Approaches to the assessment the innovation-and-investment projects within the system of "Smart City" criteria

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Abstract. The article clarifies the understanding of modern approaches to risk management in construction organizations. The authors have formed a classification of the sources of risks in construction and the reasons causing the uncertainty of the conditions of operation of construction companies. The researchers identified factors that require control in the construction industry. The authors offer, that "smart city" assumes six criteria, including smart economy, smart mobility, smart environment, smart people, smart living, smart governance. The consideration of the tendency to innovations and the assessment of innovation-and-investment risks within the concept "Smart city" was carried out for the Russian practice for the first time. The risk assessment is offered to be carried out with the use of the modern approach. The proposed approach to improve risk management, according to which all the basic processes of risk management should be carried out at each stage of the life cycle of a construction object. The authors propose to use certain methods of qualitative and quantitative risk assessment, enshrined in the risk management standard, at the appropriate stages of the life cycle of a construction object in terms of their advantages. This will increase the effectiveness of risk management and minimize the impact of risk factors identified by researchers on the performance of construction organizations. Research of risk management systems allowed us to determine the priorities and problems of construction companies in the field of risk management and increase its efficiency.

1 Introduction

Within the framework of the strategic development of the Russian Federation, the priority direction is "Construction". The building complex is a complex mechanism, the economic condition and level of development of a country depend on the integrity and effectiveness of which. The current state of the construction industry is characterized by an increase in investment activity, especially in the public sector and dictates the use of a risk-based

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approach. New mechanisms are being developed for regulating the market of construction business participants and methods for improving their relations. Co-investment mechanisms, joint investment activities of the managing and managed companies are updated. In 2017, 699.473 equity agreements were concluded [1]. In order to improve the efficiency of the construction complex and its management structures, special attention is paid to risk management in the implementation of investment programs. One of the main areas of the construction industry is the introduction of a risk-based approach. The use of a risk-based approach is associated with the distribution of capital construction and reconstruction facilities, which are subject to state supervision, by risk categories and hazard classes. Assignment of risk category is carried out on the basis of information from the conclusion of the examination of project documentation. The criterion for determining the level of risk is the severity of the potential negative consequences of possible non-compliance with the requirements established by law in the construction and reconstruction of capital construction projects.

The problem of risk assessment in construction is of paramount importance. This is due to the construction of an increasing number of modern buildings with extraordinary design features and loads, with the increasing needs of reconstruction of property objects, with a high degree of responsibility when designing capital construction projects. In the works devoted to the study of risks, given the point of view on the nature and parameters of risks. Risk is considered as the possibility of partial or complete non-receipt of income in the event of some undesirable events. Risk is considered as the result of deviations of valid data from the assessment of the current state and future development. Risk is considered as a resource that can be used as a production factor. A. Dubois and L.-E. Gadd believes that the sources of risk are interdependence of tasks and uncertainty [2]. The risk management process involves the systematic application of policies, procedures and practices to ensure the exchange of information, as well as risk assessment, risk exposure, monitoring, analysis and risk documentation. Sources of risk in construction can be both external and internal factors and processes.

The risk assessment used to be considered as a part of risk management or financial analyses, i.e. purely economic sciences. But the purpose of this article is to unite the concept of “Smart city”, which have been recently offered by the European scientists, and the assessment of risk as a factor of the innovation-and-investment project efficiency.

2 Materials and Methods

Assessment of the state of the construction complex allows us to understand and study the main trends and directions of development of construction. The number of operating organizations in the construction industry has a stable growth trend, which is confirmed by the data presented in the table. The volume of work performed by the type of economic activity “construction” in the Russian Federation in billion rubles, in actual prices also has a positive trend. The total volume of construction work for 2017 amounted to 7.55 trillion. rub. In 2016, state procurement in the construction industry amounted to only 221.678 contracts. At the end of 2017, 133.1 million m^2 of residential and non-residential buildings were commissioned (Table 1).

