The classification of transaction costs: the innovation in the construction industry based on building information modeling. A case study of multilingual schools

Olga Bakhareva\textsuperscript{1}[0000-0002-5201-1524], Timur Azhimov\textsuperscript{2}[0000-0002-7648-1950], Liliya Azhîmova\textsuperscript{1}[0000-0001-9889-2585], Ludmila Marfina\textsuperscript{1}, Aidar Khuzagaripov\textsuperscript{1}

\textsuperscript{1}Kazan State University of Architecture and Engineering, Kazan, 420043, Russia
\textsuperscript{2}State Unitary Enterprise «Tatinvestgrazhdanproekt», Russia
E-mail: OVBakhareva@mail.ru

Abstract. The problems of effective investment in social infrastructure have a contradiction between the need to expand the functions of social infrastructure in the information society and, as a result, the potential increase in the cost of this state investment projects. Based on the in-depth interview method, we prepared questionnaires for several interviews with industry experts to identify the transaction costs in the construction industry. The results of the research represent technical and organizational innovations that reduce the transaction costs of investment projects for the development of social infrastructure during the life-cycle of an object. We tested our hypothesis on the example of building a multilingual school in Kazan and gave a classification of transaction costs in the construction industry. The proposed method of reducing transaction costs of an investment project for the development of social infrastructure, based on buildings information modeling, allows solving the problem of high-quality public buildings cost-effective construction and the creation of public goods in the region.

Keywords: economic grows, innovation; transaction costs; construction industry; BIM; multilingual school; social infrastructure; public goods, regional economics, JEL-classification: E02, H54, L14, O33, R11

1 Introduction
Effective budget investments in social infrastructure have a contradiction between the requirement to build public amenity with modern, expanded educational standards for students in the information-oriented society, and, as a result, with a the potential cost increase of state investment projects compared to previous, traditional projects. The current trend in the economy sector Architecture-Engineering-Construction-Operation (AECO) is to provide the reduction in operating and transaction costs due to the practical implementation of information technology and the use of integrated information systems.

The aim of the study is the development of methodological principles for the development of an economic mechanism to ensure the effectiveness of public investments in the amenity infrastructure of the region based on information modeling technology.

Research questions are the economic affairs and functions, strategic mechanisms of investment projects transaction cost-saving for the development of social infrastructure in conditions of innovation use - information modeling technology in construction.

The object of research is the economic mechanisms of transaction cost-saving of the construction of new multilingual secondary schools in the city of Kazan (Russia).

Research objectives:
1) the problems analysis that increase the transaction costs of investment projects in civil engineering in Russia;
2) the classification of transaction costs in the implementation and use of BIM in investment projects for the development of social infrastructure during the facility’s life cycle in a network economy;

3) the best practice development of transaction cost-saving of an investment project using managerial and technical innovations as in the case of new type multilingual schools in the Republic of Tatarstan, which is implemented by a regional innovative company using BIM.

Innovations in the construction industry are based on the application of disruptive information technologies using building information modeling (BIM) in design [1]. The innovation process, as a creative destruction, accelerates companies development and resources movement in the economy, and it leads to the redistribution of investments and knowledge in favor of innovative and productive companies [2]. The state and the society, their relationships affect the trend of political and country’s economic development, how countries react to events and shocks to the estimates of techno-economic paradigm [3], including in financial markets [4].

The analysis of drivers of economic growth, the question of the existence and protection of property rights in various social orders, taking into account the role of the state, the characteristics of institutions and the problems of resources efficient use are relevant both for the economy as a whole [5] and for the new market for building information modeling of permanent facilities construction. Non-innovative countries use strategies of economic catch-up [6]. Important priorities of spatial planning were not supported by sufficient promotion of the institutional and instrumental foundations of the state policy of regional development, which acts as the main regulator of the spatial structure of the national economy [7].

«In the chains controlled by the manufacturer, the companies that produce technologically sophisticated goods act as the main economic agents not only in terms of revenue, but also in their ability to control relations with suppliers of raw materials and components, as well as distribution and retail companies. Leading companies in such chains usually belong to global oligopolies. Buyer-driven MCCs, on the other hand, are characterized by high competition and global decentralization» [8].

