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Digital transformation of the construction industry in Russia*

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Construction sector spending makes a significant contribution to the global economy, with approximately $10 trillion being spent on building and construction activities annually. However, the construction industry has traditionally been perceived as slow to adapt to new technologies compared to other sectors. Recently, the construction industry has experienced a substantial shift towards Digital Transformation. As new technologies have emerged, the construction industry has begun to realize the importance of Digital Transformation in the pre-construction, construction, and facility management phases. A high degree of Digital Transformation has been seen regarding site monitoring, wearables, sensors, and identifying hazards. This paper intends to sketch a global picture of digital technologies implemented in the construction industry throughout the entire project lifecycle. By fully analyzing more than 20 papers, the paper finds that various aspects of the construction industry, including technologies, policies, regulations, and infrastructures, are still in the early stages of Digital Transformation. The findings from this review will help researchers and practitioners in the construction industry understand the global picture of digital technology implementation and where the construction industry stands in the Digital Transformation process. This paper also serves as a starting point for future work on Digital Transformation in the construction industry.

Introduction

The Construction industry has benefited considerably from the shift from traditional to digital transformation requirement worldwide. Numerous technologies have been utilized recently in the construction life cycle. Building Information Modeling (BIM), virtual reality, augmented reality, mixed reality, 3D printing, cloud computing, artificial intelligence (AI), big data, and the internet of things (IoT) are all examples of digital technologies, in addition to robotics, drones (unmanned aerial vehicles), mobile and wearable devices, and smart data 3D printing, cloud computing, artificial intelligence (AI), big data, and the internet of things (IoT) are all examples of digital technologies, in addition to robotics, mobile and wearable devices, and smart

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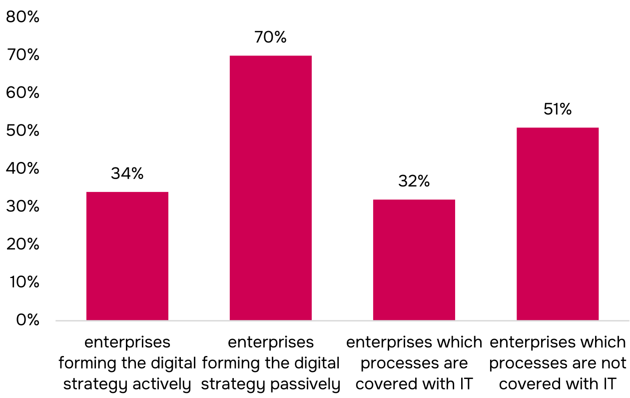

Figure 1. Indicator of the involvement of construction enterprises in the processes of digital transformation in Russia (2023), %.
Source: compiled by author.

data [2].

Materials and methods

To enhance understanding of how artificial intelligence may aid in the growth of circular economy in Russia's construction sector, the research will focus on significant industry players, obstacles to execution, and opportunities. Primary and secondary data were gathered using a mixed-method approach. Using databases like Scopus and Web of Science (WoS), secondary data from research articles was gathered, focusing on the role artificial intelligence plays in sustainable construction and the barriers to artificial intelligence and circular economy adoption. Primary data were collected using a questionnaire survey that focused on their familiarity with artificial intelligence and circular economy, the benefits of integrating artificial intelligence and circular economy, and the barriers that exist in the implementation process.

The survey was distributed to 150 industry professionals from May 2024 to August 2024, yielding a 72% response rate (108 responses). The questionnaire survey consisted of 4 sections. The first section gathers data about participants' occupational information. The second section relies on the understanding of artificial intelligence and circular economy among participants. The third segment gathers respondents' perspectives on integrating artificial intelligence and circular economy in the built environment. The fourth section collected data on possible challenges and barriers that may hinder the integration of artificial intelligence and circular economy.

The Industrial Revolution has lately become the bedrock and pillar of all businesses and sectors, the most significant of which is building and construction. The IR is the transformation of old processes into intelligent processes via the use of modern and smart technology that will surely improve production, operation, and performance at all levels. The previous three IRs formed the foundation and substance of the 4th, which is based mostly on digitalization, automation, and smart systems [4]. IR 4.0, on the other hand, focuses on the conversion of industries to digital intelligence, as this revolution is built on piers such as the internet of things, big data, cybersecurity, and simulations using augmented and virtual realities, automation, additive operations, and cloud-integrated systems.

