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On the Building Information Modeling of Capital Construction Projects Market Development

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Abstract

Sustainable economic development of the construction industry in Russia is only possible with the application of modern BIM-technologies. The construction enterprises are facing a number of problems during the process of implementing new information technologies the main problems being: the lack of funding for business development under the conditions of protracted financial crisis within 2014-2016 time frame, as well as the lack of a national industry standard of working with BIM-technologies. The step-by-step introduction of BIM- technology in Russia is planned by the Government for the period up to 2018. We offer an economic mechanism of lower production and transaction costs of development as a result of the BIM-technology introduction, taking into account successful experience in the regional economy of the Republic of Tatarstan. In our opinion the practically well-proven mechanism of introduction of innovative technologies in regional economy in public construction companies, constructing infrastructure projects, and private construction firms and approbation in practice and summarizing the lessons learned will enable one to develop building information modeling services market and ensure the sustainable economic development of the construction industry in the region. The improvement of the efficiency and transparency of the building production will create conditions so that they attract domestic and foreign institutional investors which, in turn, will allow a business to implement strategic development program for the prosperity of the economy.

Keywords: **Sustainable Economic Development; Regional Economy; The Construction Industry, BIM-Technology Institutional Changes**

INTRODUCTION

Problem Setting

Russia's economy has great potential, which is based on two fundamental factors. Russian people are naturally talented, well-educated and endowed with abundant mineral resources (land, oil, gas, minerals, metals) that allow them to form national wealth in the real economy, contribute to economic development and prosperity in Russia.

Economic growth can only be achieved if the Russian Government creates the legal and economic infrastructure which will make a business more efficient at the microeconomic level. The effective business organization allows firms to create competitive benefits with maximum efficiency on the domestic market for the entire population and, at the same time, to ensure steady exports of goods to the outside

world. An effective balance of firms will allow construction companies to borrow money for strategic projects development both from the external and from the domestic market. The impact of information technology on business in today's economy is huge. The information technology acquires special value in the industries with a higher degree of technical and technological business content. In the global practice of the development, the technology has changed its way - for more than 25 years the innovative BIM-technology, based on 3D modeling objects, is used. The most successful international practices, based on BIM-technology (Building Information Modeling) allow one to fill a building information model with technical data: building, cost, timetable and work due-dates, conducting of the governmental evaluation of the project and of works etc.

The Russian Government has planned the transition to new information technologies for the construction industry - the measures of new rules and regulations step-by-step implementation in the construction industry (classifiers, regulations, standards, etc.) are developed.

The first group of the problem, concerning the reformation of the construction industry, is that at the microeconomic level, firms face an acute scarcity of funds for financing the development and introduction of new technologies. Factors that have significant influence on reducing cash flows to the construction industry under the conditions of the prolonged financial crisis within 2014-2016 are:

- the limited availability of external financing of Russian business,
- the drop in demand for commercial and residential property in connection with a reduction in the purchasing power of households and qualified investors,
- lack of funds for the completion of existing objects
- a limited supply of objects due to the bankruptcy of real estate developers (negative net asset value, the impossibility of repaying debts on time).

The generation of cash flows to the construction industry under today's conditions is only possible through the following sources: credit funds of banks, working capital financing for completion of commenced objects and constructions, project financing in the case of integrated development of urban and rural settlements (underground railways, infrastructure, and utilities, etc.).

The following causes of liquidity problems of construction firms should be noted:

- the profitability of the company in the long term is predicted given the high level of risks
- the growing crisis of non-payments for liabilities in connection with the bankruptcy,
- ruble devaluation within 2014-2016 time frame, resulting in lower prices for raw materials,
- the difficulty in the case of obtaining a bank loan because of the construction industry institutional features (the mortgage, that a bank wants in most cases will be only a completed construction of building, commissioned and registered as a

real estate which, in turn, requires transaction costs for inventory accounting, registration of ownership rights, payment of utility bills, security, insurance, etc.).

The second problem is of economic and technological nature - industry lag of BIM-technologies introduction requires the restructuring of business models at construction industry enterprises during the process of Governmental building evaluation of already built objects exploitation and their gradual fracture.

The successful examples of implementation of BIM-technology in the Russian practice were held in large private business groups with parent companies in the oil and gas industry as well as in road construction.

The partial introduction of new technologies in construction has been used at the stage of architectural design and design stage. In other cases, the process of innovation slows down and stops at the governmental evaluation stage, building operation and reconstruction stages because of:

Absences of the national BIM-standards,
Lag with the introduction of modern information technology building modeling due to limited resources and lack of specialists - BIM managers of construction projects,
Limited demand for professionals, that are familiar with modern construction technologies.

Latest Research and Publications Analysis

The transition in Russia the construction industry towards a new economic model is accompanied by institutional changes at every life stage of construction object. The introduction of new technologies requires government make significant efforts for the legislation and regulation of training and regulation of relations between economic agents in the new conditions. For now the main impact of technological change in the construction industry is to reduce production and transaction costs in the stages of architectural production and construction.

The analysis of economic development in the process of introducing a new product, a new production method, opening a new market, the conquest of a new source of raw materials, the establishment of a new organizational structure in the industry and financing of development are studying at the beginning of the twentieth century [1].

Technical efficiency gives a measure of the total factor productivity gape an individual firm relative to the production frontier which describes the best available technique. The production frontier can itself shift with technical change, thus creating aggregate productivity grows. Productivity growth has been show to be major sours of growth of aggregate output [2].

