Risks accounting when building a management system for innovative and investment processes in construction

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Abstract. The article focuses on pressing issues of risk and uncertainty consideration in the innovation-driven development and investment support of construction companies. It gives special attention to the most essential characteristics of the risk management process as a complex type of construction companies' activity. The authors suggest their classification of risks specific to innovation and investment processes of construction companies based on the analysis of risk situations in the innovation and investment field. Pressing methodical problems of risk management are investigated. Emphasis is made on methodological approaches to risk accounting and reduction at construction companies. The authors make a number of scientific general conclusions and suggest a methodology for evaluating the effectiveness of the innovation and investment process management system through changing the value of a construction company considering the risks and their probabilities pertaining to the processes.

1 Introduction

The development, production, and implementation of innovations in the construction sector are becoming a rapidly developing area of scientific-and-technical as well as design and production activities. Innovations in construction contribute to an increase in production efficiency, improvement of works quality and the competitiveness of products, and help to save resources and reduce costs for real estate property maintenance. This is fundamentally important for transforming Russia into a dynamic, highly developed country with a level of economic and social development corresponding to its status as a major global power of the 21st century.

The creation and distribution of innovations in the modern market economy context is impossible without investments. In our opinion, these are two related and highly correlated

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processes that should be considered from the perspective of their interdependence.

However, the increased efficiency for innovation processes compared to existing solutions is largely canceled out by the high uncertainty of innovations at the initial stages of an innovation project and, consequently, by high risks relative to conventional investment projects as noted by many Russian and foreign researchers (Brown and Hagel 2005, Buzyrev et al. 2016, Egorova et al. 2012, Trushkovskaya et al. 2020). Such conditions create difficulties for maintaining the company's competitive advantages for a long time.

Risk is an integral part of innovation and investment processes in construction, so the companies should not avoid risks but be able to manage them effectively (Selyutina 2018). In our opinion, risk management regarding innovation and investment processes in construction should be understood as a purposeful, comprehensive and systematic activity of a company (organization) aiming to minimize, reduce or compensate for the adverse effects of possible consequences of various risks by identifying, assessing them and performing necessary control actions (corrective actions).

When assessing the risks of innovation and investment processes (IIP) in construction, it is important to analyze both common, generally accepted, and also special risks specific to these processes only; otherwise, distorted results and unreliable assessment may occur. To avoid this, at the stage of a qualitative risk assessment, they should be analyzed considering risks specific to innovation and investment processes.

Qualitative and quantitative changes occurring in the system represent the distinctive content of innovation and investment processes, which, as part of rational managerial decisions, are accompanied by an increase in their effectiveness. In this regard, the urgency of creating an effective system for managing innovation and investment processes in the context of uncertainty and risk is obvious.

The purpose of this study is to form a vision, assess current conditions to improve the effectiveness of the system for managing innovation and investment processes in construction considering specific risks and their management methods.

2 Entrepreneurial Risks of innovation and investment processes in construction companies and methodological approaches to their management

The existing approaches to analysis and interpretation of the etiological aspect of uncertainty and risk (including, their impact in the construction sector) are usually either too brief or insufficient to unambiguously reflect the variety of adverse situations and their consequences (Bulgakova et al. 2017, Buzyrev et al. 2015, Egorova et al. 2019b, Vasilyev & Selyutina 2007). Most researchers in their papers focus mainly on a key factor of increasing uncertainty — the lack of available experience in the development and implementation of innovations, which results in errors in statistical data necessary for accurate and reliable estimates. In our opinion, this is a significant and objective, however, not the only argument.

In this regard, uncertainties and risks pertaining to the implementation of innovation and investment processes should be thoroughly considered from a qualitative point of view.

We suggest to classify risks into groups specific to innovation and investment processes (Fig. 1) given the existing approaches to the systematization and classification of investment project development risks and based on an analysis of the typological features of innovative projects in the construction industry.

We believe that such a classification enables us to fully and unambiguously determine the place and role of individual risks and the risk of the entire project. It aggregates risks

according to the following criteria:

– stages of occurrence (risk of insufficient demand, risk of loss of profit due to errors in pricing, risk of unreliable tests, risk of misidentification of consumer preferences, inability to achieve the specified technical parameters, risk of non-compliance with building codes and standards, risk of premature functional depreciation);

– nature of occurrence (financial, scientific-and-technical, HR, social, and organizational-and-managerial risks);

– consequences for a business entity (risks of project duration increase, increased costs, demand decrease, changes in the quality level, and risks of deviation from goals and strategies).

