Recursive method in assigning materials in construction projects

D Zaycev¹, A Korchagin², V Solovev² and S Guzhov¹

¹ Department of Road Economy, Moscow Automobile State Road Transport Technical University, 64, Leningradsky Ave., Moscow, 125319, Russia
² Department of Economics and management in construction, Moscow State University of Civil Engineering (NRU MGSU), 26, Yaroslavskoe Highway, Moscow, 129337, Russia

E-mail: zaycevdv77@mail.ru

Abstract. The paper considers the issues of improvement of the evaluation methods of new materials in construction. The features of regulatory control over the use of resources in Russia are characterized by the presence of a dual approach to choosing a regulatory framework, which in some cases leads to incorrect choice of materials. Engineering solutions during design are closely dependent on the cost parameters laid down in the regulatory and methodological framework. As a result, the problem of improving norms and methodologies is relevant for highly significant regulation. The property of recursivity of design solutions, normative support of construction and quantitative parameters of construction materials used in the design of structures is noted. The mutual influence of the process of developing standards and their further application in projects made it possible to use the recurrent formula tool for pre-design analysis of the possibility of using certain materials. The method allows performing a separate analysis of the possibility of application in projects for different materials, which can be useful when introducing new materials. On the basis of the proposed calculation method, conclusions on the need to improve the process of developing standards were drawn. The main problems of regulating the consumption of construction resources at the present stage are formulated. The need to design new standards based on the practice of applying new materials in construction projects was noted. The paper suggests the mechanisms to solve the problem of improving the reliability of determining a set of construction materials when designing construction works in transport construction, which would reduce the time for developing new and updating the existing standards. The assessment of the applicability of construction materials should not remain within the framework of subjective decisions of the engineering practice; on the contrary, it should improve the calculation methods to justify the applicability of materials.

1. Introduction

Industry-specific features of construction products determine the need to develop and apply new methods of construction materials and technical resources, taking into account design characteristics, individual conditions of production and economic activity of contracting organizations, market conditions and other factors [1, 2]. Besides, specialists pay increased attention to the issues related to improving the mechanism for developing new and updating costing standards. In this regard, the relevance of proposals aimed at solving the problem of a reasonable choice of construction materials is beyond any doubt.
It should be noted that in the period from the beginning of the 2000s to the present, not only the normative, but also the methodological segment in the pricing of construction products is divided into federal and industrial [3]. The share of industry standards is about 40 percent in the total quantity. Methodological requirements for the accounting of transport schemes for the delivery of construction materials and for the calculation of other costs as part of the consolidated estimate also have significant differences in federal and industry bases [4, 5]. All this leads to a well-known difference in the cost of the same object, calculated according to different bases. In fact, in the practice of investment activities, the choice of the estimated regulatory framework is the determining and major factor in defining and justifying investment costs [6]. In the practice of investment projects abroad there is no unambiguous affinity to regulatory support, priority remains with the general economic selection criteria, as noted by many researchers [7-11]. For projects financed from the budget system of the Russian Federation, the procedure for applying the federal budget and regulatory framework is legally fixed, however, it should be borne in mind that there is an extensive class of specialized objects of the industry segment implemented by quasi-state structures – Russian Railways [12, 13], Rosatom Group of Companies and others [14]. In this case, the choice of the estimate and regulatory framework ceases to be unambiguous, and it opens up the possibility of a two-fold determination of the estimated cost, as noted in [15].

2. Materials and methods

The current situation, when for the specialized industry segment of construction the choice of construction materials and technologies for their processing implies a dual definition of costs, also determines the dual approach to the selection of the supplier [16]. In conditions of market interaction, the possibility of using similar types of materials with different properties under the influence of a price factor in a construction project should be considered possible. In any case, the experience of the interaction of suppliers of materials with consumers in countries with market regulation allows making such conclusions [17]. The practice of implementing investment projects in Russia shows that the choice of material of span structures of pedestrian bridges depends on the peculiarities of application of certain regulatory bases, as confirmed in [18]. If there is an accurate standard for new materials – epoxy resin-based composites with filler – it was used in the design documentation. With the relative use of standards, i.e. with their actual non-conformity, traditional materials (steel, reinforced concrete) with non-competitive technical characteristics were used.