Econometric analysis of the impact of technological progress on economic growth of the

economy requires the observation of historical data in the economy, which could use econometric models to estimate the contribution of technical progress Productivity Total factor (TPF), and other factures: the rate of male enrollment influence the girls' enrollment rate, investment rate, the ratio of government consumption, inflation rate, change in terms of trade, openness and institutional variables on economic growth [3,4]. In the Solow model studies was added human capital, and studied for a group of countries economies with different initial levels of technology, then they regressed estimate for intersectoral sample of non-oil producing countries, they realized calibration, MRW model is an endogenous growth model [5].

Public policy has traditionally focused on the important sources of economic growth: factors depending in response to prices incentives, to nonprices factors such as public investment or private investment, access to credit; efficiency gains (technical and allocative efficiency) by producers in response to better information and education technological efficiency; productivity gains (technical change) as a result of research or the transfer of new technologies [6].

The impact of institutional changes on the dynamic of macroeconomic indicators of the national economy may be different, including in crisis and the volatility of world markets [7].

The construction industry is implementing investment, ensuring the development of the national economy and the financial infrastructure in the country.

Empirical studies of the relationship between financial sector development et the varieties of financial instruments used in the national economy showed a positive relation with economic growth [8].

Research of the impact of technical changes to the structure of the economy, the impact of financial development to economic development industrial sector are shown significant relations [9].

The studies have shown a significant role of the government, of the Competition Policy, institutional infrastructure changes for the economy [10].

At the same time the private investors, including institutional investors, play an important role, especially in the cases of effective investment (pension funds) in infrastructure projects [11].

Economic growth of the economy and the national economy sectors allows analyzing the structure of the economy and the contribution of each sector of the economy [12].

Note particularly the introduction of technical changes to Russia. Studies of modernization of the national economy based on technological change in Russia should take into account national particularities, especially particular geographic, climatic,

institutional [13].

Transfer of new technology may occur through various mechanisms, including the use of third-party inventions, information communication with other companies, purchase of equipment, recruitment of qualified personnel, the use of third parties services contract R & D, the purchase of the company. Especially useful in the Russian practice can be an institutional understanding of the importance of the relationship between the buyer, the form of the transfer of technology and their impact on the effectiveness of the implementation of technological changes [14].

An innovative type of progressive macroeconomic dynamics requires a transformation of the source transition to a new type of economic development, and a brand-new mechanism of national economy management, taking into account the characteristics of the globalization and regionalization processes [15].

There are legal constraints and administrative difficulties when using innovative technologies in the construction industry that are not adapted to the transformation of social production and to the use of information technology. Strategic directives of regulatory changes (national standards and codes, the regulatory framework for the application of European rules and regulations, unification in the sphere of technical regulation) in the construction industry will alleviate the restrictions, created with the existing conventional building regulations [16].

Pension market growth has exacerbated the problem of investing: the demand for high-quality investment instruments among funded pensions market participants is growing, on the other hand, the set of instruments for investment of the pension accruals funds remains underdeveloped, the market lacks significant proportion of reliable investment projects with the guarantee of refund, including in the construction industry of the regional economy [17].

Information technologies leverage the economic potential through the effective use of management practices in enterprises and through the use of formation mechanisms and capital accumulation [18].

In accordance with the Decree of the Government of the Russian Federation, the State program “Economic development and innovative economy” is formed (The Order of the Government of the Russian Federation [19], State program of the Russian Federation Economic development and innovative economy), being aimed at reducing administrative barriers to doing business, using innovative technologies of the information society.

The Research Objectives

The strategy of scientific research is aimed at studying possible directions of the information modeling market development in the construction industry and at studying

long-term investments of institutional investors for realization of investment projects. The purpose of this study is to analyze the practice of successful introduction in the practice of building information modeling of construction projects in the regional economy of the Republic of Tatarstan as well as the proposal of the economic mechanism of improvement and development of the construction market in the case of the use of financial and technological innovation. As a result of the use of the proposed economic mechanism corporate culture in the construction industry will face a substantial change. The efficiency of work at each stage of the life cycle of the construction will grow (market research-development-construction-maintenance-reconstruction) which will reduce production and transaction costs, help to comply with the terms of construction objects and will create the conditions for engaging institutional investors to the construction industry.

METHOD

The methodological basis of the research is the system analysis of the structural development of the construction industry at the national and regional level, modeling of the functional relationship among economic agents in the economy, comparative market analysis of information modeling.

The study is based on the empirical analysis of legislative and normative acts of Russian Federation, and the region of Russian Federation - The Republic of Tatarstan and on the analysis of statistic data and analytical materials of the Accounts Chamber of the Russian Federation, the Ministry of Economy of the Republic of Tatarstan as well as on the public sources of statistical information, published reports of experts of the real estate market and construction market.

Scientific research is based on institutional analysis of changes that occur in the construction industry in connection with the transformation of technological systems and changes in the technology of construction, based on BIM-technology modeling of governmental intervention into the process of developing new national standards both in the construction industry and in construction education in Russia.

In the study; the analysis of scientific and empirical research in theoretical field of the BIM-technologies impact on the efficiency of building production, its impact on economic growth, and practical experience in various countries around the world; is carried out.

RESULTS

The First Group of Problems

Development of the market of Computer Aided Design has passed several stages in Russia. In the early 70s of the twentieth century a wild first stage of theoretical developments were construction industry professionals to create computer models in

addition to the mock-ups and models of future buildings and structures, used in engineering projects. However, there were no tools to implement the idea of a single information object in construction. Software and computers are not allowed to practice the theoretical models of the construction industry engineers. In the second phase development of the market after the invention of personal computers, the development of Computer Aided Design of buildings in the second half of the XX century it has allowed to automate the design stages of construction products, to create a 2D-model. At each stage of manufacture of the construction product by various developers to create special computer programs. In this regard, various specialists had difficulties with the coordination of the flow of information at different stages of the life cycle of the object.