According to transaction costs theory, transaction costs are associated with the costs of information resourcing related to exchange [9]. In the public choice theory it is noted that the causes of transaction costs are associated with the problems of coordinating the positions of the parties on the issue of public goods and the intension of economic agents to delegate the expenditures of the desired result to others [10]. The theory of agreements suggests that a transaction occurs when a product or service moves from the final point of one technological process to the starting point of another one, adjacent to the first process, within the company or in the external environment [11].

Transaction costs arise from transactions. According to the neoclassical approach, expenses arise during the transfer of ownership in the market [12] and the approach of neo-institutional economic theory says that transaction costs arise not only as expenses of using the price mechanism in the market, and a comparative institutional approach was used to analyze the possibilities of transaction cost-saving [13].

K. Arrow called transaction costs: “the operating costs of the economic system” [14].

Transaction costs represent the costs of trade and protecting competencies, non-productive costs consist of resource costs, time expenditure for making a transaction and losses due to an incomplete or ineffective contract, since market interaction is not free due to market transaction costs.

The relation between voluntary mutually beneficial cooperation and transaction costs is described in the form of Coase's theorem. According to the latter, “with the help of market transactions it is always possible to change the initial legal boundary delimitation of rights [15]. If such transactions are carried out without expenses, such a redistribution of rights will always occur, if it opens the gate to the growth of production value” [16]. J. Graf describes Coase’s theorem in the following way “if bargaining and conclusion of transactions did not require costs and did not run into legal restrictions, then optimizing behavior of market entities would automatically ensure the conclusion of all mutually beneficial transactions” [17].
In the world of zero transaction costs, an effective solution will prevail that can produce the highest total income [18]. T. Eggertsson formulated the “generalized Coase theorem” as follows: “If institutional costs are small, then the economy will always develop along an optimal path, regardless of the set of institutions it has” [19].

Breakthrough technologies of the network economy can reduce the transaction costs of the market mechanism. These include: artificial intelligence, computer-aided design, robotics, 3D printing, the Internet of things, sensors and transducers, intelligent networks, creating materials with desired properties, which reduce material costs, ensure increased labor productivity, increase the intellectual share in costs, and also the geographical accessibility of goods [20], the main subject of which is the e-state and the labor market [21].

In the context of business digitalization, companies face with special management problems, old rules are not applicable, barriers for entering markets disappear, a fundamentally new digital business infrastructure appears - digital platforms [22-24].

Competition Policy and Antitrust research show the role of the state in regulating the competitiveness platforms of companies of various sizes and involve contractual arrangements that might be considered as anticompetitive [25-27].

Three basic parameters affect the profit of an intermediary company in the bilateral market when using a quality differentiation strategy, taking into account the presence of network external effects and uncertainty when assessing the quality of the goods by the user, the demand for interaction from the participants and the connection fee to the platform, namely: the size of the cross network external effect, the quality of the test version of access to the platform and the uncertainty in assessing the quality of the platform by the user before making a purchase [28].

The introduction of digital BIM in the construction industry is based on the standardization of business processes of the company, the use of the BIM standard for the implementation of innovative technologies in construction [29-30].

BIM allows organizing an effective coordination of investment project participants to reduce transaction costs of information search, negotiation, change costs and monitoring of an investment project implementation [31-32]. The strategy of creating and implementing of new information systems and technologies in a company requires reengineering of business processes, integration, flexibility of the innovation process, and scalability of the business in the context of creating new digital products [33].

There is a complexity of technical and organizational innovations when changing the construction production system and creating new-quality facilities by construction companies in Russia [34] and the peculiarities of BIM system integration in the construction sector of the economy are also not easy to implement [35].

The implementation of investment projects based on BIM is mostly effective in the case of creating quality control systems in projects using BIM [36].

The information model of the building allows to proceed with engineering modeling, to perform comprehensive analysis of buildings design solutions with low environmental impact as a part of the sustainable design process [37]. The advantages of energy-efficient modeling of a real estate unit based on BIM give the possibility of analyzing several scenarios of object design [38-39].

BIM can be successfully applied at the operational stage. The economic efficiency of reusing the building’s information model can reduce the cost of investment projects, to recreate architectural, historical and cultural heritage in the region [40], as well as energy-efficient renovation of non-standard buildings of the historic city center [41].

