

METHODS OF USING DIGITAL PLATFORMS AND SMART SYSTEMS IN CIVIL ENGINEERING DISCIPLINES

Artiqova Baxtigul Mirzaraximovna

Researcher at Tashkent State Transport University

Orcid: <http://orcid.org/0000-0001-8921-4125>

<https://doi.org/10.5281/zenodo.20307481>

Abstract. *This article analyzes the methods of using digital platforms and smart systems in civil engineering disciplines. The study highlights the role of modern technologies such as Building Information Modeling (BIM), artificial intelligence, machine learning, and virtual reality in education and practical projects. It also examines the importance of these technologies in optimizing engineering processes, automating decision-making, and enhancing safety.*

Keywords: *civil engineering, BIM, digital platform, artificial intelligence, machine learning, virtual reality, smart systems, engineering education, digitalization.*

Annotatsiya. *Mazkur maqolada qurilish muhandisligi fanlarida raqamli platformalar va aqlli tizimlardan foydalanish metodlari tahlil qilinadi. Tadqiqotda Building Information Modeling (BIM), sun'iy intellekt, mashinaviy o'rganish va virtual reallik kabi zamonaviy texnologiyalarning ta'lim va amaliy loyihalardagi o'rni yoritiladi. Shuningdek, ushbu texnologiyalarning muhandislik jarayonlarini optimallashtirish, qaror qabul qilishni avtomatlashtirish va xavfsizlikni oshirishdagi ahamiyati ko'rib chiqiladi.*

Kalit so'zlar: *qurilish muhandisligi, BIM, raqamli platforma, sun'iy intellekt, mashinaviy o'rganish, virtual reallik, aqlli tizimlar, muhandislik ta'limi, raqamlashtirish.*

Аннотация. *В данной статье анализируются методы использования цифровых платформ и умных систем в дисциплинах гражданского строительства. В исследовании освещается роль современных технологий, таких как Building Information Modeling (BIM), искусственный интеллект, машинное обучение и виртуальная реальность, в образовании и практических проектах. Также рассматривается значение этих технологий в оптимизации инженерных процессов, автоматизации принятия решений и повышении безопасности.*

Ключевые слова: *гражданское строительство, BIM, цифровая платформа, искусственный интеллект, машинное обучение, виртуальная реальность, умные системы, инженерное образование, цифровизация.*

Introduction: Modern civil engineering is undergoing rapid digitalization processes. Digital platforms and smart systems serve to enhance efficiency at the design, construction, and operation stages. In particular, Building Information Modeling (BIM) technology enables integrated management of construction processes. Today, artificial intelligence, machine learning, and virtual reality technologies are widely used in civil engineering disciplines not only in practice but also in the educational process. These technologies play an important role in developing the competencies of students and specialists.

Literature Review: The issue of applying digital technologies in civil engineering is one of the relevant directions of modern scientific research, and significant studies have been conducted in this field by a number of foreign and local scholars. In particular, Eastman C. M. interprets BIM (Building Information Modeling) technology as a key tool for managing

construction processes and substantiates its integrative significance at the stages of design, development, and operation. According to the researcher, BIM technology increases efficiency by digitalizing construction processes, optimizing information exchange, and collaboration [1]. Kerimbayev N. and co-authors analyze the role of smart educational technologies in the individual learning process and highlight the pedagogical potential and effectiveness of digital platforms. Their research substantiates the possibilities of organizing a learning process adapted to students' individual needs through adaptive learning systems [2].

Liu C., Wang G. C., and Wang H. F. systematically analyze the application of artificial intelligence technologies in engineering education and reveal its potential in adaptive teaching, knowledge assessment, and decision-making processes. According to the results of the study, AI-based systems play an important role in individualizing the educational process and increasing its effectiveness [3]. Li X. and Mostafavi A. develop methods for assessing risk and resilience in infrastructure systems based on machine learning algorithms. This approach enables ensuring safety in civil engineering, predicting risks, and improving system reliability [4].

