

# Intensification of the investment process of construction

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**Abstract.** The article provides negative trends of braking development of the investment process of creating buildings and structures and describes the dynamic system of the investment process and its components given the basis of domestic and foreign experience. It also categorizes the factors influencing the duration of the investment process, which are presented as procedural, engineering design and manufacturing. The article discloses the accounting procedures of these factors by measuring their information content with access to the formation of a rational structure of the investment process.

## 1 Introduction

Improving the efficiency of the investment process and reducing of its duration is one of the main tasks at the present stage. In recent years, Russia adopted indigenous measures for the restructuring of the whole process of design and construction at the expense of wide introduction of scientific and technical progress, resource conservation, maximizing the use of intensive factors of growth rates of construction [1, 6].

But there are negative trends of braking the emerging positive phenomena – the absence of target orientation to shorten the duration of the investment process, the separation of the functions of activities of the participants of creating the object, weak convergence of the stages and elements of the investment process, the irrational decision making. The ineffectiveness of the applied in certain cases schemes of erection of enterprises, buildings and constructions manifests itself in the face of the principles of full cost accounting and self-financing [2, 3, 4]. For example, system analysis of construction of enterprises buildings and constructions held in eleven branches of industrial construction (electric power engineering, metallurgy, oil refining and petrochemical industry, chemical industry, mechanical engineering, etc.) indicates that about 65.6% from 100% of all failures in the construction were because of the imperfection of the planning, design, logistics and financing of construction works, and 29.8 % were because of poor organizational and technological solutions.

Russian and foreign experience, progressive approaches and solutions of reduction of the length of the investment process proposed by a number of construction, design and research organizations have shown the reality of shortening of the speed of creating objects in 1.5-1.6 times due to intensive factors, which do not require any additional resources [5, 6, 7, 9].

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## 2 Methods

The investment process of objects creation should be seen as a complex dynamic system, consisting of four main functional subsystems - feasibility study, design, preparation of an object for construction process and construction itself, which are in the certain relations and connections with each other.

Each of the subsystems in turn consists of a set of elements (as indivisible parts of subsystems), with both the internal relationships between elements, subsystems and external links with elements from other subsystems.

Existing in the system of the investment process the flexible relationships between elements and subsystems are subdivided into recursive synergies, and cyclic.

Recursive relationships are irreversible in the system, they install the specific reason of a lengthening of the timing of the investment process (according to the functions of the participants creating the objects of construction) and the resulting consequences.

The synergistic relationships characterize the strengthening of the data flow in this element and, therefore, such an element is treated as a multifunctional.

Cyclic relationships describe periods of enabling the participants object creation into the investment process.

The ideology form of the structure of the investment process of an object creation is outlined in Figure 1.

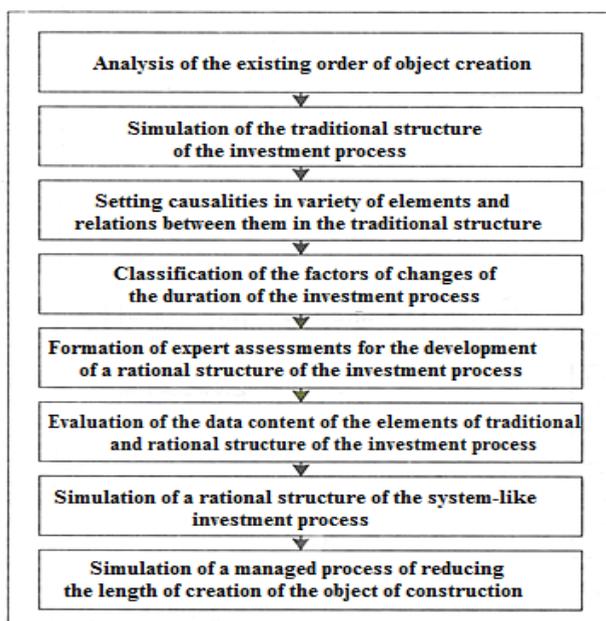


Fig. 1. Ideology form of the structure of the investment process of creating an object of construction.

## 3 Main part

Development of the system of the object creating is determined by the combination of sustained actions made in order to achieve the quantified results – solution development, coordination and approval of documents, construction of buildings and structures, etc. Such actions on the basis of their specific products are divided into three types of processes:

1. Procedural processes characterizing features of the object creation order and forming on this basis the relationship between the parties;

2. Engineering and computational processes, including the development of a space-planning, structural, organizational, technological, technical and other solutions;
3. Production processes, providing the preparatory and main construction works.

The driving force of a quantitative manifestation of the processes is the set of factors that determine the nature of the changes in the system or its separate subsystems. Some factors directly or indirectly reduce the length of the investment process, while others extend it. A number of factors is acting throughout the whole stage, and a number of others run only in a very short period of time. At the same time the properties of the factors are also various – deterministic and stochastic [8, 10, 11].