Table 1. Number of operating construction organizations in the Russian Federation, billion [3].

	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Total	175.8	196.2	209.2	205.1	217.9	226.8	232.2	271.6	
including by ownership									
State	1.25	1.20	1.11	0.95	0.88	0.82	0.83	0.78	

municipal	0.51	0.53	0.50	0.45	0.40	0.40	0.46	0.43	
private	171.3	192.2	205.4	201.3	214.1	223.0	229.9	269.5	
Russian mixed	0.86	0.78	0.61	0.61	0.52	0.41	0.29	0.24	
Other	1.9	1.6	1.6	1.8	2.1	2.2	0.63	0.61	
Scope of work performed by type of economic activity "construction" in the Russian Federation									
Billion rub., in actual prices	4.0	4.5	5.1	5.7	6.0	6.1	7.0	7.2	7.6
In percentage terms in comparable prices to the previous year	86.8	105.0	105.1	102.5	100.1	97.7	96.1	97.8	98.6

However, the share of the final value of goods and services by the type of activity “Construction” in the total volume of the gross domestic product of the Russian Federation (GDP) decreased from 7.9% in 2012 to 6.6% in 2016. The main composite indicator of the study is the index of entrepreneurial confidence (ICS). It is calculated as the arithmetic average of the balance of estimates of the level of the portfolio of orders and the expected changes in the number of employees, as a percentage. The indicator characterizes the state of the business climate in construction. Index fluctuations are due to changes in estimates of both the level of the order portfolio and changes in the number of people employed in construction organizations from 8.4% in 2014 to 7.9% in 2017 [4]. To assess the competitiveness of the construction industry, the ICSO index is calculated, which is a convenient indicator of changes in the level of development of the construction industry. Separately, it is worth analyzing the dynamics of the share of overdue debts in the structure of total debt of domestic construction organizations to banking structures [5]. According to the Federal State Statistics Service of the Russian Federation, the factors limiting the business activity of construction organizations are: lack of work orders; competition from other companies; lack of skilled workers; high taxes; insolvency of customers; high cost of materials of construction, products; shortage and deterioration of machines and mechanisms; a high percentage of commercial loans [6]. To increase the competitiveness of organizations in the construction sector, it is necessary to develop a risk management mechanism. The main features of the construction industry are the influence of climatic conditions on technological processes, labor productivity, operation of machines and mechanisms. A wide variety of objects being erected by architectural design features, volume and complexity of work, territorial location. The erected building object has influenced the architectural appearance of the settlement for many decades. Construction sites have a significant impact on the safety of people and their social conditions of life [7]. A wide range of construction work in the billing period makes it difficult to determine the numerical composition of production personnel. The long period of production and strict sequence of technological processes, the specialization of enterprises or their divisions on a technological basis. The final construction products are created by many manufacturing enterprises that have their own economic goals and interests. A special form of payment for construction products. These aspects may lead to a whole range of risks.

3 Results

According to the experts of University of Vienna [8], there are six criteria for considering a city to be a "smart city" (Figure 1).

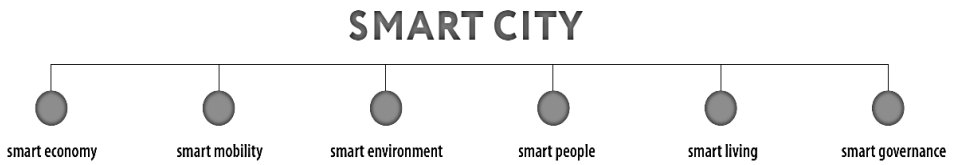

Fig. 1. Criteria of the "smart city"

In turn Smart economy is characterized by six aspects:
1) tendency to innovations;
2) the level of the development of the entrepreneurship;
3) the economical attractiveness of the cities;
4) productivity;
5) the flexibility of the labour market;
6) involvement into the international economical processes.

The authors focused on the tendency to innovations and considered innovative risk assessment as an important factor of the efficiency of the innovative activity.

