Analysis of financing mechanisms for the digital transformation in construction sector

Timur Ablyazov¹*, Sergey Shirshikov¹, and Ivan Petrov¹

¹Saint Petersburg State University of Architecture and Civil Engineering, Vtoraja Krasnoarmejskaja ul. 4, 190005, Saint Petersburg, Russia

Abstract. Digital transformation of the construction sector is one of the key tasks in the development of the digital economy both in Russia and abroad. However, at present, the digital transformation of the construction sector is carried out at an insufficient pace due to the lack of an effective mechanism for financing this process in construction. In this article, we have collected and analysed data on financing mechanisms for digital transformation projects in the construction sector in the European Union, China, India, UAE, as well as in Russia. As a result of this study, we substantiate the relevance of improving the mechanisms to finance digital transformation projects in the construction sector and substantiate the dependence of the pace of digital transformation in the construction sector on the level of development of the mechanism for financing the digital transformation process.

1 Introduction

In the emerging digital economy, the task of introducing digital technologies in all spheres of economic activity is of paramount importance to intensify economic growth of individual sectors of the economy, regions, and the state as a whole. Construction is the most important sphere of economic activity, within which basic assets are created for the population and enterprises, which determines the need for digital transformation of this sphere of activity [1-3].

Digital transformation involves three stages: pre-digitalisation, digitalisation, and digital transformation [4]. The digitisation phase transforms analogue data into digital data [5]. In the digitisation phase, there is an increase in the degree of interconnectedness of different information systems to improve the quality of interaction between the different structural elements [6]. The third stage, digital transformation, is a process of full-scale change in the model of operation of the sphere of activity, based on the use of digital technologies at the operational and strategic levels of management [7].

Construction has traditionally been considered a sphere of activity with a low level of digital transformation, despite the high demand to increase productivity and economic efficiency in the implementation of investment and construction projects [8]. Currently, the academic community is paying the greatest attention to the development and implementation

* Corresponding author: 3234969@mail.ru
of the digital transformation strategy of construction organisations [9, 10], the adaptability of business models [11, 12], and the acquisition of digital skills [13].

It should be noted that the implementation of investment and construction projects is associated with the interaction of many subjects of investment and construction activities in the framework of creating an object with specific, unique properties [14]. In such conditions, digital transformation is often not carried out due to the lack of financial and time resources, which leads to low productivity growth compared to other areas of activity - an average of 1% per year [15].

Construction organisations often view digital transformation as the introduction of some form of digital technology into the work process, which does not involve the creation of new business models and structural improvements throughout the value chain [16]. As a result, organizations invest in technological development, but do not get the maximum possible effect from the introduction of digital technologies [17].

We believe that currently the digital transformation of the construction sphere is carried out with insufficient pace due to the lack of an effective mechanism for financing the process of digital technology implementation in construction, which makes this study relevant.

2 Materials and Methods

Digital technologies used in the construction sector can be broadly divided into groups according to the life cycle stages of an investment and construction project: design, construction, operation and renovation (Figure 1).

Fig. 1. The use of digital technologies at different stages of the life cycle of construction projects [18].

As part of the digital transformation of the construction sector, the most widespread implementation of technologies such as BIM [19, 20], Internet of Things [21], blockchain [22], cloud models [23], big data [24], artificial intelligence [25], which leads to a qualitative change in the processes inherent in the creation of construction products [26].

In addition, according to the strategy for the development of the construction industry and housing and communal services of the Russian Federation for the period up to 2030 with a forecast until 2035, the tasks of digital transformation of the construction sphere include digital transformation of administrative procedures, implementation of information technologies at all stages of the life cycle of the capital construction object; ensuring the formation of methodological and regulatory legal framework for digital transformation.

It should be noted that, according to the European Commission, it is the existence of a developed regulatory framework in the field of digital technologies, as well as the application
of policies that stimulate the use of digital technologies in construction that is most important for the digital transformation of the construction sphere [18]. In addition, more than 60% of the surveyed participants of the investment and construction market recognize that it is the presence of regulatory measures at the legislative level that contributes to the digital transformation (Fig. 2).

Fig. 2. Factors influencing the digital transformation of the construction sector in the European Union [18].

In this article, we have collected and analysed data on financing mechanisms for digital transformation projects in the construction sector in the European Union, China, India, UAE, as well as in Russia. As a result of studying various mechanisms for financing digital transformation in the construction sector, including grant funds, state programmes to support innovation, tax incentives, etc., we substantiate the dependence of the pace of digital transformation on the level of development of the financing mechanism for the digital transformation process.

3 Results

Financing the digital transformation of the construction sector has received attention in various countries. Let us analyse some common mechanisms for financing digital transformation of the construction sector used abroad and in Russia.

