Development of the “quality-efficiency” model of construction investment projects for road construction on the basis of sustainable growth

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Abstract. The urgency of the problem to improve the quality of the road construction is due to the need to stimulate demand for toll travel, increase efficiency of construction and investment projects and reduce the cost of resources as well as negative impact on the environment. The authors state levels and criteria of quality for the construction products on the basis of the semantic analysis, that allowed to structure the quality elements of the road construction object. Taking into account justified quality parameters, standard technical basis for building sector is systemized and directions for its optimization are suggested. There is developed a model to estimate the efficiency level of construction and investment projects in terms of quality which is carried out through the construction projects of toll roads.

1. Introduction
The problem of assessing the quality of construction products is due to the inconsistency of the very concept of quality in regulatory documents: in the ISO standard ISO 9000: 2000, quality is defined as the degree of fulfillment of requirements, however, in GOST (All Union State Standard) R 50779.11, quality is defined as a set of product properties [1]. Therefore, it can be assumed that the quality of construction products is a combination of its properties, characterizing the consumer value, and most of these properties must meet regulatory requirements for safety [2].

Regarding the process specifics of construction products, the opinions of researchers [3] on the representation of the quality of construction products as a combination of the quality of final and intermediate products are considered to be fair. Moreover, it is the quality of the final product that largely reflects the totality of its properties, which form the value proposition, while the quality of the intermediate products (in the process of its creation before the object is put into operation) is directly determined by compliance with the requirements of normative and technical documentation and project indicators [4].

To date, the quality basis of the final construction products is the quality of the project, formed by objective engineering surveys and quality assured design documentation. The quality of the design documentation, that is determined by qualitatively performed engineering surveys and predevelopment analysis, can not today be described as satisfactory for the entire aggregate of projects. So, according to the FAO "Glavgosekspertiza" (General Board of State Expert Review), the design documentation of almost a third of the objects contains significant violations in terms of ensuring the reliability and safety of facilities. However, it is the design and estimate documentation that defines the required quality criteria for construction works and facilities in accordance with the requirements of regulatory and technical documentation and the specifics of the facility. Qualitative execution of works along with a
sufficient level of quality of building materials and structures ensures the quality of the objects under construction. Therefore, there is a need to develop a practice-oriented methodological tool for assessing the effectiveness of construction and investment projects based on quality [5].

The objective of this study is to develop a "quality-efficiency" model of construction and investment projects for road construction, including public-private partnership.

2. Materials and Methods

The functional dependence of the quality level of the final construction products on the intermediate quality levels allows to conclude that, the quality level of each of the intermediate stages should be brought closer to normative, design and reference values in order to optimize the quality level of the object. Therefore, the criterion for assessing the level of quality in construction should be considered correspondence of the actual values of each of the quality parameters to regulatory ones [6].

The standard technical basis of construction activity provides the required level of safety and quality of construction products. Once again, we note that due to the adopted methodology for quality assessment in construction, it is necessary to continuously monitor, adopt and change on a priority basis technical regulations and standards in accordance with innovative developments, environmental safety and utility of certain design and construction solutions for the consumer.

According to the key parameters of the quality concept [7], its hierarchical character and the typology of criteria, the efficiency model of construction projects, based on quality, is a system of the most important properties and indicators characterized by clear interrelations (Figure 1).

The suggested model characterizes the efficiency of the project as the construction object value proposition, based on its quality parameters, and the maximization of the efficiency is achieved through the benefit of users, creating demand and based on the utility of the object, which depends on the set of its qualitative criteria. At the same time, the utility is achieved by ensuring the safety of the facility, which is established by compliance with the basic norms and standards at all levels and stages of the construction, and by ensuring the users' needs achieved by meeting certain environmental standards or the requirements of comfort living or the operation efficiency of the facility.

![Figure 1. Model of efficiency of the construction investment projects on the basis of quality](image-url)
where \( K_o \) is the quality of the construction object, \( K_p, K_m, K_d, K_r \) - the quality level of the design and survey work, materials, design and estimate documentation, installation and construction work, respectively. \( K_{st} \) is the complex normative level of quality, \( e \) is the specific efficiency of the project (or Its parts), \( x \) is the number of units of measurement.

3. Results

It should be noted that the influence of the quality of construction products is significant both for the criteria of commercial efficiency (by influencing demand and user value) and for the criteria of social efficiency (by taking into account the effect of improving the quality of preparation and implementation of the project, its environmental load). The stated provisions for implementing projects on the basis of public-private partnership are of particular relevance.

Formalization of qualitative indicators is carried out individually for each category of objects in view of their weak formalizability. With regard to concession projects for the construction of toll roads, based on criteria and conclusions, the following levels of assessment and quality control can be distinguished [8].

The quality factors of the toll road affect the commercial efficiency of the PPP (further – public-private partnership) project through the current and potential increase of traffic intensity, as well as its budgetary and social efficiency. The social (socioeconomic) effect is the sum of the received intra-transport (the result of accelerating the delivery of goods and reducing transport costs) and an out-of-transport or external effects. The components of the external effect are the effect of saving the time of finding passengers on the road, the effect of increasing the comfort of travel (these two types of effect also influence the commercial efficiency of the project by changing the dynamics of traffic intensity), the effect of reducing the number of accidents and the environmental effect.

![Figure 2. Formation model of the economic effect from the quality improvement in the implementation of the construction of a toll road on the basis of PPP.](image-url)
4. Discussion
The suggested model may not take into account all the possible benefits of users of high-quality roads, which can be counted up. However, the calculation for this model forms a basic effect that is minimally permissible for solving the problem of allocating financial resources and planning investment projects for the transfer of highways to a concession.

It should be noted that the achievement of the stated types of effect from the quality improvement of construction and investment projects is possible only if a number of conditions, which are necessary for eliminating bottlenecks in the program for improving the quality of road construction, are fulfilled. The problem is, firstly, the incompliance of norms and standards with modern innovative building technologies and the corresponding actions of the expertizing bodies. Secondly, there is the need to reduce the cost of projects, which does not allow to implement modern methods of process management and equipment; and thirdly, the inability to clarify working documentation [9].

5. Conclusions
In connection with the foregoing, we consider it necessary, firstly, to correct institutional norms in the field of project expertise, and secondly, to develop modern norms and quality standards of design and construction products, as well as to bring the estimate standards and costs in accordance with applicable in the construction modern materials and mechanisms. Thirdly, compulsory registration of quality parameters in determining the efficiency of public projects and, fourthly, a clear regulation of a number of changes in the working documents, that require amendments of project documentation.

Furthermore, the authors consider it necessary to build a system when various ways of monitoring over the implementation of investment projects will be harmonized in order to ensure the quality and improve the efficiency of the implementation of concession projects in road construction. Solving the problem of effective integration of control mechanisms over the implementation of investment projects will significantly improve the efficiency of investment programs and projects.

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