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На обложке печатаются работы фотохудожника Валентина Герцмана (Нью-Йорк).

Уважаемые читатели!

Функционирование строительных предприятий и организаций в современных турбулентных условиях, связанных с экономическими санкциями ведущих западных стран, испытывает воздействие множества внешних и внутренних, случайных и неслучайных факторов, существенно влияющих на результаты их деятельности. Особенно это связано с началом вооруженного конфликта, в ходе которого на территориях бывшей союзной республики в результате применения тяжелых вооружений наряду с гибелью людей происходит масштабное разрушение зданий и сооружений, объектов коммунальной инфраструктуры. Каждый конкретный случай характера разрушения здания или имеющихся повреждений должен быть рассмотрен экспертом «строителем», обладающим специальными знаниями в области механической безопасности. Предприятия и организации инвестиционно-строительного комплекса, работающие в этих условиях по восстановлению разрушенного фонда жилищной недвижимости, представляют собой сложную человеко-машинную организационно-управленческую систему, включающую технические, технологические, экономические, экологические и социальные подсистемы. Они характеризуются определенным уровнем надежности, который необходимо учитывать при их деятельности, связанной с восстановлением жилищного фонда и коммунальной инфраструктуры.

Начиная с этого номера, редакция журнала будет публиковать статьи, связанные с методами восстановления поврежденных зданий, сооружений и надежностью предприятий инвестиционно-строительного комплекса, работающих в чрезвычайных условиях.

Главный редактор, **Пётр Грабовый**

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The purpose and meaning of the integrated development of territories is the removal from the existing housing stock of those types of buildings, the repair or reconstruction of which will not ensure the creation of convenient planning solutions and the possibility of implementing a comfortable living environment.

The existing consensus on the lack of alternatives to the energy-saving vector of economic development has led to the formation of national and international energy saving programs and numerous studies of methods for improving the energy efficiency of the full life cycle of projects in the architecture, engineering, construction and operation sectors

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Prospects of the public–private partnership on integrated development of areas in regions

Problems of the state, associated with the implementation of projects on integrated development of areas are identified and described in the article. The legislation governing the implementation of projects on integrated development of areas (IDA) is examined. The experience of Russian developers in the implementation of integrated development projects is analyzed. The results of the implementation of a number of integrated development projects in the Russian Federation are analyzed; the extent of involvement of regions in such programmes is identified. Current projects, implemented in the Russian Federation in the field of integrated development of areas, is considered. Given the results of the analysis, the potential classification of projects is developed within the framework of integrated development of areas. The reasons for the need to convert to packaged construction are listed. Factors, that reduce the attractiveness of the mechanism of integrated development of areas in the Russian Federation for developers, are identified. Regional practices of projects implementation were singled out and local peculiarities were considered with regard for local real estate markets. Advantages of integrated area development have been determined for representatives of government authorities, municipalities and end users of residential and nonresidential buildings. The authors also consider the views of major developers on problems and challenges of integrated development of areas. The authors consider models of interaction between the state and the private business community in such foreign countries as the UK, Germany, and the USA as a possible response to these challenges. Common features of models of public private partnerships are emphasized. Peculiarities of the practical application of such models are taken into account; difficulties encountered by developers in the process of work are described. As a result, the authors have identified the main lines for the development of such projects, taking into account public private partnerships.

Keywords: *capital construction, integrated development of areas, comprehensive development of areas, public private partnership, real estate market, development of areas*

Sternik Sergey Gennadyevich,
Dr. Sci. (Eng.), Professor, Leading Researcher; The Institute of Economic Forecasting of the Russian Academy of Sciences (IEF RAS); 47 Nakhimovsky Ave., Moscow, 117418, Russian Federation; Professor; Financial University under the Government of the Russian Federation; 49/2 Leningradsky Ave., 125167, Moscow, Russian Federation; Professor of the Department of Construction Organization and Real Estate Management; Moscow State University of Civil Engineering (National Research University) (MGSU); 26 Yaroslavskoe shosse, Moscow, 129337, Russian Federation; ID RISC: 596056, Scopus: 6507292791, ORCID: 0000-0003-1411-1011; sergey-sternik@yandex.ru

