

Development of Quality Control System for Construction of Residential Real Estate on the Basis of a Process Approach

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Abstract—The article considers the general rule of the influence of quality management processes in the planning and implementation of investment projects for the construction of residential real estate on the indicators of their effectiveness. The formation and application of a quality management system based on the process approach is proposed. Structural decomposition of processes and procedures for designing, inspecting and implementing the project is presented, problem points that cause deviations from the plan and require increased attention within the framework of the quality management system of the investment and construction project are identified. A reasonable conclusion is that the target installation, which ensures the improvement of the quality management system of the construction project, is to minimize the time period required to detect significant deviations in the actual project parameters from their planned values, which can be facilitated by the application of the process approach. The results of the testing of the developed solutions are presented.

Keywords—Construction Quality, Control System, Residential Real Estate, Process Approach, Problems, Solutions.

I. INTRODUCTION AND RELEVANCE

At present, due to the increase in the volume and rate of housing construction in the cities of Russia, the increase in commissioned housing, the most urgent is the question of the quality of construction products. Many development and construction organizations need to solve a number of problems to improve the quality of housing [1-3].

According to ISO standards, quality is the degree of compliance of the aggregate inherent characteristics of the object with the requirements, that is, the quality of construction products is understood as the entire amount (in total) of the characteristics of the construction object, ready for operation, allowing to meet the assigned needs [4, 5].

Insufficient attention to quality leads to higher cost of construction, increase in operating costs to maintain the required technical condition of the constructed object, deterioration of the necessary amenities and comfort for residents, and in some cases - to accidents of poorly constructed buildings and structures [6-8].

II. THEORETICAL PART

The effectiveness of the construction quality management system has a significant impact on the effectiveness of the investment project construction [9]. Figure 1 shows the general pattern of changes in the key parameters of the investment project, depending on the level of quality of construction production.

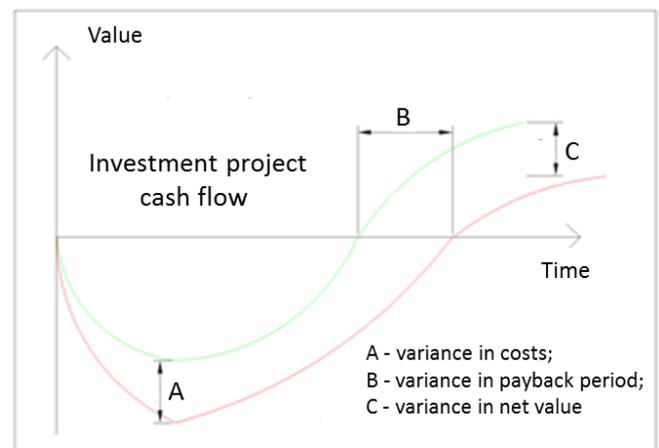


Fig. 1. The general pattern of the impact of quality management processes in the planning and implementation of investment projects of residential real estate construction on their performance indicators.

When considering a development project taking into account its specifics, it is advisable to consider the processes of ensuring the quality and consumer characteristics of the real estate object on the basis of a process approach, that is, the structural decomposition of processes within the framework of an investment and construction project.

The process approach is based on several principles. The introduction of these principles can significantly improve the efficiency of work, but at the same time, requires a high production culture. The transition from functional management to process requires employees constantly working together, despite the fact that they can relate to different units. The effectiveness of the principles of the process approach will depend on the extent to which this joint work can be achieved.

When forming a system of quality control of residential real estate construction on the basis of the process approach, it is important to adhere to the following principles:

- The principle of the relationship of processes. An organization is a network of processes. The process is any activity where the work takes place. All processes of the organization are interconnected.

- The principle of the demand process. Each process must have a goal, and its results must be in demand. The results of the process should have their own internal or external consumer.

- The principle of documenting processes. Process activities need to be documented. This allows you to standardize the process and get the base to change and further improve the process.

- The principle of process control. Each process has a beginning and an end that define the boundaries of the process. For each process within the given boundaries should be defined indicators characterizing the process and its results.

- The principle responsibility for the process. The process may involve various professionals and staff, but one person should be responsible for the process and its results.

Each phase of the investment and construction project can be presented in the form of a set of processes, including control procedures, responsible, regulatory authorities and indicators to assess the status of a particular process of project implementation.

In the framework of the study, the author conducted a structural decomposition of the processes and procedures of design, inspection and implementation of the project, identified problem points that cause deviations from the plan and require increased attention in the framework of the quality management system of the investment and construction project (Table 1) [10-15].

TABLE I. TYPICAL PROCESSES AND POSSIBLE PROBLEM SITUATIONS IN THE FRAMEWORK OF THE INVESTMENT PROJECT OF HOUSING CONSTRUCTION

