Quality of construction materials as an indicator of the design of railway transport facilities in Russia

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Abstract. The purpose of the research is to assess the global quality of project design documentation for capital construction at the preliminary stage of investment projects in the context of the properties and qualities of applied construction materials. The problem of the assessment of the quality of construction and finishing materials in the subdivisions of Russian Railways, the largest Russian company, raises fundamental issues of regulatory and methodological support during the choice of engineering solutions and reasonability grounds of investments in the construction and reconstruction of transport infrastructure facilities. According to the formal indicators for the assessment of the properties of materials in the company, the authors used a method based on a separate analysis of the regulatory and methodological support of the construction preparation process. The main quality criterion was adopted in the form of deviations in documentation by the internal examination service of the company projects due to the unreliability in the determination of the physical properties of material resources. The main tool to influence the design process is the formalization of requirements for accounting construction materials, especially innovative ones, in project design documentation. These requirements are reflected in the proposed methodology for the generation of documentation at the early stages of investment project. A retrospective analysis of the verification results of infrastructure projects in the company showed that after the introduction of uniform requirements for the applied materials and the introduction of the basic provisions of materials science in the methodological documents, a positive trend has occurred during internal verification. The decrease in the number of incorrectly determined values of the need for construction materials indicate that cost certification has become more explicit and accessible to developers. It is proved that the tool for the management of the quality of construction materials by specifying the structure of documents justifying the main design decisions is the most effective. The idea is confirmed that the greatest responsibility for the efficiency of the applied material resources falls on the early stages of project development. The efforts made by the Company in this direction lead to positive changes.
1. **Introduction**

The priority task in the improvement of the efficiency of Russian Railways investments in the context of modernization of its own infrastructure is to conduct a technological and economic examination of the investment projects being implemented in terms of the applied material resources. At the same time, two main industry-specific requirements should be presented to the expert activity. The first is the need for the initial technological examination of the project and comparison of it with the main directions of development [1]. Then it becomes reasonable to carry out a financial and economic assessment of the project and manage its cost, as it is noted in the work [2]. The second requirement is the existence of its own system of criteria for the assessment of the technological [3] and economic [4, 5] project efficiency, which would allow recording and evaluating the specific features of infrastructure projects on the railway network already at the stage of the investment concept. A number of authors note the predominant dependence of efficiency on the level of cost norms [6] and methods of their application [7].

During the implementation of investment programs, the important issue is the efficiency of application of funds invested in the creation or maintenance of railway infrastructure facilities. Every construction or reconstruction project must be justified from the standpoint of investment efficiency even before the start of design work [8]. However, the situation that has developed over the past two decades in the field of technical regulation in Russia has led to the absence of a specialized industry methodology for the development of the main document of investment project - investment explanation.

2. **Materials and methods**

In the investment process of Russian Railways, pre-project economic studies must include investment explanation taking into account the current legislation. The purpose of the work performed at this stage is, first of all, to optimize the future costs of the Company choosing the best option for the project implementation. The most frequently used in this case is the factorial model [9, 10].

The authors proposed the system of requirements for pre-project documentation which is set out in the Methodological Recommendations on the composition of investment explanation sections and requirements for their content (including the calculation of economic efficiency) for investment projects of Russian Railways. This document is intended to improve the methodology for the development of pre-project documentation - explanation of investments in the construction of enterprises, buildings and structures of railway transport in Russia. The analysis of regulatory documents on the explanation of investments, preparation of primary material for a preliminary assessment of the estimated cost, analysis of the impact of decisions taken at the pre-design stage on the organization of construction on the investment value of the object was carried out in order to make the main provisions of the methodological recommendations as accessible as possible. In this case, the consolidation of problems corresponds to the idea outlined by Yu Zhang et al. in the publication [11].

During the preparation for the development, the normative and methodological literature, as well as orders, decrees and documents of both federal and industry levels, were previously studied [12]. The degree of impact on the activities of construction organizations was taken into account in accordance with the works of Silka [13, 14]. According to the requirements of the existing documents at Russian Railways, considered during the development of the methodology, the investment justification document should have the following structure.

The 1st section “Initial data” contains the materials of the investment application developed by the initiator of the investment and materials of the pre-design engineering surveys carried out after the approval of the investment project by the Investment Committee of the Company.

The 2nd section “Market environment of the project” describes the economic, marketing, social, transport and infrastructure environment in which the project is supposed to be implemented. The main markets for the sale of products, tariff policy, plans for the implementation of transport services are
determined. According to the work [15], the factors of success in the implementation of investment projects were taken into account.