It should be noted that there are additional costs of companies for the development of a risk management system in the network economy, the digitalization of construction is changing traditional production, in order to avoid a decrease in the economic results of the company, and a new type of digital risk management system is required:

- development of a risk management system to eliminate risks: lack of an efficient strategic approach of development, implementation of risky investment policy, high operational risks, etc.;
- identification and exclusion of business risks: use of counterfeit software; lack of analysis of the economic situation. Calculation and adoption of the boundaries of the consolidated risk associated with the activities of a company operating in the context of activities digitalization;

- reduction of industry risks: rapid technological changes in the field of expert services, which may lead to an increase in the cost of expertise (including those related to improving the quality of expertise);

- a large number of available methods of expert analysis and / or their rapid implementation throughout the entire period of activity of the expert organization;

- high barriers to exit the market: a small number of potential buyers of new developments due to high prices, strong competition, low profitability and other factors;

- significant influence of public authorities on the development of the expert industry: support of state expert institutions [42].

There are well-known methods for transaction costs reducing, for example, the use of standardized contracts such as FIDIC, EPR can reduce the transaction costs of concluding a contract, reduce the investors’ risks in the construction industry and increase its competitiveness [43]. The economic feasibility of applying BIM throughout the entire property life cycle is to save on transaction costs of information retrieval, measurement costs and monitoring costs [44].

2 Materials and methods

The study used the method of in-depth interviews with experts in the construction industry. There are the analysis and ranking of the causes of transaction costs in the implementation of investment projects in the traditional economy based on 2D modeling of the property. The development of social infrastructure is planned by the year 2022 in the Republic of Tatarstan (Russia), an innovative network of educational complexes of secondary education will be created. It will meet the standards of a new type of education, with teaching in 3 languages and a set of new space-planning solutions. The complex consists of a kindergarten, an elementary school, a secondary school and an additional education center. The regional government plans to implement 6 investment projects: 2 projects in the capital of the Republic of Tatarstan, the city of Kazan and one each in the cities of Naberezhnye Chelny, Almetyevsk, Nizhnekamsk, Elabuga. The research subject is the economic mechanisms which allow reducing transaction costs of a public investment project for the construction of 6 objects of the same urban social infrastructure under the conditions of applying innovations - information modeling technology in construction. To classify transaction costs, we used the multifaceted facet classification method.

3 Results and Discussions

3.1. Analysis of the institutional environment of the information ecosystem of information modeling technology in construction in Russia

The innovative process of introducing BIM in the construction industry of Russia began in 2014. It is characterized by interdisciplinary and intersectional interaction of participants in the investment and construction process to create a real construction project and its digital counterpart from the moment the project idea was developed to the use of the constructed facility, which requires cooperation between the construction market participants and state authorities, teamwork of participants in the investment and construction project.

The institutional component of the development of the information modeling market is the development of interaction rules in construction: the creation of a regulatory field, national standards, technical regulations, and an integrated national eco-platform for the construction industry based on national information systems.

An institutional environment has been created in Russia for the development of BIM in the construction sector of the economy. National standards have been adopted and they are being developed, as well as the regulations, which are based on:
Building information modeling. Modeling guidelines and requirements of exchange data between building information models and application package models. Regulations (2018).

Building information modeling. Modeling guidelines for various project life cycle stages. Regulations (2018).

Building information modeling. Rules for the organization of work by the production and technical departments. Regulations (2018).

Building information modeling. Components. Guidelines and requirements. Regulations (2018).

The “Concept for the implementation of capital construction facilities life cycle management system with using information modeling technology in the Russian Federation” was developed, which is based on the following innovations in the field of information technologies and information systems: the introduction of BIM at the national level and the development of state platform solutions - information ecosystem: information systems for managing the capital construction facilities life cycle with using BIM in the Russian Federation.

BIM in the construction industry is used to create real estate facility, and the digital twin is created on the basis of Continuous Acquisition and Life-Cycle Support (CALS) technology at the same time as the real estate facility.

CALS is used in the design, development, testing, operation and management of a product based on information technology and the possibilities of distributed access to information, standardized data formats and methods of information exchange between project participants, publicly available state information systems, rules of international or national standards for interaction between project participants.

In construction, CALS is a highly effective technology for integrating management information systems at all stages of the construction project life cycle. It allows you to integrate siloed software and create high-quality construction documents, pool efforts of related companies, reduce the performance period for design, construction, and repair work; it also allows business processes to reengineer and create an integrated information model of a real estate facility in the form of a virtual product - a digital twin.

