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Neurocomputing in logistic management for education & science industry in unstable environments & in emergency contexts

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Abstract. *The paper examines the application of artificial neural networks (ANN) and hybrid neurocomputing technologies in logistics management for the education and science sectors under uncertainty and crisis conditions. Traditional analytical methods are often ineffective in dynamic and unstable environments. ANN, as adaptive and self-learning systems, enable intelligent forecasting, optimization, and decision support. Their use improves the efficiency, flexibility, and resilience of logistics processes in educational and research institutions. Hybrid neurocomputing models that integrate neural networks, fuzzy logic, evolutionary algorithms, and metaheuristics enhance resource management and risk prediction. These intelligent platforms form the basis for adaptive and crisis-resistant management, supporting sustainable development of education and science systems in the era of digital transformation.*
Keywords*: education; science; logistics; uncertainty; crisis management; artificial neural networks; hybrid systems.*

Introduction.

The modern service sector is developing in conditions of high dynamism, digitalization and increasing competition [1, 2]. At the same time, although the service sector (which includes the education sector) is one of the most dynamically developing, it is also the most vulnerable segments of the economy. In the context of globalization, digital transformation and increased competitive pressure, service organizations are faced with increasing instability of the external environment [3, 4]. Uncertainty manifests itself in the form of fluctuations in demand, disruptions in supply chains, resource shortages, information risks and variability of consumer behavior [5, 6]. In such conditions, traditional planning and optimization methods are not effective enough, since they are based on the assumption of stability of parameters and linearity of dependencies [7-9].

Therefore, modern logistics management requires the implementation of adaptive, intelligent and hybrid solutions [10], capable of ensuring a balance between economic efficiency and stability in unstable conditions [10], [11]. Logistics ceases to be just an operational tool - it turns into a strategic function aimed at ensuring the stability of business processes and maintaining the competitiveness of the organization in conditions of uncertainty and crises [12]. Considering the above, it can be argued that traditional management methods and classical data analysis algorithms become insufficiently effective, especially when working with unstructured information, a large number of parameters and high dynamics of processes [13]. In such conditions,

it is artificial neural networks (ANN) that become the foundation of intelligent management and strategic planning. ANNs are adaptive computing systems capable of self-learning, recognizing complex nonlinear dependencies and modeling the behavior of complex systems [14]. Their application in logistics management of the service sector provides not only automation of processes, but also intellectualization of decision-making, which contributes to sustainable development, cost reduction and improvement of service quality. Thus, the use of neural network technologies allows to increase management efficiency, improve resource utilization and ensure the stability of educational and scientific systems in conditions of crises and uncertainties.

The Main Part.

1. The role and functions of neural networks in logistics management in the education and science industries - artificial neural networks are able to learn based on accumulated data, recognize patterns and reveal hidden dependencies. In the context of education and science logistics, they are used for [15]: forecasting needs for educational and research resources; optimizing the distribution of equipment, classrooms and personnel; analyzing the dynamics of demand for educational programs and scientific initiatives; intelligent management of information flows and databases; assessing the effectiveness of educational and research projects.

2. Types of neural network models and their applications in the field of education and science logistics: multilayer perceptrons (MLP) are used to analyze and classify performance indicators of educational institutions; recurrent networks (RNN, LSTM) - to predict temporal processes, demand dynamics and academic activity; convolutional networks (CNN) - in the analysis of visual data, including monitoring of laboratory and campus systems; hybrid architectures - combine the capabilities of different models for a comprehensive solution of multidimensional management tasks.

3. Advantages of implementing ANN in the field of logistics of education and science: high forecasting accuracy and adaptation to changing conditions; processing of large volumes of heterogeneous and incomplete data; integration with other intelligent tools (Data Mining, metaheuristics, Big Data, cognitive analytics); increasing the efficiency of management decisions and transparency of logistics processes.

4. Practical significance of ANN in the field of logistics of education and science: the use of neural networks allows you to create intelligent platforms that provide: optimization of resource and personnel allocation; automated analysis of academic and research data; strategic forecasting of the development of educational and scientific systems; increasing the efficiency and effectiveness of organizational processes.

Conclusions.

Artificial neural networks are a key direction of digital transformation of logistics management in the field of education and science. They provide intellectualization of management processes, make systems more flexible, adaptive and resistant to crisis changes.

Due to the ability to self-learn, neural network technologies form the basis of intelligent logistics management, which integrates analytics, modeling and forecasting into a single decision-making ecosystem.

In the future, such solutions will contribute to the creation of intelligent management support systems capable of predicting risks, optimizing resource use and forming strategic models for the development of educational and scientific organizations in the era of uncertainty and digital transformation.

Discussion.

The sphere of education and science is developing in an environment of constant change, instability and limited predictability. Global crises and rapidly changing external factors increase the need for new approaches to management that can ensure stability and efficiency under uncertain conditions.

Traditional methods of analysis and planning are losing their relevance, because they do not reflect the dynamics and complexity of modern processes. Against this background, hybrid neurocomputing technologies are becoming a key tool for intelligent management. They combine artificial neural networks, fuzzy logic, evolutionary algorithms and metaheuristic optimization methods, creating adaptive and self-learning management systems that are resistant to external crisis influences [16].

In educational and scientific activities, such technologies are used to predict project results, model resource provision, analyze academic data and automate planning. Thanks to hybrid architectures, intelligent platforms are created that are able to form optimal solutions even under high uncertainty and limited resources.

The integration of neural network, evolutionary and logical-probabilistic methods forms a new generation of adaptive anti-crisis systems capable of learning, forecasting and optimizing development strategy. Thus, hybrid neurocomputing becomes not just a data analysis technology, but a tool for forming a sustainable and intelligent model of knowledge management in an era of uncertainty and global change.

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