Hajirasouli A. and co-authors study the pedagogical potential of BIM and virtual reality technologies in architectural design studios and demonstrate their importance in creating an interactive learning environment. The study emphasizes that these technologies contribute to developing students' spatial perception and practical skills [5]. Naser M.Z., Tapeh A.T.G., and Abdalla J. analyze the application of generative artificial intelligence technologies in construction and environmental engineering, highlighting its innovative potential. The authors substantiate that generative AI technologies are an important tool in automating design processes, efficiently using resources, and ensuring environmental sustainability [6].

In general, the existing scientific literature shows that digital technologies are being widely implemented in civil engineering. Technologies such as BIM, artificial intelligence, machine learning, and virtual reality occupy an important place not only in engineering practice but also in the educational process, contributing to increasing the efficiency of the field.

Research Methodology: This study was conducted based on a number of methods. In particular, the systematic analysis method was used to study existing scientific literature in a comprehensive and consistent manner, which contributed to forming the theoretical basis of the research. Using the comparative analysis method, different digital technologies were compared, their similarities and differences were identified, and their advantages and limitations were evaluated. Within the framework of model analysis, the functional capabilities of BIM (Building Information Modeling) and AI-based systems, their areas of practical application, and their level of effectiveness were studied. The interdisciplinary approach ensured the integration of engineering and information technologies, allowing for a comprehensive analysis of the problem. In addition, through the case-study approach, the application of modern technologies and their results were analyzed based on real practical examples.

Analysis and Results: The results of the analysis showed that digital platforms and smart systems are widely used in civil engineering disciplines based on modern technological approaches. BIM (Building Information Modeling) technology ensures effective communication between project participants by integrating project data into a single digital model, increases the level of coordination, and helps reduce errors. Artificial intelligence (AI)-based decision-making systems enable optimization of construction processes, efficient resource management, and early risk prediction. Machine learning models are used to assess the stability of infrastructure systems, analyze large volumes of data, and identify potential risks, thereby improving prediction accuracy. Virtual reality (VR) and simulation technologies contribute to developing

students' practical skills by modeling conditions close to real environments. Generative artificial intelligence plays an important role in generating design variants, optimizing them, and developing innovative solutions. Digital educational platforms, in turn, provide adaptive learning, individualized approaches, and real-time monitoring capabilities. The results indicate that the integration of these technologies increases the effectiveness of civil engineering disciplines, improves the educational process, and positively influences the development of students' professional competencies.

Conclusion: The use of digital platforms and smart systems in civil engineering disciplines is becoming an integral part of modern education and practice. Technologies such as BIM, artificial intelligence, machine learning, and virtual reality play an important role in optimizing engineering processes, automating decision-making, and improving the quality of education. The results of the study show that the integration of digital technologies contributes to making civil engineering disciplines more efficient, interactive, and innovative. In the future, the development of interdisciplinary research and the wider implementation of practical platforms in this direction are of significant importance.

REFERENCES

1. Eastman C. M. BIM handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors. – John Wiley & Sons, 2011.
2. Kerimbayev N. et al. Intelligent educational technologies in individual learning: a systematic literature review //Smart Learning Environments. – 2025. – T. 12. – №. 1. – C. 1.
3. Liu C., Wang G. C., Wang H. F. The application of artificial intelligence in engineering education: A systematic review //IEEE Access. – 2025. – T. 13. – C. 17895-17910.
4. Li X., Mostafavi A. Machine learning approach for disaster risk and resilience assessment in coupled human infrastructure systems performance //npj Natural Hazards. – 2025. – T. 2. – №. 1. – C. 56.
5. Hajirasouli A. et al. BIM-enabled virtual reality (VR)-based pedagogical framework in architectural design studios //Smart and Sustainable Built Environment. – 2024. – T. 13. – №. 6. – C. 1490-1510.
6. Naser M. Z., Tapeh A. T. G., Abdalla J. A review of generative artificial intelligence in civil and environmental engineering //Machine Learning for Computational Science and Engineering. – 2025. – T. 1. – №. 2. – C. 42.