. *Topicality of work is determined by the growing influence of risk factors for the transport industry and the risk of crises in the areas of congestion, transportation, cargo handling, and the growing role of regional and corporate structures in managing and organizing traffic flows. This is inconsistent with an outdated transportation management system, the ability to respond effectively and timely to new challenges, which necessitates the formation of new theoretical and methodological aspects of avoiding and neutralizing the consequences of risks in the process of cargo transportation. Reforming the transport management system involves the formation of new relationships at all levels, from the level of state institutions - corporate structures.*

Aim and tasks. *The purpose of the research is to develop the theoretical and methodological foundations of institutional anti-crisis policy and practical recommendations for new approaches to crisis prevention and neutralization to improve the efficiency and sustainability of the transport industry. The objective of the research is to develop theoretical provisions and methodological principles for a new structure of crisis management of the transport system and practical recommendations for creating appropriate relationships with state institutions, formulation of requirements for the regulatory framework of regulatory institutional policy, which would create conditions for the efficient functioning of the transport industry.*

Research results. *The results of the research are based on the formation of new methodological bases for the implementation of institutional anti-crisis policy in the field of transport. The new approach is based on a combination of macro and micro-prudential regulatory impacts to prevent and mitigate the effects of transport crises, ensuring the stability and efficiency of the processing, handling and transportation system, primarily of multimodal and intermodal loads. It is proposed to use anti-crisis center system as a tool for implementation of new regulatory prudential policy, based on existing regional, consolidated corporate structures and transport management centers. The basic principle of the anti-crisis activity of these centers is play at a non-zero amount.*

Conclusion. *The risks of different levels of crisis for the transport industry are increasing due to objective factors. To prevent crises, it is proposed to implement a balanced and compromise prudential regulatory policy, to form a system of anti-crisis centers. Indicative analysis was chosen by the method of compromise prudential policy. The structure of analytical services of these centers has been developed. Mathematical model of crisis forecasting and implementation of regulatory impacts created to prevent crises and minimize their effects. The scheme of identification and determination of the degree of institutional and institutionalizmal factors on the formation of regulatory impacts of multimodal and intermodal transportations is detailed. In view of the developed methodical and methodological innovations, the scheme of organization of prudential regulation and supervision in the transport sphere is proposed.*

Keywords: *macro-prudential analysis, micro-prudential analysis, crisis, multimodal transport, intermodal transport, risks.*

Problem statement and its connection with important scientific and practical tasks. Because the risks are affected by both macroeconomic and microeconomic factors, if they interact, then the regulatory

policy to prevent and counteract them should focus on analyzing the interplay of these factors. In this case, the regulator's task is to reach a balance point between the macro and micro prudential aspects of the transport industry. The solution to this problem may be the formation of a non-hierarchical system of management of the industry inherent in the economic and political system of the past (or previous) years, but the distributed system of interacting control centers - regional, corporate, etc. And the function of the national authorities will be to create conditions that contribute to the balance of these macro and micro-prudential aspects of the transport industry. This is facilitated by the increase in the share of multimodal transport (MMT) and intermodal transport (IMT) in the total volume of freight flows in the country, increasing the role of corporate structures in this process. MMTs and IMTs are forming new horizontal links between autonomous corporate entities, state-owned monopoly carriers, transport companies, logistics centers, cross-border entities, etc. These links are forging new relationships in the transport industry, forging a new freight transportation system, and growing their impact requires them to consider their interests at the national level. Management of the industry de facto moves from the level of the state to the level of a new structure of distributed but interacting in many directions interdependent elements of the transport system.

