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Improvement of methods for determining the cost of design solutions at early stages of investment and construction projects realization

The list of basic solutions for the implementation of an investment and construction project is mentioned and approved as part of the project documentation. However, the choice and justification of these decisions are made by the customer and the investor already at the pre-design stage. It is at the pre-design stage that a decision is made on the feasibility of the project, a feasibility research is formed, in which not only such basic technical and economic indicators as area, construction volume, length, etc. are of particular importance, but also the composition and cost of individual space-planning and design solutions. So, one and the same object can be erected from monolithic reinforced concrete and bricks, or from pre-fabricated metal structures and multilayer enclosing structures. At the same time, the functional purpose of the object will remain the same, but the cost will change significantly.
In this regard, the relevance of this article lies in the research of methods for determining the cost of various design solutions at the pre-project stage as the basis for successful project implementation in the future. Since the most economically sound solutions identified at an early stage can significantly reduce the costs of the entire project and increase its efficiency.
The purpose of this research is to improve approaches to substantiating the cost of various design solutions at the pre-project stage of the implementation of an investment and construction project.
The authors reviewed the existing methods of substantiating the cost of design solutions for construction projects at the pre-project stage of an investment and construction project and also developed proposals for their improvement: an algorithm for estimating the cost of construction at the early stages of an investment and construction project, taking into account the cost of alternative design solutions.
The implementation of the algorithm became possible thanks to the authors' development of a methodology for creating a data bank on the cost of design solutions, accumulation, analysis and structuring of data on the cost of already implemented residential and civil facilities (administrative buildings with a total area of 1,000 to 20,000 m²). A factorial analysis of the cost of administrative buildings was also conducted with identifying the causes of deviations in the cost of identical indicators from the average value.
The results obtained can form the basis for the formation of a new database of prices of constructive solutions necessary for calculating the estimated cost at the stage of investment justification. Such data will be able to determine the cost more reliably precisely at the early stages — at the stage of transition from the idea to the development of basic technical solutions that will determine the appearance, manufacturability and cost of construction projects.
Keywords: *cost of design solutions, investment and construction project, pre-design stage, aggregated cost indicators*

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INTRODUCTION

When implementing any investment and construction project (ICP) both the state and private companies are always faced with the task of achieving the greatest efficiency, namely, the construction of a capital construction facility with the necessary capacity, reliability, durability at the optimal cost of construction, ensuring profit from the implementation of the investment project [1, 2]. In this regard, during this study, the work on determining the cost of construction objects was studied and summarized, taking into account the phases of the life cycle of an investment and construction project both in the Russian Federation and abroad[1, 2, 3] [3–6]. One of the key objectives of Strategy for the development of the construction industry and housing and Communal Services of the Russian Federation until 2030 in the direction of improving pricing in construction is to increase the reliability of determining the cost at all stages of the investment cycle, including at the stages of investment planning, design, construction, operation and maintenance, demolition[4].

1 Methodology for the development and application of enlarged construction price standards, as well as the procedure for their approval : Order of the Ministry of Construction of the Russian Federation dated 05.29.2019 No. 314/pr. URL: https://minstroyrf.gov.ru/upload/iblock/959/Metodika-rarabotki-i-primeneniya-ukrupnennykh-normativov-tseny-stroitelstva_-a-takzhe-poryadok-ikh-utverzhdeniya.pdf

2 On approval of the Methodology for determining the estimated cost of Construction, Reconstruction, Capital Repairs, Demolition of Capital Construction facilities, works to preserve cultural heritage objects (Historical and Cultural Monuments) of the Peoples of the Russian Federation on the Territory of the Russian Federation : Order of the Ministry of Construction of the Russian Federation No. 421/pr dated 08.04.2020. URL: https://minstroyrf.gov.ru/upload/iblock/3fb/Metodika-opredeleniya-smetnoy-stoimosti-stroitelstva_rekonstruktsii_-kapitalnogo-remonta_-snosa-obektov-kapitalnogo-stroitelstva_-rabot-po-sokhraneniyu-obektov-kulturnogo-naslediya.pdf

3 On approval of the Procedure for determining the initial (maximum) price of the contract, the price of the contract concluded with the sole supplier (contractor, contractor), the initial price of a unit of goods, work, services during procurement in the field of urban planning (except for territorial planning) and the Methodology for estimating the contract, the subject of which is the construction, reconstruction of capital construction facilities : Order of the Ministry of Construction of the Russian Federation No. 841/pr dated 23.12.2019. URL: https://minstroyrf.gov.ru/upload/iblock/331/Poryadok-opredeleniya-nachalnoi_-_maksimalnoi_-tseny-kontrakta.pdf; https://minstroyrf.gov.ru/upload/iblock/ecf/Metodika-sostavleniya-smety-kontrakta_-predmetom-kotorogo-yavlyayutsya-stroit….pdf