Risk management is a complex activity, and not separate actions to minimize losses caused by a random event but rather an activity that is an integral part of the general enterprise management system. Thus, we emphasize the most important characteristics of this type of activity in the above definition, namely:

– purposiveness (solution of common targets in risk management involves a combination with individual goals pursued by individual management actions as part of risk management);

– consistency (risk management is one of the important elements of the company management system to be implemented by professionally trained specialists using the developed and implemented methodological tools);

– regularity (risk management activity involves the alignment of risk management objectives with the mission, strategy, and plans of the company).

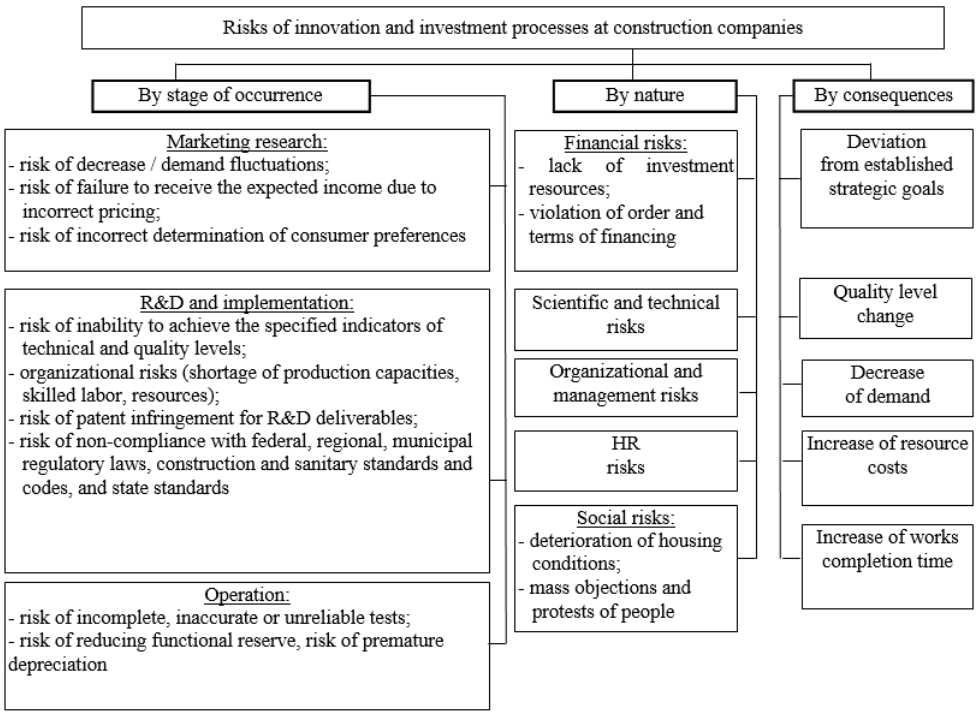

Fig. 1. Classification of risks of innovation and investment processes at construction.

When considering the risk management system of innovation and investment processes in construction, we can easily see that the development of its elements is to some extent influenced by various levels of management focused on decision-making and performing

appropriate actions (Bulgakova & Selyutina 2015).

Three such levels of management can be distinguished: top, mid-tier, and professional. Top management of a construction company substantiates the choice of an approach to risk management to answer the question of what actions should be taken against the risk. A risk management method involving the choice of a specific method of minimizing the risk shall be selected by mid-tier management. Finally, methodological tools of the management decision system (in this case, considering the adopted approach and risk management method) shall be determined by a risk management expert at a professional level.

All risks may be represented in the form of a scale with the risks of loss on one side and the risks allowing us to receive gain or profit on the other (Fig. 2). In the case of the first group, the most efficient solution is to avoid risk, e.g. by rejecting an investment proposal or an innovative idea. In the case of the second group, an efficient solution is to "take risks", considering the available winning potential of the risk.

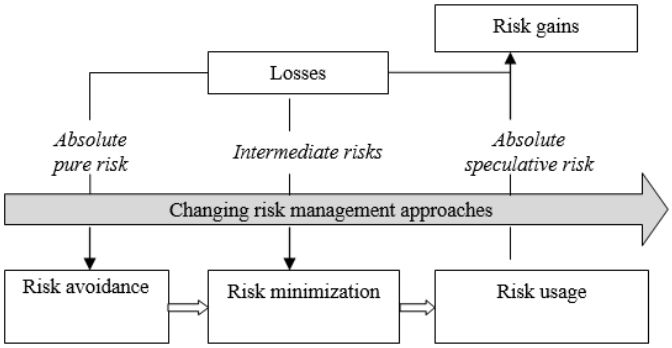

Fig. 2. Risk scale with a gradation of approaches to their management.

