ANALYSIS OF COMPONENTS OF THE COST OF CONSTRUCTION PRODUCTS

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ABSTRACT

The existing situation in the system of estimated pricing determines the need to find methods for assessing the accuracy of standards and their compliance with actual costs. In the article the issues of the functional analysis of corrections in the structure of the estimated cost of construction products that occur due to changes in the requirements of the system of estimated valuations are considered. Methodical approaches to determination of the functional state of expenditures by types of construction using private factor-dependent relationships are proposed.

Keywords: transport infrastructure, construction objects, norms, estimated cost, analysis, profit, overhead expenses.

Background. *Economic evaluation and analysis of investment processes in creation of transport infrastructure facilities are associated with the problems of calculating capital investment. This is considered as one of the fundamental features of construction [1]. The system of economic standards in the construction industry is a set of resource, value norms and correction values that are in complex functional dependencies on technological processes. Existing scientific and methodological developments in the field of estimated valuation and pricing do not affect the range of problems related to the functional analysis of components of the estimated cost in terms of regulatory requirements [2].*

The objective of the article is to identify and quantify the changes in the system of regulatory support for construction, estimate the role of indirect estimated costs in normative terms.

The solution of the accompanying tasks is connected with the study of the elements of the regulatory system – quotations, interest rates, coefficients, tariffs and indices. The result of any processing, adjusting the regulatory base for the participants in the construction business is the value of the cost adjustment of the price for each type of construction and installation work (CIW), expressed as a percentage, taken into account in the form of a target indicator. Per se it primarily measures the qualitative level of existing standards. A significant percentage of refinement, exceeding practical accuracy of determining the estimated cost, either indicates a lag in the resource-technology model that was taken into account by the actual process, or that the norm was used in relation to a certain range of work.

The second case is of primary interest in calculating the specification of the nomenclature of norms. The principle of averaging, which was the basis of pricing, was practically not confirmed in any way quantitatively, had no legislatively established boundaries, and, accordingly, a scientific justification. In the Soviet era, as a guide for distinguishing two adjacent norms, there was only the concept of accuracy of determining the estimated cost. If the unit cost provided 5 % accuracy in terms of determining direct costs, then with the proportional method of calculating overhead expenses and planned savings (from the amount of direct costs), accuracy was maintained.

With the introduction of the 2001 estimated-normative base (SNB) [1], the procedure for calculating overhead expenses and estimated profits has been changed – their magnitude has not been determined by all direct costs, but only by wages. Moreover, the norms of overhead costs, instead of differentiation by type of construction, have differentiated by type of work. In such circumstances, the issue of delimitation of related norms or their unification has acquired a much greater significance: once the direct link between the composition of the price and the estimate has been changed, a different approach is needed, involving strictly scientific economic analysis. This was most acutely manifested in the formation of territorial estimate bases [3].

In our study, we have established the necessity of calculating the boundaries of a given parameter, so the problem of rationality of delimiting adjacent norms should be solved as a private one, having values that are applicable for individual cases of rationing that are not related to the calculation of the target indicator. This will allow, in the process of developing norms and rates, to judge operatively the division or combination of norms, based on the limiting values of the indicator. When calculating the indicator, it is possible to use limit values to assess the adequacy of the refinement carried out, or in the forecast calculation – to estimate the marginal economic effect.

Objective. *The objective of the author is to consider the issue of analysis of components of the cost of construction products.*

Methods. *The author uses general scientific methods, comparative analysis, evaluation approach, mathematical methods.*

Results.

* * *

Limit values of the cost specification of the price (especially aggregated) are based on the requirements of the current regulatory framework in terms of charging overhead expenses and estimated profit [4]. According to MDS81–25.2001, the estimated profit is determined using:

– industry-wide standards established for all contractors;

– specifications for types of construction and installation work;

– individual norms (in some cases) for a particular contractor organization.

