

# Justification of directions of technological and price audit systems changes for the purpose of high-rise construction innovating

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**Abstract.** Improving the quality of high-rise buildings under modern conditions should be based not only on compliance with the norms of technical regulations, but also on ensuring energy efficiency, environmental friendliness, and intellectuality, which can be achieved only through the introduction of innovations at all stages of the life cycle of the investment project. Authors of this article justified the need for a mechanism of technological and price audit of projects. They also suggested the model of life cycle of organizational and economic changes, connected with implantation of the mechanism of projects audit. They showed innovation character of ecological high-rise construction for the whole life cycle. Authors also made proposals to change the audit system for high-rise construction projects in the focus of its environmental friendliness.

## 1 Introduction

The analysis of statistical data, as well as the results of expert studies on this issue [1] indicate a rather low innovation activity of enterprises in the construction industry, not only in Russia, but also in the world. Nowadays, a technological and price (project) audit serves as the instrument that promotes the introduction of innovations in the construction of high-rise buildings, the purpose of which is to innovate real estate objects according to the criteria of innovation, energy efficiency, environmental safety, minimizing anthropogenic impact on the environment, and economy. Thus, the key aspect in the projection of innovative construction is the quality of construction products, and according to the opinion of leading scientists, this is the quality of both final and intermediate products. It should be noted that the life cycle of construction products is quite long, which leads to the conclusion that it is necessary to take into account the quality of exploitation of the constructed real estate object [2]. Moreover, in our opinion, due to its duration, it is the operational phase of the life cycle that has an impact on the welfare of future generations. Therefore, today the problem of energy intensity and energy efficiency, ecological compatibility of construction products is sharply raised. The consolidation of all these requirements is achieved when implementing the concept of "green" construction.

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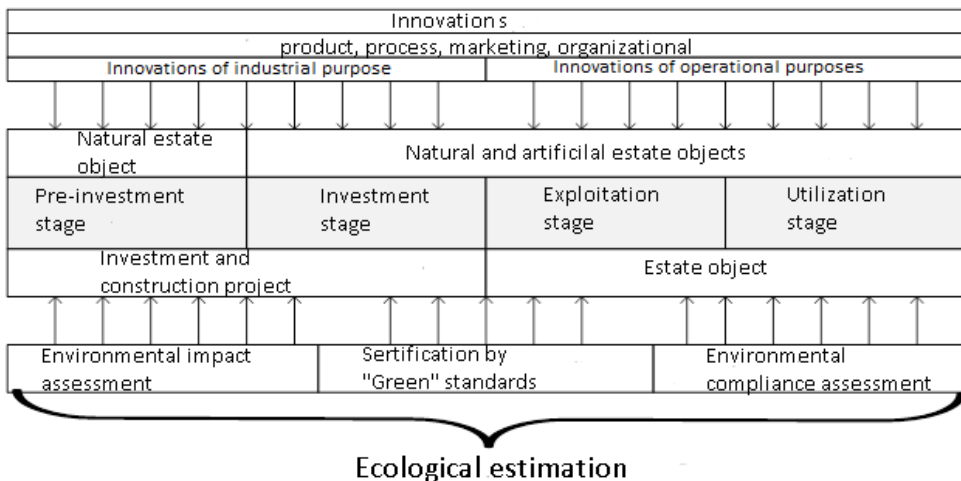
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## 2 Materials and Methods

In the process of analyzing the structure of commissioning high-rise apartment houses based on wall materials and the number of rooms, we can assume the development of two trends: first, the development of the trend "the formation of a high-quality consumer market" [3], which is confirmed by the structure of housing commissioning on wall materials (the predominance of monolithic and brick structures) and by the number of apartments (stable dynamics of three-room apartments and more); secondly, the formation of a trend of saving current costs, which is confirmed by stabilization and a slight decrease in the average size of apartments, as well as a slight decrease in the share of entering apartments with a large number of rooms. The second trend is also confirmed by the analysis of public spending on housing and utilities and fuel.

In the conditions of forming trends in the development of the real estate market, therefore, aspects of improving the quality of real estate and reducing current operating costs are becoming topical, which is in the focus of the problem of "green" construction. All researchers of this problem note their innovativeness as one of the key properties of the objects of "green" construction [4]. In "green" construction, all types of innovations are used. In addition, it is very important to "pass through" the introduction of innovations at each stage of the life cycle of the "green" construction.