In the XXI century in Architecture and Construction Industry had serious problems, the solution of which old methods was impossible. The difficulty with the processing of large data sets due to the high complexity of projects under construction, saturation infrastructure, high rates of construction and the need for rapid implementation of the design phase of engineering calculations and production of working documents, the increased role of the specifications and securing the property rights to object construction and complexity of building documentation, the need for taking into account the requirements of green standards in accordance with the concept of sustainable development (energy efficiency and environmental design), taking into account peculiarities of building maintenance to ensure green standards and the need for information about the object on the stage of exploitation, increasing competition in the market and the need to quickly and accurately produce structural elements of the building, preparation investors several investment project options to optimize the costs of the project, the international standardization of the design process, project documentation growth, the growing role of standardization projects legislation [20].

Information technology of Building Information Modeling (BIM) is a new method in the architectural and building design. BIM-technology allows you to create and describe a common information model of the object construction (building, infrastructure facilities, the new city under construction) [21], to change it, to simulate different states of the building, its interiors, special properties associated with its purpose and the reason calculations, receive the working documentation of the object accurately and easily using a computer to transmit accurate data about the object owner or the operator. At the beginning of the XXI century there was an association of architectural and design phase and construction phase of buildings: the building in 2003, Walt Disney Concert Hall in Los Angeles. Then, BIM has been used successfully around the world for the construction of a unique object, and standard.

In the Russian market of Computer Aided Design have become the development companies, developers of commercial real estate. Developers have implemented large-scale investment projects and technological innovation invited foreign experts who bring a new culture and passed BIM-technology to Russian specialists in the practical transfer of experience. At the same time private investors in industries with high and stable

incomes were able to successfully implement the construction of industrial facilities for its business groups. An example of effective management of the construction process was leaked on the housing construction market, many small and medium-sized developers implemented the first dot residential development based on BIM.

Since 2010 there was a practice of quarterly residential development in urban neighborhoods were superior and complex forms of building for urban residents with incomes average or above average income. At the same time the construction of a model of housing on the outskirts of cities at prices affordable to residents of cities with low incomes. The accumulation of experience reflects the specificity of climatic, cultural, technological and inherent in the local construction market, both national and regional. The catalyst for the standardization of the construction industry was the successful experience of the technological changes of building information modeling with large-scale construction of sports and infrastructure facilities in Sochi.

For the first time in the last 20 years in Russia a new city Innopolis was built in 2012-2015 on the territory of the Republic of Tatarstan. BIM-technology used at certain stages of the new city construction. The facilities were built in time to meet the customer's building requirements.

Innopolis Effect

We studied the case of building a new city Innopolis with BIM-technology at the stage of architectural design and poroektirovaniya (excluding the phase of construction and operation) according to the official website of the city http://innopolis.ru/en/, (date of reference 14.02.2016)):

Innopolis is a new Russian city, located in the Republic of Tatarstan. The city's economy is based on high-tech industries. In Innopolis, a unique environment has been created that combines a modern residential infrastructure in harmony with the nature, safe environment, and broad opportunities for education and professional development. Innopolis was built over 3 years, on June 9, 2015, Innopolis held its foundation ceremony: a new city's life was officially launched. At present, Innopolis provides its residents with the following amenities.

Multifamily Houses and Townhouses: Modern, high-quality residential infrastructure is another competitive advantage of Innopolis. The majority of the apartments are leased to residents and include all necessary furniture and household appliances. Special attention is paid to development of social infrastructure of the city. 5,000 people the city can accommodate by the end of the first phase of development.

Sports Complex: The total complex area is 9,000 square meters. It offers residents and city guests a universal sports hall for team sports, gym and swimming pool. In the city's immediate vicinity, the Kazan Ski Sports Complex houses restaurants, hotels, a recreational center, and a golf course.

School of the Innopolis University: The school sets an ambitious aim of fusing the best practices of the Russian and foreign education systems, while combining advanced teaching methods, innovative technologies, and teachers capable of delivering educational material in an interesting and comprehensible way. The school is located in the building of Innopolis University, in one of the most modern units recently built in the Russian Federation.

Educational Programs includes primary general education for 1-4 grades, basic general education for 5-9 grades, secondary general education for 10-11 grades.

Kindergarten: It is an educational center for 2-7 years old young residents of the city of Innopolis, designed for 225 children. The training was organized by British standards of international pre-school education. English-speaking and Russian-speaking teachers are engaged in both physical and artistic-aesthetic education of children.

Innopolis as well as interviews with experts who participated in the design and construction of facilities, including infrastructure.

The master plan of Innopolis was desined in 2012 by RSP Architects Planners&Engineers (Singapore)/RSP Architects is one of the most experienced companies in city planning and architecture around the world. Liu Tai Ker is Hed of RSP Architects Planners&Engineers. Architect designed the image of modern Singapore. Manager of Innopolis masters plan development.

University: Specializing in the field of modern information technologies, Innopolis University is not only one of Russia's youngest universities, but also the new city's intellectual center. The teaching staff consists of leading Russian and foreign IT specialists and robotic science. Driven by the demands of both business and industry, the educational programs are committed to producing a high-quality stream of professionals for companies located in Innopolis. Now 352 students are studying at the university for specialized programs.

Innopolis University is first Russian's University for 5000 students in 31 158 m2 total area. In a partnership with leading international university.

Special economic zone: The Innopolis are Special Economic Zone (SEZ) was established on the territory of the city in order to bring to Innopolis the largest and promising technology companies from all over the world.