Based on the above, the following main approaches to risk management regarding innovation and investment processes in construction can be distinguished:

Risk avoidance (risk prevention, risk elimination) is one of the strategies to reduce the possible negative consequences of risk (Egorova et al. 2019a). The essence of this approach is to evade activities, investment decisions, or an innovative project associated with significant risks for the company, and other similar events, which clearly indicates the company's desire to avoid risk rather than an attempt to win in an unpredictable situation.

In other words, in order to bring the risk to an acceptable level in terms of the implementation of certain innovation and investment processes and the restrictions established by them, the sources of high (sometimes mid-level) risk shall be eliminated and targeted actions related to a fairly low level of risk shall be performed (Pesotskaya & Selyutina 2018). The application of the risk avoidance approach is typical for the case of handling risks that cannot be minimized where the expected losses from the risks are considered unacceptable for the company (e.g. the risk of serious financial losses). It should also be borne in mind that this approach is common to a conservative business strategy, however, there is a danger that avoiding risks will prevent the implementation of new ideas or projects, which may result in the stagnation of the business.

Risk minimization (risk reduction, risk optimization and control). Such an approach involves reducing the level of risk exposure (size of losses) or mitigating the possible consequences of risks by implementing a system of anti-crisis measures. Risk minimization includes a wide range of methods aimed at creating and maintaining a manageable external and internal environment favorable for the implementation of innovation and investment processes.

Risk usage (risk acceptance, risk neglecting, risk limitation) — this option is a risky strategy, which involves risk retention through a substantiated decision (Maleeva &

Selyutina 2018). Risk can be accepted if the risk is assessed as insignificant, or if the risk is not manageable and it cannot be avoided, or if the risk is regarded as speculative and the company consciously takes the risk expecting to win.

According to the classification suggested, the above risks are specific to innovative projects in construction and should be considered when building the risk management system for innovation and investment processes. This approach makes it possible to control unplanned costs and increases the competitiveness of construction companies.

3 Evaluation of the efficiency of a system for managing innovation and investment processes at construction companies considering the risk and uncertainty

Innovation and investment processes are characterized by a number of specific features, which mostly prevent the use of standard methods for assessing the effectiveness of their management.

The current period in the development of scientific researches, aimed at improving the efficiency of management systems in companies, features the widespread introduction of the cost management concept as an integral effect that comprehensively evaluates production business processes, accumulating the results of the influence of a set of management decisions, including the innovative ones.

Existing methods of risk accounting in assessing the economic efficiency of investments in innovative projects have their own advantages and disadvantages and are especially demanding with regard to the availability of input data (Pesotskaya & Selyutina 2011, Selyutina 2019). For instance, the use of root-mean-square deviation of a random value from the expected value or index of dispersion as a risk measure limits the possibility of estimation based on insufficient data since the calculation of these indicators is based on a large array of statistical data or probabilities of possible outcomes.

Another approach based on adjusting the discount rate is easier to use, however, it does not provide an adequate assessment of risks related to the implementation of mega- and multi-projects, which are the primary investment object for large companies. Other risk measures are possible to use along with this method (in particular, well-known methods used for assets appraisal). However, these methods have a number of drawbacks (they make it difficult to objectively forecast future results, sufficient information on projects is required), which imposes certain restrictions on their applicability when making decisions regarding the accounting for the probability and risks of cash flows created by business processes at companies in a varied environment.

The obviousness of the above drawbacks of the most popular methods for risk accounting when assessing value as an indicator of effectiveness is an argument for finding innovative approaches to study this issue.

Currently, in our opinion, the main goal of assessing the effectiveness of the IIP management system in construction is to adapt it to the new realities and preferences of the digital economy society. It can be achieved by maximizing the value of a company shown as conditional cash flow. This paper suggests to define it as the difference between inflows and outflows of funds related to the IIP implementation.

It is important to emphasize that we purposefully use the concept of conditional cash flow instead of the traditional concept of cash flows in real-time. In this situation, this is due to the importance and the need to correctly evaluate the results of IIP, especially, to consider the consequences of decisions adopted to the fullest extent possible. Conditional cash flow is the most concise term with regard to content. This definition involves the analysis of any objects that are subject to objectively developing economic relations,

including those based on the use of the latest innovative information technologies, and provided in monetary equivalents, while cash flow is a general term and implies consideration of only cash and cash equivalents.