4 Strategy for the development of the construction industry and housing and communal services of the Russian Federation until 2030 with a forecast for the period up to 2035. URL: http://static.government.ru/media/files/AdmXczBBUGfGNM8tz16r7RkQcsgP3LAm.pdf

To do this, both Russian and international companies spend a significant amount of money on optimizing the engineering approach to design, creating variable models that evaluate both the technical side of the project and its economic efficiency. It is noted that currently large investors and customers, engineering companies in Russia and the world have begun to analyze and take actions aimed at organizing the process of choosing optimal solutions in construction projects, starting from the moment of defining the general concept [6–8].

The methods and indicators of determining the cost correlate with the phases of the implementation of the ICP, for them there are uniform clear rules for assessing and controlling the cost [9–17]. So, at the pre-project stage, the estimated or approximate cost of construction is determined on the basis of analogous facilities and enlarged cost indicators, at the design stage, the estimated cost is determined based on current resource prices and (or) specially developed prices with their translation into current prices, and finally, at the stage of concluding contracts, the contract price is calculated, which takes into account actual and forecast inflation indices. In many ways, they are determined depending on the type of financing of the construction object: budget or commercial [9, 12, 16].

One of the most significant from the point of view of estimating the cost of the ICP stages is the stage of pre-project studies. It is at this stage that a decision is made to implement the ICP, its investment attractiveness is calculated, data on the main planned design solutions are considered, which means that the cost is formed, which will later be clarified[5, 6] [18–20].

The difficulty lies in the fact that at the time of substantiating the estimated cost of construction at the early stages in the absence of developed project documentation, the cost is determined approximately: using enlarged construction price standards or data on the cost of analogous facilities. In both cases, mainly previously erected objects with their specific characteristics are taken as a basis, often without detailing the cost for specific solutions. At the same time, the use as analogues of project documentation for facilities whose construction has not been started or completed entails greater risks than when using documentation for facilities put into operation. It is noted that there is no single algorithm for evaluating specific design solutions, including space-planning and structural ones at this stage.

METHODS AND MATERIALS

The methodological basis for writing this paper is the methods of comparison and generalization in the framework of the literature review, as well as a number of studies by the authors in the field of construction economics, cost determination and management, the methodology of the life cycle of investment and construction projects, methods of economic cost modelling[7] [16, 17, 21]. In addition, the paper uses the authors' work in the field of research of the concepts of capitalization and cost of capital construction projects in modern conditions [9, 22, 23].

The works of a number of authors were also reviewed, in which it is noted that the final choice of design solutions is one of the most important stages of architectural and construction design, which is preceded by the stage of the investment plan[2] [10, 12, 14, 15]: determination of the purpose of the investment project, consideration by the customer of several options for the implementation of the project, providing a given project goal, but differing in the composition of the work, their cost, duration, complexity and economic efficiency of the results of the project. It is important that when working out design solutions, all stages of the implementation of an investment and construction project are studied and options for choosing design solutions are evaluated in terms of their impact on the cost and revenue side of the project (economic efficiency). In socially significant projects, economic efficiency is not the only and sufficient condition for the implementation of the project: budgetary and public efficiency are also allocated, which also affects the choice of design solutions[8] [10, 11, 24, 25]. However, a significant limitation for the implementation of the project is its cost, hence such close attention to decisions that directly affect it.

Consideration of various options for the implementation of an investment project at the early stages is carried out based on the initial data available at the time of consideration, and is subject to adjustment at subsequent stages of development. At the same time, when considering options, it is mandatory to take into account a number of factors that affect the feasibility of the investment project, the achievement of the specified parameters and goals, and the period and cost of its operation [10, 13, 26, 27]:

- regional climatic and geotechnical features of construction;
- regional and economic features of the construction region;
- purpose and planned service life of the facility;
- customer requirements for the main technological solutions, production flow chart (for industrial facilities);
- customer requirements for design and space-planning solutions;
- customer requirements for architectural solutions;
- requirements of the current legislation in terms of labor protection, fire safety, industrial safety and compliance with the requirements of technical regulations;
- conditions for the placement of objects, buildings and structures associated with the presence of zones with special conditions for the use of territories.

Thus, the development of all options for the implementation of an investment and construction project is carried out taking into account the listed factors.