Safronova Natalia Borisovna,
Cand. Sci. (Eng.) Associate Professor of the Department of Organization of Construction and Real Estate Management; Moscow State University of Civil Engineering (National Research University) (MGSU), 26 Yaroslavskoe shosse, Moscow, 129337, Russian Federation; Scopus: 57189617319, ResearcherID: N-3804-2018, ORCID: 0000-0002-0882-0017; safronovanb@mgsu.ru

Gatsenko Darya Konstantinovna,
construction engineer; Tashir Group of Companies; bldg. 1, 13 Podkolokolny lane, 109028, Moscow, Russian Federation; darya.gacenko@gmail.com

Lebedeva Alla Aleksandrovna,
engineer of the Department of Construction and Technical expertise; SKB-Engineering; p. 12, pom. III, or. 2, 19a 1st Izmailovsky Menagerie St., Moscow, 105187, Russian Federation; alla95207@gmail.com

The implementation of the national project "Housing and Urban Environment" is impossible without a drastic increase in the areas of zones of integrated residential development [1]. Even the Land Code of the Russian Federation[1] had provisions about the implementation of projects on integrated development of areas for the purpose of residential construction, which later obtained a comprehensive regulatory foundation[2, 3, 4, 5, 6]. As a result, in early 2021 legislative changes came into force, changing the mechanism once again. The IDA programme is now regulated by Chapter 10 of the Urban Planning Code of the Russian Federation, introduced by the Federal Law of December 30, 2020 No. 494-FZ "On Amendments to the Urban Planning Code of the Russian Federation and some legislative acts of the Russian Federation to ensure integrated development of areas"[7].

The law defines the notion of IDA as "a set of interrelated activities towards the development of an area, construction of infrastructure and (or) capital construction facilities conducted by legal entities, natural persons, public authorities and aimed at the qualitative transformation of built-up and free (undeveloped) urban areas for the purpose of their best and most efficient use, including the social functions ensuring sustainable development of urban areas".

The procedure for the approval of integrated development projects is established by Decree No. 1184 issued by the Government of the Russian Federation on Jule 14, 2021 "On approval o.rules of decision making by the Government of the Russian Federation about the integrated development of areas and coordination of such decision with the subject of the Russian Federation, within whose boundaries the area, subject to integrated

1 Land Code of the Russian Federation : Federal Law October 25, 2001 No. 136-FZ. Rossiyskaya Gazeta. 2001.

2 On the entry into force of the Town-Planning Code of the Russian Federation : Federal Law No. 191-FZ of December 29, 2004. Rossiyskaya Gazeta. 2004.

3 On Amendments to the Urban Planning Code of the Russian Federation and Certain Legislative Acts of the Russian Federation : Federal Law No. 232-FZ of December 18, 2006. Rossiyskaya Gazeta. 2006.

4 On Amendments to the Land Code of the Russian Federation and Certain Legislative Acts of the Russian Federation : Federal Law No. 171-FZ of June 23, 2014. Rossiyskaya Gazeta. 2014.

5 On Amendments to the Urban Planning Code of the Russian Federation and Certain Legislative Acts of the Russian Federation : Federal Law No. 224-FZ of July 21, 2014. Rossiyskaya Gazeta. 2014.

6 On Amendments to the Urban Planning Code of the Russian Federation, Certain Legislative Acts of the Russian Federation in terms of Improving the regulation of preparation, coordination and approval of Documentation on Territory Planning and Ensuring Integrated and Sustainable Development of Territories and Invalidation of Certain Provisions of Legislative Acts of the Russian Federation : Federal Law No. 373-FZ of July 3, 2016. Rossiyskaya Gazeta. 2014.

7 On Amendments to the Urban Planning Code of the Russian Federation and Certain Legislative Acts of the Russian Federation in order to Ensure the Integrated Development of Territories : Federal Law No. 494-FZ of December 30, 2020. Rossiyskaya Gazeta. 2020.

development is located, and on amendments to Regulations on the Government Commission for Regional Development in the Russian Federation"[8].

The Government of Russia, regional authorities and municipalities are intensively working on the implementation of the IDA mechanism, which allows to more effectively involve in the turnover of federal land and accelerate the launch of new housing projects in the regions. To date, it is planned to coordinate the application of the IDA mechanism in 753 territories with a total area of 27,716.15 hectares with a total urban development potential of 173.07 million square meters and 135.89 million square meters of residential area[9].