The digital twin of the property allows you to expand the capabilities of business processes in the life cycle. Firstly, it's traditional to build a real estate facility, and secondly, to model the state of the real estate property using information and intellectual technologies, use a historical database, a knowledge base, a database of transducers, sensors based on the Internet of Things (IoT) technology, as well as to predict the condition of the property using the decision support system (Figure 1).

The possibility of applying innovations in the construction industry in the context of the traditional economy (traditional CAD design environment) is discussed, and it leads to transaction costs of investment projects. The analysis of the reasons for the decline in the main economic indicators of investment projects was conducted. They are: a decrease in profitability, an increase project implementation period as compared with the planned dates, an increase in budgets, a decrease in quality, and an increase in guarantee payments. As a result of our in-depth interview, experts note the following reasons for the decline in economic indicators of investment and construction projects carried out in the traditional CAD design environment:

- high fragmentation of the construction industry and different maturity levels among numerous architectural and construction companies;
- barriers between project stakeholders and delays in decision making;
- lack of coordination of requirements management processes, by economic agents, by technological level;
- uniqueness of projects and high variability due to the nature of construction and the environment of the investment construction project, which leads to an information gap in the project requirements, project participants, working documentation, etc.
Experts note the imperfection of made decisions upon implementing investment projects, which leads to significant transaction costs. Such as:

- costs of unproductive coordination of work;
- costs of unproductive management, movement and installation;
- coordination costs due to the lack of compatibility of individual sections of the project;
- costs of dispute settlement and claims with counterparties;
- decision-making costs due to changes in the project on the construction site;
- costs of payments for warranty cases at the stage of operation of the property.

Taking into account that the information modeling of the property unit life cycle is carried out on the basis of the life cycle model of an IT project for the phases of creating a software product according to ISO / IEC 12207, we believe that BIM interoperability is a key factor in the success of BIM implementation. The concept of interoperability was taken from the information technology market to use it in the investment sphere. Therefore, state standards ISO 12006-2, Information Technologies, were developed and they are in force in Russia. It is the state standard "Industrial automation systems and their integration. Interoperability. The fundamental principles". (GOST R 55062-2012). The Technical Committee for Standardization "Strategic and Innovation Management" introduced GOST R ISO 11354-1-2012 Advanced Automated Technologies and Their Application in 2014. Requirements for establishing the interoperability of industrial enterprises. Part 1. "The basis of interoperability of enterprises."

Summarizing the research data, we propose a classification of transaction costs in AECO and connect the classification of transaction costs to the stages of the life cycle of a real estate facility and conclusion of agreements between related companies, government expert body, persons with ownership rights to the real estate object, resource supplying organizations during the operation phase of the real estate object, and, if necessary, other economic agents. To classify transaction costs, we used the multifaceted facet classification method (Table 1).
### Table 1. Classification of transaction costs of the traditional economy (the traditional environment for the design of real estate).

| Types of Transaction Costs | Costs ex ante | Types of Economic Losses | Costs ex post | Types of Economic Losses |
|----------------------------|---------------|--------------------------|---------------|--------------------------|
| Information search costs   | Undisclosed benefits. | Costs of monitoring and preventing opportunism | Emergency job | Uneven work |
|                            | Loss of data conversion |                         |              | Construction inventory over |
|                            | Opacity of solutions |                         |              |                          |
|                            | Low unification |                         |              |                          |
| Negotiation costs          | Excessive over-cautiousness | Specification and protection costs | Manual labor | High human dependence |
|                            | Lack of motivation |                         | High level of alignment | Bi-directional vectors of participants |
|                            | Loss of time for changes |                         | Low qualification of participants | |
| Measurement costs          | Lack of availability of resources | Third party protection costs | Scalability of losses: the unit cost of error correction is higher in the later stages of the life cycle | |
|                            | Irregularity of operations |                         | Defect | |
|                            | Imbalance of resources |                         | Risk compensation | |
|                            | Non-optimal solutions |                         |              |                          |
|                            | Errors in decisions |                         |              |                          |
|                            | Invalid data |                         |              |                          |
| Conclusion of the contract costs | Irregularity of timing | | | |
|                            | Low manufacturability | | | |
|                            | Inaccessibility of information | | | |
|                            | Imperfection of the legal foundations of management | | | |
|                            | Low intensity | | | |
|                            | Excessive transportation | | | |

Source: compiled by the authors based on in-depth interviews with experts from the construction sector of the economy.