Accommodation in Innopolis SEZ gives a set of advantages to companies (Table 1). A key infrastructure facility of the SEZ is the Technopark. It is a complex of modern buildings, in which all conditions for residents' comfortable work are created. The special economic zone Innopolis have 192,7 ha total area and: Special tax rates, Favorable terms on vital infrastructure, Access to highly qualified specialists, Land and premises lease, Low administratives barriers.

In addition, we studied the official statistics about the process of building a new city. We have studied the statistics of the Accounts Chamber of the Russian Federation on the results of the construction of the new city (Table 2).

Table 1: Tax benefit for residents [22].

Innopolis Special Economic Zone in Republic of Tatarstan for the period 2015-2019

Payments		**Percent**
Corporate income tax	Federal tax rate	0% - until 2018
	Regional tax rate	0% - first 5 years 5% - next 5 years 13,5% - after 10 years
Insurance payment		14% - until 2017 21% - during 2018 28% - during 2019 30% - general tax rate
Transport tax		0% - for 10 years
Property tax		0% - for 10 years
Tax on land		0% - for years

Innopolis SEZ Technopark comprises Popov Building (2 200 specialists and 43 000 m2 total area, office space lease terms $8,5 - $10 (from 1400 m2 up to 700 m2) and N. Lobatchevsky Building (1500 specialists and 30 000 m2 total area).

Currently Aiteco, Fix, NITC, GROUPIB, etton, RAFT, Universal IT Systems, Level90, DomBobra.Ru, CIC, IMC, Govermedia, Stroikapp, ICL are first residents of Innopolis SEZ.

Residential infrastructure have apartment blocks 1 585 apartments, 160 000 m2 total area and townhouses 202 houses, 45 208 m2 total area. Social infrastructure include School for 480 students 13 090 m2 total area, Kindergarten (Innopolis international school) for 225 children, 5 589 m2 total area, Sport Complex 9 000 m2 total area and Medical Center 6 335 m2 total area. First Stage of Construction accommodation for 5 000 people.

Table 2: Analysis of the production costs of building the city Innopolis, (mln. rub.) for the period 2012-2015 [22].

Building or infrastructure facility	**Design, construction, state expertise, technical customer service**	**Costs**	**Including: the cost of the contract for the construction**	**Paid upfront contractor**	**The remainder to be paid**	**Stade**
Educational and laboratory building of the university	2 130,25	The cost of construction works	2 068,52	1 982,72	85,81	The building used to August 13, 2015.
Residential and sports complexes	1 850,53	The cost of construction works	1 780,16	1 729,61	50,55	The building used to Juin, 08 2015.
Overhead pedestrian crossing	39,81	The cost of construction works	35,07	31,51	3,57	The building used to September, 04 2015.
Landscaping	420,94	The cost of construction works	405,76	152,67	253,09	Under construction
Total	4 441,53		4 289,51	3 896,51	393,01	

The use of innovative construction technology ensures high quality of construction, to meet the terms of construction, originally scheduled to perform an estimate of the construction of each of the objects (currently one of the objects is not finished). Furthermore on the basis of activities annual Meeting of OAO Innopolis decisions on profit distribution (Table 3).

Table 3: Dividends OAO Innopolis for the period 2013-2014 [22].

Expenditure	**2013**		**2014**	
Net profit total, thou. rub.:	14 626,67	100,00%	169 405,15	100,00 %

Reserve Fund	731,33	5,00%	8 470,25	5,00%
Dividend Payment	3 884,77	26,56%	42 732,50	25,23 %
Use profits to finance the expenses of operating the university complex "Innopolis" (after commissioning)	10 010,56	68,44%	118 202,39	69,77 %

An analysis of the results of the construction of a new city using BIM-technology, we can observe two effects on the implementation of the project.

Direct effect: increasing IT sector of the regional economy especially: registration and operation of residents of the Special Economic Zone Innopolis, regional economic grows,

Indirect effect: economic development of the construction industry of the Republic of Tatarstan regional economy: reducing transaction and production costs and increasing the strength of technological processes.

Thus, in 2016 in Russia has accumulated the successful practice of the implementation of the BIM, formed a community of experts, which is adapted to the international standards of construction, developed for their company's internal regulations, rules, allowing to build in Russia a significant number of complex objects using the new technology.

However, small and medium businesses have failed to adapt to the new technology, there were problems of a different kind, which required the intervention of public authorities in the standardization process of the construction industry. State authorities have developed an action plan for implementation at the national level national standards BIM-technology until 2018.

National BIM-standarts

In January 2016 the Ministry of Construction and Housing and Communal Economy of the Russian Federation has published the news about the drafting of the first national standards for information modeling of buildings and structures. In order to harmonize international and national standards based on ISO standards, taking into account the geographical, climatic, institutional features of national construction industries drafted with the following standards.

A. Information Modeling buildings. The main provisions

(ISO/TS 12911:2013/Framework for building information modeling guidance)

The standard establishes the basic requirements for the implementation of BIM on different levels: in the software projects (enterprises), investment in the construction in accordance with national and international standards-based BIM.

The standard defines a framework for the use of BIM (regulation processes, harmonization of international standards, national regulations and guidelines for the investment project or enterprise, the introduction of regulations, guidelines on a common platform and basis).

The development of user-friendly application of normative documents (complexity management at various levels with a controlled list of initial data and information management results, the validity of the required parameters, the possibility of guidelines supplement the ability of management to compare and association) and the procedure for monitoring compliance with regulations in the industry (compliance guidelines basics regulated in national standard, matching the requirements of the model guidance, the proper use of guidelines demands a formal contract).

The standard allows to achieve the following objectives: the definition of expected results and the required quality of BIM, regulation and control processes used by software, compliance management between the use of BIM and the necessary resources, the execution of the state programs of BIM implementation.