Analysis of recent publications on the problem. Micro-prudential regulation is applied to prevent risks and mitigate their consequences for individual companies and corporations, and macro-prudential regulation is used to prevent systemic risks, in this case, the transport industry as a whole [1]. By definition, macro-prudential regulation is related to macroeconomic factors [1, 2]. Previously, micro-production regulation was applied to influence the activities of individual companies and corporations exogenous risks and, as a rule, was not applied in the case of exposure to endogenous risks. Micro-prudential analysis did not take into account the emergence of the system, that is, it did not consider the impact on the system of individual economic entities. That is, economic, political and other types of influence on the industry (system) of individual companies and corporations were not taken into account, regardless of their importance for the industry, the share of the transport services market, the available levers of influence, complexity and importance for the system as a whole of the structural links of these economic entities [3,4].

A number of scientists for example, Kodres and Narain [5] have considered that a valid regulatory framework for time-lengthened and sustainable economic periods cannot correspond to reality in times of increased risks, economic shifts, realignments, etc. That is, the regulatory impact directed at protecting, maintaining the position and influence of individual economic entities (e.g. transport monopolies, state institutions of transport system management) does not correspond to the strategy of sustainable development and security of the system as a whole. This happens, in particular, because in the event of a crisis, significant risk and impact, individual structures, companies pursue policies that, in their view, are consistent with their corporate interests, but it harms the performance of the system as a whole, or even the existence of the system. That is, prudential regulation of the elements of the transport system is a prerequisite for reducing systemic risks and threats, preventing crisis phenomena, providing regulatory factors, factors and resources to counteract their consequences, forming conditions for the viability and efficiency of the transport system.

Thus, there is a contradiction between the macro- and micro-prudential regulations of the transport industry. The consequence is the need to strike a balance between macro- and micro-prudential regulation, in particular, the establishment of boundaries between the monitoring of the activity of economic entities of the industry by representatives and structures of state institutions and the creation of conditions for total resilience of these economic entities. This leads to the need to rigidly set boundaries for the formal powers of state structures and to monitor compliance of their activities with the established rules and regulations, to prevent the implementation of total control.

In the face of a risk or crisis, the macro-prudential approach should aim at restricting or even suspending some entities in the transport industry, or even modes of transport, and the primary resource for preventing or mitigating the effects of the threat (systemic risk) is directed to a specific, identified group of specified economic entities.

Macro-prudential policy should focus on monitoring the factors that affect the full range of risks for transport enterprises, institutes and the industry as a whole and the development of a toolkit for risk mitigation measures and their consequences and the degree of expediency and conditions of use of those instruments. The efforts of regulators must be aimed at the specific purpose of preventing the crisis, and, in the event of its occurrence, the reduction of losses from its effects both on the system as a whole and on the system's players.

The micro-prudential approach is that resources should be directed at shaping the ability of economic agents and institutions to withstand the impact of the crisis and in reducing the likelihood of failure of

individual institutions, regardless of their importance to the transport industry. Most often, this risk is defined as "individual".

Crisis industry-wide macro-prudential policy for literature [3-5] includes identifying risks for the industry as a whole and implementing measures to mitigate these risks and reserve the resources needed to counteract their effects. But in our view, the effectiveness of such a policy will not be high, since the micro- and macro-prudential effects of risks cannot be separated and the transport industry is a system and it has a system of emergence. That is, the micro-prudential impact of risks on individual structures or companies of the industry, depending on their economic weight and importance to the industry, may be critical for the whole system. Similarly, the macro-prudential impact of systemic risks will affect the activities or even the functioning of individual entities or companies. Therefore, the task of combining macro and micro-prudential analysis is to produce a non-zero result for all players in the event of a crisis scenario.

Table 1.

Differences of purpose, results and characteristics of macro- and micro-prudential regulation

Factor	Macro-prudential regulation	Micro-prudential regulation
The main goal	Crisis risk reduction	Reduce the risk for the company or corporation
Result	Avoiding collapse or significant damage to the transportation industry	Protection of corporate interests
The nature of the crisis	Endogenous	Exogenous
Strength of horizontal ties between economic entities	It matters	Not taken into account
Organization of prudential regulation	Centralized	Distributed

Source: Compiled by the authors based on [1-5] and other sources

The reciprocal impact of micro- and macro-prudential policies has been considered since the very use of the definition of micro- and macro-prudential policies by the Cook Commission in 1979 [6].According to the theory of systems complication of technological structures leads to an increase in the likelihood of crises in their work and the growing impact of crises as complications for the continued sustainable and efficient functioning of systems. This was mentioned in the works of R. Wack and U. Eko as the inevitable degradation of large and complex technological or economic systems, which will result in a decrease in trends towards globalism. This creates new threats to MMTs and IMTs - because they are predominantly transboundary and more systematic than other transportation needs.