As part of the consideration of various options for design solutions, the solutions planned for implementation are analyzed for compliance with the current regulatory requirements, the effectiveness and feasibility of the main (fundamental) considered solutions are assessed, the availability of opportunities for optimization of the decisions made is analyzed, requirements for the preparation of initial data for the design of facilities are formed (Fig. 1). The adopted project decisions must comply with the requirements of legislative acts, regulatory legal acts of the constituent entities of the Russian Federation, standards, set of rules, technical standards, land use and development rules.

The result of a pre-design analysis of an investment and construction project is an assessment of the main advantages and disadvantages of the proposed project options, the proposal of

5 To speed up the construction needs the design stage “Justification of investments”. Ministry of Construction of Russia. URL: https://www.minstroyrf.ru/press/dlya-uskoreniya-stroyka-nuzhdaetsya-v-stadii-proektirovaniya-obosnovanie-investitsiy/ (accessed: 13.01.2022)

6 Register of cost-effective design documentation for reuse. URL: https://fgiscs.minstroyrf.ru/#/

7 State Information System Unified State Register of Conclusions. URL: https://egrz.ru/

8 Official website of the Unified Information System in the field of procurement. URL: https://zakupki.gov.ru/epz/main/public/home.html

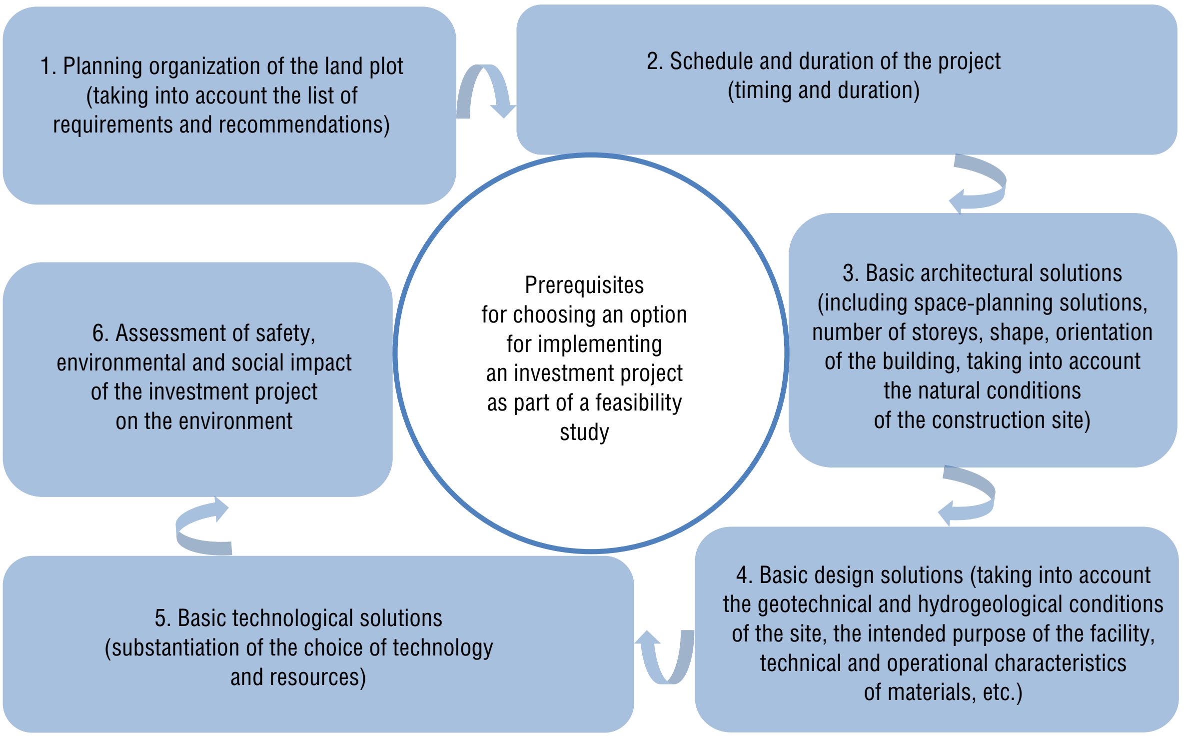

Fig. 1. Prerequisites for choosing an option for the implementation of an investment and construction project as part of a feasibility study

recommendations for choosing an implementation option, recommendations on the preparation of initial data for the design of facilities, as well as the formation of a recommended list of regulatory legal acts necessary for subsequent stages of the project life cycle [12–14, 18].

When developing options for implementing an investment and construction project, state and private companies can obtain the proposed design options from various sources, but these sources of information are imperfect and have a number of specific features (Table 1).