Features of the construction industry due to the special nature of the final product, specific working conditions, the use of special equipment, technology and organization of construction and installation works. One of the most important distinguishing features of construction products is its high material consumption, which constitutes the bulk of the value of the object. Construction of objects can be carried out from several days to several years [9]. Taking into account the peculiarities of construction as a special branch of material production allows the use of specific economic mechanisms, to develop ways to improve them, to identify methods for improving the economic efficiency of functioning. To increase the competitiveness of organizations in the construction sector, it is necessary to develop a risk management mechanism. Assessment of factors limiting business activity of construction organizations for the third quarter of 2017, 2018 for the fourth quarter of 2016, 2017 is presented in the Tables 2, 3.

Table 2. Factors limiting the business activity of construction organizations for the third quarter of 2017, 2018 [3].

Factors limiting the business activity of construction organizations	**Share of total number of surveyed organizations, %**	
	Quarter III 2017	**Quarter III 2018**
High taxes	35	37
The high cost of materials, structures and products	30	29
Lack of work orders	30	29
Customer insolvency	28	27
Lack of funding	24	22
Competition from other construction firms	22	26
Unfair competition from other construction		
A high percentage of commercial loan	15	17
Weather conditions 13 12	13	12
Lack of qualified personnel	12	11
Lack of materials	3	2

Shortage and depreciation of machines and mechanisms	3	2

Table 3. Factors limiting the business activity of construction organizations for the IV quarter of 2016, 2017 [3].

Factors limiting the business activity of construction organizations	**Share of total number of surveyed organizations, %**	
	Quarter IV 2016	**Quarter IV 2017**
Insufficient demand	59	56
High taxes	36	34
High cost of materials, structures and products	31	30
Unfair competition from other construction firms	24	23
Lack of funding	24	23
High percentage of commercial loan	19	15
Lack of qualified personnel	13	11

The data in the table show that the factors that had the greatest impact in 2016–2017 were a high level of taxation, a high cost of material resources, and a lack of funding [10]. Currently, among the main problems of construction companies are the level of taxation, insolvency of customers, and a high percentage of commercial loans, lack of work orders, and lack of funding and competitive conditions [11]. Thus, it is possible to identify the main sources of risks that are significant for the construction industry. The most important factors that are subject to control in the field of construction are: the characteristics of a project or a construction object (scale, implementation conditions, characteristics of the life cycle, technical characteristics changes in the implementation process); material resources (the used resources, quality and innovative component of resources, timeliness of receipt of information and its processing); deadlines and schedule of work (deadlines); staff qualification and performance; financial resources (cost estimates, compliance with actual costs planned); the relationship in the process (the degree of consistency and limitations [12].

Thus the dynamics of the factors studied during the research allows to judge, how this or that innovative activity allows the city to become "smart".

4 Discussion

A prerequisite for effective risk management is the operation of an information system with the allocation of a risk monitoring subsystem. In construction at the early stages of the project life cycle, it is difficult to predict how conditions will be formed in the future. In addition, conditions may change during the project life cycle, and the level of risk will be higher than originally estimated [13].

In accordance with the PMBOK guidelines, project risk management objectives are to increase the probability of occurrence and increase the impact of favorable events and reduce the likelihood of occurrence and mitigate the impact of adverse events during project implementation.

Project risk management includes identification, qualitative and quantitative analysis, response planning, and risk control that should be carried out at each stage of the life cycle of a construction object [14]. For each stage of the risk assessment process, an appropriate risk assessment method should be defined.

In the construction industry, risk analysis should be carried out based on the following methods. The authors propose the use of specific methods of ISO 31000: 2018 (E) Risk

management - Guidelines from the perspective of the advantages and disadvantages of each at the relevant stages of the life cycle (Figure 2) [15].