These piers are critical for all businesses, particularly the construction industry, to improve productivity, reliability, and performance. The construction industry is undergoing a significant shift as a result of the implementation of IR 4.0, which will result in the establishment of a fully digitally integrated industry. The adoption of the principles of the IR 4.0 with projects lifecycle is still in its early stages, and the construction sector lags behind other sectors [5]. Any new revolution comes with effects and impacts on countries' economical, sociological, and environmental levels either positive or negative. The impact of IR 4.0 technologies on the construction industry demonstrates that they will help the industry by enhancing project performance by cutting construction time, costs, flaws, and conflicts, in return, increasing the quality.

Table 1. Advantages of digital twin technology applications, classified based on the stages of the construction life cycle.

Lifecycle Stage	Construction Function	Benefits
- Design and engineering - Operations and maintenance	- Safety management -Sustainability enhancement - Quality assessment - Construction logistic	- Improve the managing of safety on construction sites by analyzing risk factors, using preventative risk management measures, and evaluating threats. - Support data synchronization, include the smart product-service model, and integrate blockchain for traceability. - Improve safety management on construction sites by analyzing risk factors, using preventative risk management measures, and evaluating threats
Operations and maintenance	-Construction site monitoring - Building occupancy monitoring - Indoor environment management - Smart city development.	- Improve construction digitalization through automated site and assembly progress detection and monitoring. - Easier public explanation of administrative activities, urban planning, and policy through visualization and analysis of digital prototypes.
Operations and maintenance Decommissioning Design and engineering	Material information tracking - Reuse and recycling - Durability and response monitoring - Structure design optimization.	- The 3D-printed modules' design validation is supported by providing more precise models. - Improve the radiological detection and traceability of construction materials. - Use quantitative analysis to direct material flows toward a sustainable material flow Reduce safety hazards and steady-state mistakes. - Increase the security mechanism for the digital triplet's object detection with more assurance
On-site construction	- Worker safety - Worker training	- Improve the learning outcomes for construction professionals and reduce training risk with a virtual practice platform. - Synchronize information to process threats in dynamic and complicated situations.

Source: compiled by author.

"Construction 4.0" was coined to describe and strengthen the construction industry by incorporating intelligent and cutting-edge new technologies, as well as advanced construction techniques to increase productivity and compete with other industries to contribute to the country's sustainable development.

Figure 1 shows the processes of digital transformation of involvement in construction enterprises in Russia.

In Russian construction projects, fragmented projects perform rather poorly, are less productive, and are less likely to adopt novel ideas. One could contend that companies are less likely to change their goals to adopt cutting-edge technology. This industry adopts new technologies at a very slow rate, which lowers project efficiency and labour productivity.

The least digitized industry, the construction industry has carried on as usual for a long time. Other than that, when it comes to data collection and analysis, progress management techniques that are frequently utilized on construction sites are

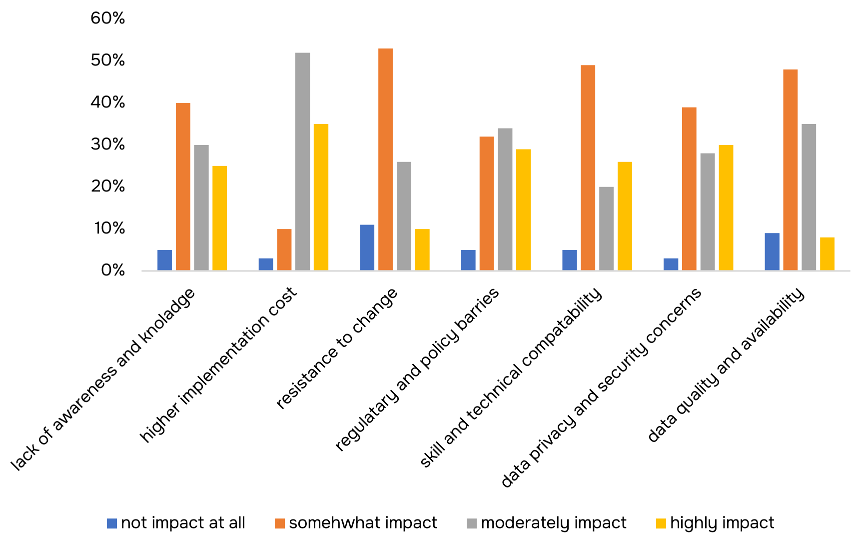

Figure 2. Barriers for implementing artificial intelligence and circular economy integration in Russia.
Source: compiled by author.

inaccurate and time-consuming. A lot of manual labor is required; hence it is also labor-intensive. The construction industry faces an immediate global crisis. Lack of productivity, constant material waste, and safety risks are among the most common construction site problems that have a significant impact on society [1].