All of the above sources do not form a single information field and have limited use, which determines the need to improve existing methods of forming databases on design solutions and their cost indicators for their subsequent use in cost modelling of projects (elaboration and evaluation of options for the implementation of investment and construction projects). It is also not obvious exactly how and in what sequence the data from these sources should be taken into account.

In terms of cost formation, consideration of various options for the implementation of the project at the early stages is carried out based on the initial data available at the time of consideration, and is subject to adjustment at subsequent stages of development. The difficulty lies in the fact that at the initial stages there is no clear data as such on design solutions and their cost, hence the complexity of a detailed calculation of cost elements.

So, it is natural to determine the value using enlarged cost indicators. Thus, when financing the construction of an object from the state budget, consolidated indicators of the cost of construction (construction price standards CPS) are used[9, 10, 11]. However, the nomenclature of indicator's collections is rather limited[10, 11, 12]. At the same time, the collections do not allow replacing certain constructive solutions as part of their cost, on the one hand. On the other hand, in most indicators, it is possible to adjust only the cost of foundations, equipment and design and survey work. In this regard, in the analysis of design options, in the absence or inapplicability of the corresponding consolidated indicators of the cost of construction, data on the cost of analog objects and their design solutions are used. The selection of an analog object is also a difficult task, since there is no single database of sources of the cost of analog objects, regularly updated and available for work, as evidenced by the data given in Table 1.

Analysis of existing sources of information on the cost of construction and the cost of design solutions at the pre-project stage showed:

1. Currently, there is no unified database on actually implemented investment and construction projects and the list of capital construction objects as part of such projects, which allows an automated search for an object according to the main specified characteristics, including the main performance indicators and cost.

2. Existing data sources have a number of limitations that complicate the search and comparison of capital construction projects, which in some cases does not allow using the experience gained in the development of design solutions for such projects.

9 Town-planning Code of the Russian Federation dated 12.29.2004 No. 190-FZ. URL: http://www.consultant.ru/document/cons_doc_LAW_51040/

10 Official website of the Ministry of Housing and Communal Services of the Russian Federation, section "Pricing". URL: https://www.minstroyrf.ru/trades/gradostroitelnaya-deyatelnost-i-arhitektura/14/

11 Official website of the State Information System of Pricing in Construction. URL: https://fgiscs.minstroyrf.ru/#/

12 Cost-effective reuse project documentation, information about which, as of October 1, 2021, is included in the unified state register of expert opinions on project documentation for capital construction projects, is recognized as standard project documentation

Table 1. Analysis of data sources on capital construction facilities and their assessment

Data source	Advantages	Disadvantages
Register of cost-effective design documentation for reuse[6, 12]	• significant amount of information; • presence of estimate documentation as part of the project documentation; • reliability of information	• lack of data on production facilities; • lack of data on unique, technically complex and especially dangerous capital construction projects; • complexity of the analysis of posted information; • lack of design and estimate documentation for some objects
GIS USRR (Unified State Register of Reports)[7]	• reliability of information; • possibility of obtaining information about the results of non-state examination of project documentation and (or) the results of engineering surveys	• lack of open access to design (including estimate) documentation of objects, information about which is contained in the USRR
Databases of design organizations containing data on objects, the design and working documentation of which was developed by these organizations	• accumulated information on previously designed facilities (for organizations that have existed for a long time); • reliability of information	• lack of information about the cost of the completed construction of the object
Databases of individual large companies, formed on the basis of data on completed or planned investment projects of new construction, reconstruction, overhaul	• accumulated information on previously designed and implemented objects (for organizations that have existed for a long time); • availability of information on the actual cost of the completed construction of the facility; • presence in a number of companies of consolidated unit prices for certain types and sets of work	• lack of information about other objects or alternative options implemented in other companies
Open sources (books, media, internet)	• availability of data on the cost of large investment projects	• unreliability of information

3. Available sources of data on investment and construction projects contain information about the capital construction object at the stage of "design documentation". There is no data on changes made at the stage of "working documentation" and information about the facility at the stage of commissioning. Thus, there is no statistics on changes in the cost of implementing an investment and construction project at different stages of its life cycle.

4. Due to the lack of systematized data, comparison of both capital construction objects in general and individual design solutions and their cost is possible only within companies or organizations that have accumulated experience in the design and/or implementation of similar objects.

RESULTS

The results of the preliminary assessment of the cost of implementing the ICP serve as the basis for making a decision on the need, technical feasibility, commercial, economic and social feasibility of investments in construction. For a preliminary assessment of the cost of implementing an investment project, it is recommended to make a decomposition of the main decisions and factors affecting the cost indicators of the project. It is important to take into account that all decisions should be considered comprehensively, taking into account the stages of the life cycle of the ICP.