Allocation of previously unsolved parts of the general problem. The situation in the transport sector of Ukraine is characterized by the fact that it is a large, complex and eclectic system. The consequence may be that, for example, a crisis that will force the market out of the micro-prudential factors of a single influential player or a group of small and medium-sized players may affect the market in an impact on the market. Certainly, in the event of a crisis, different structures and components of the transport system will be vulnerable [7]. But it is the MMPs and the IMPs that are the most vulnerable of all modes of transport, since they require coherence in actions consistently (in accordance with the transport chain) of the carriers involved and the smooth operation of the points of congestion. It is also an incentive to find a reasonable compromise for the simultaneous application of micro- and macro-prudential regulatory influences. Obviously, it is necessary to choose the components of joint regulatory impacts for each of the crisis variants individually. In the current difficult economic and political situation, the components of a set of regulatory influences may be different, depending on the genesis of the crisis, circumstances, number of players involved, etc. But it is worth preparing the scenario trees before any crisis becomes a reality. Despite the growing vulnerability of the transport system, crisis prevention, the provision of anti-crisis regulation in domestic scientific literature received little attention. All aspects of prudential regulation, systemic anti-crisis approach - implementation of theoretical and methodological foundations, practical measures and proposals remain unaddressed, management algorithms, developing crisis scenarios and anti-crisis measures, institutional policies, institutional tools, mathematical models of prudential prevention and regulation.

Formulation of research objectives (problem statement). This allows us to formulate the purpose of the research - to develop theoretical and methodological foundations and practical recommendations to justify new approaches in crisis prevention and neutralization of their consequences, to increase the efficiency of the transport industry.

The objective of the research is to develop theoretical provisions and methodological principles for a new structure of crisis management of the transport system and practical recommendations for creating appropriate relationships with state institutions, formulation of requirements for the regulatory framework of regulatory institutional policy that would create conditions for the efficient functioning of the transport industry.

An outline of the main results and their justification. To monitor the situation in the industry, to create the necessary and sufficient set of regulatory impacts, to control the implementation of anti-crisis measures in real time, we recommend to create an anti-crisis center (ACC), equipped with monitoring and early warning system (MEWS). The scheme of work of the analytical department of the ACC with the corresponding MEWS is presented in Fig. 1.This requires the formation of a communication system, control of execution, pre-development of the script tree, development and implementation of appropriate software and hardware, structure of analytical services (see Fig. 1) and other components of MEWS, etc. Appropriate indicators should be developed to indicate the threat of the crisis, its characteristics, the range of companies, modes of transport, infrastructure that will be affected by the crisis. This will help to resolve the crisis in the initial stages and reduce the devastating impact of its effects. The measures involved are called "macro- or micro-excitation indices" (MPI) [8, 9].To do this, we define the following stages of the algorithm:

1.From the whole set of indicator arrays, including MPI, characteristic of an array of different crises (big data), an option is automatically selected based on the actual indicator set, that is, a crisis that threatens the transport industry is identified.

2. The event tree corresponding to the specific identified crisis is selected.

3. A prudential analysis of the crisis is conducted and a set of appropriate regulatory influences is selected for each of the stages of crisis development - from crisis prevention to crisis minimization.

