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TRANSFORMATION OF DIGITAL PROCESSES IN THE CONSTRUCTION SECTOR OF KAZAKHSTAN

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Abstract. *The relevance of the study is driven by the urgent need for accelerated transformation of Kazakhstan's construction industry. It has been established that the digitalization of the construction sector is a complex process that involves not only the implementation of technologies, but also changes in business processes, staff training, and the development of a regulatory and legal framework. Based on the identified trends in industry digitalization, stages of digitalization and the implementation of digital solutions have been developed. It is substantiated that digital solutions are intended to accelerate the development of the construction sector, increase its contribution to GDP, and reduce engineering and infrastructure strain.*

Key words: *digitalization, digital solutions, Kazakhstan, construction industry*

Introduction

The construction sector in Kazakhstan is developing against the backdrop of rapid urbanization, primarily affecting major industrial cities. Despite the high pace of construction, Kazakhstan is unlikely to meet international standards for comfortable housing before 2040, as in 2024, the average housing provision per person was 24.5 square meters—5.5 square meters below the standard recommended by the United Nations [1].

In line with global trends, Kazakhstan has in recent years focused on innovative development, incorporating digital technologies, as well as environmental and energy-efficient principles [2,3]. At present, construction in Kazakhstan can be characterized by the planning of new projects using information modeling and project control systems, as well as the formation of in-house IT infrastructure for buildings. This also includes the mandatory use of innovative construction materials and modern operational technologies (such as digital twins of engineering systems, environmentally sustainable energy consumption, etc.).

The objective of this study is to define the stages of implementing digital solutions

in the construction industry, based on the identified trends in the digital transformation of Kazakhstan's construction sector.

Results Obtained

The assessment of digital transformation processes in Kazakhstan's construction sector is based on the following digitalization trends:

- Increased use of digital platforms for construction project management (medium-sized construction companies increasingly utilize digital platforms for project management, material accounting, and supplier interaction through tools such as 1C: Enterprise, Trello, Asana, and others);

- implementation of artificial intelligence and Internet of Things technologies in construction combined with the development of digital twins for modeling and optimizing construction processes;

- uneven digitalization (large construction companies like BI Group actively adopt digital technologies, including BIM (Building Information Modeling), while medium and small enterprises lag behind due to limited resources and a shortage of qualified personnel);

- adoption of BIM technologies (major market players actively use BIM, medium companies are beginning to adopt these technologies, yet approximately 40% of construction companies in Kazakhstan are not yet ready to transition to BIM modeling, indicating significant growth potential);

- digitalization of government services (the government of Kazakhstan is actively working on digitizing public services in construction, facilitating interaction between construction companies and government bodies; the development of an urban planning cadastre system simplifies access to necessary information).

Despite these challenges, enterprises in Kazakhstan strive to implement digital technologies to increase operational efficiency, reduce costs, and improve construction quality. Overall, digitalization enables construction companies in Kazakhstan to become more efficient, competitive, and sustainable.

Based on the analysis conducted, stages of the enterprise digitalization process and the implementation of digital solutions have been developed (Table 1).

Table 1. Stages of Digital Solutions Implementation

Stages	Content
Stage 1. Analysis existing digital technologies (BIM, IoT, artificial intelligence)	Detailed Analysis of digital technologies in construction: - BIM (analysis software complexes for informational modeling buildings - AutodeskRevit, ArchiCAD And BentleySystems); - IoT (Internet of Things) (study devices and systems for data collection in real time, including sensors and network technologies); - artificial intelligence (analysis) algorithms machine training, their application in forecasting And optimization construction processes).
Stage 2. Development algorithms integration of these technologies V construction processes	Development algorithms integrations technologies BIM, IoT And artificial intelligence in construction processes (definition stages implementations, necessary equipment And software provision using MATLAB, Python, testing and verification of algorithms).
Stage 3. Modeling And construction project simulation With using digital doubles	Creation of digital twins of construction objects for modeling scenarios And optimization process owls (3D models, Simulink, Ansys, simulations, analysis And adjustment model deley on basis data).
Stage 4. Implementation sensory technologies For monitoring states objects V real time	Development And implementation systems monitor toring states construction objects With using sensory technologies. System includes installation sensors For from- measurements various parameters (temperature, humidity, pressure) And development interfaces For collection And analysis data IoT platforms (AWS IoT, Microsoft Azure IoT, Tableau, Power BI)
Stage 5. Development And testing digital platforms For management projects	Creation and testing of digital platforms (tools For planning (MicrosoftProjec), control resources, tracking progress And interactions between participants) for construction management projects.
Stage 6. Grade efficiency implemented technologies on basis key indicators productivity	Calculation of key indicators about productivity (KPI). Data analysis By productivity, quality, tomorrow there, security construction projects to And after implementations digital technologies

Source: Developed by the authors based on [4-6]

At the first stage of digitalization, data digitization is carried out through the implementation of information systems in management (accounting, internal document

flow, preparation of cost estimates) and in the interaction between construction organizations and customers, designers, suppliers, and government authorities.

The second stage involves the introduction of digital technologies at all stages of the construction project's life cycle (design, construction, and operation), as well as within the framework of construction control. As a result of this stage, internal digitalization of specific areas of construction management is performed within individual construction companies.

The third stage of digitalization implies the “stitching together” (integration) of all digital processes during the transfer of the digital model from one participant to another. That is, the formation of a system in which shared data for design from the customer is passed to the designer, then from the designer to control authorities and experts, subsequently to the construction organization’s contractors, and finally, upon completion of construction, to the operating organization.

For the formation of the final digital model of the complex, it is important to initially “stitch” digital tools within the internal business processes and departments of construction companies, followed by the integration of digital technologies with similar solutions used by other participants in the construction market throughout the life cycle of the construction object.

Conclusion

Overall, the following conclusion can be drawn: the digitalization of Kazakhstan’s construction industry requires a sequential progression through all stages, involving the gradual implementation of digital technologies in the activities of construction companies and their integration with one another. Achieving interoperability of the created digital model is only possible if clear requirements exist for the components of information models, software data exchange interfaces, and the volume and content of transmitted information.

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