

Modelling the Reduction of Project Making Duration

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Abstract. The article points out why earlier patterns of investment process were ineffective in developing the construction projects and shows sources for reducing of its total duration. It describes the procedure of statistical modeling and obtaining medium-term time parameters required for modern pattern of project-making; offers design formulas for assessment of total time required for project-making as well as for its main stages; reveals advantage of modern system of project-making against traditional one by comparing indicators of their duration.

1 Introduction

Shorter periods of constructing buildings and facilities are a challenging problem of capital construction. Investment process in project-making includes many stages, most important of them are: feasibility study, engineering, preparation for construction, construction, commissioning [1, 2, 3, 4].

Pre-2000 pattern of traditional project-making was ineffective due to variety of reasons. Firstly, all types of resources were scattered among numerous projects being built at the same time. E.g. year 1980 saw simultaneous construction of 600,000 industrial design projects, and, with residential, public, preschool, administrative, medical, sport and trade projects added, total amount of the projects under construction was not less than 800,000. Consequently, each project employed 7.5-8 workers on average. That explained why ingrained notions of ‘start-up’, ‘extremely important’ project laid almost legal foundation under a rushed work, as it was not earlier than the final year when such projects received the largest part of the funds allocated. Secondly, the first year of construction spent usually 3-12 % of construction-and-assembling operations cost, the sum sufficient just for some preliminary works at the site, with many similar works and main construction-and-assembling operations remained not fulfilled. The result was a severe shortage of resources and performance of the most profitable resource-demanding operations as a key factor. These and some other reasons made de-facto duration of construction 1.8 – 2.5 times longer than the normative one [2, 4, 5]. Years of economic reforms managed to agree intricate multi-layer construction procedure and capacities of economic mechanism. On average, duration of buildings and facilities construction takes 1.3-1.4 less time thanks to management-organizing factors, that does not need attraction of any extra funds [6, 7, 8].

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2 Methods

The findings of Russian and foreign researchers give a reason to conclude that further reducing of facility making investment process duration is reached mainly via revealing and considering of factors that harmonize various steps of construction and reducing of their duration [4, 9, 10, 11].

Economic reforms contributed a lot to combining and shortening of investment process steps [1, 12, 13], e.g.: uniform requirements for structure and contents of project documentation sections for construction of industrial and non-industrial projects, cancellation of design staging, and (for some projects) wider content of feasibility study in replace of traditional construction management project, etc. Of equal importance are implementation results of innovative methods, ways and forms of construction management: long-term-flows-based construction, component assembly and complete containerized construction methods, advance design preparation of territories, conveyer block building system, mobile forms of work (rotation, expedition, rotation and expedition, etc.) [2, 6, 14].

To create a modern topology pattern for facility making investment process and obtaining its mean time parameters, we scrutinized more than 60 projects in various sectors of industry that were built and commissioned in different years and required significant capital investments. Statistical parameters for empiric distribution of duration included absolute and relative frequencies, mathematical expectation, statistical dispersion, root-mean-square deviation with plotting of bar graphs. Statistical parameters were calculated separately for actual and normative duration of each facility making step.

The research proved that approximately 65.6 % of all failures fall on imperfect planning, procurement and financing. At the same time, inadequate organizational and procedure decisions make 29.8 %. Functioning system of making project has typical drawbacks like segregation of participants, huge lags between planned actual dates of obligations fulfilment, time-consuming procedures of making key decisions. Additional factors are wrong choice of the construction site, inappropriate correction of documents and processing of orders, separate construction of substructure blocks of the buildings and infrastructure, many provisional buildings and facilities, unprepared field of operations, etc.