The standard is intended to create a guide to information modeling in organizations, implementing BIM (design, construction, maintenance), the standard can also be used by software developers.

Economic and social impact of the introduction of the standard is the creation of guidelines for the implementation of BIM in the building industry practice.

Having made the transition to a unified information model construction products into account that in the construction industry, it should be noted the expected effects of the introduction of WIT

- The first effect - increasing the efficiency of the processes of construction,
- The second effect - the implementation of institutional investor requirements to the quality of construction products and the price of construction products.

In order to create a comfortable, predictable institutional environment for investors in the construction industry and to maximize the return on the capital investment of institutional investors requires new institutional framework of the construction and production, including normative documents (standards, manuals) for building information modeling.

B. Modeling the information of buildings and structures. Requirements for operational documentation facilities completed construction.

(Requirements for operation and maintenance documentation for construction in progress). Operation of the construction project is considered as a control material, the physical part of the created asset. For efficient operation of the building or structure BIM-model planned interaction with the information management system of the operating organization. At the stage of operation of the facility operational information is added to BIM-model and corresponds to the composition and attributive characteristics of the actual physical building or structure.

The use of the operational model allows you to:

- Lower the stage of commissioning costs through automated transmission accurate, complete and unambiguous information about the asset owner,
- Improve the quality of the organizational and strategic planning in the operation based on full and accurate information about the asset,
- Improve the quality of decision-making related to the operation and maintenance costs of assets, based on their actual performance and condition,
- To maintain a given level of asset reliability (minimizing downtime, bounce, drop of system performance) due to the quality of information support of processes of operation and maintenance of assets.
- Monitoring the status of the asset should be provided throughout the facility lifecycle, enabling the operating organization to make management decisions on the implementation of the following works planned (unplanned) character:
- The preservation of the integrity of data and information for the implementation of business processes by managing the building or structure,
- Availability of information on the building for the staff of the operating organization.

Thus, the use of information model of a building or structure at the stage of operation of the facility can afford to increase the level of operational safety at the expense of the organization real-time access to information in case of accidents and emergency situations, to implement the work planned (unplanned) nature of the reconstruction of the decommissioning.

C. Modeling of information of buildings and structures. The requirements for the exchange of information at all stages of the life cycle.

(ISO 29481-1:2010. Building information models – Information delivery manual. Part1: Methodology and format). The standard establishes a methodology for combining streams of construction processes and information about them. The standard contains the recommended form to provide integrated references to processes and data provided at the BIM-modeling and during operation, setup, in accordance with national, local and project requirements. The aim of standardization is the reliability of the information: the information obtained should be accurate enough, ready to work under the terms of the reliability of the sources.

D. Model the organization of data on construction works. The structure of the project management information.

(ISO 22263:2008/Organization of information about construction works Framework for management of project information). The standard was created to facilitate the monitoring process, sharing, retrieval and use of information about the project and the building structure. The standard is intended for the participants of the project in the field of the construction process as a whole, the coordination of sub-production facilities on construction sites.

E. Information Modeling buildings. Guidelines for the libraries of knowledge and object libraries.

(ISO 16354:2013. Guidelines for knowledge libraries and object libraries). Knowledge Base (libraries) and database (objects) are subject to standardization.
Standard introduces common knowledge replenishment procedures, adjustments to maintain up to date information on the information model building or structure and provide access to it stakeholders.

F. Construction. Model Organization of construction work data. Part 2: The structure of the classification of information.

(ISO 12006-2:2015. Building construction – Organization of information about construction works – Part 2: Framework for classification of information). The standard describes the structure of the classification of the information. It is technical in nature and takes into account the geographic, climatic and cultural characteristics of the national construction industry.

G. Construction. Model Organization of construction work data. Part 3: The structure of the classification of information.

(ISO 12006-3:2007. Building construction – Organization of information about construction works – Part 3: Framework for object-oriented information). Model of the relationship between the classification systems and processes modeling of construction projects throughout the lifecycle of the building and facilities is a subject of standardization.

Currently under discussion on the draft standards with experts and stakeholders. The projects of the Russian national BIM standards laid international standards that are adapted to Russian conditions. The standards take into account the climatic, cultural and institutional features of the construction industry in Russia.

Analysis of the draft standards allows us to draw the following conclusions about the advantages of BIM implementation.

In our opinion, the integrated use of new effective BIM technologies, the prognoses advantages of BIM technologies in construction industry may contribute to economic growth and sustainable development of the construction industry including in conditions of financial crisis and market volatility 2014-2016.

Technological innovation in Russia can be effective in a very short time in the case of the creation of the necessary institutional environment, as well as the generalization of good practice and the creation of standardized mechanisms for transfer of BIM-technologies, including the establishment and improvement of industry standards in the future. In this connection it should be noted that in Russia the process of introducing technological changes in the construction industry began under the auspices of public authorities.

Institutional Investor

One of the ways to increase investment attractiveness of the construction industry for institutional investors is the introduction of innovations to the construction industry during the process of building information modeling technology of objects (buildings).

The transparency increasing of the construction industry, the reduction of transaction costs for realization of construction project investment, the predictability of results and due-dates through the use of building information modeling can expand the limits of the portfolios of institutional investors by share of pension investment assets in the construction industry.

Introduction of building information modeling technologies to the field of industrial and civil construction, in our point of view, will improve information transparency of construction industry and will create the conditions for operational risk management of institutional investors, thus allowing institutional investors of pension insurance market to create a flow of investment to the construction sector.

The object information modeling Technology (buildings, construction) is an innovative integrated approach to the construction, supply, ensuring the maintenance and repair of a building - building operation management [23-25].