4. Regulatory influences are being introduced.

5. The situation is monitored in real time with appropriate adjustment, if necessary, of regulatory policy.
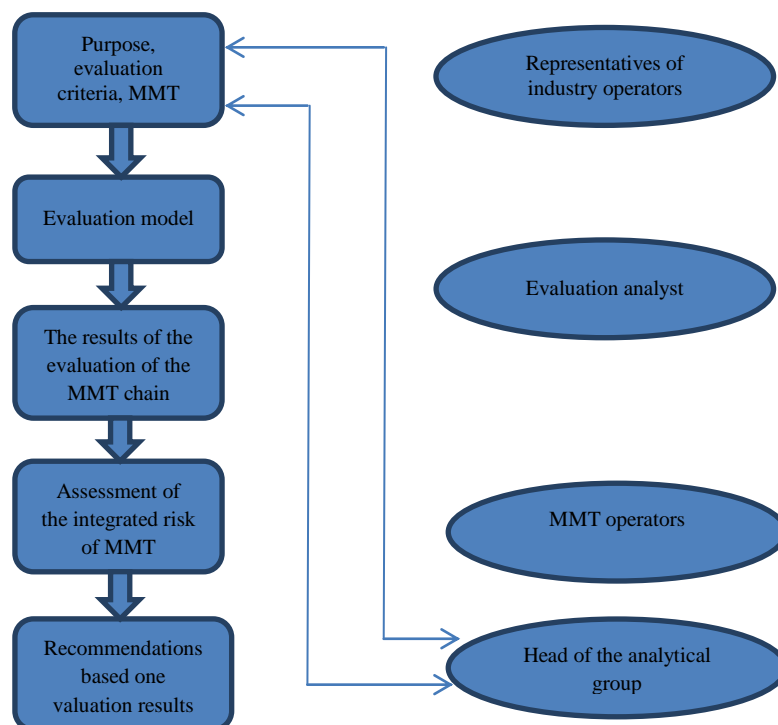

Fig. 1. Diagram of the work of the analytical department of the anti-crisis center.

In our opinion, it is necessary to use not a crisis center formed according to a hierarchical structure, but a networked, distributed system of crisis centers to monitor and coordinate the implementation of regulatory actions and control their implementation. We propose to implement the network system on the principles of consolidation of the most influential players in the transport industry by types of transport, by areas of activity, by regions of deployment, etc. And we recommend assigning purely advisory functions to the single state anti-crisis center of the network structure.

The scheme of organization of identification and determination of the degree of institutional and institutional factors on the formation of regulatory influences of MMTs and IMTs is shown in Fig. 2. This scheme defines the role and place of state institutions in the regulatory structure of the transport sector.

The network system of anti-crisis centers must operate according to the rules of the game with a non-zero amount. The scheme of organization of macro- and micro-prudential regulation and supervision in the transport sphere is shown in Fig. 3.

Consider the mathematical model of the transport system as a connected structure of indicative graphs (digraphs or orgrafs) of consolidated players in the industry (integral digraph).The nodes of each of the digraphs are the points of loading, unloading, reloading (for the case of MMT and IMT), arcs are elements of transport routes that connect (or can connect) these points. Obviously, some consolidated players in the industry can use the same transportation routes, reloading points as other players. Common congestion points will be incident to the digraphs of the linked structure.