The decision on the choice of the calculation of the amount of the estimated profit is provided to the investor and the contractor on an equal basis.

When determining the estimated cost of construction and installation works, the industry-wide standard of the estimated profit is 65 % of the amount of means for remuneration of labor of workers (builders and machine operators) and is used to perform general economic calculations in the investment sphere. It can also be used for macro-assessment of regulatory support for the construction industry. As a part of the estimated cost of repair and construction work it is taken equal to 50 % of the amount of funds for remuneration of labor of workers. In addition, industry-wide standards of estimated profit are recommended to

be applied for development of investment estimates, feasibility studies of projects and determining the initial price of the subject of the tender for the conduct of contract auctions.

Since by agreement between the customer-builder and the contractor the standards of the estimated profit can be applied at the stage of preparation of the working documentation and in calculations for the performed work, the analysis of statistical data on completed objects can be carried out taking into account the industry average index. At the same time, the analysis of the level of costs in certain prices by comparing the standard costs with the actual cost of work requires the application of standards for the estimated profit by types of construction and installation work, since in determining the estimated cost at the stage of preparation of documentation and calculations for the work performed, the standards of estimated profit by types of construction and installation works.

To determine the cost of construction at various stages of the investment process, MDS81–33.2004 recommends the use of a system of norms for overhead expenses that, according to their functional purpose and scope of application, are divided into the following levels:

– enlarged standards for the main types of construction;;

– specifications for types of construction, installation and repair and construction work;

– individual standards for a particular construction, installation or repair and construction organization.

Also, the normative document introduces an average branch structure of overhead expenses that is applicable to generalized cost analysis, including a possible evaluation of the regulatory system itself.

When considering the aspect of normative provision of pricing in terms of calculating the values of the estimated profit and overhead costs, it is necessary to take into account:

– hierarchy of norms – a two-level system of indicators for measuring complex processes and work processes is established;

– the principal possibility of taking into account the corporate factor in the organization of construction, expressed in individual norms, is given;

– the scope of application of approved methodological documents for the tasks of investor project evaluation and scientific research is expanded.

The processes of normative and methodological support of pricing are not synchronous at all. In this case, the requirements for the procedure for calculating the estimated cost and its individual components can change quite thoroughly at certain points in time, which can be demonstrated by the introduction of SNB-2001. Then the order of accounting for overhead costs and estimated profit, the cost and composition of materials in the pricing and the cost of their delivery changed. Changes have also affected other items in the consolidated estimate.

The content of norms and quotations, if abstracted from the price factor, in general by the regulatory system changes gradually. Development of technological maps, normals, observation, creation of elemental norms – all these processes are very time-consuming and long, take years, even for individual collections. Therefore, over time, jumps occur, gaps in the chain of comparison of construction costs, caused by a change in the methodological basis of pricing. Later there is a «smoothing:» of the difference. Contracting and design organizations adapt their own methods and technologies for compiling POK and estimates, adapt financial and economic activities to the changed structure of the estimated cost, and as a result, at some point, the structure of public costs under the influence of the pricing factor takes on a different form and other proportions.

In fact, it is possible to distinguish two characteristic time periods in the system of

Table 1

Calculation of a one-time change in the estimated cost under the influence of the regulatory methodical factor

Type of construction and CIW	Norms of SNB-1984			Norms of SNB-2001			Share of wages in DC	gr. 4/gr. 7
	DC, %	EP, %	K_{X1}	OE, %	EP, %	$K_{X1'}$		
1	2	3	4	5	6	7	8	9
Railway construction	17	8	1,26	114	65	1,36	0,20	0,93
Earth mechanized works				95	50	1,29		0,98
Monolithic foundations				105	65	1,34		0,94
Prefabricated reinforced concrete frames				130	85	1,43		0,88
Brick walls				122	65	1,37		0,92
Exterior finish				105	55	1,32		0,95
Heat supply				130	89	1,44		0,86
Landscaping				115	90	1,41		0,89

methodical and normative provision of construction.