The widespread practice of digital transformation also requires leaders to focus on the organizational side of change by putting plans into action. The lack of organization will affect the process of making plans work. The organization's ability to influence its business must be taken into consideration if it is planning for long-term success. Financial management becomes a crucial part where they need to allocate an amount of money to implement digitalization. There is no specific standard for digitalization implementation cost estimation. The construction industry's adoption of I4.0 makes it risky for the majority to invest in new technology [3].

A digital twin technology is a virtual counterpart to a tangible entity existing exclusively within the digital sphere. Within the construction industry context, this could extend from individual structures and infrastructures to expansive systems such as cities, nations, or even the entire planet. For a digital model to merit the designation of a twin, it must co-exist alongside its physical counterpart throughout its lifecycle [2].

Table 1 describes the advantages of digital twin technology applications, classified based on the stages of the construction life cycle.

Figure 2 shows barriers for implementing artificial intelligence and circular economy integration in Russia

One of the most important areas where AI and machine learning could have an important impact on the construction industry is safety, which is of tremendous importance since construction jobs are consistently among the highest-fatality ones. The ability of AI to recognize risks before they come into being is one of its genuinely amazing features [1]. Incidents can be analyses and enable managers to devise more effective worker safety protocols.

Additionally AI can help construction companies in their process of planning and controlling material flows. Their efficiency can be improved by estimating the amount of materials needed for buildings and the like. The right materials can be ordered in the right quantities and the right quality by using an AI based ordering process and, in turn, managed by an AI based inventory management. As a result, the material waste and costs of its recycling or disposal will be reduced as well.

Conclusion

In conclusion, technologies have altered the way of designing, constructing, and operating constructions and buildings. Technologies utilization led to augmented profitability, reduced cost, reduced project duration, and enhanced customer-client relationships. The implementation of digital technologies has progressed rapidly. Digitization of the industry is an enduring problem in developing countries. In Russian construction industry is still at the nesting stage of implementing digital technologies. There is an immense need for government and private sector support to enhance the adoption. All industries' beneficiaries and contributors have to make a move towards digitalizing the industry and overcome the challenges that coping with the Russia construction industry.

This study reviews the trend of digitalization around the globe and focuses on the adoption of digital technologies in the Russian construction industry. There are challenges facing the industry including weak internal investment and contractors not complying with contracts and regulations, a high percent of corruption from all parties, also weak government support for projects and organizations.

References

1. *Aleksandrova E., Vinogradova V.* Integration of digital technologies in the field of construction in the Russian Federation // Engineering Management in Production and Services. – 2020. – Vol. 11(3). – P. 38–47.
2. *Hu W., Lim K. Y. H.* Digital twin and industry 4.0 enablers in building and construction // Buildings. – 2024. – Vol. 12 (11). – P. 2004.
3. *Mateev M.* Industry 4.0 and the digital twin for construction industry // Industry 4.0. – 2023. – Vol. 5(1). – P. 29–32.
4. *Moshood. T. D.* Barriers and benefits of ICT adoption in the Nigerian construction industry // Applied System Innovation. – 2020. – Vol. 3 (4). – P. 46.
5. *Urban H., Nassereddine H.* Integrating construction 4.0 technologies: a four-layer implementation plan // Frontiers in Built Environment. – 2021. – Vol. 144. – P. 326.

Цифровая трансформация строительной промышленности в России

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Расходы строительного сектора вносят значительный вклад в мировую экономику: ежегодно на строительство и строительство тратится около 10 триллионов долларов США. Однако традиционно считается, что строительная отрасль медленно адаптируется к новым технологиям по сравнению с другими секторами. В последнее время строительная отрасль пережила существенный сдвиг в сторону цифровой трансформации. По мере появления новых технологий строительная отрасль начала осознавать важность цифровой трансформации на этапах подготовки к строительству, строительства и управления объектом. Высокая степень цифровой трансформации наблюдается в отношении мониторинга объектов, носимых устройств, датчиков и выявления опасностей. Целью