Systems engineering real estate development projects

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Abstract. In recent years, real estate development has accumulated a wealth of experience in implementing major projects, which requires comprehension and systematization. The scientific instrument of system engineering is studied in the article and is substantively interpreted with reference to real estate development projects. The most perspective approaches and models are substantiated, allowing strategically to plan the life cycle of the project as a whole, and also to solve the engineering but problems of the project. The relevance of further scientific studies of regularities and specifics of the life cycle of real estate development projects conducted at the Moscow State University of Economics and Management at the ISTA department is shown.

1. Introduction
Professional-entrepreneurial activity in the real estate development, its development, under current conditions is one of the most complex types of business. This is determined by the growth in the scope of projects, the need for long-term strategic planning of the life cycle of the project, and a large number of different factors affecting the project.

Effective implementation of real estate development projects involves the use of modern scientific approaches, models and technologies that allow to take into account and manage numerous changes in conditions and requirements for the project. The analysis makes it possible to identify the most promising tools, taking into account the specifics of development projects: the genetic approach and organizational and technological genesis, the functional models of the project result and the engineering aspects of the project's adaptation to the projected changes (adaptive manufacturability).

2. Instruments and methods
Recently, following the acceleration of changes in investment and socio-economic priorities and needs, engineering and construction technologies, technologies and production processes, external and internal parameters and constraints of the project, the complication of the relations between the project participants has become increasingly demanded by the highly professional real estate development. In this regard, following the changes in the construction industry and the real estate market, real estate development projects were gradually formed and systematically complicated. Initially, when construction intensively absorbed the tasks and functions of financing projects, marketing, engineering and many others, construction projects were transformed into investment and construction projects. Then, when investment and construction activities, adapting to the changing market conditions, replenished with project management, investment and construction projects developed into real estate development projects - development projects (Figure 1). All these transformations took place in the construction industry in a historically short time.
Recently, following the acceleration of changes in investment and socio-economic priorities and needs, engineering and construction technologies, technologies and production processes, external and internal parameters and constraints of the project, the complication of the relations between the project participants has become increasingly demanded by the highly professional real estate development. In this regard, following changes During this period, development has accumulated significant experience in implementing projects under different conditions [17, 18], which is of interest for system and complex analysis. Currently, the development requires a scientific base, based on the study of decision-making processes, the identification of regularities in the implementation of the life cycle of real estate development projects. Effective project and effective development require new approaches based on the methodological concept of development, as well as new economic and mathematical models of calculation, which enable us to study and substantiate the long-term strategy of the project in the face of many significant factors of influence and risks.

System engineering studies these aspects of building science, explores intersystem and interface engineering problems, develops solutions that cover the entire project, multiple interdisciplinary conditions and the requirements of customers and users throughout the life cycle of the facility [4, 5, 7]. Analyzing proven methods of system engineering with reference to real estate development projects, it is possible to justify and objectively adapt concepts and decision-making models that are as relevant as possible to the specifics of development.

The idea of continuous development is the basis of development. It corresponds to a genetic methodological approach that considers any object or project as a developing system. In genesis, all the parameters of the system, the characteristics of emergence and formation are determined by cause-effect relationships and changing external conditions and factors of influence. The development of any engineering project, including, in particular, the real estate development project, is methodologically based on organizational and technological genesis [7, 8]. Just like the genetic approach in the natural sciences, he analyzes the initial needs and development goals of all subsystems of the design object, including organizational, technological and engineering. Genesis, in addition to the conventional and traditional approaches to project development, explores and takes into account both direct and inverse causal relationships between the stages of the life cycle of the project. Accordingly, the organizational and technological genesis of a real estate development project (or a genetic approach to its development) involves forecasting the further development of an engineering facility, analyzing feedback information, and recording it in a project based on planning stages or stages of its life cycle. As a consequence, the genetic approach allows objectively to reflect in the project the more complex interrelationships of a building or engineering structure with the external environment and their dynamics.

Real estate development projects are unique in engineering and organizational and technological parameters. Therefore, designing and ensuring the conformity of a development project to the multiple and diverse needs of customers and users, innovations and unavoidable changes in requirements during a long life cycle makes up a multicriteria and iteration problem [6, 10, 11, 14, 16]. Obviously, solutions of such problems and prognostic calculations of genesis require significant volumes of initial high
quality analytical data [15]. System engineering in construction uses for this purpose neural-like, logical-
semantic, dynamic and other analytical models based on modern technologies for processing large
amounts of information [3, 20]. At the same time, in the sequence of the organizational and technological
genesis of the life cycle of various projects, there are many common patterns. This allows us to use the
existing experience and solutions of similar implemented and successful projects and increases the
relevance and relevance of the methodology of organizational and technological genesis.

The management of real estate development projects and all decision-making processes rely on
economic-mathematical models [2, 9, 13]. They operate with the logic of implementing any project,
business or production by presenting it as a sequence of stages or blocks: the need - the project (the
object of research) is the result. As you know, there are two types of economic and mathematical models:
structural and functional. Their difference is in the definition of the backbone or the main stage (Figure 2).