Passive – is characterized by the invariability of methodological conditions and legislative restrictions in the field of pricing. At the same time, the regulatory support system naturally changes, individual norms are processed, errors in the database are corrected, which is aimed at approximating the normative values (hence, the estimated costs) to the indices of the normals in construction.

Active – during this period there is a sharp change in the norms of legislative regulation of construction, not necessarily only in terms of determining the estimated cost. Examples include building risk insurance, organization of work and delivery of construction materials in large urban agglomerations, testing and certification of building materials, and correcting the tax burden for individuals and organizations. These non-recurring changes occur periodically (or rather write: unpredictably), predetermining the system of social production costs. However, for construction, a characteristic event of the onset of the active period is a change in the estimates and methodological requirements, often confined to the introduction of a new estimate and regulatory framework.

A sharp one-time change in the terms of the calculation naturally leads to a change in the estimates of the estimated cost of work, approximating or, conversely, deviating the calculated values of cost from the real ones, conditioned by a statistically grounded process normal.

Some changes in the regulatory provision of construction can lead to a spasmodic reduction in the cost of construction. One such example is the indexation of the cost of resources produced at the federal, regional and sectoral levels. The methods used in this [5] do not guarantee the accuracy of price indexation within the limits of market requirements for the functioning of contracting organizations.

If in SNB-1984 and earlier the order of indirect determination of costs was based on the application of interest rates to the amount of direct costs, then with the introduction of MDS81–33.2004, the estimated wages of workers and machinists became the basis for the calculation. Percentage have also changed, with differentiation by type of construction. Applying the industry-average indicators of wage shares as part of direct costs, one can find the magnitude of a one-time jump in the estimated cost from a change in the regulatory and methodological conditions (Table 1). For this it is necessary to determine the nomenclature of norms. Correspondingly, railway construction and construction of industrial buildings were considered, which can be represented both as part of railway construction projects, and separately, in the construction of depots, stations, EC posts.

For the quantitative description of the factor x_1, linear equations of the estimated cost of CIW were used in various adjacent normative bases:

$$C_{CIW}^{84} = DC^{84} * K_{x1}, \quad (1)$$

$$C_{CIW}^{01} = DC^{01} * K_{x1'}, \quad (2)$$

where DC^{84}, DC^{01} – the amount of direct costs, calculated in accordance with the requirements of the estimated norms of adjacent regulatory bases – SNB-1984 and SNB-2001;

K_{x1}, $K_{x1'}$ – coefficients that take into account the accrual of overhead expenses and estimated profit according to the methodological requirements of SNB-1984 and SNB-2001.

$$K_{x1} = \left(1 + \frac{OE^{84}}{100}\right) \bullet \left(1 + \frac{EP^{84}}{100}\right) \quad (3)$$

$$K_{x1'} = 1 + D_{rL} \frac{OE^{01} + EP^{01}}{100} \quad (4)$$

where OE and EP – norms of overhead expenses and estimated profit;

D_{rL} – the share of remuneration of labor of workers in direct costs.

As can be seen from Table 1, as a result of a single-moment change in the procedure for calculating overhead expenses and estimated profit for each type of work, their value changed to $\Delta K_{x1} = K_{x1'} - K_{x1}$, which explains the relative change in the estimated cost of CIW (in column 9).

Given this, the estimated cost of construction can be determined by the equation

$$C_{constr} = C_{ciw}(1 + k_c) + R_{wc}, \quad (5)$$

Table 2

Examples of interrelated components of the estimated construction cost function

$\{c_n\}$	$\{A_n\}$
Price of imported building materials, ex-customs	Changes in customs legislation
Depreciation deductions as part of the car-hour price	The same
The same	Changes in depreciation rates for depreciation groups
Conditionally constant costs in the production of auxiliary production	The same
The same	Changes in the rules of Gosgortechnadzor for lifting equipment of industrial enterprises
Price of domestic building materials, supplier's ex-warehouse	The same

where k_c – coefficient that takes into account the costs conventionally dependent on the estimated cost of CIW from the number of costs for equipment, inventory and so on;

R_{wc} – remaining costs for equipment, inventory and other, determined without a conditional connection with the cost of CIW.