Thus, for successful implementation of a company’ s investment project in a network economy based on IT and BIM (application of information and intellectual technologies based on digital ecosystems and their interoperability), an integrated system based on BIM needs to be implemented to an allied industries of investment and construction projects in the AECO sector, and also an institutional environment, technical and technological environment of the investment project throughout the life cycle of the property should be created.

The institutional environment of the project is the standardization and regulation of the project management process in the external and internal environment of the company to ensure a coordinated work in a universal information model of the property.

The technological and technical environment of the project, which aims to create a universal parametric model of the construction object at all stages of the life cycle, is the development of design specifications for the realization of an information system and capital construction management system, a BIM implementation plan, integration of technological solutions and information platforms, implementation of the concept of analysis of spati-temporal collisions, scheduling and network planning, uploading of local estimates, inventory and logistics management in construction, records of an actual volume of works, records of write-off of material and technical resources and other administrative data, collection of design and estimate documentation, and initial permits, construction progress visualization, planned maintenance, refurbishment and renovation of the property.
3.2. Case Study of Multilingual Schools in Kazan

Currently, a chain of multilingual educational parks is under construction in the Republic of Tatarstan (Russia). The creation of a network of multilingual education will take place in 3 stages. In 2019-2020 there is a construction phase of the complex “ADYMYR - to knowledge and consent”. The reconstruction of Kazan school 165 will be carried out; additional facilities will be created to allow children to be educated at a next level. At the second stage poly-lingual complexes will be built in Kazan and Elabuga in 2020-2021. At the third stage, a second multilingual complex will be created in Kazan; it will be established on the basis of Lyceum 178 in the residential complex “Kazan-XXI Century” and in the city of Elabuga. Architectural, structural and engineering systems design of the first multilingual complex was carried out with the use of BIM by an innovatory company and market leader in the region. The information model of a new building, which is attached to the main school building in the city of Kazan, is presented: the southern facade, the northern facade, the western facade and the eastern facade (Figure 2) and the northwestern and southeastern parts of the building (Figure 3).

Figure 2. An information model of the side wing attached to the main school building in Kazan, the Republic of Tatarstan (Russia): southern facade, northern facade, western facade, eastern facade. Source: model is provided by partners, visualization is provided by authors.
The purpose of creating classification systems for transaction costs by us is to develop and use a unified systematic approach for information structuring, applying structured technical and economic information to AECO, unifying participants in the investment and construction complex at all stages of the property’s life cycle into an effective team, ensuring unambiguity in understanding information.

The analysis of the information model of the network of the educational multilingual complex on Bondarenko street in the city of Kazan, the Republic of Tatarstan (Russia), field studies using BIM as an example allow us to draw conclusions about the reduction in transaction costs of the investment project and the economic effect of the use of innovative technologies (Table 2):

- information search costs (a universal information model is used, it is full of graphic and non-graphic information at all stages of the facility’s life cycle),
- negotiation costs (tender documents were used),
- measurement costs (use of product classifiers and FSIS, other platforms),

Figure 3. Information model of the educational complex of the multilingual school in the city of Kazan, Republic of Tatarstan (Russia): the north-western and south-eastern parts of the building. Source: model is provided by partners, visualization is provided by authors.
• conclusion of the contract costs (standardized construction contracts were used),
• monitoring costs (virtual reality and augmented reality technologies were used to monitor the construction site and compare real construction with the planned information model),
• specification and property protection costs (standardized construction contracts were used),
• third party protection costs (the use of re-use projects for the construction of a chain of multilingual educational parks).

In the studied network structure, the economic effect is achieved by scaling up the business and re-applying the information model for typical facilities network of the educational multilingual complex.

**Table 2.** Grid facet classification of transaction costs in a network economy based on BIM (application of information and intelligent technologies based on digital ecosystems).

