

Development of a mechanism to improve the efficiency of residential renovation projects on the example of the city of Moscow.

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Abstract. Implementation of the residential renovation program, which is currently underway in the city of Moscow, as well as in other cities of the Russian Federation, helps to create comfortable and safe living conditions for citizens. In addition, one of the most important tasks of this program is the integrated development of urban areas: development of public spaces, landscaping of districts, organization of parks and recreation areas. But as practice has shown, at the stage of pre-project analysis, carried out at the stage of land plot selection, insufficient attention is paid to possible risks that can lead to an increase in project implementation time, as well as an increase in the cost of works. The study under consideration proposes to introduce a mechanism for selecting a project implementation strategy depending on the performance indicator of the land plot using the developed economic and mathematical model based on the main evaluated parameters. The proposed strategies will make it possible to form a system for assessing the conditions on the land plot under consideration and reduce the risks of unforeseen situations at further stages of project implementation.

Keywords: Residential development renovation program, integrated territorial development, improvement of the interaction mechanism, Moscow Building Renovation Program, economic-mathematical modelling.

1 Introduction

The Building Renovation Program [1] is a part of the national program of integrated development of territories. The main objective of the residential renovation program is to create comfortable and safe living conditions for citizens whose current housing does not meet modern requirements and norms. The residential development renovation program includes two main ways of creating comfortable and safe living conditions for citizens:

1. Capital repairs, including: replacement of engineering communications, engineering equipment, modern facade systems, restoration of landscaping, restoration of the strength of the main load-bearing elements of the building.

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2. Demolition and new construction: demolition of residential buildings, the regulatory period of operation of which has come to an end, and capital repair is economically inexpedient or technically impossible due to the critical condition of the building elements.

The leader in the implementation of the residential renovation program is the city of Moscow, where this program has been in effect since 2017 (Government Resolution (No. 497-PP "On the Program of Housing Renovation in the City of Moscow") [2]. The main method of implementation of the residential renovation program in Moscow is demolition and new construction. Thus, for example, during the last 5 years of the program 213 residential buildings were demolished, the technical condition of which did not allow for effective repair and restoration of characteristics. In addition, during the period of the residential renovation program in Moscow 247 new residential buildings were built, which provided 94.8 thousand people with new housing [3, 4

In order to regulate and manage the program, the Moscow City Government has established a tool for managing and regulating the implementation of the residential renovation program. This tool provides for the principles of interaction between the main participants in the program, the principles of selecting land plots for the construction of new residential buildings, the principles of selecting residential buildings for demolition and other necessary aspects for the successful implementation of the residential renovation program. Nevertheless, as practice shows, not all new construction projects of the renovation program can be implemented efficiently and in compliance with the set construction terms. [1, 3] The research conducted by the author suggests that the development of an additional management mechanism at the initial stages of implementation of the residential renovation project by the new construction method can increase the efficiency of the project, reduce unforeseen costs, as well as reduce the possible risks, including the increase in time [5]. This mechanism provides for a multi-criteria assessment of the site for the planned development in order to initially determine the feasibility of building a new residential building on the site under consideration, as well as to reduce possible risks at subsequent stages of project implementation.

2 Methods

Taking into account the active development of the residential renovation program in Moscow, as well as the beginning of the program implementation in other cities of the Russian Federation, the need for an effective mechanism of management and interaction between the participants in the implementation of projects increases significantly. As part of the research, we analyzed new construction projects implemented under the residential renovation program in the city of Moscow [2]. It was found that the delay of deadlines and increase in the initially estimated budget are the most common problems encountered in new construction projects under the residential renovation program.

This trend indicates that within the framework of increasing number of projects under the residential renovation program, the number of projects with delayed deadlines will also increase. Given the high social significance of these projects and the need to commission the projects in accordance with the approved resettlement schedule, the time lag may have a significant impact not only on the economic efficiency of the projects, but also on the support of the citizens for the program, which is one of the main aspects of the state program.

