Development of Theoretical Foundations, A Set of Methods and Algorithms for Substantiating Decision-Making by a Management Organization in an Infrastructure-Complex Territory in the Interest of Reducing the Risk of the Possibility of Cascading Accidents Escalating into Intersystem Accidents

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ABSTRACT

A new direction in the system analysis and decision making of the occurrence of cascade accidents escalating into intersystem accidents is successfully developing in the world. The aim of the article is to develop theoretical foundations, methods and algorithms to justify the most adequate decision-making by one of several independent managing organizations at the same time to manage the risk of cascading and intersystem accidents. Existing methodological approaches to risk analysis do not allow to fully solve the problems of substantiating a number of managerial decisions. For example, in the sphere of organizing the activities of managing organizations, it is important to justify the criteria and target levels of indicative indicators, to forecast the effectiveness and efficiency of activities using risk criteria.

To solve problems of this kind, it is necessary, on the one hand, a conceptual framework for risk management, and on the other, a complex of methods and algorithms based on existing information arrays. The complexity of such management is determined by its cascading nature, as well as by the presence of several organizations independently managing the critical infrastructure of the territories of the organizations (energy systems, transport systems, housing and communal services systems, etc.), and therefore, it is difficult for the organization managing critical infrastructure to determine direct and final management results. For example, several management organizations independent from each other, within their competencies, act on objects of the first level, which, in turn, affects objects of the second level, etc. The task also consists in selecting from the set of possible control actions one control action depending on the control object or on the territory in which the control is carried out in order to achieve the target indicator of the stable functioning of critical infrastructure.

Management tasks of this kind arise in energy, transport, housing and communal services and in other spheres of human activity, however, at present, there is no unique algorithm for solving them. This determines the relevance of the problem of developing the theoretical foundations, a set of methods and algorithms for substantiating decision-making by the managing organization at the facility or territory with cascading risk management of one of several simultaneously managing organizations.

Algorithmization of finding target indicators and algorithmization of the choice at the facility or territory by the managing organization of actions from a possible set of control actions aimed at achieving the target risk management of cascading accidents that develop into intersystem accidents are necessary. To carry out planned and unscheduled oversight activities by critical infrastructure managers, organizations need to solve the following tasks:

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- determination of thresholds for acceptable level of risk;
- identification of a manageable share in indicative indicators;
- finding the critical value for indicative indicators;
- identification of territories and facilities where it is most appropriate to carry out supervisory measures to manage the risk of intersystem accidents for critical infrastructure.

To solve such problems, a mathematical apparatus developed for continuous statistical monitoring of objects can be applied.

To carry out planned and unscheduled supervisory activities by managing organizations, it is necessary to solve the problem of identifying territories and objects where supervisory activities are most appropriate. The use of probabilistic and statistical analysis allows not only to assess the relationship between the indicators of the direct and final result of the activities of the managing organization within the framework of the target program, but also to determine priority areas and objects for planning management activities. Adequate for this is the mathematical apparatus of continuous statistical control - a method of probabilistic-statistical analysis that allows you to recognize critical situations to justify the need for decision-making.

Risk management is conceptually described by successive management models, which we call cascading. The cascade management model, in addition to controlling and controlled factors, has two intermediate layers of indicative indicators (primary and secondary characteristics). To effectively manage the result, it is necessary to consistently evaluate the influence of uncontrolled conditions and predetermined control factors on the controlled factors, to forecast changes in the controlled factors when the control factors change and to identify the optimal values of the control factors.

The nonlinear matrix forecasting method allows you to establish causal relationships between control and controlled factors, makes it possible to build and analyze a set of control models, choose the best, in a sense, control model, establish the share of influence of control factors on controlled factors, and predict controlled factors.

Conclusions on the work

1. The concept and methodology of risk management of one of several simultaneously managing organizations in the constituent entities of the Russian Federation or in the territories of the constituent entity of the Russian Federation have been developed. Moreover, if the number of managing organizations and the number of objects in the territories can be different, then the number of characteristics and risks is always the same.

2. Modeling methods have been developed for substantiating decision-making by a managing organization in an infrastructure-complex territory in order to reduce the risk of the possibility of cascading accidents escalating into intersystem accidents.

3. The method of matrix nonlinear forecasting (the time parameter significantly affects the model), based on the formulated concept of the minimum amplitude corridor of the matrix of dynamic coefficients. The method allows you to determine the percentage of controlled factor (controlled factors), which is influenced by control factors.

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