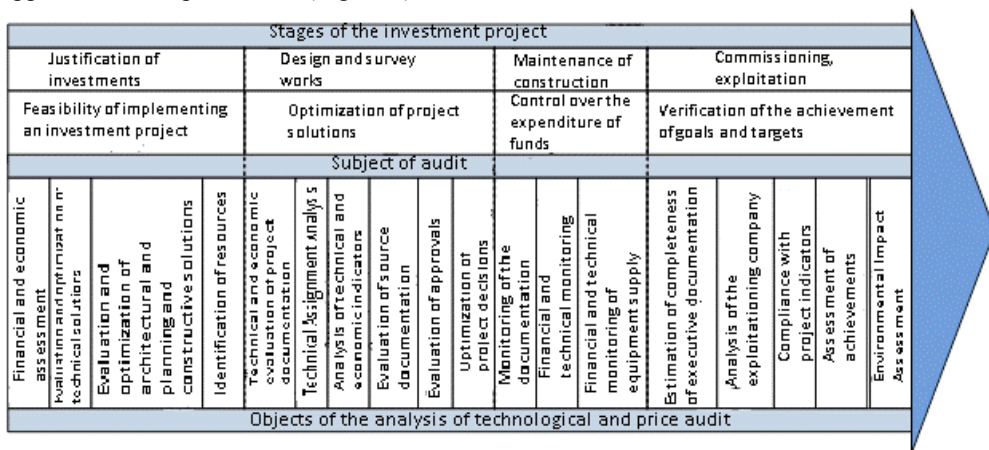
Considering the certification as the main criterion for classifying the building as "green", it should be noted that at each stage of the investment and construction project, as well as the life cycle of the building, an environmental assessment is carried out (Figure 1) - from the section of the EIA of projects documentation and environmental expertise in the examination of design estimates to assess compliance with environmental requirements in accordance with GOST R 54964-2012 at each stage of the life cycle of the property and its certification for one of the "green" standards. It should also be noted that if the certification of the facility as a "green" at the time of its commissioning for is a mandatory, then at the stage of exploitation and, especially, the recycling of such a system of confirmation of the "green" status is not a mandatory, which, in our opinion, can provoke a change in the "green" status of the object during its physical life, especially after major overhaul or reconstruction. It is also necessary to comply with the principles and criteria of "greening" at the stage of liquidation of the facility, which is one of the directions for improving the system of standardization and certification of "green" construction.



**Fig. 1.** Innovative character of "green" high-rise construction throughout the life cycle of the facility

The implementation of the principles of "green" construction, the improving of quality parameters of high-rise buildings, the introduction of innovations are associated with increased costs. Therefore, given the insufficiently high level of solvent demand in Russia and the high degree of competition with conventional construction projects, the demand for adequate economic profitability of the final and intermediate products of "green" high-rise construction is revealed. It should be noted that the indicator of the efficiency in this case can not be considered as the listed costs. Only discounted flows of funds, combining capital and current costs, taking into account the material expression of all types of effect, can serve as a criterion for the effectiveness of "green" high-rise construction.

Nowadays, a mechanism providing a comprehensive evaluation of construction investment projects and allowing to ensure the implementation of effective innovative solutions both at pre-investment and investment stages is a public technological and price audit implemented for projects with state participation. The implementation of the mechanism of public technological and price audit allows to optimize the price-quality ratio of both investment projects [5] and the resulting objects, based on the requirements of the "green" standards. It should be noted especially, the mechanism of public technological and price audit covers all stages of the life cycle of the project, which fully corresponds to the approach we adopted above (Figure 2).



**Fig.2.** Substantiation of the subject-object content of the public technological and price audit throughout the life cycle of the project

The introduction of a public technological and price audit can be interpreted as changes, therefore, applying the methodology of planning and implementing organizational and economic changes to the planning and implementation of the audit. At the same time, it is necessary to take into account the innovative nature of the audit mechanism, as well as the fact that the need to implement changes aimed at the creation and operation of this mechanism is also dictated by the introduction of innovations in the process of high-rise construction.

Planning and implementation of organizational and economic changes, including the mechanism of technological and price audit, on the basis of compliance with the life cycle of organizational and economic changes contributes to the solution of the task of ensuring the complexity of planned reforms.