In the 3rd section “Basic technological solutions”, the main production indicators of the facility, the technology of the transportation process and the technical solutions used for various farms affected by the project should be specified.

During the development of the 4th section “Provision of the project with resources”, the need for basic resources for the implementation of the investment project is determined. The possibilities to obtain them are studied, as well as the prospects to obtain necessary construction resources as a result of tendering [16].

In the 5th section “Location of the object” the possibility of the territorial location of the construction object is substantiated, the basic needs of land reservation and restrictions in their use are determined.

For the development of the 6th section “Basic construction solutions”, the main structural and technological solutions of buildings and structures are selected as a part of the investment project.

In the 7th section “Environmental Impact Assessment” the analysis of the initial state of the environment is carried out, the calculations of man-made impact as a result of the project implementation and the comparison of the existing exposure limits with the calculated ones are carried out.

The 8th section “Enterprise structure. Personnel” defines the possibilities and needs of staffing at the stage of creation and operation of the project.

In the 9th section “Project Implementation Schedule”, the main timing of the investment project and its parts is calculated. Moreover, the basis for scheduling works, commissioning of capacities and financial management is created. The calculation of the construction time, along with the normative method can be assessed using statistical methods [17].

The part of expenses on the project is determined in the 10th section “Determination of investment expenses”. It contains the calculations of the amount of costs for the implementation of an investment project based on the use of enlarged indicators or analogous objects.

The 11th section “Evaluation of the effectiveness of an investment project” defines the indicators of the effectiveness of investment in the project, the main economic consequences of the project for its participants, the state and society. It is necessary to mention the possibility of the assessment of the effects using the mathematical models proposed by Lie-Jane Kao [18].

The 12th section “Conclusions and proposals” completes the development of the investment case. It contains a comparison of the results of the calculation of economic efficiency for the developed alternative project options, proposals for choosing the best option for further development of project documentation, similar to the work [19].

Such a structure for the explanation of investments is primarily reasoned by the needs of the subsequent design process, i.e., a detailed study of the main decisions made in investment explanation.

3. Results

According to the practical results of departmental examination of projects, most technological errors in projects are laid down at the stage of the development of investment application. Table 1 shows the statistical distribution of the dependence of the values not confirmed by the calculation of the explanation of the effectiveness of investments or investment costs from various factors of pre-project and project activities increasing the cost of the project over the parameters of this calculation.
Table 1. Distribution of reasons for overinvesting

| The reasons for the decrease in quality during the determination of the project cost | Share of unreasonable investment costs, % |
|---|---|
| Inaccuracy in the collection of initial data on the economic state of an object and its surroundings | 3 |
| Incorrect definition of the organizational pattern of the object construction, stages and terms | 26 |
| Wrong choice of structural solutions for buildings and technological equipment | 12 |
| Incorrect determination of the cost of work at the pre-project stage | 15 |
| Errors in the calculation of the economic efficiency of investments | 8 |
| Overestimation of the estimated cost of design work completion | 14 |
| Lack of coordination of the goals of construction (reconstruction) of the facility with the development strategy of the landfill and the technology of transportation process | 7 |
| Inaccuracy in the collection of initial data on the economic state of an object and its surroundings | 18 |

The significant contribution to the problem of unjustified investments is caused precisely by the defects at the stage of the emergence of an investment concept and the development of explanations for upcoming investment project. The correlation between the economic and financial results of the implementation of an investment project is a separate problem with an ambiguous solution [20], since the overestimation of costs can be interpreted in different ways. The prevention of inaccuracies in the determination of costs at the early stages of a project, rather than elimination of them later, is the task of the specialists of functional customer and investment departments of roads, who develop investment applications and explain investments.

4. Conclusion
The monitoring of investment projects shows that pre-project activities cover a significant part of the responsibility for ineffective investments. The contribution to this problem at the design and costing stage is not as great as it is commonly believed. The proposals for the systematization of the content of design materials at the pre-design stage are aimed at the increase of the validity of the calculations, therefore, at the improvement of the quality of the project as a whole. The allocation of sections of resource provision and descriptions of the construction time are obligatory. The commercial environment of the project provides the basis for detailed calculation of cost elements in a future construction project. The improvement of the quality of the explanation of investment projects should be considered a guarantee of future success in the improvement of investment efficiency.

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