Based on this method, it becomes possible to calculate the quantitative parameters of the change. Taking for the railway construction $k_c = 0.61$ and R_{wc} = const for the case of a change in the regulatory requirements for overhead expenses and the estimated profit for conditional construction, substituting them in (5), we get:

$$C_{constr} = 1{,}61C_{ciw} + const. \quad (6)$$

This makes it possible to determine some parameters of the private value model. It is rational to limit the number of calculations to the most significant types of work for transport construction. Thus, in the construction of a new railway, with rare exceptions (in a flat terrain with good geolithological conditions), the objects of the erected roadbed on the hauls and stations are significant. Taking the value $\Delta K_{X1} = K_{X1'} - K_{X1}$ for the quantitative value of the factor x_1, it is possible to describe the change in the function of the estimated construction cost (i.e., investment costs) from the action of the normative medium $\Delta F_{Cconstr}(x_1)$ under the conditions of a negligible small time interval $t \to 0$. With the linear character of the normatively given function of the estimated costs (a model of the estimated cost of construction), the definition of the desired change in the function will be related to the expression:

$$\Delta F_{Cconstr}(x_1) = F_{Cconstr}(x_1) - F_{Cconstr}(x_{1'}), \quad (7)$$

where $x_{1'}$ – new value of the regulatory methodical factor x_1.

Substituting (3) and (4) in relation (7) and reducing the unchanged part, we have:

$$\Delta Fc_{constr}(x_1) = \left[\begin{array}{l} \left(\dfrac{OE^{84}}{100} + 1 \right) \bullet \left(\dfrac{EP^{84}}{100} \right) \bullet DC - \\ DC \bullet D_{rL} \left(\dfrac{OE^{01} + EP^{01}}{100} \right) \end{array} \right] \bullet 1{,}61$$

Or, by presenting the expression in square brackets as argument A_1 and taking out the direct costs determined by the unchanged normative base as $t \to 0$, we get:

$$\Delta F_{Cconstr}(x_1) = 1{,}61 \cdot DC \cdot A_1. \quad (8)$$

In the considered example for railway construction in general $A_1 = 1{,}26 - 1{,}36 = -0{,}10$, i.e. $\Delta F_{Cconstr}(x_1) = -1{,}61 \cdot DC \cdot 0{,}10 = -0{,}161 \cdot DC$, and for works on the construction of heat supply networks (for which the value in the last column is the smallest), $A_1 = 1{,}26 - 1{,}44 = -0{,}18$, i.e. $\Delta F_{Cconstr}(x_1) = 1{,}61 \cdot DC \cdot 0{,}18 = -0{,}290 \cdot DC$. At the same time, for works of the most significant importance in linear railway construction – earthwork: $A_1 = 1{,}26 - 1{,}29 = -0{,}03$, i.e. $\Delta F_{Cconstr}(x_1) = -1{,}61 \cdot DC \cdot 0{,}03 = -0{,}048 \cdot DC$.

In this way, it is possible to analyze any sample. Including building models for the construction of various facilities with statistically justified cost allocations. When switching to the SNB-2001 in industry publications, at conferences and seminars on pricing, questions were raised about the fact that the cost of a particular type of construction (group of facilities) became lower or higher than before [6]. There were claims of the production community to the developers of the methodical and normative system.