The mechanism of public technological and price audit, ensuring the formation of the property of "innovation" among its participants, also launches the mechanism of interaction of innovations in the creation of construction products, stimulating demand for technological innovations.

Despite all of the advantages of current mechanism of technological and price audit, its one-sided focus on major investment projects with state participation should be noted. The need to ensure the implementation of innovative design and construction solutions in high-rise construction in accordance with the requirements of "green" standards leads to the expediency proposed in [6] projecting this mechanism for the implementation of any construction investment projects through the implementation of project audit. Consequently, there is a need to build a methodology for implementing a project audit in high-rise construction based on the correspondence to the life cycle of organizational and economic changes (Figure 3).

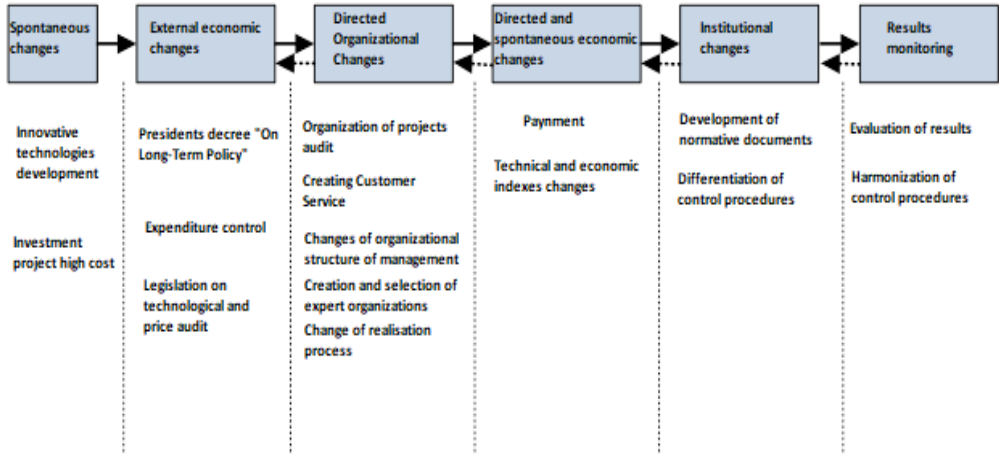


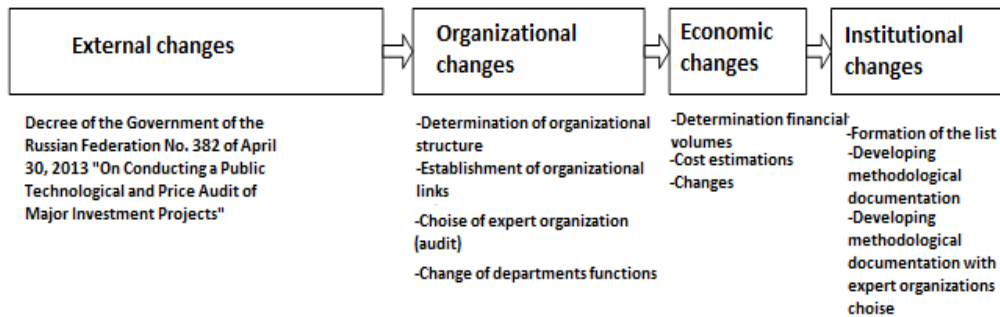
Fig. 3. Life cycle of organizational and economic changes of projects

The proposed model will make it possible to implement the necessary transformations on the basis of the developmental spiral