| Market Transaction Costs | Methodology Cost-saving | Economic Effect |
|--------------------------|-------------------------|-----------------|
| Information search costs | A unified information platform in construction (the family of FSIS, GIS, etc.) as a method of providing information on the assortment, prices, terms of use, weight and other parameters for architects, designers, economists, managers and other interested parties. | Reducing the cost of finding information. Efficient financial distributions between the information provider, the acquirer and the public. |
| Negotiating and contracting costs | 1. The use of standard form contracts to coordinate the various stages and elements of the production process: standard form construction contracts EPC, FIDIC, etc. with sanctions for non-fulfillment of obligations and bonuses for high performance of the contract. Contract of adhesion 2. Legal framework and reputation mechanism, risk insurance. | 1. Problem solving is in sharing the overall exchange benefits (cooperative surplus) 2. Institutional contract approval mechanism. 3. Improving the competitiveness of the company and access to international markets. 4. Significant reduction in transaction costs of negotiating and contracting. |
| Costs of measuring quantitative and qualitative characteristics of the good | 1. Contract performance bond on the life cycle of the property as a method of measuring the qualitative characteristics of the goods during its operation and assistance in maintaining the property through proper operation. 2. The trademark of the innovatory-company as an effective and successful economic operator. | 1. Development and provision of a “Certificate of quality of the house” for the operating organization 2. Development and provision of a “Certificate of quality of the flat” and operating instructions for each tenant. |
| Costs of contract enforcement and prevention of opportunistic behavior | Mechanisms for protecting contracts and preventing opportunistic behavior when implementing a transaction of a sequential nature based on hybrid “state-company-household” information ecosystems in the Architecture-Engineering-Construction-Operation (AECO) economy sector. | 1. Realization of the goal of legal defense of contracts for the creation of conditions for intertemporal exchange. 2. Due to the participation of the government, economies of scale are achieved, which allows release significant resources due to savings on transaction costs. |

Source: Authors Model

A theoretical and practical analysis of the causes and consequences of transaction costs of the design, construction, operation of social infrastructure in the network economy allows us to determine a methodology for cost-saving and the corresponding economic effect of using BIM, information and intellectual technologies based on digital ecosystems. We suggest an effective economic mechanism to reduce transaction costs of project management of organizational adjustment, implementation of BIM projects in the company using innovations and traditional technical approaches of engineering software throughout the life cycle of an IT project in a network economy:
• determination of the scope of use of BIM,
• audit of the company and, if necessary, reengineering of the business processes of the company depending on its profile (development company, architectural bureau, design company, construction company, construction industry enterprise, operating company),
• developing business requirements for developing an integrated system for modeling the life cycle of a building project,
• BIM implementation strategies,
• formation, justification and protection of the budget to the owners of the company,
• development project program planning and managing,
• determination of requirements for development projects and their results,
• verification of the results of subprojects and the project as a whole,
• testing the created complex of information systems,
• implementation;
• operation and use of the created integrated eco-platform based on a flexible approach and openness of the system.

The development of the market of information modeling technology in construction means the formation of an institutional system for buyers and sellers to share information of approximate prices, conditions of supply and demand. Thanks to the technology of information modeling in a heterogeneous environment of various economic agents implementing one investment project, there is an additional system-forming factor, which arises as an information model throughout the life cycle of an object.

4 Conclusions
Lack of interoperability is the main barrier to the effective data exchange and information between the participants of the investment project in the architectural bureau, construction organization, organization for the reconstruction (refurbishment) of cultural heritage sites and the operating organization when implementing investment projects of the traditional economy.

Technical and organizational innovations that reduce the transaction costs of investment projects for the development of social infrastructure during the life cycle of an object are identified.

We tested our hypothesis using case study of a multilingual school in Kazan and gave a classification of transaction costs in the construction industry of the network economy:

1) there is an analysis of the problems that increase the transaction costs of investment projects for the development of amenity infrastructure, the classification of transaction costs of the traditional economy (the traditional environment for the design of real estate facility);
2) a classification of transaction costs was compiled when introducing and using BIM in investment projects for the development of social infrastructure on the life cycle of a facility in a network economy in the form of a grid of facet classification of transaction costs in a network economy based on BIM (application of information and intellectual technologies based on digital ecosystems);
3) an economic mechanism has been developed to reduce transaction costs of an investment project and project management of organizational adjustment, implement BIM projects in a company using managerial innovations and traditional technical approaches of engineering software throughout the life cycle of an IT project in a network economy, which can be used by authorities public authorities, regional authorities, local governments for the effective use of public investments on the effect in the other BIM market.