The task of preliminary determination of material selection at the pre-design stage was considered by the authors in a discrete task. This was facilitated by studies on the selection of engineering solutions in construction [19-22], as well as conclusions drawn from the analysis of a number of investment projects in transport construction [23, 24]. The recursive function tool is used, which allows obtaining a decision on the selection of the construction material type under consideration based on the analysis of previous design solutions and corresponding normative support of the design activity.

For a classic recursive-specific factorial, the function of which can be taken as the volume or cost of material No. i, a subsequent recursive reference (for example, to the data of the design documentation) is made with a decrease in the argument by one. Depending on the initial value of the argument through n recursive references, the calculation of the function will stop due to the termination of recursion. Thus, the computed function for any argument from the domain is finite in essence.

In practice, the choice of materials in a project and their accounting in the composition of production or value standards is better described by a recurrent formula, in which each next component of the sequence is calculated as a result of a function from n previous components. This is best in line with the practical principle of the interdependence of project and normative activities.

Let us denote the generating function of the sequence $f_0, f_1, ..., f_n$, using $F(z)$. Build the polynomial $K(z)=C+a_1z+a_2z^2+a_3z^3+...+a_nz^n$. This polynomial can be considered as the generating function of the
sequence $11, a_1, a_2, \ldots, a_m, 0, 0, \ldots$. This sequence represents a set of quantitative ideas on the applied material – its target consumption, cost in pricing.

Using standard methods of working with characteristic polynomials and rational functions generated by the generating function, it is possible to present the generating function as follows:

$$F(z) = \sum_{n=0}^{\infty} \left( \sum_{i=1}^{S} p_i(n) a_i^n \right) z^n,$$

where $p_i(n)$ – polynomial consisting of actual data on the use of material in construction projects in quantity $S$. The variety $z^n$ is determined by the rules and conditions for the use of construction material in design. The more varied the scope of the material, the more $z$ is needed to assess its applicability.

The peculiarity of this approach is that it is possible to compare the values of the generating function for different materials, on the basis of which it is possible to draw conclusions on the priority of using materials in different segments of the construction industry, which indirectly contributes to the solution of previously set applied tasks [25].

The proposed method is design-theoretical, and solves the problem of improving the design standards for buildings and structures.

3. Results

On the basis of solving the set tasks, it first of all becomes possible to reasonably recommend the construction industry to carry out the following:

- to create a single information space on industry pricing issues, as well as to complete the formation of a single data pool on the list of used construction resources and their value in the context of the constituent entities of the Russian Federation;
- to create a new industry center (project office), which in the “one window” mode will consider all issues on the addition, update or elimination of outdated standards of the current estimate and regulatory framework used to determine the set of material resources during construction, reconstruction, overhaul, and maintenance of capital construction facilities;
- to simplify the process of creating standards, expand the range of specialists involved in standards’ development and update;
- to create a single publicly available regulation for the development and update of resource standards.

Within the framework of the proposed events, it is necessary to constantly carry out work aimed at optimizing the processes of collecting and analyzing design and as built documentation for previously implemented projects, as well as proposed innovative materials and associated technologies for the performance of works, summarizing the received information and forming the basis for re-use projects, guided by the principles of optimizing budget expenditure. The collection and analysis of information on changes in market prices and the list of construction resources used in the industry in the context of the constituent entities of the Russian Federation will make it possible to quickly form draft changes in standards, as well as analyze data for annual update of consolidated cost indicators of construction and installation works.

In order to ensure the quality of the work performed, all organizations interested in developing new and updating existing costing standards should continue to implement the events necessary to supplement the regulatory framework with costing standards required in the industry, including:

- analysis of construction resources included in the costing standards for their replacement with more modern ones, the parameters of which will meet the requirements of existing regulatory documents;
- interaction with industry producers in terms of supporting requests for inclusion in the list of legal persons providing information necessary for the formation of estimated prices of construction resources, and for the inclusion of materials produced by them in the Classification of Construction Resources;
- collection of data on the cost of purchasing price-generating construction resources in the industry with a view to their further comparison with the prices of similar resources available in the estimated regulatory framework and further settlement of issues arising in this field with organizations responsible for the formation of estimated prices.