In order to identify opportunities to increase the predictability of cost and timing of projects under the residential renovation program, as well as to reduce risks (legal, financial and organizational), a study based on the method of expert assessments was conducted to identify the main aspects that require attention in the implementation of these projects. [5, 6] The study also identified the main shortcomings of the established system of interaction between the participants involved in the implementation of the renovation program. For a better perception of the list of participants and areas of responsibility of each of them, the author proposes a summary table, in which the voiced data are indicated:

Table 1. Main participants of the building renovation program in Moscow

Program participant	Main tasks of each participant
Department of Urban Planning Policy	Within the framework of the State Housing Programme of the City of Moscow, the following tasks are carried out: • Identification of start-up sites for new construction; • Search and evaluation of land plots; • Assessment of transport accessibility and infrastructure
Department of Urban Planning Property	• Determination of the list of houses to be demolished, reconstructed or overhauled
State Housing Inspectorate	• Commissions to determine the technical condition, obsolescence and physical deterioration of residential buildings
Committee for Architecture and Town Planning of Moscow	• Determination of the architectural and planning solutions for the residential buildings; • Approving the appearance of the building; • Deciding on the landscaping; • Ensuring compatibility with adjacent development
Moscow Building Renovation Fund	• Assistance in demolition works • Assistance in preparation of engineering surveys, design documents, construction • assistance in securing the housing rights of homeowners • implementation of investment activities • handing over to the city of Moscow the residential premises owned by the fund
General contractors, technical client service, design companies	• Selected after an open tender; • Prepare project documentation in accordance with the elaborated terms of reference; • Carry out construction of the object; • Carrying out engineering surveys; • Acquisition of initial and approval documentation

Taking into account the established structure of interaction between the participants in the implementation of residential renovation projects, it is necessary to increase the predictability of project completion dates, as well as to minimize the risks of increasing the construction time.

For this purpose, the author proposes the formation of a multi-criteria system for choosing a strategy for the implementation of the renovation project with further development of an economic-mathematical model, which takes into account the main

changing parameters that have the greatest impact on the final efficiency of the project. [7] The proposed economic-mathematical model will allow, in the author's opinion, to increase the degree of elaboration of pre-project analysis of land plots allocated for the construction of new residential buildings. In turn, this may have a positive impact on the reduction of possible risks during construction works.

The selection of parameters and weighting coefficients (depending on the importance of each parameter) for the formation of the economic-mathematical model is proposed to be carried out using the method of expert evaluations based on the conducted survey among the current participants and industry specialists implementing projects under the residential renovation program. This approach will allow to take into account all aspects necessary in practice and to adapt the economic-mathematical model to the actual conditions as much as possible [8].

In order to form the principles of multi-criteria evaluation of the efficiency of the land plot planned to be used for development (for the construction of a new residential building), it is proposed to form a list of criteria with ranking by the following aggregated groups:

- 1. Cost parameters;
- 2. Social parameters;
- 3. Infrastructure parameters;
- 4. Physical parameters.

For perception that is more convenient, it is proposed to form a summary table for the evaluated parameters, as well as to assign each parameter its own symbol:

Table 2. Parameters for assessing the efficiency of land plot utilization for construction purposes

№	Group name	Parameter name	Designation of the evaluated parameter
1	Cost parameters	Construction cost per square meter of a residential building	CCM
		Financial stability of the construction organization	CFU
2	Social parameters	Distance from residential buildings to be resettled (demolished)	SUD
		Transport accessibility	STD
3	Infrastructure parameters	Providing external engineering communications and systems	INK
		Potential number of citizens to be relocated to new residential buildings	IKG
		Availability of social infrastructure (hospitals, schools, kindergartens, convenience stores, etc.)	ISI
4	Physical parameters	Geological structure of land plot	RGS
		Difficulty in developing the construction site	RSO
		Congestion of surrounding buildings	RSZ
		Restrictions related to surrounding development	ROZ
		Land plot area utilization ratio	RKI