We consider the main stages of a building life cycle the following ones:

- marketing studies to assess the feasibility of the project;
- engineering (architectural and construction design and survey work, approval of project documentation);
- governmental evaluation of project documentation and obtaining permission for construction;
- construction of the facility;
- operation and maintenance;
- the destruction of an object when changing to a new facility construction [26].

In case of using building information modeling technology of a facility, and all information about, it constitutes a single dynamic digital object which consists of interrelated data on architectural, technological, economic and other information about the object and it is stored as data in the program complex. The introduction of management innovation to the construction industry will increase the competitiveness of the industry, quality of work throughout the life cycle of an object; reduce the costs of construction and operation; eliminate the risks of emergency situations at objects.

In our opinion, the development of information modeling market in capital construction projects throughout the life cycle of an object will also significantly change the efficiency of investment and projects under construction:

- accelerate return of investment to projects,
- reduce the investment risks,
- improve the quality and speed of design,
- reduce construction time and operating costs,
- increase their attractiveness to the institutional investors.

In the international practice of building information modeling of capital construction projects throughout the whole life cycle of a project in most cases is accompanied with using standardized construction contracts: EPC-contract, FIDIC-contract and outers. In the international and Russian practice on use of standardized construction contracts [24,25,27-30]. EPC/M-contractor is fully complied with investment and construction project, undertakes project management risks since the designing process until the moment of transfer of a finished object, with the given warranty obligations under the contract, to the customer.

During the implementation of the EPC/M-contract pricing problems arise, and these problems are related to the risk accepted by the contractor:

Firstly, efficient calculation of estimated profit, taking into account a reasonable level of profitability of the investment and construction process participants;

Secondly, the need for establishing the investment and construction process of pricing for services of main contractors and EPC/M-contractors, being transparent for all the participants that could increase market transparency of Russian EPC/M contract for potential investors [31].

Contracts for construction projects such as EPC (engineering, procurement, construction) is used to implement construction projects that are the part of another major investment and commercial project and are used to exclude financial or industrial risks of failure of a construction project. By increasing the EPC-contract price, the contractor assumes the risk responsibility for implementation of the construction project (adverse geological conditions, the risk of failure to achieve the objectives of the project

as a result of new customer requirements). Contracts for EPC construction projects provide the customer with the ability to predict the final cost of a contract, and due-date of a completion, and, therefore, can be used in the practice of pension assets investing by the institutional investors. A significant role in the monitoring of the results of the enterprises' investment activity within the cluster of regional economies is also put on the set of indicators which help to achieve goals and contribute to the competitiveness of the region [32].

In order improve the effectiveness of funding pension services market to the construction industry by the institutional investors, we offer to use the following economic mechanisms of reducing risks of a proposed investment construction project:
The use building information modeling for capital construction objects throughout the whole life cycle of a construction object;

The use of standardized contracts in the process of building an object - Special investment contracts for the construction of facilities on the basis of one of the construction models (IPS-contract EPC/M model EPC/M-contract EPCS-contract PCM-contract FIDIC contract) will allow pension services market investors to develop tools for investing pension assets, reduce the risks of an investment, get predictable financial results from the implementation of a project, thereby increase the flow of pension capital to the construction industry.

The proposed mechanism allows one to manage the process of capital investment of institutional investors, taking into account the reduction of industry-specific risks (liquidity risks and market risks), to the construction of facilities for various purposes, as well as to get predictable revenue during the process of implementing the investment and construction of the project and to ensure compliance with the obligations to the investors.

The main idea of governmental support on market development of the information modeling projects in construction industry

Institutional changes in the construction industry and the rapid introduction of innovative technologies, in our opinion, are possible when using the following economic mechanism:

- Summarizing of successful practical experience with the use of BIM-technologies in the world and in Russia,
- Standardization of business processes,
- Control of pricing in construction industry
- Establishment of a unified branch codifier (electronic version) norms, regulations,
- Establishment of the national industry standard, taking into account the information modeling of construction projects,
- Development of normative and legal base for innovation at the State level as well

as in private enterprise level,
- Mass vocational training/retraining and credentialing of specialists at vocational training institutions.

The latest achievement of the world practice in the field of architectural design and management is the use of information technology for modeling objects of industrial and civil engineering throughout the whole life cycle of a facility (design, construction, operation, demolition).

Integrated information data bank about a construction object is constantly “saturated” with information, taking into account the changes of the present the state of an object during the realization of an invested construction project. Information model of the construction project will communicate all parties: investors, customers, main contractors, architects, designers, specialists in engineering and logistics networks, specialized evaluating State bodies, construction-assembly and maintenance organizations.

The use of information technology in construction modeling creates comfortable conditions for work of all kinds of experts, participating in the project, improves the efficiency at all phases of the project, reduces the transaction costs of project implementation, eliminates uncertainties when investing to the construction industry.

The main advantages of using BIM-technologies in the investment-building complex are: operational project management visualization of results at any stage of a project, high-quality project documentation process control of investment and construction project timeliness implementation and getting projected revenues from investment and construction projects realization.

Architectural Bureaus, world renowned development and construction companies are successfully using a new methodology for information modeling of industrial and civil engineering for the design of buildings and construction planning, and create complex model objects in the new information environment.

BIM-technology in the field of industrial and civil construction is the process of creating digital object of construction, its use and management decisions throughout the whole life cycle of the object (in the process of marketing research planning for the construction of a facility, in architectural design, during the analysis and examination of documentation about an object at all stages of construction, reconstruction and dismantling of already built structures).