A comparative analysis of the cost of projects can be carried out both in an enlarged way, when considering implementation options that differ significantly from each other, and in detail, by comparing the cost of individual solutions, for example, in terms of foundations, the cost of enclosing structures, solutions for interior decoration, etc.

During the initial consideration of options, as a rule, it is done "from top to bottom", by assessing from the total cost of the project to the analysis of the cost of certain types of work and expenses. As the cost is detailed, the types of expenses can be aggregated:

1. Necessary for any option for the implementation of an investment project (costs of engineering surveys, development of design and working documentation, payment for land and land tax during the construction period, work on site preparation, archaeological surveys (if necessary), cleaning the area from explosive objects (if necessary), compensation payments for the demolition of green plantings, payment for the state examination of project documentation and the results of engineering surveys (in cases stipulated by the legislation of the Russian Federation), costs of temporary buildings and structures, costs of work in the winter, etc.

2. Expenses, the cost of which varies depending on the implementation option of the investment project (costs of construction and installation work, purchase of process and utility equipment, commissioning, costs of connection (utility connection) to engineering networks, etc.

3. Expenses that, in some options for project implementation, are not necessary (costs of relocation of certain types of construction equipment, costs of a rotational work method, individual solutions to protect construction from various geological and hydrogeological processes (mudflows, landslides, flooding and other hydrogeological processes).

For the most reliable determination of the cost of design solutions at the pre-project stage, the authors have developed an algorithm for justifying the cost of the ICP implementation option. The basis of the algorithm was the decomposition of the stages of evaluation and analysis of the cost as an object as a whole, and the main design decisions and factors affecting the cost indicators of the project.

The first stage of the algorithm is based on a preliminary factor analysis of the cost of implementing the ICP (Fig. 2).

1.1. Analysis of regional climatic, geotechnical, regional economic features of the construction region

↓

1.2. Analysis of the list of buildings and structures included in the ICP

↓

1.3. Analysis of preliminary performance indicators (capacity of facilities, length of external engineering networks, area of improvement and landscaping)

↓

1.4. Analysis of the technical characteristics of space-planning and structural solutions (structural diagram of a building, type of foundations, wall material, type of floors, roofs, etc.) (if any)

↓

1.5. Analysis of the main technological equipment for the enlarged nomenclature

Fig. 2. Stage 1. Analysis of factors influencing the cost of an investment and construction project at the pre-project stage

2.1. Comparative analysis of the cost of the options for project implementation	1) determination of the cost structure of each variant of the project implementation with the determination of the specific weight (in percentage) of each consolidated cost element; 2) comparison of the structure and specific weight of cost elements of all considered options; 3) factor analysis of changes in the cost of elements in comparison with other considered options; 4) if errors in the calculations are identified that significantly affect the cost of an option, an analysis of changes in the final cost of this option is made, taking into account the correction of the identified inconsistencies
2.2. Comparative analysis of the cost with similar objects (including international objects), implemented in comparable conditions, as well as with their individual cost indicators	1) selection of objects similar in functionality, design capacity, natural and other conditions of the territory on which construction is planned; 2) analysis of the similarity of the performance indicators of the object under consideration and the analogue object in terms of the functional purpose of the investment project, design capacity, composition of buildings and structures, construction region, main performance indicators; 3) analysis of the estimated regulatory framework and the current price level adopted to determine the current cost of analogue projects, bringing the cost indicators of all analogue projects to the price level of the object under consideration; 4) decomposition of the cost of an analogue project; 5) determination of the boundaries of the range of cost of analog projects for the adopted unit of measurement; 6) comparison of the value of the cost indicator and similar indicators of analog projects. Analysis of the reasons for deviations from the average cost; 7) in case of significant deviations of the value of the object under consideration from the cost of analogous projects, an analysis is carried out in terms of the possibility of cost optimization, indicating the identified factors affecting the cost of the project
2.3. Analysis of methods for determining the cost of the project	1) analysis of the analog method and the method based on aggregated cost indicators; 2) consideration of pricing methods: base-index, resource and resource-index methods