Most often, a comparison was made of estimates compiled in two adjacent bases for similar facilities. However, the fact was not taken into account that, for construction, especially transport, the definition of the estimated value depends not only on the structural outline of the structure and the amount of work, but also on the organizational conditions and local features of the construction. However, a simple comparison of the estimated cost did not disclose the reasons for the changes. Another extreme was the private study of the values of quotations and norms in isolation from the combined picture of their application. For example, the reduction in the tariff rates of workers could be compensated by an increase in the norms of overhead expenses, accounting for delivery schemes at closed prices – selling prices for materials, etc. This did not give an answer to the question of the relationship of causes and effects when it came to changing the estimated construction costs.

The proposed method is free from the shortcomings of a practical, «handicraft» approach to assessing the consequences of rotations of estimate-normative bases and such similar one-time changes in regulatory requirements. The representation of the partial changes in the value system in the form $\Delta F_{Cconstr}(x_1)$ with the description of the dependencies on the individual factors of influence x_1 through the normative description of the components of the estimated cost allows us to reduce the study to predetermined tasks. As parameters of influence in such research tasks, the following can be proposed:

– norms of overhead expenses, estimated profit, expenses for temporary buildings and structures, winter appreciation;

– regulatory requirements to the structure of the estimated fund of labor remuneration for workers and remuneration of administrative staff;

– tax legislation (social deductions, personal income tax, profit tax, taxes on fixed assets);

– qualification requirements for performers (ETCS) and the provisions of labor legislation (Russian Labor Code);

– rules for accounting, registration, other actions with construction and transport vehicles;

– implementation of ISO quality standards and industry (corporate) technologies for building production management;

– cost accounting rules for determining the estimated prices for the operation of machinery;

– methodological rules and requirements of customers to replace or adjust a set of resources accounted for by unitary rates;

– rules for development and application of aggregated indicators in determining the cost of construction;

– nature of accounting for costs of delivery of construction materials in the composition of prices and estimates;

– application of correction factors determined by technological and organizational conditions of construction;

– indexing the cost of CIW and resources in pricing;

– structural changes in the import of machinery and building materials.

For each case, the set of functionals will be determined by the circumstances of the ongoing changes in the regulatory support system and the economic environment.

Formula (8) will be valid for the calculation at a given point in time, but it should be taken into account that changes in the regulatory and methodological support of construction can have a continuum character – for example, with monthly indexation of prices for resources. Then, on a significant calculation horizon, considering the set of factors x_i, it is expedient to represent a continuous differentiable function:

$$F_{Cconstr} = F(c_1A_1 + c_2A_2 + \ldots + c_nA_n), \quad (9)$$

in which the set of arguments $\{A_n\}$ is element-wise associated with the components of the estimated costs $\{c_n\}$. Examples of possible options are shown in Table 2.

For the time interval $t \in \{0 \ldots \infty\}$ it is possible to determine the intensity of the change in the value of construction products on the basis of differentiation of the functional of the cost $F_{Cconsrt} = F(c_1A_1 + c_2A_2 + \ldots + c_nA_n)$ in time.

The analysis $\frac{dFc_{constr}}{dt}$ will make it possible to compare the changes in the cost of construction products with the dynamics of macroeconomic processes – both traditional (inflation, changes in social cost structures in the NTP), and those that are of a one-time nature (default, sanctions).

Conclusion. A significant number of examples similar to those considered in the pricing system can be identified and described quantitatively, at least in the enlarged form [7]. In terms of scope, such work should correspond to the general federal target program for modernization of regulatory support for construction. At the present time, for reasons of lack of funds, there is no reason to expect the inclusion of large-scale scientific research on the problem in the R&D plans of the profile agencies, however, it is entirely possible to develop a scientific-methodical approach to construct a dynamic model of regulatory support for construction. There is also the possibility of private confirmation of methods based on statistical data and investment projects.

On the basis of the studies carried out, it can be concluded that there are cost «leaps» that accompany the transition processes between estimates and regulatory databases, and the nature of the consequences of this is different for different types of construction.

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Article received 30.03.2017, accepted 21.05.2017.