Besides, it is advisable to create an understandable mechanism for approving the procedure for timely development of costing standards that take into account the use of new technologies and structures, which allows the implementation of the design of the facility within the established time, since the period of their approval often exceeds the duration of the design.

It is necessary to accelerate the process of creating and implementing an information analytical system in the structures of industry customers, which will provide timely information on changes and additions to costing standards, indexes, prices for construction resources, catalogs of model projects and optimal design solutions, as well as catalogs of efficient technologies, new materials and modern equipment. It is necessary to implement comprehensive automation of the construction cost management through the implementation of the industry software complex.

At the same time, we recommend simplifying the process of developing estimates and expanding the range of participants in this process. Specialized commercial organizations should be widely involved in the development and update of costing standards, and state structures should ensure the examination of results and, if there is a positive conclusion, the order of inclusion into the Federal Register of costing standards.

The authors propose to consider the possibility of using the Cost Estimate Designer and expand its functionality. The standard designer is primarily a regulation, and secondly – a software product that allows creating costing standards according to single publicly available rules. Currently, the access to this type of activity is artificially limited and therefore is implemented only by a narrow circle of specialists, which requires changes. The implementation of this task is not as difficult as many people think, but it will require agreement on the positions of all interested parties.

The main idea of the tool is to create and accumulate a database of the simplest operations, and subsequently compile costing standards that describe a particular technological process, acting on the principle of combination. By accumulating the required number of simple (elementary) operations from year to year, the rate of development of standards for new technological processes will increase, since rationing will require not all processes related to the new production technology, but only those that have not previously found a display in the Designer.

The structure of the Standard Designer shall consist of a working module, basic directories and a number of auxiliary directories.

The working module will combine data from directories, and process chains will be formed from “elementary” operations. As a result of combinations, an estimated standard is created that describes a particular technological process, which is stored in the data storage and can subsequently be used, including as part of a more complicated complex process.

The main and auxiliary directories can include normative literature on the proposals of the developers of costing standards.

Implementing the concept of the designer it becomes possible to significantly reduce the time for the development of new and update the existing estimates, create a tool that will work on a single principle of universality, attract a wider range of specialists and reduce the budget for financing these works.

4. Conclusions
The use of recursive expressions in the analysis of problems with the use of construction materials allows solving a number of related problems of the design process and its regulatory support. It is also important to solve another problem – not all existing regulatory and methodological documents take into account the elements of the transition period to the resource method for determining the cost of construction, as well as additional types of costs that customers, design and contracting organizations actually bear when implementing construction projects. Therefore, it is necessary to continue work on
updating outdated regulatory and methodological documents with their mandatory subsequent inclusion into the Federal Register of Costing Standards.

The implementation of planned activities will provide industry specialists with the necessary regulatory documentation, optimize the process of developing new and update the existing costing standards, which will ultimately increase the reliability of determining the cost of construction products and reduce the likelihood of controversial situations when calculating the performed work.

References

[1] Tarasov M M 2020 Analysis of the use of the PPP tool in the investment and construction sphere Economics and management: problems, solutions 1(3) 26-31 (in Russian)

[2] Silka D N 2011 Key factors for identifying the phases of the business cycle in construction Bulletin of the University 21 210-212 (In Russian)

[3] Ardzinov V D 2018 Problems and risks of reforming pricing and budget rationing in construction, in: Proceedings of the scientific and practical conference with international participation RYASKE-2018, S G Oparin (ed) pp 353-363 (In Russian)

[4] Yuanle Cheng and Hai Hu 2020 Analysis of the Problems, Causes and Countermeasures in the Brand Construction of the Postgraduate Entrance Examination Institutions Open Journal of Business and Management (Nanjing, China) 08(02) 32-44. DOI: 10.4236/ojbm.2020.82025

[5] Hasan Mathar, Sadi Assaf, Mohammad, Hassanain, Abdullahf Abdallah, Ahmed M Z Sayed 2020 Critical success factors for large building construction projects: Perception of consultants and contractors Built Environment Project and Asset Management 9(5) 29-33. DOI: 10.1108/BEPAM-07-2019-0057