Fig. 3. Stage 2. Analysis of the cost of options for the ICP implementation

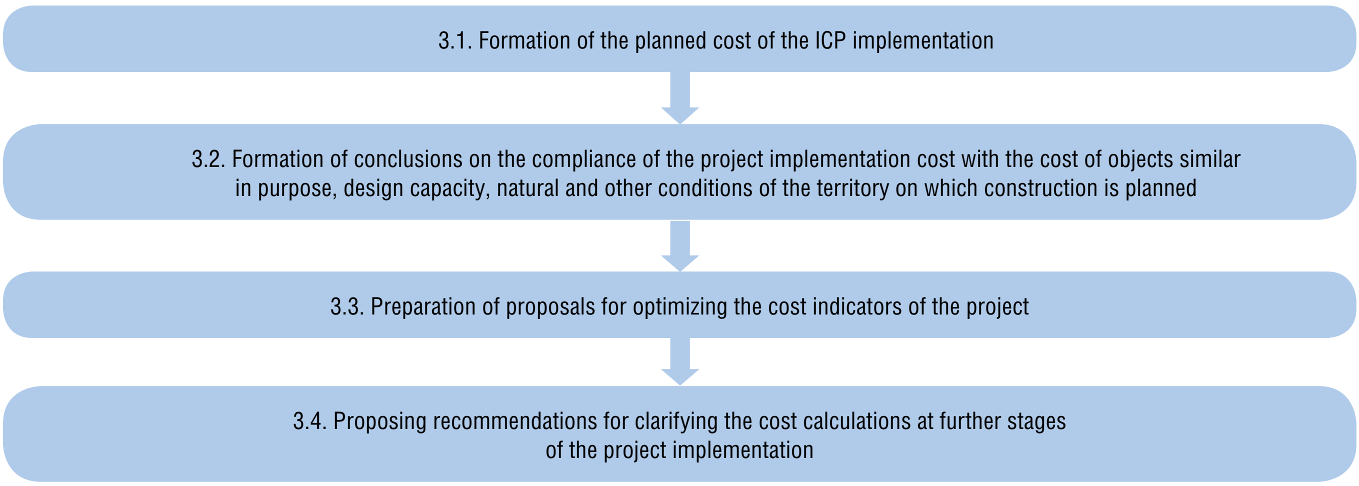

Fig. 4. Stage 3. Estimation of the cost of ICP

The second stage of the algorithm directly describes the analysis of the cost of options for the implementation of ICP (Fig. 3). It includes working with similar objects (including international objects) implemented in comparable conditions, as well as with their individual cost indicators, a comparative analysis of the design decisions adopted in the project, as well as methods of their calculation.

The third stage is the final cost assessment at the pre-project stage, including the preparation of proposals for optimizing the cost indicators of the project, as well as proposals for recommendations on clarifying cost calculations at further stages of the project (Fig. 4).

The algorithm proposed by the authors for the cost estimation of project solutions at the pre-project stage is the basis of a system for analyzing the cost of project implementation options. This algorithm can be actively used in the customer's organizations when evaluating various project implementation options, including for the purpose of preparing a reasonable design assignment.

The application of the algorithm in the practice of construction companies is difficult due to the lack of statistical data on the cost of various solutions for previously implemented projects. However, at the moment there is no unified methodology for analyzing the cost of design solutions for the formation of such a data bank. In this regard, one of the authors' proposals is to return to the idea of creating at the state level a base of price standards for constructive solutions that will allow forming an idea of the cost of specific structural elements and work complexes at the pre-project stage. Also, within the framework of using the prices of constructive solutions, it is possible to finalize the indicators of the CPS (construction price standards) in terms of allocating the share of costs for the technical characteristics of constructive solutions and types of work taken into account in the indicator. In this case, it would be possible to replace the cost of a constructive solution in the CPS based on the standards of the price of constructive solutions.

At the same time, in the absence of officially approved collections of the standards of the price of constructive solutions in order to create a data bank on the cost of project solutions, the authors propose their own methodology and forms of documents for analyzing the cost of project solutions based on already approved project documentation.

Next, we will give an example of the implementation of the methodology of systematization, processing and accumulation of data on the cost of already realized objects and the cost of their design solutions. The data for the example are taken from the project documentation of open sources[6, 8], as well as data from development projects. Further, the analysis of the cost of design solutions for housing and civil objects will be considered: administrative buildings with a total area of 1,000 to 20,000 m². For

Table 2. The cost indicators of the construction of administrative buildings

Number	Capital construction object name	At the price level for 2022 (thousan.rubles, VAT included)							
		Cost of 1 m²	CIW	Equipment	Other	Cost of 1 m³	CIW	Equipment	Other
Average indicator for objects									
1	Administrative buildings up to 1,000 m²	**110.1**	86.8	10.1	13.2	**22.9**	18.2	2.2	2.5
2	Administrative buildings from 1,000 to 5,000 m²	**99.7**	69.5	19.9	10.3	**23.6**	16.4	4.8	2.4
3	Administrative buildings from 5,000 to 20,000 m²	**111.5**	74.5	27.9	9.1	**25.2**	16.8	6.3	2.1
4	Administrative buildings more than 20,000 m²	**178.6**	139.0	27.6	12.0	**25.1**	19.5	3.9	1.7

each type of the considered objects, the weighted average indicator of the unit cost of the measurement unit was determined (1 m² of total area, 1 m³ of construction volume, 1 place (if any) at the stage of "design documentation").