### 3 Results

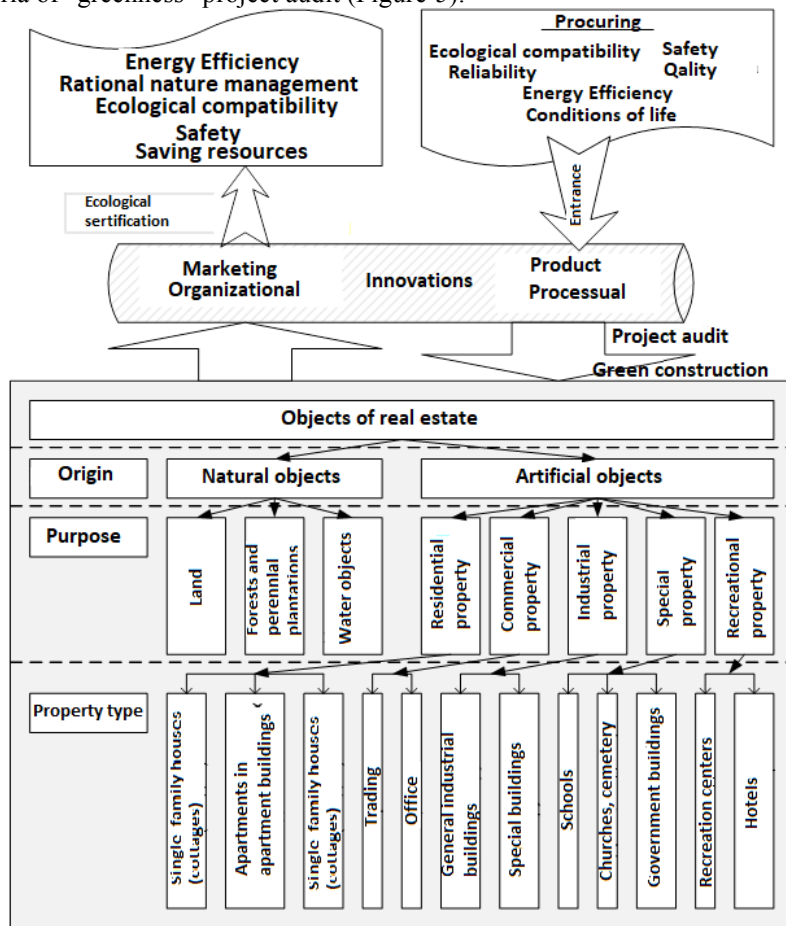
Project audit of investment projects in high-rise construction is a tool for confirming proposed innovative design solutions, selecting optimal technological solutions for new investment projects, optimizing the cost and timing of their implementation, and introducing the requirements of "green" standards.

The procedure for project audit, the subject of which is the evaluation of the selection of optimal innovative design solutions that correspond to the "green" standards, and the evaluation of the cost parameters of the investment and construction project, ensures their systematic and consistent implementation. The implementation of project audit at the enterprise of the investment and construction complex begins with the adoption of a strategic decision on its implementation and it is developed in accordance with the life cycle of organizational and economic changes (Figure 4).



**Fig. 4.** Life cycle of organizational and economic changes of introduction of projects audit on the enterprise

Summarizing the conclusions above, we consider it expedient to present high-rise construction from the point of view of the system approach as a feedback system in which modern problems and requirements for construction products are realized in effects through the innovation of the processes of creating and operating real estate objects until the criteria of "greenness" project audit (Figure 5).



**Fig. 5.** Schematic diagram of the innovation of real estate objects by the criteria of "green" construction

## 4 Discussions

Considering the existing state level requirements for energy efficiency and energy saving, as well as environmental compatibility, it is advisable to develop innovative construction technologies in this segment. This is the reason why constant updating of the system of construction norms and quality standards on the basis of monitoring of innovative technologies is necessary. In our opinion, the system of estimations of the effectiveness of project taking into account operating costs based on energy-saving technologies should be specified. It is also necessary to take into account the environmental effect when assessing the effectiveness of all projects, taking into account the deferred costs associated with environmental impact. These findings should be implemented in the practice of expert organizations that implement mechanisms of public technology and price, as well as project audit.

## 5 Conclusion

As a result of conducted research, we consider it necessary: at first, implementation of the requirement of compliance with energy efficiency and environmental standards in the system of evaluation of investment projects for objects of public technological and price, and project audit; secondly, the feasibility of implementing a project audit with the relevant requirements for the evaluation and selection of high-rise construction projects; third, the introduction at the enterprises of the projects audit mechanism on the basis of compliance with the life cycle of organizational and economic changes to ensure compliance with their requirements of completeness and complexity; fourth, harmonization of existing mechanisms for monitoring investment projects based on innovation in construction.

We believe that adherence to the above principles will allow to increase not only the innovative activity of construction production and the level of innovation in construction products, but also to ensure, first of all, the quality of construction projects, while observing the condition of a certain balance of economic and non-economic (environmental, social) efficiency, especially production.

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