In future studies, we would like to study investment projects for the development of urban infrastructure, compare and summarize industry experts’ opinion and prepare a new, more enhanced study. We understand the limitations of our research and, nevertheless, we tried to attract the best practitioners of the regional construction market and we are grateful to them for their time.
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Reference
[1] Kim J, Kim H, Tanoli W A and Seo J 2019 3D Earthwork BIM Design and ITS Application in an Advanced Construction Equipment Operation Architecture and Engineering 4(2) pp 22-26
[2] Katukov D D, Malygin V E and Smorodinskaya N V 2019 The factor of creative destruction in modern economic growth models and growth policy Voprosy Ekonomiki 7 pp 95-118DOI: 10.32609/0042-8736-2019-7-95-118
[3] Acemoglu D and Robinson J A 2019 The narrow corridor. States. Societies and the Fate Liberty (New York: Penguin Press)
[4] Bourguignon H, Gomes R, Tirole J 2019 Shrouded transaction costs: must-take cards, discounts and surcharges International Journal of Industrial Organization 63 pp 99–144 DOI:10.1016/j.ijindorg.2018.10.004
[5] Shastitko A 2019 Institutions do matter vs. only (formal) institutions matter Voprosy Ekonomiki 12 pp 90-110 DOI: 10.32609/0042-8736-2019-12-90-110
[6] Polterovich V M 2016 Institutions of catching up development (to the draft of a new model of economic development of Russia) Economic and social changes: facts, trends, forecast 5 pp 34–56 DOI: 10.15838/esc.2016.5.47.2
[7] Buchwald E 2019 Institutional problems of spatial development planning in Russia Journal of the New Economic Association 2(42) pp 121–136
[8] Kondratiev V B 2019 Global value chains in economic sectors: general and military World economy and international relations 63(1) pp 49-58 DOI: 10.20542/0131-2227-2019-63-1-49-58
[9] Eggertsson T 1990 Economic Behavior and Institutions (Cambridge: Cambridge University Press)
[10] Olson M 1996 Notes for Paper on Transaction Costs (University of Maryland: IRIS-Centre)
[11] Williamson O E 1985 Economic Institutions of Capitalism (NY: Coller MacMillan Inc)
[12] Hicks J A 1935 Suggestion for Simplifying the Theory Money Econometrca 2(1) pp 1-19
[13] Coase R H 1937 The nature of the Firm Econometica 4(16) pp 386-405 DOI: 10.1111/j.1468-0335.1937.tb00002.x
[14] Arrow K 1969 The Organization of Economic Activity: Issues Pertinent to the Choice of Market versus Non-Market Allocation. The Analyses and Evaluation of Public Expenditures: The PBB-System, Joint Economic Committee, 91st Cong, 1st sess. (Washington, D.C: Government Printing Office) Vol 1 pp 48
[15] Dementiev V V 2019 Innovation: between Coase's theorem and Hobbes's theorem Journal of Institutional Studies 11(1) pp 95-114
[16] Coase R 2007 Firm, market and law (Moscow: New Publishing House)
[17] Graf Ya D 2004 Social costs. Economic theory (Moscow: INFRA-M)
[18] North D 1997 Institutions, institutional changes and the functioning of the economy (Moscow: Fund of the Economic Book "Beginnings")
[19] Eggertsson T 2001 Economic Behavior and Institutions (Moscow: Case)
[20] Uskov V S 2020 Scientific and Technological Development of the Russian Economy in the Context of the Transition to a New Technological Structure Economic and Social Changes: Facts, Trends, Forecast 13(1) pp 70–86 DOI: 10.15838/esc.2020.1.67.4
[21] Pugacheva A S, Filippova V P, Kon A Y, Dorzhieva L B, Silchenok I S, Pugacheva N B, Lunev A N and Mustafina A A 2016 Market Regulators of Service Spheres Innovative