Therefore, in order to effectively manage the entire coherent system of creation of the objects of construction it is needed to identify almost all the major influencing factors. Moreover, it should also be borne in mind the fact that in some circumstances, there may have been a negative impact, and in other conditions – a positive influence. In order to take account of the totality of the factors influencing on the duration of the investment process, there was developed their classification (Table 1), including five classifications. In the process of grouping factors there were identified more than 50 of them, extending both the length of separate phases and the investment process as a whole (Table 2).

**Table 1.** Classification of the factor changes for the duration of the investment process.

Level indication	Classification indicator	Factors and their groups
I	Belonging to the parts of the process	Procedural (organizational management, procedural-performing, economical). Engineering and design (design and engineering, organizational and technical). Production (common site, object, nature and climate).
II	Degree of influence on the process duration	Shortening the duration. Prolonging the duration
III	Impact duration	Short-term. Long-term.
IV	Nature of manifestations	Deterministic. Stochastic.
V	Accounting functions	Customer-developer. General Designer. General contractor. Subcontractor. Bank. Project organizations. Bodies of material maintenance. Transport organizations.

**Table 2.** Groups of factors, prolonging the duration of the investment process, in accordance with "the belonging to a constituent process".

Components of the investment process	Groups of factors	Factor	Code of factor
1	2	3	4
Procedural	Organizational and managerial $(h_i^{n1})$	Inconsistency of participants creating an object of construction	$h_1^{n1}$
		Disruptions of supply of material and technical resources	$h_2^{n1}$

		Failures in supply of technological equipment	$h_3^{n1}$
		Inefficient use of manpower (downtimes, non-production costs)	$h_4^{n1}$
		Inappropriate use of technical resources	$h_5^{n1}$
		Irrational use of material resources	$h_6^{n1}$
		Failure to comply with the order of development, agreement and approval of documents	$h_7^{n1}$
		Irregularities in the selection of constructional sites	$h_8^{n1}$
		Violations of approval of constructional site	$h_9^{n1}$
		Irregularities in the transfer of the object of construction (part of the object) to subcontracting organizations	$h_{10}^{n1}$
	Procedural-performing $(h^{n2})$	Improper design specifications, specifications for developing design and preparation works, etc.	$h_{11}^{n2}$
		Delayed correction of documents	$h_{12}^{n2}$
		Transferred documentation is not full	$h_{13}^{n2}$
		Non-arrival of the representatives of oversight services	$h_{14}^{n2}$
	Economical $(h^{n3})$	Delayed opening and uneven funding	$h_{15}^{n3}$
		Improper allocation of funds and limits	$h_{16}^{n3}$
		Incorrect definition of contract prices	$h_{17}^{n3}$
		Failure to fulfil contractual obligations	$h_{18}^{n3}$
		Delays in signing of contracts	$h_{19}^{n3}$
		Irregularities in the registration of orders, requests, etc.	$h_{20}^{n3}$
Engineering calculations	Design and engineering $(h^{p1})$	Poor quality of design solutions:	$h_{21-23}^{p1}$
		technological	$h_{21}^{p1}$
		space-planning	$h_{22}^{p1}$
		constructive	$h_{23}^{p1}$
	Organizational and technical $(h^{p2})$	Violations of the duration of the construction	$h_{25}^{p2}$
		Lack of continuity solutions	$h_{25}^{p2}$
		Irrational timing of labor, material and technical resources	$h_{26}^{p2}$
		Irrationality of the deadlines of the nomenclature and volumes of preparatory works	$h_{27}^{p2}$
		Disunity of the projected production processes	$h_{28}^{p2}$

		Inefficient distribution of volumes of works on the projects and years of construction	$h_{29}^{j2}$
		Approximate calculation of parameters of work implementation	$h_{30}^{p2}$
		Lack of consistency in the development of building sites	$h_{31}^{c1}$
Productional	Common ground $(h^{c1})$	Separate construction of underground parts of buildings and constructions and engineering communications	$h_{32}^{c1}$
		Separate laying of engineering communications	$h_{33}^{c1}$
		Large amount of temporal engineering and transport communications, buildings and structures	$h_{34}^{c1}$
		Violations of priority works	$h_{35}^{c1}$
		Performing primarily material-works	$h_{36}^{c1}$
		Errors in binding mounting and storage sites	$h_{37}^{c1}$
		High labour intensity of works	$h_{38}^{c1}$
		Low level of sanitary and domestic service for workers	$h_{39}^{c1}$
	Object $h^{c2}$	Unpreparedness of the front work performed by general contractor	$h_{40}^{c2}$
		Delayed execution of works performed by subcontracting organizations	$h_{41}^{c2}$
		Lack of combining of the primary and preparatory periods of construction process	$h_{42}^{c2}$
		Transfer of the start of the main construction to a later date	$h_{43}^{c2}$
		Significant proportion of manual labor	$h_{44}^{c2}$
		Mismatch in number and qualification of the working staff to the structure of works	$h_{45}^{c2}$
		Inconsistency of construction machinery to structure works	$h_{46}^{c2}$
		Failure of construction machinery	$h_{47}^{c2}$
		Weak interaction of labor resources	$h_{48}^{c2}$
		A large volume of work in the year of commissioning	$h_{49}^{c2}$
		The discrepancy of the actual rhythm of building to a settlement	$h_{50}^{c2}$
	Natural and climatic $(h^{c3})$	The loss of working time due to low temperature, snow, strong wind, fog, heat, etc.	$h_{51}^{c3}$

The process of forming a rational structure, providing in outlet a sharp reduction in the duration of creation of the objects of construction represents a connection of united into some coherent whole optimized elements, including their integration, summation, and re-combining, and is held in the three procedures.