Calculations proved the hypotheses for normal distribution of durations in each step of project making. From graph bars follows that the mean total duration of feasibility study, designing and preparation for construction (before construction proper) takes 13 months or 22 %, and mean duration of the construction, 75 % of total duration. Mean actual duration of facility making (\bar{T}) was obtained as a weighted mean value

$$\bar{T} = \frac{\sum_{i=1}^n V_i (t_i^1 + t_i^2)}{\sum_{i=1}^n V_i} \quad (1)$$

where V_i is: construction costs for the i^{th} facility, ths. RUB;

t_i^1 is: duration of the phases of: feasibility study, design, preparation of the facility for construction prior to the start of construction at the i^{th} facility, months;

t_i^2 is: duration of the construction phase at the i^{th} facility, months.

$$j = \overline{1, n}, n = 56$$

3 Main part

Mean duration of facility making makes 58 months for the sample mentioned. Feasibility study, required approvals inclusive, takes about 6 % of a total duration of project making, and duration of designing, including time for the peer review of project documentation, takes 54 %. It is implied that after the project approval detailed documents are to be com-

piled for complex of operations: substructure block, superstructure block, infrastructure, finishing, etc, that allows the construction company to support high rate of operations. Preparation for construction comes at the same time with designing and includes: concluding a construction contract between the general contractor and the technical customer, delivery of project documents and notarized copies of a building permit and a land allocation certificate, developing of construction projects, etc.

Construction-and-assembling operations begin in month 14 and finish in 43 months. Commissioning takes approximately 2 months. Time parameters of facility making are shown in Table 1.

Table 1. Time parameters of the facility making

#	Main phases	Temporal phases of indicator		
		start t^s	finish t^f	duration $t^f - t^s$
1	Feasibility study	$t_1^s = 0$	$t_1^f = 0.1 \cdot T$	$t_1 = t_1^f - t_1^s$
2	Design	$t_2^s = 0.06 \cdot T$	$t_2^f = 0.6 \cdot T$	$t_2 = t_2^f - t_2^s$
3	Preparation of the facility for construction	$t_3^s = 0,1 \cdot T$	$t_3^f = 0.81 \cdot T$	$t_3 = t_3^f - t_3^s$
4	Construction	$t_4^h = 0.22 \cdot T$	$t_4^o = 0.97 \cdot T$	$t_4 = t_4^f - t_4^s$
5	Comissioning phase	$t_5^s = 0.97 \cdot T$	$t_5^f = T$	$t_5 = t_5^f - t_5^s$

Total duration of investment process, as a part of facility making, is obtained from its parameters as follows:

$$T = t_1 + t_3 + (1 - u_4) \cdot t_4 + t_5 \quad (2)$$

where $u_4 = 0,79$ is: a coefficient of combining the construction phase with the phase of preparation of the facility for construction.

Indications of advance lags make 58.3% for feasibility study, 7.9% for designing, 17.1% for preparation for construction.

Implementing of modern patterns for investment process of facility making while planning, designing and construction revealed their advantages, in particular:

- validation of priority and duration of construction, dates of developing the project documents and implementation preparation for construction measures;
- expediency of advanced development of work performance projects for the part of working documents to be brought;
- reality of negotiated construction price agreed between the customer and the contractor (with regard to methods of construction, job management, etc.).

Comparison studies of mean durations of traditional and modern patterns facility making (Table 2) strongly support significant advantage of the modern pattern in almost every stage of the investment process. The gap is largest in the designing step (more than 2 times) and steps before the start of construction.

Table 2. Time indicators for the traditional and modern patterns of the facility making

#	Name of indicator	average values in days	
		according to traditional scheme	according to modern scheme
1	Total duration	112	58
2	Duration of feasibility study taking	4	3.5
3	Duration of design phase	77	31.5
4	Duration of preparation of the facility for construction phase	53	41
5	Duration of construction phase	58	43
6	Duration of commissioning phase	2	2
7	Duration before construction phase	54	13

4 Findings

The necessity for modelling the investment process in facility making allows establishing firm organizational-procedure interrelations between its main steps presented compactly and rationally. Organizational-procedure interrelations are described via time indicators (start, finish, and duration of the stage), coefficients of coincidence and advance lags of the steps.

Modelling the investment process in facility making is attractive for various sectors of industrial construction for, firstly, finding the sources for reduction of total duration, and, secondly, for harmonization of facilities in terms of strategic and current planning and creating the work program for the construction company.

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