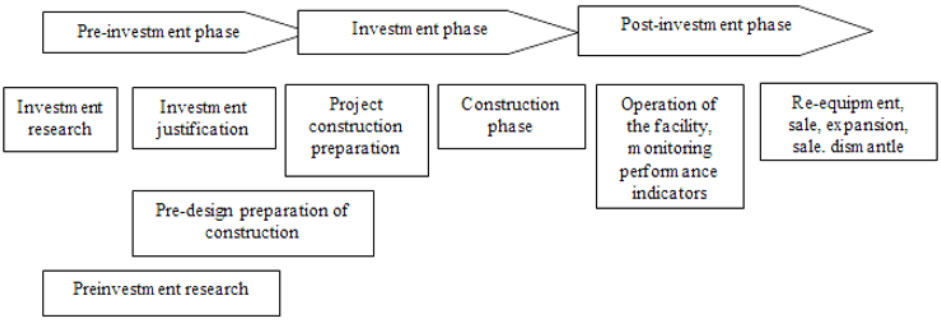

Fig. 2. Life cycle of an investment construction project

Thus, analyzing the risk assessment methods, we believe it is advisable to use the following methods in the pre-investment phase: Delphi method; brainstorm; structured interviews; checklists; preliminary hazard analysis (PHA); hazard and performance study (HAZOP); Hazard Analysis and Critical Control Points (HACCP); toxicological risk assessment; structured scenario analysis using the "what if?" (SWIFT); scenario analysis; business impact analysis (BIA); failure mode and effects analysis (FMEA); fault tree analysis (FTA); event tree analysis (ETA); analysis of causes and effects; causal analysis; protection level analysis (LOPA); Human Factor Analysis (HRA); maintenance services designed to ensure reliability; analysis of hidden defects (SA); risk indices; matrix of consequences and probabilities; cost effectiveness analysis (CBA) and multi-criteria decision analysis (MCDA) [16].

Expert method - is based on the use of expert opinions to assess risk parameters. An organization should identify risks, regardless of whether the sources of these risks are under its control. The possibility of several outcomes should be considered, which could lead to many different tangible or intangible consequences. Sensitivity analysis - allows you to assess the impact of various factors on key performance indicators of the project. During the sensitivity analysis, the limiting values of risk factors are estimated. In general, the sensitivity analysis helps to identify the factors that have the maximum impact on the project results, and select the most risk-resistant variant of the project. In the investment phase, it is recommended to use the following methods, presented in Table 4.

Table 4. Methods of risk assessment in the investment phase.

Trialize Protection Levels (LOPA)
Root Cause Analysis (RCA)
Hazard and Health Study (HAZOP)
Toxicological risk assessment
Fault Tree Analysis (FTA)
Event Tree Analysis (ETA)
Analysis of causes and consequences
Structured scenario analysis using the "what if?" (SWIFT)
Failure Type and Effects Analysis (FMEA)
Business Impact Analysis (BIA)
Decision Tree Analysis
Human Factor Analysis (HRA)
Bow Tie Analysis
Reliability Maintenance

FN curves
Risk indices
Matrix of consequences and probabilities
Cost Effectiveness Analysis (CBA)
Multi-criteria decision analysis (MCDA)

Methods of statistical analysis - can be used in conjunction with other methods, primarily with the method of analogies. They are used to test the hypotheses of the influence of risk in the presence of the required amount of information reflecting the frequency of occurrence of an event and the magnitude of the resulting damage.

In order to increase the efficiency of risk management in the post-investment phase, the use of the following methods in the table 5 is recommended.

Table 5. Methods of risk assessment in the investment phase.