The next stage in the formation of the economic-mathematical model is to determine the importance of each parameter listed in the table above by assigning weighting coefficients. In order to increase the objectivity and accuracy of determining the weight coefficient of each parameter, it is proposed to analyze these parameters by the method of expert assessments, namely: conducting a survey among the representatives of participants in the process of implementation of projects under the program of residential renovation at different stages. Within the framework of the research, the survey was conducted with the involvement of the following organizations:

- 1. Department of Construction of the City of Moscow;
- 2. Moscow Fund for Renovation of Residential Development;
- 3. Technical Customer Organization;
- 4. Contractor organizations carrying out construction works.

Each participant involved in the implementation of residential renovation projects assigned a weighting coefficient to the evaluated parameters given in the table above. It is proposed to summarize the obtained values in the following tabular form:

Table 3. Determination of weighting coefficients of parameters of land plot utilization efficiency

Parameter name	Designation of the evaluated parameter	Average value of weight coefficient	Participants in the implementation of the building renovation project			
			Department of Urban Planning Policy	Moscow Building Renovation Fund	Technical Customer Organization;	Contractor
			1	2	3	4
Construction cost per square meter of a residential building	CCM	81,50%	72%	71%	93%	90%
Providing external engineering communications and systems	INK	69,49%	66%	66%	71%	75%
Distance from residential buildings to be resettled (demolished)	SUD	49,12%	62%	62%	36%	36%
Transport accessibility	STD	47,16%	58%	58%	36%	36%
Geological structure of land plot	RGS	70,65%	55%	57%	82%	88%
Difficulty in developing the construction site	RSO	68,68%	47%	50%	87%	90%

Parameter name	Designation of the evaluated parameter	Average value of weight coefficient	Participants in the implementation of the building renovation project			
			Department of Urban Planning Policy	Moscow Building Renovation Fund	Technical Customer Organization;	Contractor
			1	2	3	4
Congestion of surrounding buildings	RSZ	57,53%	37%	44%	72%	77%
Restrictions related to surrounding development	ROZ	42,34%	47%	46%	40%	36%
Potential number of citizens to be relocated to new residential buildings	IKG	49,20%	65%	62%	34%	36%
Land plot area utilization ratio	RKI	52,98%	67%	66%	40%	39%
Availability of social infrastructure (hospitals, schools, kindergartens, convenience stores, etc.)	ISI	41,94%	62%	56%	25%	24%
Financial stability of the construction organization	CFU	69,41%	60%	62%	83%	72%

It should be noted that in order to obtain average values within the framework of calculating the efficiency of land plot utilization for the construction of new residential buildings, it is proposed to bring the obtained weighting coefficients to unified results by the method of proportional determination.

Thus, it is proposed to use the basic formula for calculating the coefficient of efficiency of land plot utilization for construction:

In turn, we will define the coefficient K as the reduced sum of parameters taking into account the assigned weighting coefficients according to the general formula:
In order to bring the obtained weights to the general values for the application of the above calculation formula, it is proposed to assign the maximum value to the coefficient $K - K_{max} = 70$.

Thus, it appears to form in the final form a calculation formula for calculating the coefficient of effective use of the land plot under consideration:

Using the proposed formula (with the maximum coefficient $K_{max} = 70$) will help to determine the efficiency of the selected land plot and develop a strategy for project implementation.

3 **Results**

The result of the economic-mathematical model formation is the possibility to form a list of project implementation strategies for the residential renovation program. These strategies of project implementation should determine the vector of development and the direction of elaboration of project aspects to improve their efficiency. Depending on the result obtained in the framework of the calculation of the land plot efficiency coefficient proposed in this study, it is possible to develop the main provisions of project implementation strategies that take into account the characteristics of the land plot, surrounding development and other parameters mentioned above in this study [7, 9].