Each of the local anti-crisis centers takes care of its digraph. When a crisis is related to micro-prudential factors of a particular player (or group of players) or to macro-prudential factors that cause. For example, hostilities, accidents, natural disasters that block a number of congestion points or a number of roads, the transport system must, through regulatory actions, redirect goods to other routes, use other reloading points. It is possible that a certain group of players wants to use economic pressure on others, for example, by introducing a system of tariffs that give it a surplus but lead to losses of other players. In this case, the consolidated game of other market participants to redirect goods bypassing the violator can stabilize the situation and localize the artificial crisis.
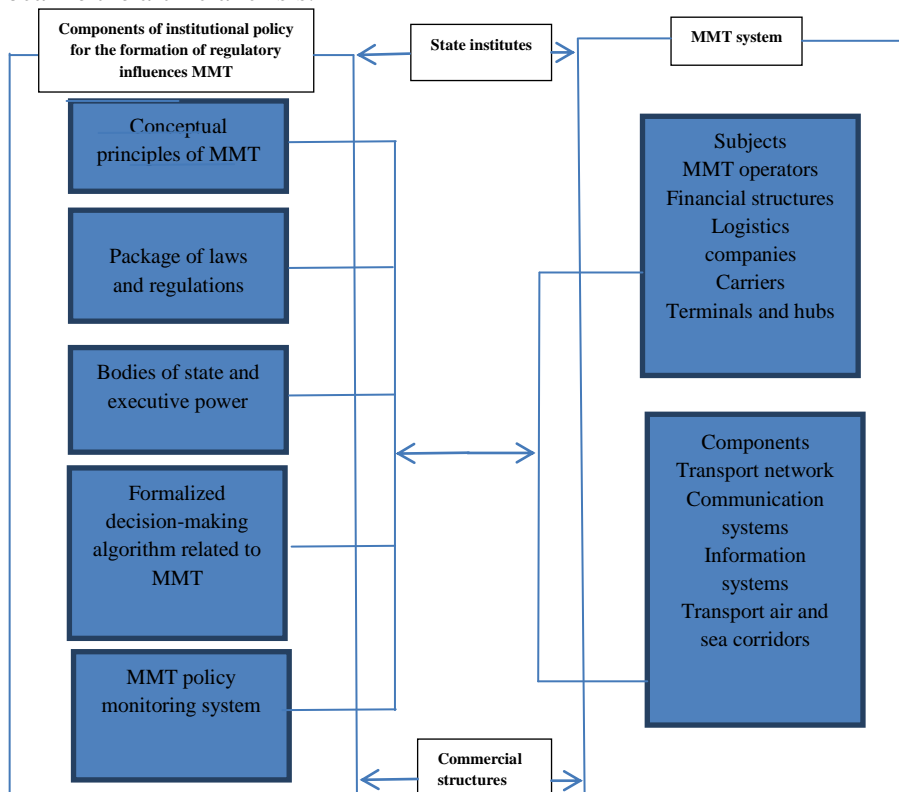

Fig. 2. Scheme of organization of identification and determination of the degree of institutional and institutionalizmal factors on the formation of regulatory influences of MMT and IMT.

To implement the model, we use the approach proposed in [10], modifying it. Consider a set of k digraphs $G_k = (U_k, E_k),$ which make up an integral digraph.

Since the integral digraph as a topological structure in a multidimensional continuum can be described analytically using the tensor equation

$$WQ = V, \qquad\qquad\qquad (1)$$

where W - connectivity tensor, Q- the bandwidth tensor of each element of transport routes (each arc of a digraph), V- the bandwidth tensor of communication arcs between individual digraphs.

Since each crisis is characterized by a set of parameters that determine the probability of a scenario, the probability of increasing the risks of transporting goods through certain points on certain routes, which leads to an increase in the cost of transportation, causes the need to change the planned routes to routes that were previously considered economically unprofitable. That is, equation (1) can be interpreted as follows. V-tensor of probabilities of capacities of communication arcs between separate digraphs for transportation of concrete cargoes and cargo flows, Q - the tensor of probabilities of presence of cargoes in points of transportation in the set intervals of time. Invariance of tensors will allow to optimize transportation during the crisis of the transport system which leads to a change of coordinates for the requirements of replacement of the objective function or a radical change of it under the circumstances of changing its parameters.