[6] Zykov R A 2020 Problems of development of innovative infrastructure of the petrochemical complex of Russia, in: Problems of development of modern society. Collection of scientific articles of the 5th all-Russian scientific and practical conference, V M Kuzmina (ed) pp 244-246 (In Russian)

[7] Yalu Ping 2020 Analysis of the Influence of Multiple Linear Regression on Construction Price Statistics and Application 09(01) 56-60

[8] Adamko P and Chutka J 2020 Company bankruptcy and its prediction in conditions of globalization SHS Web of Conferences 74 05002. DOI:10.1051/shsconf/20207405002

[9] Rashid Bhutta and Angappan Regupathi 2020 Predicting Corporate Bankruptcy: Lessons from the Past Asian J. of Multidisciplinary Studies 8(1) 13-21

[10] Ir. Shamsuddin Sabri, Ir. Mohd Eric Husairrie Ismail, Mohd Nazri Ali and Rohayu Abd Aziz Roads B 2020 Towards better road contractor performance ranch (Public Works Department (PWD), Malaysia) Preprint No. 2394 2020

[11] Yu Zhang, Dangqiang Yin and Yating Zhu 2019 Method for Construction Progress Measurement for EPC Oil and Gas Pipeline Projects Journal of Oil and Gas Technology 41(06) 39-47. DOI: 10.1007/978-981-13-0107-0_109

[12] Bashirov A E, Rubchenko D S and Kurbakaya E P 2012 On pricing in the construction of railway transport facilities Economy of Railways 6 34 (In Russian)

[13] Silka D N and Babaeva M S 2018 Ways to improve the quality and efficiency of relationships between participants in investment and construction activities Economy and entrepreneurship 1(90) 682-685 (In Russian)

[14] Goryachkin P V 2010 On the state of issues of pricing and estimated rationing in construction Urban planning 6 50-58 (In Russian)

[15] Solov’ev V V 2016 The significance of the concept "400 days" for the industry's estimated rationing Economy of Railways 5 62-69 (In Russian)

[16] Solov’ev V V and Korchagin A P 2014 Ways to improve the quality of pre-project documentation in Russian Railways Economy of Railways 3 21-26 (In Russian)
[17] Wang S, Zhang H, Wang C and Wu Y 2020 Cost Analysis Between Prefabricated Buildings and Traditional Buildings *IOP Conf. Ser.: Mater. Sci. Eng.* 768 052090. DOI: 10.1088/1757-899X/768/5/052090

[18] Alekseev S A, Viktorov M Yu, Grabovyj P G, Zajceva L I, Kazanskij N V et al 2019 *Spatial restructuring. New meanings and rules of investment and construction activities* (Moscow: Delo) (In Russian)

[19] Garcia-Macia D 2020 Labor Costs and Corporate Investment in Italy *IMF Working Papers* 20(38). DOI: 10.5089/9781513529721.001

[20] Park D 2019 The Effect of Leverage on Labor Cost Management *Review of Accounting and Policy Studies* 24(1) 25-63. DOI: 10.21737/RAPS.2019.02.24.1.25

[21] Do Y, Kang N and Li L 2019 Temporary Employment and Behavior of Labor Cost *Korea Association of Business Education* 34(3) 325-344. DOI: 10.23839/kabe.2019.34.3.325

[22] Kereri J 2019 Construction Sector versus Labor Costs in Kenya: A Two Way Love Affair *International Journal of Architecture, Engineering and Construction* 8(2). DOI: 10.7492/IJAEC.2019.011

[23] Solov’ev V V and Korchagin A P 2020 Topical issues of improving the pricing system in construction in the transition period *Vestnik MGSU* 15(4) 605-616

[24] Poltava A V and Korchagin A P 2019 Problems of determining the reliable cost of construction in the framework of project management, in: *Development of the methodology of modern economics, management and education in the context of information and digital trends: Materials of the III Interdisciplinary all-Russian scientific conference* pp 208-213

[25] Korchagin A P 2019 Problems and prospects of development of costing standards in construction *Financial aspects of structural transformations of the economy* 5 83-90