Hazard and Health Study (HAZOP)
Hazard Analysis and Critical Control Points (HACCP)
Toxicological risk assessment
Structured scenario analysis using the "what if?" (SWIFT)
Markov analysis
Business Impact Analysis (BIA)
Root Cause Analysis (RCA)
Failure Type and Effects Analysis (FMEA)
Event Tree Analysis (ETA)
Analysis of causes and consequences
Causal analysis
Protection Level Analysis (LOPA)
Decision Tree Analysis
Human Factor Analysis (HRA)
Bow Tie Analysis
Reliability Maintenance
Bayesian Analysis and Bayesian Networks
FN curves
Risk indices
Matrix of consequences and probabilities
Cost Effectiveness Analysis (CBA)
Multi-criteria decision analysis (MCDA)

Diagram method - involves the construction of diagrams reflecting causal relationships, The impact on the risk can be one or more of the following:

- elimination of the source of risk;- change in probability;
- change of consequences;
- sharing the risk with the other party or parties;
- avoidance of risk by deciding not to start or not continue an activity that generates a risk [17, 18].

To minimize construction risks, risk management programs for construction projects are needed with the search for organizational and technological solutions, modeling of construction site logistics, rational use of resources and territory; checking the calendar-network schedule for the completeness of the content and correctness of the links; We will single out several levels of influence of factors in the direction of the “construction” activity:

1. factors of political-economic conditions for the implementation of construction: taxation, financial and credit policy, inflation rate, investment climate, changes in legislation;

2. factors of the construction industry: existing and new technologies; development of production of building materials, products and equipment; state of the market of building materials;

3. factors operating in the market for building products: the level of competition; nature of demand, market segments; technology of construction and installation works; local government actions; conjuncture of the market of building materials and equipment; counterparty behavior; development trends of the region;

4. elements of the corporate environment: organization of management of the construction company; staff qualifications; company reputation; quality of performance of commercial, logistic functions; quality of use of the information system; mistakes in decision making. Their influence is reflected in the cost and timing of the project. Limiting the range of sources initiating the occurrence of critical risks will allow concentrating efforts on controlling their impact and choosing the best management methods.

In a quantitative risk assessment, we consider it effective to use the weighting factors of the selected factors in order to accurately forecast possible adverse situations. The assessment of the factors is necessary. This is a review of the risk factors:

$$K = w_i k_i + w_j k_j + w_r k_r + w_k k_k \quad (1)$$

where k_i, k_r, k_j k_k - risk factors;

w_i, w_j, w_e w_k - the corresponding weighing factors.

An effective process for managing qualitative and quantitative risk assessment is essential for effective risk management and minimizing their impact on the performance of a construction organization.

5 Conclusion

The process of macroeconomic stabilization, which is associated primarily with a decrease in inflation and exchange rate risks, a possible decrease in the limiting influence of the economic uncertainty factor, and, a number of other parameters, is becoming increasingly noticeable. These positive changes lead to the revitalization of the state and the corporate sector to an increase in investment activity in the acquisition of construction projects with the aim of expanding production and realizing the demand for housing. Despite some different directions of changes in the main indicators characterizing construction in the country, the main resultant composite indicator of the research, the index of entrepreneurial confidence in construction, retained its value at the level of the previous year.

However, the low positions of individual indicators characterizing construction activity in international ratings remain. In the course of business activities, construction organizations face a number of factors hindering the development of their business. Based on the results of the analysis, key negative factors significant for the construction industry were highlighted: high tax burden, high cost of materials, lack of funding, lack of skilled workers, a high percentage of commercial loans, etc.

In order to improve the efficiency of the construction complex and its management structures, special attention should be paid to risk management. One of the main directions of the construction industry should be the introduction of a risk-based approach. Project risk management includes identification, qualitative and quantitative analysis, response planning, and risk control, which should be carried out at every stage of the life cycle of a construction site. For each stage of the risk assessment process, an appropriate risk assessment method should be defined. The authors propose the use of specific methods ISO 31000: 2018 (E) Risk management - Guidelines from the perspective of their advantages at

the relevant stages of the life cycle. This will increase the effectiveness of risk management and minimize the impact of selected factors on the performance of construction organizations.

The authors managed to unite the aforesaid indicators and the concept of "smart city" (and "smart economy" as its part) and also to adopt this concept to the practice of the innovation-and-construction activity efficiency management in Russia.

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