It is the advent of innovative BIM technology that has significantly changed the way of technology implementation in the industry, in the developed countries a fundamentally different method for creating objects is widely used. “paralleling” of the investment-building process has taken place:

The transition from sequential (linear) stages of investment and construction project-model of sequential processing of information on investment project (Figure 1), to the parallel information processing, using building information modeling buildings, based on BIM models 3D parametric objects (3D-modeler) throughout the whole life cycle of the building.

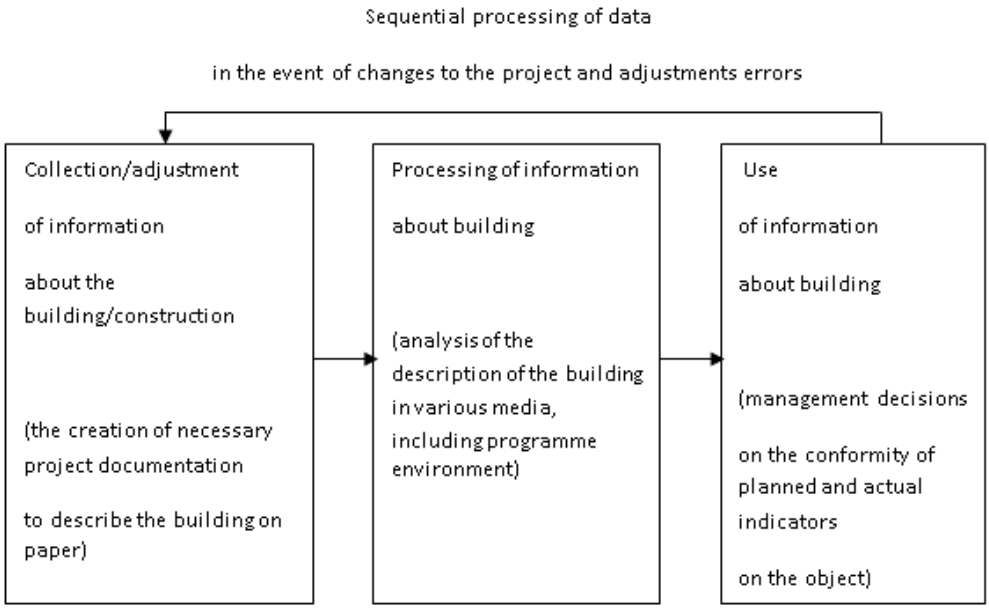

Figure 1: Model of sequential processing of information about investment project.

Building information model allows one to make management decisions based on reliable data, obtained expeditiously during the process of building construction schedule, logistics planning construction, at the stage of investment construction project management operational control of building production, production of construction materials automated control system of an enterprise for the operating organizations.

BIM technology can be classified by types of binding of additional information to the traditional information of buildings and structures 3D-models.

4D model = 3D + time: planning of construction works: construction schedule, schedule of construction works, simulation of construction works investment planning, logistics

5D model = 4D + cost and specification: value engineering: using electronic data models for the calculation of object estimated value, interaction with software for the calculation of estimated value.

6D = 5D model + exploitation: facility management, maintenance of engineering systems building of united management systems, monitoring of building present condition, reconstruction and dismantling (if necessary).

Over the past decade, building information modeling found application not only in the construction of buildings, but also in the construction of highways as well as in new fields of engineering, for example, machine-building and others.

The process of realization of investment construction project using BIM technology has distinct properties and represents:

- Element based design (specialists conduct an assembly of the finished 3D-models of individual parts of buildings (parametric objects), each of which features properties and relationships with other objects);
- Automatic acquisition of 3D-models of all types and sections tables, specifications estimates,
- parallel work of the team of specialists in different trades;
- Information support of the building throughout the whole life cycle of the object [23].
- In comparison with the traditional methods of investment construction projects realization, project implementation process, with using BIM technology, provides good opportunities for project participants since BIM technologies have the following unique features:
- Three-dimensional visualization of the object;
- Finding and correcting inconsistencies (technical conflicts) in a project by imposing architectural and engineering solutions on the draft prior to the implementation of the project;
- Real-time project management;
- Construction cost assessment at any stage of the project (planned and actual);
- Operational control of planned and actual performance indicators of investment and construction project;
- Exclusion of main operational risks in the construction industry – i.e. technical inconsistency, failure to comply with the planned dates and planned construction cost exceeding.

Intensive introduction of information modeling innovative technologies in developed countries has made the investment-building process cost-effective for investors, to summarize the successful experience of the construction industry first pioneers, and then to create and introduce the national industrial construction standards for the use of information technology for modeling objects.

The practice of using BIM-technologies in developed countries demonstrated significant economic benefit from the use of innovative construction technologies. According to the survey among construction companies, conducted by consulting company “MCGraw Hill Construction”, the main advantages of BIM-technology: improving the quality of work in process engineering (architectural and construction design, survey work, approval of project documentation) (Figure 2).

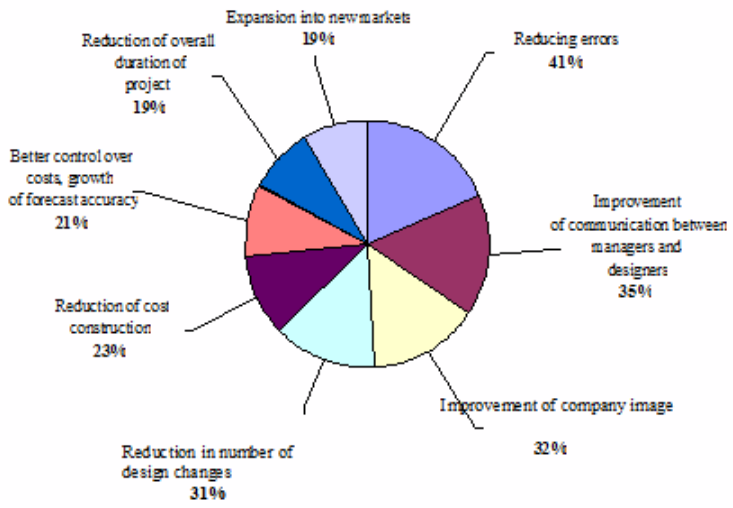

Figure 2: The advantages of using BIM technology in construction (according to the survey of consulting company “MCGraw Hill Construction”).

