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Mathematical optimization as element of innovative educational management in modern complex conditions

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Abstract. The article explores the importance of mathematical optimization as a core instrument of innovative educational management under conditions of uncertainty, crises, and rapid transformations. Optimization methods provide a scientific basis for effective resource distribution, scenario forecasting, and reduction of management risks. Their integration with hybrid approaches, including big data analytics and artificial intelligence, enhances adaptability, sustainability, and innovative development of educational institutions.

Keywords: mathematical optimization, innovative management, education, uncertainty, crisis.

Introduction.

Modern socio-economic systems operate under conditions of increased turbulence [1, 2], instability [3, 4] and regular crises [5-7]. Globalization processes, rapid technological development, geopolitical challenges and market volatility form an environment in which classical management methods often prove ineffective [8-10].

In these circumstances, innovation management [11, 12], focused on the use of flexible, adaptive and scientifically based tools to ensure the sustainability of organizations and maintain their competitive positions [13, 14], acquires special importance.

The key tool in the arsenal of modern innovation management is "mathematical optimization" [15]. It is a system of methods and models that allow finding the best solutions in conditions of resource scarcity, conflicting goals and high uncertainty [16]. Optimization approaches are actively used for strategic forecasting, effective resource allocation, development scenario building, and selection of rational management strategies [17]. Thus, mathematical optimization becomes not just a technical method, but a strategic component of innovation management, which creates a scientific and methodological basis for decision-making in times of crisis and uncertainty.

The Main Part.

The modern educational sphere is affected by numerous factors of uncertainty, such as economic fluctuations, technological transformations, geopolitical changes and social challenges. In such conditions, traditional approaches to the management of educational projects and institutions often turn out to be insufficiently effective for ensuring stable development, adaptability and innovation of educational systems [18].

Mathematical optimization, as a tool for scientific analysis and decision-making support, acquires special importance within the framework of innovative management. It allows you to formalize and systematize management processes, determine optimal resource allocation strategies, predict the results of various scenarios and reduce the risks associated with uncertainty. In the field of education, this is manifested in financing planning, scheduling, managing teacher workload, selecting curricula and implementing project initiatives. The introduction of mathematical optimization methods into the innovative management of educational institutions provides a systematic approach to planning and implementing development strategies. The use of such methods allows you to create adaptive management models that can quickly respond to external and internal changes, maintain a high level of quality of educational services and stimulate the introduction of new technologies and practices.

Particular attention should be paid to hybrid approaches [19] that combine mathematical modeling, big data analysis and elements of artificial intelligence. These approaches open up new opportunities for predicting student needs, assessing the effectiveness of educational programs and managing risks and crisis situations that educational institutions face.

Thus, mathematical optimization becomes a key tool that ensures the integration of innovations, increasing the efficiency and sustainability of educational systems in a dynamic and uncertain environment.

Conclusions.

1.1. Mathematical optimization is a fundamental element of innovation management, which allows to produce optimal solutions in conditions of resource constraints and unpredictability of external factors.

1.2. The use of optimization models contributes to increasing the effectiveness of management processes, reducing risks and minimizing losses in periods of crisis.

1.3. The inclusion of optimization methods in the innovation management system enhances the flexibility and resilience of organizations, and also increases their ability to quickly adapt to changes in the external environment.

1.4. In conditions of uncertainty, mathematical optimization becomes a tool of strategic management focused on innovative development and long-term stability.

1.5. The prospects for the application of optimization approaches are associated with their integration into digital technologies, artificial intelligence systems and intelligent decision support platforms, which will significantly expand the capabilities of innovation management in the future.

2.1. Mathematical optimization is the foundation of informed management decision-making in the field of education, allowing to formalize complex processes and choose optimal strategies in conditions of uncertainty.

2.2. Innovative management of educational institutions benefits from the implementation of optimization methods, as they provide a systematic approach to resource allocation, planning of the educational process and implementation of new educational projects.

2.3. The adaptability and flexibility of educational systems increases through the use of hybrid models that combine optimization, data analysis and artificial intelligence [20], which allows for a timely response to crisis and unstable situations.

2.4. The use of mathematical methods in educational management contributes to sustainable development, improving the quality of educational services and stimulates innovative changes in curricula, processes and organizational structures.

2.5. Development prospects include the integration of optimization models with digital platforms and big data analysis systems, which opens up opportunities for more accurate forecasting, personalization of the learning process, and reduction of management risks.

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Application of evolutionary algorithms for innovative educational management in modern uncertain environments in conditions of dynamic complexity

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Abstract. *The paper addresses the limitations of traditional educational management in unstable and complex environments. It highlights the potential of evolutionary algorithms and hybrid intelligent systems for adaptive decision-making, forecasting, and optimization. The study proposes integrating genetic algorithms, swarm intelligence, and machine learning to enhance flexibility and resilience in modern digital education.*

Keywords: *educational management, decision support, uncertainty, optimization, evolutionary algorithms.*