Project stage/ project phase	Process	Problem situation
Pre-project stage	Collection of initial data for design	Insufficient completeness and reliability of initial data
	Market analysis	Insufficient elaboration
	Evaluation / comparison of construction sites (ecology, transport, organizational factors)	Lack/imperfection of multi-criteria system of land valuation
	Assessment and forecasting of financial aspects	Overestimation of performance indicators
	Formation of the project concept	Choosing the best concept
	Formation of the	Insufficient elaboration

	design assignment	
	The choice of the designer	The choice of the designer with insufficient qualifications
	Conclusion of contracts	Insufficient elaboration
Design	Analysis of the design assignment	Disruption of communication between the designer and the customer
	Ordering of technical specifications for design	Specifying incorrect capacities
	Ordering and conducting engineering surveys	Saving on carrying out all necessary surveys
	Design documentation development	Deviation from the requirements of the design assignment
	Development of working documentation	Deviation from the design documentation, untimely development
	Order / receipt of coupons for garbage and soil removal	Get directions to remote landfills
Construction	The selection of the General contractor	The selection of the General contractor's qualifications and experience
	Conclusion of contracts	Insufficient elaboration
	Contractor mobilization	High duration of mobilization, the unwillingness of the General contractor and subcontractors to the stated maturity of the start of construction
	Construction and installation works	Savings on materials, equipment and skilled workers
	Control of construction and installation works	Violation of order and completeness of control
	Formation of as-built and balance sheet documentation	Untimely and incorrect registration of the executed works
	Formation of documents on the conclusion of compliance	The problem of losing the original documents required
	Execution of a temporary contract of operation management	Difficulties with the acceptance of the systems in temporary operation
	Conclusion of contracts for the provision of public services	Lack of necessary documents for the conclusion of contracts
	Final inspection	Detection of difficult to eliminate defects, lack of

		necessary documents
	Commissioning of the facility	Absence of documents to be provided by subcontractors, inability to operate engineering systems for formal and technical reasons
The acceptance of the completed facilities to the buyers	Compensating for deficiencies	Occurrence of unforeseen expenses
	Signing of the act of acceptance-transfer	Delay in the signing procedure without objective reasons
	Signing of temporary contracts for operation (taking into account the meter readings)	Unwillingness of owners to sign contracts, as well as to participate in the General house meeting
Operation	The selection of a permanent UK	Long-term procedures, conflicts, unwillingness of the district administration to hold a competition
	Elimination of defects in the warranty period	Long the General contractor responds to the complaints of owners and management company in terms of removal of comments
	Current repairs	Ignoring requests for current repairs
	Major repairs	Ignoring applications for major repairs

III. RESULTS AND SUGGESTIONS

On the basis of the author's hypothesis, it is concluded that the target setting, which provides an increase in the efficiency of the quality management system of the construction project, is to minimize the period of time required to identify significant deviations of the actual parameters of the project from their planned values, which can be facilitated by the use of the process approach:

$$\begin{cases} E_{project} = F(\sum Q_{process}) \rightarrow \max \\ Q_{process} = F(\sum T_{process}) \rightarrow \max \\ T_{process} \rightarrow \min \end{cases} \quad (1)$$

where

$E_{project}$ – efficiency of investment and construction project;

$Q_{process}$ – effectiveness of quality management of a separate process in the planning and implementation of the investment and construction project;

$T_{process}$ – period of time required to identify significant deviations of the actual project parameters from their planned values within a separate process.

IV. PRACTICAL PART

With regard to the specifics of management of the implementation of investment and construction projects of residential use on the basis of the identified and structured list of processes and problem situations, a set of practical provisions aimed at preventing the occurrence of problem situations and, as a result, to improve the quality of construction products and the efficiency of the investment and construction project as a whole.

A set of practical provisions to improve the processes of project management includes:

- the use of 3D geomodelling geosystems in the course of quality control of compliance of design decisions and control the work performed [16];
- use of accepted payments when ordering materials and programmable locks on machines when delivering materials to the construction site;
- use of chips for intensification of monolithic structures [17];
- application of the system of electronic digital signatures in the daily formation of records in the General journals of works;
- application of specialized software systems that automate storage, classification and structuring of information within the quality management system [18, 19];
- use of available high-tech quality control tools to detect defects of hidden works;
- regular advanced training of the direct perpetrators, carrying out of certification of employees of the contractor from the customer [20];
- organization of show-rooms (standard apartments) to pre-identify weaknesses in the execution of the works and mitigate risks and identify deficiencies at the stage of receiving customers.

V. IMPLEMENTATION RESULT

The developed provisions were tested by the author on the basis of the materials of the investment project of construction of a residential complex of business class "Heritage", located in Moscow, Preobrazhensky district.

The project involves the construction of 45,000 sq. m of housing and 8,000 square meters of commercial premises and two-level underground Parking of 22,000 sq. m. Planned construction period is 36 months. The expected investment volume is 8.5 billion rubles.

Based on the results of multi-stage modeling of the procedures for the implementation of the developed provisions to improve the quality management system on the basis of project and as-built documentation for the project under consideration, the results presented in Table 2 were obtained.

The results allow us to conclude about the effectiveness of the developed provisions for improving the quality management system in the planning and implementation of investment projects of housing construction.

TABLE II. THE RESULTS OF THE IMPLEMENTATION OF THE DEVELOPED PROVISIONS TO IMPROVE THE QUALITY MANAGEMENT SYSTEM

The resulting indicators of the project	Changes in the indicator based on the results of implementation
Duration	- 3 months (- 8.35 %)
Amount of financing	- 0.2 billion rubles (- 2.35 %)
Net profit	+ 0.4 billion rubles (+ 3.26 %)

VI. CONCLUSIONS

The project implementation requires the developer to control almost daily in terms of financial activities, technical compliance, project risk control and other most important parameters of the project. The application of the developed provisions on the development of quality management system can contribute to the sustainability and effectiveness of investment projects of housing construction. Implementation of the proposed procedures can be carried out as a specialized customer services, and involved independent organizations that provide a range of services for the control of production and business processes.

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