The average value of deviations between the minimum and maximum indicators of objects of the same functional purpose was about 40 % (Table 2).

In terms of the cost of administrative buildings, the consolidated, object and local estimates developed at the stage of "design documentation" were analyzed.

The comparative analysis was performed according to the following algorithm:

1. Selection of design documentation (including the section "Estimates for building capital construction objects") for capital construction projects that are identical in functionality.

2. Grouping of objects by capacity characteristics (total area "from" and "to", number of places "from" and "to", etc.) and thus dividing objects of the same functional purpose into groups.

3. Analysis of objects within the formed group according to the technical characteristics of design solutions.

4. Analysis of the structure of the estimated cost on the basis of summary estimate calculations among objects within the same group, aggregated identification of cost items that differ significantly among the same type of objects. For comparison, the total cost was reduced to a single specific indicator — the cost of 1 m² of the total area.

5. Identification of deviations in the values of the specific indicator, as well as the difference in the ratio of costs in the technological structure of capital investments (construction and installation work, equipment, other costs).

6. Additional analysis of objects with significant differences in cost items. In order to identify the reasons for the deviation of a significant difference in the volume of work, the cost of types of work and expenses were reduced to an indicator per unit of measurement (m² of total area, m³ of construction volume, 1 km of utility networks, 100 m² of landscaping area, etc.) in form based on the structure of the consolidated estimate calculation, given in Table 3.

As a result of the analysis, identical indicators were identified that significantly differ in cost.

Within the framework of factor analysis, the reasons for deviations in the cost of identical indicators of capital construction objects were analyzed, subject to consideration for the reasons for deviations from the average. Among the solutions that significantly increase the cost of construction, we can highlight:

1. Design solutions related to the selection of the construction site:

- the presence of hazardous natural processes requiring engineering protection of the territory. At the same time, the most

Table 3. Form of a table for analyzing the cost indicators of a capital construction object

<table>
<tr><th rowspan="7">Number</th><th rowspan="7">Cost structure</th><th colspan="3">Design documentation code;
Object name</th><th colspan="5">Consolidated estimate calculation</th></tr>
<tr><th colspan="3" rowspan="2">Object name</th><th colspan="4">Estimated cost, thousand rubles</th><th rowspan="2">Total estimated cost, thousand rubles</th></tr>
<tr><th>Construction works</th><th>Installation works</th><th>Equipment, furniture and fittings</th><th>Other costs</th></tr>
<tr><th>Measurement units</th><th>Quantity</th><th>Price per unit, thousand roubles, at the current price level without VAT</th><td rowspan="4"></td><td rowspan="4"></td><td rowspan="4"></td><td rowspan="4"></td><td rowspan="4"></td></tr>
<tr><td>Place</td><td></td><td></td></tr>
<tr><td>m² of total area</td><td></td><td></td></tr>
<tr><td>m³ of construction volume</td><td></td><td></td></tr>
<tr><td>1</td><td>Chapter 1. Preparation of the construction site</td><td></td><td></td><td></td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td></td><td>including:</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>1.1</td><td>Layout of the main axes of buildings and structures</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>-</td></tr>
<tr><td>1.2</td><td>Payment for land upon withdrawal (redemption) of a land plot for construction, as well as payment of land tax (lease) during the construction period</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>-</td></tr>
<tr><td></td><td>….</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>-</td></tr>
<tr><td></td><td>and so on in accordance with the chapters of the consolidated estimate</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

common solutions were the construction of retaining walls from monolithic reinforced concrete and cementation of soils. The solutions for the construction of the land cofferdam are also expensive. Design solutions related to the seismicity of the construction site and the possibility of karsts (installation of damper joints in the building, installation of sleeves in the foundation for cementation of possible karst cavities under the foundation of the building) did not have a significant impact on the total cost;

- design solutions involving the use of imported materials that require significant transport costs.

2. Design solutions related to the type of foundations. The choice of the type of foundation is largely affected by the results of engineering surveys. However, in a number of cases, when considering objects, excessive design solutions were revealed — an increase in the thickness of the foundation slab, an excess thickness of the basement walls.

3. Design solutions related to the construction of buildings with complex shapes.

4. Design solutions related to the use of non-serial (non-standard) building products and structures, for example, non-serial products made of precast concrete, non-standard metal structures, etc.