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Development as a Tool of Regional Socio-Economic Policy International Review of Management and Marketing 6(2) pp 294-300
[22] Kornberger M, Pflueger D and Mouritsen J 2017 Evaluative Infrastructures: Accounting for Platform Organization Accounting. - Organizations and Society 60 pp 79–95
[23] Parker G, Van Alstyne M and Jiang X 2017 Platform ecosystems: How developers invert the firm MIS Quarterly 41(1) pp 255-266
[24] Yablonsky S A 2020 Multi-sided Platforms: Current State And Future Research Russian Management Journal 17(4) pp 519–546 DOI: u18.2019.407
[25] Avdasheva S B and Korneeva D V 2020 Does Competition Enforcement Prevent Competitive Strategies of Digital Platforms: Evidence from BRICS Russian Management Journal 17(4) pp 547–568
[26] Eisenmann T and Parker G Van Alstyne M 2011 Platform envelopment Strategic Management Journal 32(12) pp 1270–85 DOI: 10.1002/smj.935.
[27] Lévêque F 2005 Innovation, Leveraging and Essential Facilities: Interoperability Licensing in the EU Microsoft Case World Competition 28(1) pp 71–91
[28] Borovkova A E 2019 Behavior of an Intermediary Company in the Bilateral Market with Product Differentiation Under Conditions of Information Asymmetry Economics and Mathematical Methods 55(2) 104-117
[29] Grishina N M and Mitsko D I 2017 Development and Implementation of the BIM Standard: Research of Management Methods in Construction Izvestiya KGASU 3(41) pp 266-276 [in Russian]
[30] Grishina N M and Chaly Yu Yu 2017 Problems and Prospects of Teaching BIM in Universities: Development Management in Construction Izvestiya KGASU 3(41) pp 277-288 [in Russian]
[31] Eastman C, Teicholz P, Sacks R and Listo K 2011 BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors (Hoboken: Wiley John & Sons)
[32] Sandeep L and Criminale A 2017 Challenges with BIM Implementation: A Review of Literature 53-rd ASC Annual Int. Conf. Proc. of the Associated Schools of Construction https://www.researchgate.net/publication/317842173_Challenges_with_BIM_(03.04.2020)
[33] Kaplan R S and Norton D P 1996 The Balanced Scorecard: Translating Strategy into Action (Boston: Harvard Business School Press)
[34] Bochkareva O and Kharitonovich A 2019 Development of Construction Company: Technical and Economic Aspects Architecture and Engineering 4(3) pp 4-12 DOI:10.23968/2500-0055-2019-4-3-4-12
[35] Abbasnejad B and Moud H I 2013 BIM and Basic Challenges Associated with its Definitions, Interpretations and Expectations International Journal of Engineering Research and Applications 3(2) pp 287–294
[36] Nguyen T and Yudina A 2019 Objectives of the Quality Control System for Construction and Installation Operation in Vietnam Architecture and Engineering 4(2) pp 27-32
[37] Andreani M, Bertagni S, Biagini C and Mallo F 2019 7D BIM for Sustainability Assessment in Design Processes: A Case Study of Design of Alternatives in Severe Climate and Heavy Use Conditions Architecture and Engineering 4(2) pp 3-12
[38] Aksamija A A 2015 Strategy for Energy Performance Analysis at the Early Design Stage: Predicted vs. Actual Building Energy Performance Journal of Green Building 10(3) pp 161–176 DOI: 10.3992/jgb.10.3.161.
[39] Kota S, Haberi J S, Clayton M J and Yan W 2014 Building Information Modeling (BIM)-based delighting simulation and analysis Energy and Buildings 81 pp 391–403 DOI: 10.1016/j.enbuild.2014.06.043
[40] Bakhareva O and Kordonchik D 2019 Investment in Preservation and Development of Regional Cultural Heritage: A Library of BIM Elements Reprenting National Architectural and Urban-
Planning Landmarks *Architecture and Engineering* 4(3) pp 39-48 DOI: 10.23968/2500-0055-2019-4-3-39-48

[41] Bakhareva O V 2019 Development of Housing Stock and Urban Infrastructure: Energy-efficient Rehabilitation of an Atypical Apartment Building [Razvitie zhilischnogo fonda i gorodskoy infrastruktury: energoeffektivnaya sanatsiya netipovogo mnogokvartirnogo doma] *Russian Journal of Housing Research* [Zhilischnye strategii, ISSN = 2410-1621] 6(4) pp 487-508 DOI: 10.18334/zhs.6.4.100436 [in Russian]

[42] Tiulkin E, Evtyukov S and Bezgina V 2019 Digitalization as a Factor of Risk Management in a Research and Production Company in the Field of Motor Vehicle Examinations *Architecture and Engineering* 4(4) pp 58-64 (2019) DOI: 10.23968/2500-0055-2019-4-4-58-64

[43] Bakhareva O V 2015 Investments in a Regional Building Complex with Attraction of Capital of the Pension Services Market [Investirovanie v Regionalnyi Stroitelnyi Complex s Privlecheniem Capitala Rynka Pensionnyh Uslug] *Izvestiya KGASU* 4(34) pp 377-383 [in Russian]

[44] Eadie R, Browne M, Odeyinka H, McKeown C and McNiff S 2013 BIM Implementation Throughout the UK Construction Project Lifecycle: An Analysis *Automation in Construction* 36, 145–151 DOI: 10.1016/j.autcon.2013.09.001