1. STRUCTURAL MODEL LIFE CYCLE OF THE PROJECT

![Figure 2. Structural and functional models of the real estate development projects life cycle](image)

Now in the management of production, business and projects in most cases, structural models are
used, which are developed from the internal structure of the object being studied or created. It is the
structure of the project that is considered as a system-forming unit of the model and is carefully and
thoroughly worked out. The result is a consequence of the functioning of a well-structured structure.
Accordingly, projects implemented on the basis of structural models develop along the path of
improving the systems of existing ones [2, 19]. A characteristic structural approach to modeling:
designers and designers took as their model the best implemented project, for example a multifunctional
complex, and optimized it by finalizing it according to the customer's proposals, based on the results of
marketing research and analysis of innovations and scientific and technological progress in this field.
However, it is obvious that the original sample was designed at least several years ago and embodies
the past investment concepts and technical ideas. Therefore, new designs for structural models recreate
existing analogues or improved analogues. Thus, good projects are being developed, but fundamentally
new solutions are not created and innovative project ideas are not generated for advanced development
[1]. The functional approach to modeling considers the logic of development from the reverse - the
model is developed from the result, it is considered a priority and a system-forming stage in the
development sequence. The ideal result of the project, satisfying initial requirements is defined. The
most important thing in this case is to abstract from the similar realized objects [7]. The structure of the
project is accepted secondary, it is considered less significant for research (the "black box" or "black
box" principle is used), and is formed as a result of the result. To develop a functional model means to
find and define functions or operators that uniquely link the result to the original requirements and
identify what needs to be done to achieve the result. Functional models are suitable for project
optimization tasks. They do not solve the problem of a complete description of the object, but open the
way to understanding the most significant requirements for the structure of the project and then forming its structural model. Examples of structural and functional approaches to the modeling of real estate development projects very clearly illustrate their differences. So, if the commercial real estate project aims to increase labor productivity by improving the spatial planning of office premises, then with the help of a structural model we could optimize the area norms per employee or division, accommodation, engineering support and a list of requirements for falsity-management etc. The functional approach “from the result” allows generating new ideas, such as the organization of office space “open space”, in which the productivity of labor, the efficiency of the use of areas is significantly increased and all the problems of office accommodation of employees are solved in principle. In the same way, there are projects for organizing a common working space (coworking space) or projects for a "virtual office" are being developed. Similar examples of functional modeling of pioneer, innovative projects exist in all directions of development. In residential real estate it is lofts, coaching (combining in one house small-sized apartments and large joint public spaces). In the organization of industrial zones are clusters, in retail real estate - multifunctional centers; In the hotel real estate - projects of capsule hotels, etc. [17, 18]. In practice, functional economic and mathematical models show strategic and forecast advantages in comparison with structural models. They help developers, initiators and project developers to find absolutely new unique design, organizational and technical solutions, create innovative projects and facilities that form and meet new needs.

Principal and logical question: what is the desired function in the functional model of an investment-building project or a real estate development project? Development is not just a "strategically capacious" activity, strategic planning is the same function (operator) of a functional model of development activity.

Russian and foreign experience shows that strategic planning is an important condition for the existence of the real estate market and the company and the project. For a development company - this is a condition of survival and competitiveness, for a development project - a necessary condition for its effectiveness and expediency. In general, strategic planning is what is being developed, a specifically important function, its basis and basis. It can be argued that a sound long-term, strategic planning of the project is the main sign that the project under consideration relates to development projects. At the same time, despite the rather obvious importance of the strategy, Russian developers do not often spend money and efforts on a systematic analysis of the strategic prospects of their portfolio of projects [11, 13]. To support the expediency and effectiveness of a long-term project under conditions of constant changes is to justify and preserve the strategy in managing the changes and requirements of the multiple and dissimilar engineering and technical-economic subsystems and participants making up the project. The task of substantiating the strategy of a real estate development project is solved by functional models. This requires much more complex project analysis, life cycle forecasting, organization and coordination of the stages and participants of the project [5, 12, 15, 20]. To this end, in functional modeling, traditional pre-investment studies and project analysis are expanded by proactively taking into account early information flows and feedbacks from the outcome of the project.

It is no less difficult task to adhere to the strategy, considering that the horizon of strategic planning is the life cycle of development projects. It is the longest in comparison with other types of technogenic products, almost always goes beyond the boundaries of a single macroeconomic cycle [1, 9, 21]. Most of the conditions and requirements of the project inevitably and naturally change during this time. A retrospective analysis of recent decades indicates a constant increase in the number and significance of changes and risks of project implementation [11]. The forecast of development for the future also allows to assert that the high dynamics of external and internal changes and requirements will remain a long-term and constant factor of their realization [15]. Therefore, the entire life cycle of a development project is the identification and management of changes and requirements. From the point of view of preserving the strategy, the management of changes and project requirements is methodologically based on organizational and technological genesis, its methods of research and decision making, and on appropriate technologies that allow, if necessary, to make changes to the project as technologically as possible at any stage of the life cycle of the project. These technologies include the development in the early stages of designing the engineering aspects of the project's adaptation to the projected changes (or
adaptable of the process design), which is related to the extent to which the most probable possibilities for the changes and development of all its subsystems are considered in the project implementation strategy [7, 8].

3. Conclusion
Thus, the development of an effective real estate development project should be based on a methodological approach that reflects the concept of development and on economic and mathematical models that allow forecasting a long-term strategy for the project. System engineering and system management offer a scientific tool for engineering analysis, docking and coordination of individual subsystems and stages, objectively interpreted for the specifics of such projects:

- Organizational and technological genesis as a methodological approach to the development and management of changes in engineering aspects of the project, based on the cause-effect relationships of the stages of its life cycle;
- Functional models of planning and accounting for the long-term strategy of the project from the system-forming result;
- management of changes and requirements throughout the life cycle of the real estate development project, based on technologies for adapting the process design of design solutions. Further application development of these methods will significantly improve the efficiency of real estate development projects.

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