In the European Union, the following strategic legal and regulatory acts are in place for digital transformation in the construction sector: the Construction 2020 Strategy, the Renovation Wave, the EU Digital Strategy and the White Paper on Artificial Intelligence (AI). The goals and objectives in these documents, such as BIM, digital platforms, robotisation, etc., are financed through mechanisms such as 1:

1. EU Cohesion Policy, which is intended to finance the digital transformation of individual construction organisations, as well as the processes of interaction between the state and construction actors in the implementation of investment and construction projects. The total budget allocated for the period 2021-2027 exceeds €330 billion and between 65% and 80% of this amount will be spent on increasing the use of innovation in Europe, including in construction [27].
2. The Digital Europe programme and the digital innovation centres based on it, which create digital ecosystems based on the Internet of things, artificial intelligence, big data, BIM. In France, the Netherlands, Spain and Italy, 69 centres are directly involved in the digital transformation of construction, and there are 124 centres responsible for related areas of construction [27]. The Digital Europe programme has invested a total of around €5.8 billion in digital transformation of the European economy [18].

3. The InvestEU programme, which has established a database of potential digital technology investors, with a total of €31.6 billion in funding [18]. In addition, InvestEU involves technical support for the digital transformation process, which contributes to increased investment efficiency.

Note that Germany also has a mechanism for financing the digital transformation of the construction sector through the High-Tech Startup Fund, established in 2005 as a public-private partnership. The Hi-Tech Startup Fund is a way to strengthen the interaction between investors, technology creators and building sector organisations. Investments in new technologies are highly risky, so the creation of this Fund has addressed the funding gap in the digital technology segment at an early stage of its emergence. Initially, €272 million was invested in the Fund, whereas as of 2022, the Fund has commitments totalling more than €400 million [28].

In the United Arab Emirates (UAE), the digital transformation of the construction sector is being addressed through the creation of digital construction standards, in particular the Principles of the 50, which outline the direction of all areas of the country for the next 50 years. According to a survey of construction experts in the UAE, it can be concluded that digital transformation contributes to more efficient project delivery (100% of respondents), increases process manageability (58% of respondents), and reduces project time (29% of respondents).

The financing of digital transformation in the UAE is based on the following strategic documents [29]:

1. The UAE's Strategy for the Fourth Industrial Revolution, which covers the introduction of nanotechnology, digital transactions (blockchain), artificial intelligence.
2. The UAE's Strategy for Artificial Intelligence, which, by 2031, will have introduced artificial intelligence technologies in all areas of human activity, including construction.
3. the UAE's Blockchain Strategy, which will reduce costs by AED 11 million, 77 man-hours, 389 million documents per year.

In China, the digital transformation of the construction industry is being addressed through five-year plans [30]. Between 2011-2015 (12th five-year plan), the regulatory framework for digitalisation, in particular BIM, was developed and significant investments were made in technology infrastructure. In 2016-2020 (13th Five-Year Plan), the Chinese authorities focused on integrating digital processes across projects and investing in the most advanced technologies (Internet of Things, Artificial Intelligence). The 14th Five-Year Plan (2021-2025) now aims to fully integrate digital technologies at all stages of the construction lifecycle within China's construction industry. The 14th Five-Year Plan takes into account the development directions of different provinces and emphasizes the need to accelerate the digitalization of construction-related industries and promote digital empowerment in all spheres of life.

In terms of the financing mechanism for the ongoing digital transformation of construction, we note that digital investment in China has two main areas: public financing and investment by enterprises themselves. The EqualOcean think tank estimates that in 2020, the added value of China's digital economy as a whole was 7.9 trillion yuan [31]. The average annual compound growth rate for the period 2021-2025 is projected to be 11.9% [31]. It is also projected that the value added of China's digital economy will reach 14.4 trillion yuan by 2025 [31].
At the local government level, China is also adopting a number of documents to accelerate economic growth and efficiency of digitalisation of territories. For example, the Shanghai government has published documents such as "Shanghai City Digital Transformation Comprehensive Promotion Guidelines" and "Shanghai Special Action Plan for Building Over 100 Smart Enterprises (2020-2022)", which have created an enabling environment for building a digital city, building smart enterprises and promoting digitalisation, networking and smart upgrading of key industries.

In contrast, in some countries in Asia, the digital transformation of the building sector is only just beginning to receive attention at the level of government measures. In India, for example, six LightHouse Projects were implemented in 2021 as part of the Global Housing Technology Challenge-India (GHTC-India) initiative. These projects are related to the implementation of digital technologies for faster, more cost-effective and at the same time high-quality construction of residential buildings [32]. However, since the initiative is not yet widespread, more than 70% of Indian construction organisations are in the early stages of digital transformation and one of the reasons for the low rate of digitalisation is considered to be lack of funding - only 9% of organisations invest more than 5% of annual revenue in new technologies, which is 22% lower than other countries in the Asia-Pacific region [33].

