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APPLICATION OF SYSTEM ECONOMIC THEORY IN NEURAL NETWORK MODELING OF RISK MANAGEMENT PROCESSES

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Abstract. This study proposes an approach to the formation of decision-making models, which is based on the use of artificial neural networks. We propose the development of solutions in problems of managing the level of risk in enterprises based on the system economic theory of G. B. Kleiner. Four aspects of the functioning of the socio-economic system are considered: planned, forecast, informational and operational.

The problem of modeling risk management in an enterprise is difficult. The number of homogeneous and independent operations at the enterprise is small, unlike the banking sector, insurance or retail trade, so the use of methods of probability theory and statistical methods is limited. In this study we are considering the use of artificial neural networks in risk management tasks.

Universality of use of neural networks is expressed in the following: the type of dependency between the initial data set and the result of its processing will be determined during neural network learning. The use of artificial neural networks in modeling is constrained by the lack of standardized approaches to the creation of neural network structure. For forecasting and classification problems, the choice of neural networks as a tool is optimal.

The use a set of four interacting subsystems (intentional, expectational, cognitive, functional) and artificial neural networks will allow one to adequately describe complex situations of economic risk. Even if we do not have a clear idea of the formalized form of the relationship between a set of economic risk factors and the result of their treatment.

Keywords: enterprise risk management, artificial neural networks.

The complexity of the development of scientific knowledge in the field of enterprise management creates the need to integrate many areas of humanitarian knowledge, such as: economics, psychology and sociology. This fact determines the need for a multidisciplinary approach to improving the mechanisms of support for management decision-making. At the same time, the uncertainty of the external environment of the enterprise, can significantly limit the decision-making and the degree of feasibility of management decisions. Therefore, the use of modern methods of behavioral economic theory can be very promising. Since the modeling process takes into account the fact that many alternatives are known to the head of the enterprise in advance, but in the selection process may be additional factors, the presence of which was previously unknown (Thaler, 2017). This may contribute to the significant development of the theory of risk management in the enterprise.

Using a systematic approach, in the structure of any enterprise that represents an example of a socio-economic system, four main transboundary subsystems can be distinguished (Klejner, Rybachuk, Ushakov, 2018). Each subsystem influences the decision-making process. The first subsystem is a subsystem that includes the formation of intentions for future activities, the so-called *intentional subsystem*. The second one is subsystem covering the expectations of the system with respect to the reaction of the environment on those or other actions or *expectational subsystem*. The third subsystem is including the formation of knowledge

about the environment and the system itself or *cognitive subsystem*. The subsystem responsible for the actions necessary for the system to perform its functional purpose is the *functional subsystem*.

This study, supported by the Russian Foundation for basic research (project 18-010-01042), proposes an approach to the formation of decision-making models based on the use of artificial neural networks to support decision-making. There is a view of the development of solutions in the tasks of managing the level of risk in enterprises on the basis of the system economic theory developed by G. B. Kleiner (Kleiner, 2013). This approach takes into account four aspects of the functioning of the socio-economic system: planned, forecast, informational and operational.

The type of dependency between the initial data set and the result of its processing will be determined during neural network learning. The use of artificial neural networks in modeling is constrained by the lack of standardized approaches to the creation of neural network structure (Orlov, 2003).

Artificial neural network is configured in the learning process on the example of a particular enterprise, taking into account its inherent set of risk factors, the four main cross-border subsystems and the propensity of its leaders to accept the risk. It should be noted that the advantage of the system approach is that it allows to compare different-scale economic agents, to reveal their common ground (Kleiner, 2015a, 2015b).

We understand that risk management involves the development of intentional and exploratory subsystems, which imply various social impact mechanisms: organization, moderation, mediation, support, stimulation, etc.

It is assumed that the setting of an artificial neural network is carried out according to a certain algorithm, based on the development of a cognitive subsystem, which implies a comparison of several evaluated alternatives. Such an algorithm involves evaluating each of the alternatives when making anti-risk controlling action. Each network element - a neuron - builds a weighted sum of its inputs and then passes this value through the activation function, obtaining the value of the estimated characteristic of this network element at the output.

Elements are arranged layer-by-layer with direct signal transmission. Such a neural network allows us to build a model of a function of almost any degree of complexity. And the complexity of the function is determined by the number of layers and the number of elements in each layer. The number of input elements of the network is determined by the number of risk factors taken into consideration, and the output elements can be treated as a level change for each type of risk.

Interpretation of initial sets of output elements is made on the basis of expert evaluation (Kachalov, 2012, Kachalov, Sleptsova, 2015). Thus, the plausibility criteria in the model are set by the subjective opinion of specialists. This fact can be regarded as a drawback of the model (Smith, 1994).

Determining the number of intermediate layers and the number of elements in each layer is a key issue in the design of multilayer neural networks. As independent variables, the elements of the above subsystems are used:

a) variables, elements of the expectational subsystem, which describe the assessment of the significance of risk factors by the criterion of the possibility of the occurrence of adverse events, or the magnitude of the expected damage;

b) variables, elements of the cognitive subsystem, containing an assessment of the effectiveness of anti-risk controlling action, for example, based on the life experience of this particular specialist.

This takes into account the dynamic nature of these effects.

If unrealistic output elements of the neural network are detected, the model is adjusted to increase the likelihood of the results obtained with it. The final choice is made on the basis of a comparison of the expected effects for each recognized alternative.

To assess the reliability of a management decision, each decision is evaluated in the context of the most unfavorable developments. (Gabrel, Murat, 2014). To select the worst case scenario, you can use a finite number of scenarios from the historical database.

The use of four main cross-border subsystems in the neural network approach of risk management will allow to describe complex situations of economic risk quite correctly, without having a clear idea of the formalized form of the relationship between the set of economic risk factors (set of initial data) and the result of their processing. For the tasks of predicting possible adverse events in the activities of the enterprise, and the planning of appropriate anti-risk controlling action, the choice of neural networks as a tool may be the best.

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