The target function of route optimization may vary depending on the circumstances and tasks of the transport operator. This may be, in particular, the minimum cost of transportation, the minimum time of transportation, the maximum safety of transportation, the maximum efficiency of the transport system or individual modes of transport and routes according to certain, predetermined criteria (indicators).
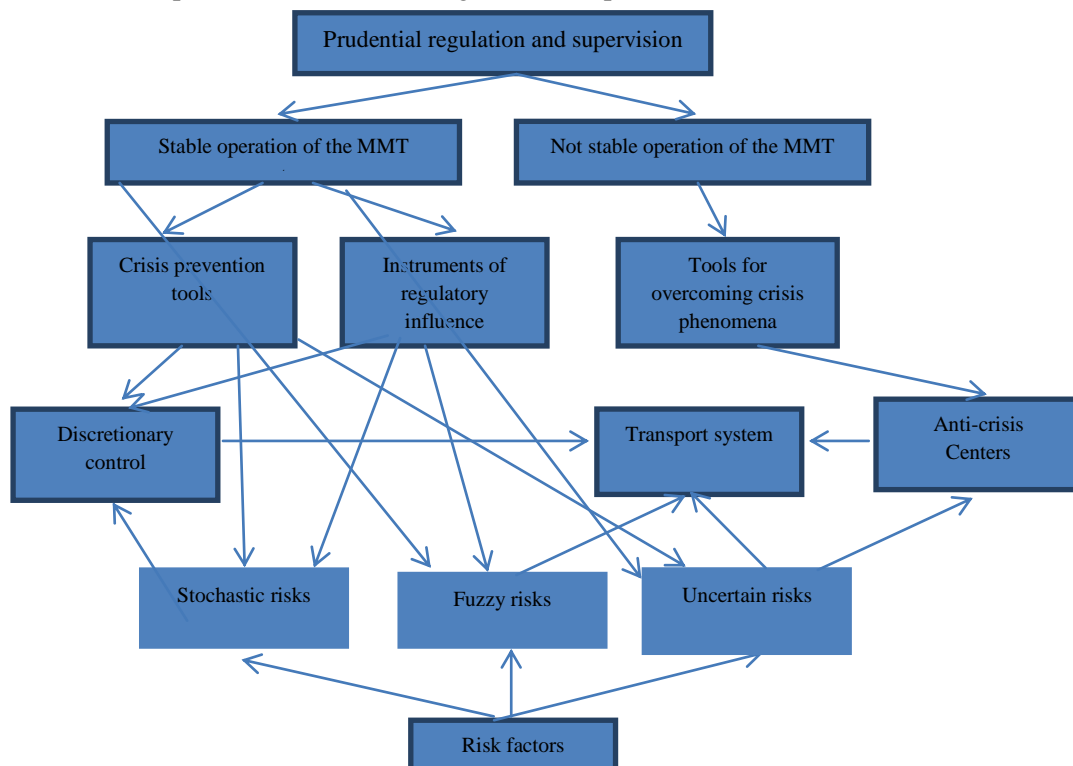

Fig. 3. Scheme of organization of prudential regulation and supervision in the transport sphere.

The invariance of the tensor equation also simplifies the optimization problem under the circumstances of a radical change in the transport conditions [11]. The integral objective function ($\vec{F}$) can be represented as the vector sum of the corresponding values of the local objective functions ($\overrightarrow{f_{ij}}$) in individual nodes (i) and arcs (j).It is expedient to represent objective functions as vectors as each of them is defined by a matrix of parameters.

$$\vec{F} = \sum_1^n \overrightarrow{f_{ij}} \qquad (2)$$

where n - the number of values of local objective functions. For this problem, the local objective function of the arc (edge) is identified with the concept of the weight of this edge. In the digraph G with the weight function $w: E \rightarrow R$ the weight of the path p will be the additive value of the weights of the arcs belonging to this path. The optimal path from node a to node b can be found as

$$\delta_{opt}(a,b) = \begin{cases} min\left\{w(p): a \xrightarrow{p} b\right\} provided (a,b) \in p \text{ та } \exists a \xrightarrow{p} b \\ \infty \; other \; wise \end{cases} \qquad (3)$$

where ∃- quantifier of existence. The following algorithm for finding the optimal path on a digraph for a complicated MMA and IMP problem is also proposed, to satisfy not one but two more targeted functions, such as the efficiency of transportation and its minimum cost under boundary conditions

$$t_i \in [0, t], \quad \sum_1^n s_i \leq S_{max}, \sum_{1,}^n w_i \leq W_{max}, \quad i \in \{0, i_{max}\} \tag{4}$$

where t_i–the time of passage of the goods through the node / arc of the digraph, t - the maximum time of the route, s_i–the cost of passing the goods through the node / arc of the digraph, S_{max}-economically justified maximum cost of the route.

