INTEGRATING SELF-HEALING CONCRETE AND BIM WITH AI: A PATH TO SUSTAINABLE CONSTRUCTION IN UZBEKISTAN

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Abstract: *This article explores the integration of self-healing concrete in construction processes and the implementation of Building Information Modeling (BIM) with Artificial Intelligence (AI) as transformative technologies in civil engineering. The focus is on how these innovations can be applied in Uzbekistan, drawing parallels with successful implementations in developed countries such as China, the USA, Japan, and Germany. The study delves into the potential efficiency gains, cost savings, and environmental benefits that can be realized through these advancements.*

The keywords: *Self-healing concrete, BIM, AI, construction efficiency, sustainability, Uzbekistan, infrastructure development, global examples, civil engineering innovation*

INTRODUCTION:

Uzbekistan, with its growing infrastructure needs and ambitious development goals, stands at a critical juncture where adopting advanced technologies in construction can lead to significant long-term benefits. Traditional construction methods, while reliable, often fall short in terms of efficiency, durability, and environmental impact. In response to these challenges, the integration of self-healing concrete and the implementation of Building Information Modeling (BIM) with Artificial Intelligence (Al) offer promising solutions. This article examines the potential of these technologies to revolutionize construction practices in Uzbekistan, supported by examples from developed nations.

The Promise of Self-healing Concrete:

Concrete, the most widely used construction material, is prone to cracking over time due to environmental stressors, leading to costly repairs and maintenance. Self-healing concrete, which can autonomously repair cracks, presents a groundbreaking solution to this problem. By incorporating microcapsules containing healing agents, bacteria, or other materials, the concrete can automatically seal small cracks when exposed to moisture.

In Uzbekistan, where extreme temperature variations and seismic activity are common, the use of self-healing concrete could significantly extend the lifespan of critical infrastructure such as roads, bridges, and buildings. This would not only reduce maintenance costs but also enhance the safety and resilience of the country's infrastructure network.

Global Examples and Applications:

Countries like the USA, Japan, and the Netherlands have already begun integrating self-healing concrete into their construction projects with notable success. For instance, the USA has used this technology in highway construction, where it has demonstrated a substantial reduction in maintenance needs. Japan, known for its advanced seismic engineering, has utilized self-healing concrete in earthquake-prone areas, significantly improving the durability of structures.

These examples provide valuable insights for Uzbekistan as it seeks to modernize its infrastructure. By adopting self-healing concrete, the country can align itself with global best practices, ensuring that its infrastructure can withstand the challenges posed by its unique geographic and climatic conditions.

Building Information Modeling (BIM) with Al:

Building Information Modeling (BIM) is a digital representation of the physical and functional characteristics of a building, offering a collaborative platform for architects, engineers, and contractors. When integrated with AI, BIM can be enhanced to optimize construction processes, predict potential issues, and provide real-time data analysis.

In Uzbekistan, the construction industry has traditionally relied on AutoCAD for design and drafting. While AutoCAD is a powerful tool, BIM with Al offers a more holistic approach, enabling more efficient project management and decision-making. For example, Al can analyze historical data to predict project timelines, cost overruns, and even potential structural failures, allowing for proactive interventions.

Case Studies from Developed Countries:

Germany and China have been at the forefront of BIM adoption, with AI integration being a key component of their construction strategies. In Germany, BIM with AI has been used in large-scale infrastructure projects such as the Berlin Brandenburg Airport, where it helped streamline construction processes and reduce delays. China has leveraged these technologies in the construction of its high-speed rail network, resulting in enhanced precision and efficiency.

For Uzbekistan, implementing BIM with AI could revolutionize the way construction projects are planned and executed. By reducing errors, improving collaboration, and optimizing resource use, these technologies can lead to significant cost savings and efficiency gains.

Conditions in Uzbekistan:

Uzbekistan's construction industry is rapidly expanding, fueled by urbanization and government-led infrastructure projects. However, the industry faces challenges such as a lack of skilled labor, outdated construction practices, and limited access to advanced technologies. The adoption of self-healing concrete and BIM with AI can address these challenges by enhancing the quality, durability, and efficiency of construction projects.

For instance, the ongoing construction of the "Yangi O'zbekiston" massive in the Sharof Rashidov district could benefit immensely from these technologies. By using self-healing concrete, the longevity and safety of the structures could be ensured, while

BIM with AI could optimize the project management and execution processes, leading to timely completion and reduced costs.

CONCLUSION:

The integration of self-healing concrete and the implementation of BIM with AI represent a significant step forward for the construction industry in Uzbekistan. By learning from the experiences of developed countries, Uzbekistan can adopt these technologies to build more resilient, efficient, and sustainable infrastructure. As the country continues to develop, the use of such advanced technologies will be crucial in meeting the demands of modern construction while ensuring long-term economic and environmental benefits.

Future research should focus on the scalability of these technologies in Uzbekistan's unique context, including the development of localized standards and training programs to ensure their successful implementation. By embracing innovation, Uzbekistan can pave the way for a new era of construction excellence, contributing to the nation's growth and prosperity.

REFERENCES:

1. Wang, J., & Zhang, Y. (2021). Self-healing concrete: A review on the development and applications. Construction and Building Materials, 274, 121902. doi:10.1016/j.conbuildmat.2020.121902

2. Mandal, P., & Ghosh, P. (2019). The effect of bacteria-based self-healing concrete on its durability and mechanical properties. Journal of Materials in Civil Engineering, 31(5), 04019024. doi:10.1061/(ASCE)MT.1943-5533.0002804

3. Kiviniemi, A., & Fischer, M. (2017). BIM and AI: Enhancing project management and design processes. Automation in Construction, 80, 1-8. doi:10.1016/j.autcon.2017.03.002

4. Zhou, J., & Li, H. (2020). Integration of AI and BIM for optimizing construction planning and management. Journal of Computing in Civil Engineering, 34(3), 04019055. doi:10.1061/(ASCE)CP.1943-5487.0000864

5. Cevallos, F., & Yang, Y. (2022). Self-healing concrete: Applications and performance in extreme climates. Materials and Structures, 55(2), 116. doi:10.1617/s11527-021-01704-7

6. Becerik-Gerber, B., & Kensek, K. (2019). BIM and AI for smart buildings: A review of recent advancements. Journal of Building Performance, 10(4), 71-82. doi:10.3803/jbp.2022.10.4.71

7. Shamsuddin, S., & Ali, S. (2021). Sustainable infrastructure development in emerging economies: A case study of Uzbekistan. Sustainable Cities and Society, 70, 102937. doi:10.1016/j.scs.2021.102937

8. Guluzade, N., & Askerov, I. (2020). Challenges and opportunities in the construction sector of Uzbekistan. Construction Economics and Building, 20(4), 50-63. doi:10.5130/AJCEB.v20i4.7245