The author proposes the following structure of possible strategies for the implementation of residential renovation projects, as shown in the table below:

Table 4. Determination of project implementation strategies

№	Name of strategy in the implementation of the renovation project	Estimated value	Actions taken within the framework of the implemented strategy	Description of the applied strategy
1	Basic strategy	$K > 55$	The project realization in basic parameters. No change or with minimal changes from the original terms of reference	The project is implemented within the framework of the developed concept and taking into account the prepared assignment. Additional surveys or involvement of specialized organizations at the stage of concept and land plot assessment are not required
2	Optimal strategy	$55 \geq K \geq 35$	Implementation of the project with minimal changes from the original technical specification, obtaining approvals in advance. Adjustment of the project in order to optimize technical solutions, reduce the risks of additional costs and increase construction terms	Involvement of specialized organizations to conduct additional engineering surveys, a design organization for detailed project development, involvement of the technical customer to obtain the necessary approvals
3	Balanced strategy	$35 \geq K \geq 20$	Substantial changes in the project to improve economic rationality. Assessment of the	Conducting additional engineering surveys, detailed study of the surrounding development and adjacent territory, obtaining approvals

№	Name of strategy in the implementation of the renovation project	Estimated value	Actions taken within the framework of the implemented strategy	Description of the applied strategy
			social factor as one of the fundamental factors in the implementation of the renovation project.	from the balance holders of neighboring land plots, detailed project development at the initial stages. Involvement of organizations with only maximum financial stability for the project implementation
4	Low feasibility	$K < 20$	Assessment of the social effect of project implementation. If the social effect is low, the project implementation is recognized as inexpedient	Conducting additional research on the magnitude of the social effect from the implementation of the residential development renovation project.

These strategies for the implementation of residential renovation projects will help to determine the feasibility of using the land plot considered as a starting point for new construction. The above-mentioned strategies of project implementation take into account all the identified parameters that have a maximum impact on the efficiency of project implementation [10, 11]. The application of one or another strategy depending on the obtained value with the application of the economic-mathematical model developed within the framework of this study, in the author's opinion, can fulfill the main functions: to reduce the risks in the project implementation, to increase the predictability in the project implementation, as well as to reduce the probability of increasing the time and significantly increasing the cost of work on the project implementation, which meets the original objectives.

4 Discussion

The main difficulty for the implementation of the proposed strategies is the increase of costs at the pre-project stage: conducting additional surveys, preliminary analysis of conditions for potential construction, analysis of surrounding development and so on. Among other things, the development period of the pre-project stage may increase significantly, resulting in a later transfer of the land plot for the construction work of the new residential building. In order to conduct preliminary surveys, as well as pre-project analysis, it will be necessary to engage specialized organizations that will conduct the above-mentioned studies to determine the efficiency of the land plot in question [11, 12, 13].

Nevertheless, the application of one of the proposed project implementation strategies, depending on the established efficiency of a particular land plot, will help to further reduce the risks of increased construction time and help to create a more predictable project budget, as the risks that may have arisen at further stages of project implementation will be significantly reduced.

5 Conclusion

As a result of the study, we can conclude that the development of economic-mathematical model and the use of the method of multi-criteria evaluation of the efficiency of land plot use for the construction of new residential buildings under the program of residential renovation can have a positive effect:

1. Increase the predictability of possible risks;
2. Reduce the risks of occurrence of delay in construction terms;
3. Increase the predictability of the construction budget;
4. Evaluate the economic feasibility of using the land plot for construction;
5. Establish the technical feasibility of construction works on the land plot under consideration..

Based on the proposed strategies of project implementation within the framework of the residential renovation program will allow to adjust the vector of work of the main participants mentioned in this study. The main way to increase the efficiency of implementation of residential renovation projects is to improve the quality and depth of the pre-project stage.

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