5. Design solutions involving the use of expensive building and finishing materials, for example, aluminum stained-glass mullion-transom systems, porcelain stoneware, decorative wall panels, etc.

6. The use of expensive process and utility equipment exceeding the necessary requirements in terms of its technical characteristics.

DISCUSSION AND CONCLUSION

If we level out legal and permissive issues in the implementation of an investment and construction project, then we can see that the choice of imperfect or unsuitable design solutions for a particular case has the greatest impact on the timing of the implementation of projects and on their cost in terms of achieving a given level of quality.

When assessing the cost of design solutions for each variant of the implementation of an investment and construction project, in most cases, the need for a detailed assessment of the cost of individual solutions is revealed, even at the pre-project stage. Construction companies can apply the algorithm within the framework of project implementation in order to accelerate the cost determination process at the early stages of design, as well as increase the reliability of cost determination. The algorithm will also be relevant for government agencies to verify projects as part of the technological and price audit of projects to include them in state-funded budget programs. The algorithm is based on an up-to-date data bank on the cost of design solutions, which determines the reliability of cost forecasting. Processing and systematization of this kind of information can be carried out by both large commercial developers and other stakeholders, for example, Centers for Pricing in construction, state and non-state expertise bodies, engineering companies, etc. In general, such a detailed study of the cost of individual solutions at the pre-project stage will increase the accuracy of cost calculations and in some cases save budget funds.

At the moment, calculations within the framework of the methodology are carried out only for administrative buildings, which is a significant drawback. However, it seems promising to further accumulate and systematize data on various implemented projects with the allocation of initial data on various types of objects implemented in various conditions and regions of construction according to the forms of documents developed by the authors.

The results obtained can form the basis for the formation of a new database of prices of constructive solutions necessary for calculating the estimated cost at the stage of the project concept. Such data will be able to determine the cost more reasonably precisely at the early stages – at the stage of transition from the idea to the development of basic technical solutions that will determine the appearance, manufacturability and cost of our facilities, as well as be in demand at the early stages of object modelling using information modelling technologies.

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Совершенствование методов определения стоимости проектных решений на ранних этапах реализации инвестиционно-строительных проектов

Перечень основных решений по реализации инвестиционно-строительного проекта описывается и утверждается в составе проектной документации, однако выбор и обоснование этих решений производятся заказчиком и инвестором уже на предпроектном этапе. Именно на предпроектном этапе принимается решение о целесообразности проекта, формируется технико-экономическое обоснование, в котором особое значение имеют не только такие основные технико-экономические показатели, как площадь, строительный объем, протяженность и т.п., но и состав и стоимость отдельных принятых объемно-планировочных и конструктивных решений. Так, один и тот же объект может быть возведен из монолитного железобетона и кирпича, а может — из быстровозводимых металлоконструкций и многослойных ограждающих конструкций. При этом функциональное назначение объекта останется прежним, но стоимость значительно изменится.

В связи с этим актуальность данной статьи заключается в исследовании методов определения стоимости различных вариантов проектных решений на предпроектном этапе как основы успешной реализации проекта в будущем, так как наиболее экономически обоснованные варианты решений, выявленные уже на ранней стадии, могут существенно снизить затраты всего проекта и повысить его эффективность.

Целью исследования является совершенствование подходов к обоснованию стоимости различных проектных решений на предпроектной стадии реализации инвестиционно-строительного проекта.

Авторами рассмотрены существующие методы обоснования стоимости строительства на предпроектном этапе инвестиционно-строительного проекта, а также разработаны предложения по их совершенствованию: составлен алгоритм оценки стоимости строительства на ранних этапах инвестиционно-строительного проекта с учетом стоимости альтернативных проектных решений.

Реализация авторами алгоритма оценки стоимости строительства на ранних этапах инвестиционно-строительного проекта стала возможной благодаря разработке методики создания банка данных о стоимости проектных решений, накопления, анализа и структурирования данных о стоимости уже реализованных объектов жилищно-гражданского назначения (административных зданий общей площадью от 1000 до 20 000 м^2). Также проведен факторный анализ стоимости административных зданий с выявлением причин отклонений стоимости идентичных показателей от среднего значения.

Полученные результаты могут лечь в основу формирования новой базы данных цен конструктивных решений, необходимых при расчете предполагаемой стоимости на этапе обоснования инвестиций. Такие данные смогут позволить определять стоимость более достоверно именно на ранних этапах — на этапе перехода от задумки к разработке основных технических решений, которые будут определять облик, технологичность и стоимость строительных объектов.

Ключевые слова: *стоимость проектных решений, инвестиционно-строительный проект, предпроектный этап, укрупненные показатели стоимости*

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