The first procedure involves selecting elements of the new structure, based on the experience of design and construction of facilities and expert evaluations.

Generalization of experience in the design and construction using high-speed methods shows that the decisive factor to reduce their terms of creation were - parallel implementation of the design and construction, type-ahead start of the launch complexes, the introduction of innovative solutions of construction organization, continuous financing of the construction on the basis of contractual prices, concentration human and material resources with the use of a rotational form of work organization and collective contract [12, 13, 14].

The second procedure is to establish linkages between the elements of the new structure, based on assessments of information messages.

At the beginning of the procedure a topology of relationships is generated (recursive, synergistic, circular) between elements of the structure throughout the investment process.

As a measure of the information content there is used an informational message (IM)-table, chart, list, clearly formulated position etc. The main provisions of the pragmatic approach include:

1. Mandatory exclusion of duplicated and derived information;
2. Consideration of im as a complete unit (without any initial data, techniques of receipt);
3. Ability to change the im in the elements, regardless of the existing regulations;
4. Evaluation of textual materials on a qualitative level only.

The third procedure directly generates efficient structure of the investment process, based on the results of the analysis of the information content of elements.

The evaluation of information flows for more than 50 objects resulted in a rational structure of the investment process through validation and development of the rational priority in construction and its duration, timing of working documentation development, composition and timing of preparatory and basic works, requirements in labour and technical resources, etc.

The resulting calculation formulas for determining the timing of the initial and final stages of the investment process for the average facility are summarized in Table 3.

**Table 3.** Calculation formulas for determining the timing of the initial and final stages of the investment process.

Stages	Calculation formulas	
	initial, $t$	final, $t^0$
Feasibility study	$t_1 = 0$	$t_1^0 = 0.1 T$
Designing	$t_2 = 0.06 T$	$t_2^0 = 0.6 T$
Preparation of a building for construction	$t_{no}^n = 0.1 T$	$t_3^0 = 0.81 T$
Construction	$t_3 = 0.22 T$	$t_4^0 = 0.97 T$
Putting into operation	$t_4 = 0.97 T$	$t_5^0 = T$

The final formula to calculate the overall length of the investment process for the average object of construction is expressed as follows:

$$T = t_1^0 + (t_3^0 - t_3) + (1 - u_4) + (t_4^0 - t_4) + (t_5^0 - t_5) \quad (1)$$

Where  $T$  – the duration of the investment process of creation of an object of construction;

$u_4$  – coefficient of the combination of a construction stage with other stages ( $u_4 \approx 0.79$ ).

This model is fairly compact and allows to fully or partly exclude the influence of the most part of factors which can negatively influence on the duration of the investment process (Table 4).

**Table 4.** Composition factors, the influence of which is completely or partially excluded because of the implementation of the concept of express creation of the objects of construction.

Components of the investment process	Groups of factors	Codes of factors
Procedural	$h^{n1}$	$h_1^{n1}, h_2^{n1}, h_3^{n1}, h_4^{n1}, h_5^{n1}, h_6^{n1}, h_7^{n1}$
	$h^{n2}$	$h_{12}^{n2}, h_{13}^{n2}, h_{14}^{n2}$
	$h^{n3}$	$h_{15}^{n3}, h_{16}^{n3}, h_{17}^{n3}, h_{18}^{n3}, h_{19}^{n3}$
Engineering calculations	$h^{p2}$	$h_{24}^{p2}, h_{25}^{p2}, h_{26}^{p2}, h_{27}^{p2}, h_{28}^{p2}, h_{29}^{p2}, h_{30}^{p2}$
Productional	$h^{c1}$	$h_{31}^{c1}, h_{32}^{c1}, h_{33}^{c1}, h_{34}^{c1}, h_{35}^{c1}, h_{36}^{c1}, h_{37}^{c1}, h_{38}^{c1}, h_{39}^{c1}$
	$h^{c2}$	$h_{40}^{c2}, h_{41}^{c2}, h_{42}^{c2}, h_{43}^{c2}, h_{44}^{c2}, h_{45}^{c2}, h_{46}^{c2}, h_{47}^{c2}, h_{48}^{c2}, h_{49}^{c2}, h_{50}^{c2}$

## 4 Conclusion

For the effective management of the system of creation of the object of construction, it is required to take into account all the influencing factors both extending and reducing the duration of the investment process.

The analysis shows that such a combination of factors represents more than 50 factors, classified by various characteristics of their influence.

The process of accounting of the influencing factors involves three procedures, the end result of which is the rational structure of the investment process.

As an example, there is shown a model for determining the length of the investment process for an average object of construction specifying a number of decisions mentioned in the text. This model demonstrates the possibility of statistical accounting of various factors and building the investment process for the uniform objects both of productive and non-productive function.

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