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Forming the complex quality indicator of social objects

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Abstract. One of the key priorities of government policy is to improve the quality of life of its citizens. The most important focus in this area is the construction of socially important infrastructure. A comprehensive approach to the problem of improving the quality of construction of social facilities, allows us to take into account various major factors affecting the quality of construction in general. Using the method of expert assessments, the most significant factors were identified. In the course of the experiment three levels of significance variation for each group of factors were studied. The method of determining the effectiveness of organizational and technological solutions during the construction of social facilities has been proposed.

1 Introduction

One of the key priorities of government policy is to improve the quality of life of its citizens. The construction of socially important infrastructure is a major focus in this area.

One of the main requirements for social infrastructure projects is the quality of project implementation at all stages of the life cycle.

A comprehensive quality indicator is a tool that allows the quality of a social facility to be assessed at various stages of the life cycle of an investment and construction project during the organisation of construction, from the design phase of the project to its commissioning.

Following an analysis of the literature written by foreign and Russian experts, the main parameters that affect the quality of the finished building are identified:

1. Source permitting documentation;
2. Engineering surveys;
3. The project documentation;
4. The organisational structure of the organisation;
5. The equipment and materials used;
6. Carrying out construction and installation work;
7. Execution and other documents that need to be drawn up in order to commission the facility, to be inspected for compliance with approved standards.

In order to identify the most significant factors, a survey was conducted among experts in the investment and construction sector. Each expert was asked to study and fill in a

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questionnaire, assigning points. With the data collected through expert assessments and the ranking of the results, the eight most important and significant factors affecting the quality of a social construction project were identified:

- existence of technical conditions (F1);
- completeness of engineering surveys (F2);
- implementation of organisational and technological solutions (F3);
- compliance with construction and installation techniques (F4);
- selection of a design and contracting company (F5);
- efficiency of the building materials used (F6);
- application of information modelling technologies (F7);
- use of modern engineering equipment (F8).

2 Materials and Methods

An intercorrelation matrix is compiled for the eight factors selected from the calculation.

The analysis of the resulting intercorrelation matrix identifies four groups of well-correlated variables (*z1*, *z2*, *z3* and *z4*):

1) first group *z1*: existence of technical conditions (F1) and compliance with construction and installation techniques (F4);

2) second group *z2*: completeness of engineering surveys (F2) and application of information modelling technologies (F7);

3) third group *z3*: implementation of organisational and technological solutions (F3) and selection of a design and contracting company (F5);

4) fourth group *z4*: efficiency of the building materials used (F6) and use of modern engineering equipment (F8).

According to the results of the expert survey, the most significant group of factors influencing the quality of social facilities is group *z2*.

An expert survey conducted to determine the significance of each individual factor for the social infrastructure quality process under study and pairwise correlation made it possible to achieve the local research objective of reducing the number of experiments in the experiment to the minimum necessary and sufficient in two steps to obtain the desired model.

In order to build an effective mathematical model, the ranges of variation of the factors must be found, as this determines the scope of the objective function Y.

In this case, the search for a solution falls on the factor space formed by the coordinate axes of each of the factors.

The factors must be converted into dimensionless values (coded).

$$z_i = \frac{(zi - z0)}{dzi}, \quad (1)$$

where *zi* – coded factor value,

zi – the value of factor (*i*) on a natural scale.

$$dzi = \frac{zimax - zimin}{2}, \quad (2)$$

$$z0 = \frac{zimax + zimin}{2} \quad (3)$$

Each of the coded factors zi can only take certain values of -1; 0 or +1.

Table 1. The coded value of the factors.

Factors	Code	-1	0	+1
Existence of technical conditions	F1	Missing	Partly present	Present
Completeness of engineering surveys	F2	Lack of most sections and reports	Lack of separate sections and separate reports	Presence of all sections and reports
Implementation of organisational and technological solutions	F3	Not in progress	Partially implemented	Implemented
Compliance with construction and installation techniques	F4	Not complied with	Partially complied with	Complied with
Selection of a design and contracting company	F5	Organisations without authorisation, certification, qualifications, delayed work, poor quality of work	Organisations without parts of permits, certifications, qualifications, carrying out work with no significant delays, satisfactory quality of work	Organisations with all permits, certifications, qualifications, performing work in the prescribed, high quality of work
Efficiency of the building materials used	F6	No modern building materials are used	Partly modern building materials are used	Modern building materials with the necessary tests and certifications are used
Application of information modelling technologies	F7	Not applicable	Partly applicable	Applicable
Use of modern engineering equipment	F8	Not used	Partly used	Used

Each factor is subject to certain criteria: it has a significant impact on the final CRC value, is subject to unambiguous description, and varies qualitatively at all three levels: at the lower level (its coded value is -1), the main level (with a coded value equal to 0), and the upper level (coded value is +1). The distribution of the levels of variation for each factor is presented in Table 1.