Since the cash flow indicator is identified as a random variable, which normally should be assessed, some assumptions about the nature of the probability distribution shall be made to build a model. A significant feature and advantage of the proposed model are, in particular, that it enables us to assess the likelihood of outcomes and correctly consider such an important element of quantitative risk management and cost theory models as an indicator of a quantitative assessment regarding the possibility of occurrence of the corresponding cash inflows and outflows. This also considers the inherent riskiness of these flows when assessing business value with increased uncertainty in IIP implementation:

$$C^{IIP} = \sum_{t=1}^{T} \sum_{k=1}^{K} \frac{X_{kt}^{IIP} \times \rho_{X_{kt}^{IIP}}}{(1+e_{kt})^{t}} - \sum_{t=0}^{T} \sum_{k=1}^{K} \frac{(Y_{kt}^{IIP} \times \rho_{Y_{kt}^{IIP}} + \gamma_{kt}^{IIP} \times \rho_{\gamma_{kt}^{IIP}})}{(1+e_{kt})^{t}} \quad (1)$$

where C^{IIP} — the value of the company as a result of IIP management system implementation;

X_{kt}^{IIP} — the size of the conditional cash inflow resulting from IIP management system implementation by the k[th] object in the t[th] time period;

$\rho_{X_{kat}^{IIP}}$ — the degree of outcome occurrence adequate to the conditional cash inflow in the k[th] object in the t[th] time period, projecting the economic risk attributed to this inflow;

Y_{kt}^{IIP} — the size of the conditional cash outflow resulting from IIP management system implementation by the kth object in the t_{th} time period;

$\rho_{Y_{kt}^{IIP}}$ — the degree of outcome occurrence adequate to the conditional cash outflow in the k[th] object in the t[th] time period;

γ_{kt}^{IIP} — the size of the additional conditional cash outflow in the k[th] object in the t[th] time period, projecting the economic risk attributed to this outflow;

$\rho_{\gamma_{kt}^{IIP}}$ — the degree of outcome occurrence adequate to the additional conditional cash outflow in the k[th] object in the t[th] time period, projecting the economic risk attributed to this outflow;

T — the investment horizon;

K — the set of objects within the economic space where the company's IIP are possible to implement;

e_{kt} — the risk-free annual discount rate at a spatial point characterizing the object k in the t[th] time period.

Adhering to the strictness and clarity of the description of equation (1) semantics, we emphasize the importance of the k and t indices, as well as the need for the corresponding double summation in the convolution of cash flows when using these two indices. These indices are introduced, first of all, to point out to the adequacy of the evaluation of the parameters used not as relative conditional numbers, considered in separation from the real economic situation, but rather as variables with a specific economic meaning that exist within the economic space and time. The need to consider the k index is also closely related to the variability of risk constituent elements in relation to a specific economically active territory; e.g. discrepancies in the size and structure of risk within the region and even the city, as well as in different countries, should be noted. The risks and probabilities

corresponding to certain flows will be characterized by an individual temporal and spatial composition considering the specific point in time and place of the cash flow occurrence. In our opinion, this circumstance is of great importance in the analysis and assessment of the probabilities and risks arising during the implementation of each specific innovation and investment process at investment construction companies.

Along with it, it should be noted that if the initial information is incomplete or if it is not necessary to measure the company's value in such a detailed and accurate way after IIP management system implementation, a gradual simplification of equation (1) is possible, however, this, unfortunately, may depreciate the result by reducing its adequacy. The application of the proposed model involves both consideration of the probabilities specific to conditional cash inflows and outflows related to IIP implementation, and also the risks that are an integral part of them. In a situation when they are related to conditional cash inflows, the risks show the size of the flows' amount decrease compared to their expected value. In case of consideration of conditional cash outflows, the risks inherent to them fix the amount of the flows' increase in comparison with their planned value.

4 Conclusion

The following should be noted as general conclusions on the study:

First, when choosing specific areas (tools) for managing risks arising in the process of carrying out innovation and investment activities in construction, one should proceed from the effectiveness of analysis and assessment of risks and consequences of possible losses. According to the classification suggested, the examined risks are specific to innovative projects in construction and should be considered when building the risk management system for innovation and investment processes.

Second, if it is impossible or impractical to perform a quantitative assessment of certain types of risks at the stage of qualitative analysis, these risks shall be considered when developing measures to deal with risks, in particular, measures aimed at reducing or eliminating project risk situations. In this case, a smooth way is to create a reserve of funds to cover unforeseen costs.

Third, the specific features of innovation and investment activities do not allow for the use of standard methods for assessing the effectiveness of managing innovations and investment processes in conditions of risk and uncertainty. The proposed model for evaluating the effectiveness of the IIP management system through changing the value of a construction company enables us to correctly consider the probabilities and risks of cash flows under uncertainty.

Moreover, the above problems impeding the development of innovation and investment processes in construction are not exhaustive. In this regard, in our opinion, the directions for future research are the development of a risk management system in construction in the context of modeling the accounting of the IIP risk degree, making it possible to classify them depending on the possible reduction of the company value due to innovation and investment initiatives.

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