In Russia, the main mechanism for financing the digital transformation of the construction sector is grant support for entities engaged in investment and construction activities. For example, since 2021, the Skolkovo Foundation has been supporting Russian organisations that implement domestic solutions based on artificial intelligence technologies, including in the construction sector. The grant amounts to between RUB 20 million and RUB 100 million. This support is possible on condition that the customers of IT solutions co-finance at least 50% of the project estimate from non-budgetary sources. Also, as part of the federal budget subsidy to the Russian IT Development Fund to support projects for the development and implementation of Russian IT solutions, since 2021 there has been a competition for grants for digital transformation of organisations, including construction companies.

In addition, the stimulation of the digital transformation of the construction sector in Russia in terms of funding is based on tax incentives. Thus, in accordance with the letter of the Russian Federal Tax Service dated 22.02.2023 N SD-26-3/3 "On tax incentives for the purchase and implementation of advanced domestic information and telecommunication technologies" from the beginning of 2023, the purchase and implementation of domestic digital technologies will not be included in the calculation of income tax in the amount 1.5 times higher than the actual cost of the company to purchase advanced Russian developments.

Thus, the mechanism of financing the digital transformation of the construction sector in various countries of the world is inextricably linked to the level of development of the regulatory framework governing the implementation of strategies for the development of the construction sector and the economy as a whole. In addition, in the developed world, there are already financing mechanisms for digital transformation that facilitate successful implementation of digital technologies, while in developing countries with a low level of digitalisation of construction, the financing mechanisms for digital transformation are in their infancy.

4 Discussion

Despite the existence of legislative initiatives for the digital transformation of the construction sector, the pace of digital adoption in construction differs around the world. For example, consulting firm UnivDatos estimates that the pace of digital transformation in the construction sector in Europe is significantly lower than in other areas of activity in European countries (Figure 3).
Nevertheless, 40% of construction organisations in Europe are going through a digital transformation process, which positively characterises the effectiveness of existing measures to stimulate digital transformation, mentioned earlier in this study. However, it is noted that the greatest contribution to the digital transformation of construction is made by large enterprises, while the activities of small and medium-sized enterprises are characterized by an initial level of digital adoption [34].

In the UAE, which has a well-developed system of strategic planning and financing of the digital transformation of the construction sector, there is an active growth in the rate of infrastructure and housing construction that is built using digital technology. Experts estimate that by the end of 2023, the UAE construction industry will reach a finished output of AED 265,969 million (an increase of 6.9% over 2022) [35]. In addition, the country's finished construction output is projected to reach AED 331,659.9 million per year by 2027, with an average annual growth rate of 5.7% [35].

According to a report by the International Data Corporation, the pace of digital transformation of construction in Asian countries lags far behind that of European countries. In India, only 3% of construction organisations are investing in digital transformation, while 72% of organisations are in the early stages of the process [36]. In China, digital transformation is prescribed in five-year plans, but currently, more attention of construction organizations is paid to project management in the implementation of investment and construction projects based on BIM, rather than the introduction of the most advanced digital technologies, such as artificial intelligence and virtual reality [36].

Speaking about the Russian practice of digital transformation, it is worth noting that among the participants of the investment and construction market, the highest level of digital transformation is characterized by project organizations [37]. Among the various digital technologies, Russian construction organisations most often use technologies whose application is legislated for certain construction segments (for example, within the framework of the state order). Thus, the leading technologies in terms of application in Russia are BIM, as well as big data and smart systems for the management of finished construction projects [37].

Based on the analysis of the growth rate of the construction sector and digital transformation in various countries around the world, it can be concluded that the financing mechanism of digital transformation has a significant impact on the level of digital transformation of construction. According to a GlobalData report, 36% of construction organisations globally face a lack of funding for digital innovation, with 28% of organisations overall insufficiently aware of existing digital technologies [38].

Countries with well-developed systems of incentives and financial support for digital transformation have higher levels of digital maturity among construction organisations than those that are just beginning to actively develop measures to improve the financing mechanism for digital transformation in the construction industry. Therefore, the development of measures to improve the efficiency of digital transformation of construction
at the state level should take into account the experience of developed countries and the measures of financial support and stimulation of digital transformation adopted by them.

5 Conclusion

Thus, the digital transformation of the construction sector is one of the key areas for the emergence of the digital economy both in Russia and abroad. The introduction of digital technologies in the construction sphere, such as BIM, big data analysis, artificial intelligence, Internet of things, etc., is associated with the need to finance this process, and investments are highly risky due to the novelty of these technologies and the uncertainty of the result of their implementation.

There are various mechanisms for financing the digital transformation of the construction sector, including grant support, tax incentives, innovation development and implementation centres, state co-financing programmes enshrined in national strategies, and programmes for digital transformation within the framework of individual investment and construction projects.

As a result of the study of the digital transformation of the construction sector in different countries, we can conclude that the digital transformation of construction is not uniform and depends largely on the availability of financing mechanisms for the digital transformation process applied in a particular country, including incentives and financial support measures for construction organizations. In our opinion, in order to accelerate the process of digital transformation of construction, it is necessary to approve the need for financing this process at the state level, which will contribute to the creation of effective mechanisms for financing digital transformation of construction with the participation of budgetary and private funding sources.

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