In order to obtain a regression equation, it is necessary to calculate the coefficients at the reciprocal, quadratic and linear terms of the equation.

The resulting second-order regression equation is a mathematical model of the process under study.

The mathematical model allows adjustments to be made to achieve the required levels of reliability, quality, durability at any of the stages of a socially significant investment project.

The use of a mathematical model, which reflects in the end the essence of the phenomenon we are considering, acts as an optimal solution, allows us to successfully predict, assess the impact of individual factors on the complex indicator of the quality of social facilities.

In the following calculations, a composite quality indicator, defined by its parameters rather than by groups of factors, will be referred to as CQI.

In order to derive a detailed mathematical model based on a particular functional relationship that produces CQI values, the methodology for modelling factor systems is applied, from which we derive an expression of the form:

$$CQI = \sum_{i=1}^{n} W_i pi, \tag{4}$$

where Wi – the coefficient of importance (weight), of the i-th parameter.

The resulting model not only sufficiently characterises the complex quality indicator process under study, but also allows it to be upgraded to make the process more complex or simpler.

Having developed the methodology, which allows to define the effectiveness of organizational and technical solutions at designing and erection of socially significant objects by means of complex index of quality of objects of social purpose, the necessity to develop the methodology, which allows to influence positively the quality of realised projects of social infrastructure of cities, has appeared.

According to the scientific hypothesis, it is possible to achieve an increase in the actual quality indicators on a building site by increasing the values of the factors.

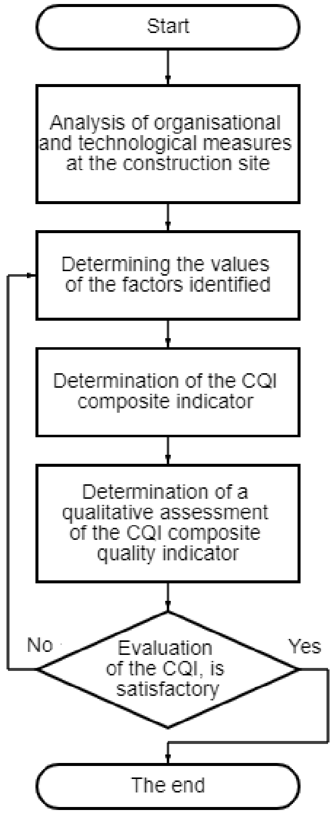

Fig. 1. Block diagram of the algorithm for calculating and improving the CQI composite performance indicator.

With the establishment of a comprehensive assessment and CQI calculation algorithms, the methodology for the comprehensive quality assessment of social facilities has been described:

1. Monitor the organisational and technical solutions that are involved in the construction of social facilities, taking into account the applicable regulations;
2. Correlation of organisational and technical solutions, taking into account the factors identified;
3. Determination of a composite quality indicator for social facilities;
4. The value already obtained correlates properly with the tabulated data of the qualitative interpretation of the discrete assessment, with the determination of the qualitative assessment of the developed organisational and technical solutions.

If an unsatisfactory quality assessment has been found, the following methodology can be used:

1. Implementing activities that will lead to a significant improvement in quality with minimal financial costs, possible adverse effects on the client himself;
2. Calculation of new values for the refined factors;
3. Redefining factors;
4. Reconciliation of the criterion with the qualitative interpretation table to determine the qualitative assessment of already approved technical and organisational solutions.

If the customer is still not satisfied with the value of the indicator, the algorithm can be repeated until the work satisfies all requirements.

3 Results and Discussion

To date, the current problem is the lack of a comprehensive approach to assessing the quality of socially significant infrastructure, which would help to take into account the range of available factors affecting the quality level of social construction projects, to meet the needs of the construction industry to control the quality of construction work throughout the life cycle of the project.

As part of the research work, the authors looked at the implementation of a construction project, including pre-investment studies and project planning, design and construction phases.

The validity of the hypothesis put forward in the course of the research about the possibility of practical use of the concept "complex indicator of the quality of social purpose objects" has been substantiated.

The main factors affecting the quality of social facilities at different stages of the project life cycle during the construction organisation were selected, structured and ranked.

A methodology for calculating a composite quality indicator for social buildings in the construction organisation process is generated.

4 Conclusion

The lack of comprehensive indicators and criteria for evaluating construction progress is the most significant shortcoming of the methods currently in use.

The methodology formed by the authors allows at various stages of an investment and construction project with the help of such a tool as "comprehensive quality index of social purpose facilities", to determine the level of quality, as well as adjust the organisational and technical solutions, if necessary.

This topic is relevant and promising for further research. For further development of the topic it is recommended to:

1. Formation of an information database, including information on the progress and

stages of construction of social infrastructure facilities;

2. Creation of a software package to automate data collection as well as to visualise the results of the quality improvement method for social facilities.

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