Source: official website of Autodesk, access mode: http://static-dc.autodesk.net/content/dam/autodesk/www/campaigns/BTT-RU/BIM%20for%20buildings_Autodesk.pdf, C. 4-5 (date of views 12.01.2016)

Russian Practice of Using BIM Technology

In Russia the practice of BIM technology use is closely connected to the implementation of projects by private investors, investment business groups in oil, gas and chemical industries of the national economy.

Russian regions also gained experience in the use of innovative construction technologies. For example, in the Republic of Tatarstan the Arbitration Court of the Republic,(TatInvestGrazhdanProekt) TANECO refinery plant («SoyuzKhimPromProyekt»), 12-14-story pre-cast concrete residential house in Kazan etc were built, using BIM-technology.

Federal policy in the area of construction production management involves the phased introduction of proven effective ways to manage one, based on information models and BIM-technologies.

In 2014, Bureau of the Board for modernization and innovation development of Russia decided to implement information modeling at the national level.

In 2015, the Ministry of construction and housing and communal services of Russian

Federation, Federal Agency on technical regulation and Metrology is conducting preparation of phased introduction of building information modeling technologies to the field of industrial and civil engineering, taking into account the interactions between economic agents, investment and construction process with government agencies evaluation (the list of normative acts, educational standards, that will require revision and adjustment to the work under the new arrangements).

In the year 2016 the accomplishment of work in conjunction with the autonomous non-profit organization "ASI" is planned The FAA "Glavgosexpertiza of Russia» and the National Association of Surveyors and Designers (NOPRIZ) will prepare a set of documents for approval of the proposed changes.

At the end of 2017, in order to accomplish the training - for the use of BIM technology in the field of industrial and civil construction, as well as the training of Government evaluators - is planned.

We believe that the introduction of BIM-technology will increase the competitiveness and efficiency of the construction industry in Russia; will get at the global level services provided by improving the quality of investment and construction works, reduction of cost evaluation and maintenance of commercial, residential facilities and infrastructure; will reduce the risks of disasters and technological accidents.

As a result of the development of market information modeling in the construction industry there will be more attractive opportunities for invested and construction projects, for institutional investors of pension insurance market. The proposed economic mechanisms reduce uncertainty (risk) of investment realization in construction project by means of the use of innovative construction process management, through the use of building information modeling of the construction and use of standardized construction contracts. Reducing uncertainty and risks of investing to the construction industry will increase investment limits of pension assets; will help to receive the projected revenue from the investment and construction project throughout the whole life cycle of the construction [17].

Summing up the results of the market development theoretical analysis in building information modeling, and practical experience in the construction industry of the Republic of Tatarstan, We believe that the use of the proposed economic mechanism will allow to:

- reduce costs (production and transaction ones)
- ensure compliance with the planned construction time,
- implement operational control of construction and installation works,
- switch to more efficient building management and reducing the cost of their operation,
- enhance the investment attractiveness of the construction industry at the expense of effective business management structure

- reduce the risks of technological disasters.

The Second Group of Problems

The second problem is the lack of sufficient funding from the business to ensure the introduction of BIM-technology.

For the purposes of a separate debt-restructuring firms may use the following methods of debt restructuring:

- full payment,
- exchange of debt for shares,
- debt forgiveness.
- For the restructuring of the construction industry, in our view, it is possible to make the following steps:
- awareness of new technologies of the construction business,
- diagnosis and analysis of the status of the starting capacity building development in the regional economy
- the stabilization of the production processes under the conditions of development companies crisis,
- development of sectoral development strategies (national, regional),
- negotiating with creditors the procedure of recovery of bankrupt firms (or elimination without prejudice to investors),
- monitoring of business reorganization in the construction industry,
- the development of a long-term action plan to minimize overhead and maximize the impact that a construction company and the industry make.

We assume that the building information model and structures may be part of the working documentation of the investment project and construction of the facility to make the process transparent.

Building information model may be equally available to institutional investors, owners, developers, architectural bureaus, construction enterprise, the operating company.
As a result, as we have seen in the city Innopolis construction of the main problems can be avoided:

- Complied with the terms of construction,
- Production and transaction costs do not exceed the targets for the project,
- Return on capital investment of institutional investors in the construction industry becomes predictable, reduces uncertainty and operational risks specific to the construction industry.

DISCUSSION

The authors proposed a typology of restructuring that will solve two pressing problems: to increase the efficiency of construction firms by minimizing the costs of resources and increase the benefits from their use, as well as to use new sources of funds for the strategic development of the construction business by introducing new BIM-technology for construction projects.

CONCLUSION

In conclusion, we must note that this study suggests the solution to the problem of the funding sources formation for the strategic development of the construction industry in order to introduce BIM-technology.

As a result of the proposed economic mechanism use by means of construction industry workers the synergy potential, the availability of natural resources and the introduction of effective technologies for construction of possible restructuring of the construction industry and the transition to the economic development of Russia were made possible.
In future work, we would like to consider the effect of technological changes on economic growth in the regional economy, we will try to do after the accumulation of sufficient statistical data BIM-technology use technologies in the Republic of Tatarstan as well as in Russia.

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