The task of finding the optimal path on the local digraph under certain circumstances, for example, when it is necessary to move from the analysis of the micro-prudential level to the analysis of the macro-prudential level, can be part of the problem of finding the optimal path on the integral digraph. Then it is necessary to consider the following set of problems: finding the optimal path from the initial node a to all nodes of the digraph; from all nodes of the digraph to the final node b; from an arbitrary node a_i to an arbitrary node b_i; between all arbitrary pairs of nodes. We solved these problems by a simple variation of the main problem. Since the weight of each node and arc in the task will be guaranteed to be non-negative, the best algorithm that can be used in this file will be tested Dijkstra's algorithm. The developed mathematical model, as proved, organically combines macro- and micro-prudential levels. Its application is able to predict the possible course of the crisis in the relevant scenario tree and therefore it can be an impetus for combining the efforts of individual anti-crisis centers and their activation to joint action as a single system. The problem is complicated by the fact that the parameters of the values of local objective functions can be both probabilistic and fuzzy values, because, obviously, part of the parameters that allow identifying the crisis will be risks of various kinds. Analysis and classification of risks for MMTs and IMTs are detailed in scientific work [11].When there are fuzzy parameters, it is necessary to generalize the approach given in the scientific article [12], applying the approach proposed in scientific work [13] using the method of intuitionistic dominant semi-invariants on a fuzzy digraph. This allows us to distance ourselves in some way from the use of fuzzy sets, because the method of intuitionistic dominant semi-invariants guarantees the absence of mutual influence of belonging and non-belonging of crisis factors. Our study also identified a group of uncertain risks (see Fig.2), the nature of the impact of which, as shown by the analysis, can be absorbing. That is, the impact of each of the uncertain risks may be greater than the combined impact of all other risks. An example of uncertain risks can be large-scale aggression; default; banking crisis, special one, which is accompanied by a sharp jump in the national currency; pandemic and countermeasures to overcome it, etc.

Conclusions and perspectives of further research. The risks of crises of various levels for the transport industry increase due to objective factors. This is facilitated by the increasing impact of globalization on the transport sector, external threats, the instability of the national economy and currency, increased traffic and quality requirements, increasing the complexity of the state transport system and more. In order to prevent crises and mitigate their consequences, increase the level of sustainability and efficiency of the transport sector, it is proposed to pursue a balanced and compromise prudential regulatory policy. Indicator analysis was chosen as the method of such policy. This requires the use of the MPI system, which would identify the threat of a crisis, the characteristics of the crisis, corporate structures, modes of transport, transport infrastructure that will be affected by the crisis, and the algorithm for working with these indicators. As an institutional tool for the implementation of prudential policy, it is proposed to introduce a networked system of anti-crisis centers using existing influential corporate structures and for the consolidation of small and medium-sized players in the transport services market. The structure of analytical services of the specified centers is developed. A mathematical model of crisis forecasting and implementation of necessary and sufficient regulatory influences to prevent crises and minimize their consequences has been created. The scheme of organization of identification and determination of the degree of institutional and institutional factors on the formation of regulatory influences of MMT and IMT is detailed. Taking into account the developed methodical and methodological innovations, a scheme of organization of prudential regulation and supervision in the transport sphere is proposed.

The work should be extended in the direction of MPI system development with determination of numerical intervals of their admissible, pre-crisis and limit values on the basis of the degree of crisis danger.In addition, scenario trees and indicative pointer values should be developed at each tree fork. This work should be carried out in close cooperation with experienced practitioners in the field of transport.

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