Having analyzed IDA projects implemented in the Russian Federation, specialists of the Fund of assistance to housing and utility services reforms, joint stock company DOM.RF[10] identified the advantages of integrated area development for representatives of state authorities, municipalities and end users of residential and non-residential buildings:

- launching auctions to grant unprepared urban plots for the purpose of housing construction;
- reducing the period of preparation of areas for construction from two years to 6–9 months;
- the possibility to fix the parties' obligations to implement the project in a contract when making a decision about the IDA;
- the possibility of donating social facilities, common areas and part of residential premises to regional/municipal ownership;
- subjects will have an opportunity to comprehensively solve the problem of the emergency housing stock, renovation of industrial areas, withdrawal of plots through simplified procedure.

At the federal level, the legislative acts, allowing for the launch of IDA implementation have been adopted in full, but not all regions are ready to start these projects due to the lack of the legal and regulatory framework at the regional level.

Since the adoption of Government Decree No. 1184 of July 14, 2021 and until the beginning of 2022, the IDA programme (approval of new projects) expanded at an accelerated pace. For example, by the end of 2021, the Government Commission, headed by Deputy Prime Minister of Russia Marat Khusnullin, had approved nine new integrated area development projects (IDA) in eight regions of Russia. Their total urban development potential amounted to more than 2.4 million square meters. Also the IDA programme gained momentum in the capital region. On December 27, 2021 86 projects on the integrated development of areas were approved[11].

However, subsequently, since the launch of the special military operation (SMO), the rate of approval of new IDA projects has decreased significantly.

That is why we have analyzed the statistics of IDA projects in the process of implementation according to DOM.RF at the time of the start of the SMO[12].

As of February 21, 2022 the total of 471 agreements on the construction of 1,343 residential facilities were concluded within the framework of the IDA programme.

We propose to classify IDA projects according to the following criteria.

1. By scale:

- federal;
- regional;
- local.

2. By duration (from the date of conclusion of the CDA/IDA/DBA agreement to the planned date of commissioning):

- short-term (up to 5 years);
- medium term (5–15 years);
- long term (more than 15 years).

3. According to the method of securing the builder's obligations:

- escrow accounts;
- without using escrow accounts.

4. By the number of floors:

- low-rise construction (1–3 floors);
- medium-rise construction (3–5 floors);
- high-rise construction (6–9 floors);
- multistory building (10 and more).

The largest share of projects were agreements on development of built-up areas (DBA) — 265 projects. For example, the development of former industrial areas, renovation, programmes for the resettlement of dilapidated and emergency housing. In addition, owners themselves can enter into an agreement on comprehensive development of the area (CDA). At the analyzed moment, 35 such projects were being implemented. The smallest number of projects are implemented at the initiative of the local government; only 13 such agreements have been made. Unfortunately, this fact has proven the low interest of local authorities in the development of their areas and improvement of the comfort of the residential environment (Fig. 1).

Of the total number of projects, 787 houses have already been commissioned, while the remaining 556 houses are under construction (Fig. 2).

The total residential area of the projects that are being implemented exceeds 12 million square meters of housing of various formats and floors (Fig. 3).

Project agreements have been concluded in every federal district of the Russian Federation. The leader in terms of the number of projects is the Central Federal District (CFD), where 153 IDA contracts were concluded. The Volga Federal District (VFD) comes next with 98 projects. It is well known that this federal district is the second largest in terms of population, with IDA projects being implemented in 13 of 14 subjects of the Russian Federation. The missing subject of the Russian Federation is the Republic of

8 On approval of the Rules for the Adoption by the Government of the Russian Federation of a Decision on the Integrated Development of the Territory and coordination of such a decision with the subject of the Russian Federation, within whose Borders the territory subject to integrated Development is Located, and on Amendments to the Regulations on the Government Commission for Regional Development in the Russian Federation : Decree of the Government of the Russian Federation No. 1184 of July 14, 2021. Government of Russia. URL: http://government.ru/docs/all/135641

9 More than 35 thousand people will receive housing with the integrated development of territories. Rossiyskaya Gazeta. URL: https://rg.ru/2022/04/11/bolee-35-tysiach-chelovek-poluchat-zhile-pri-kompleksnom-razvitii-territorij.html

10 DOM.RF proposed to improve the mechanism of the Kyrgyz Republic to improve the quality of life in the country. DOM.RF. URL: https://www.xn--d1aqf.xn--p1ai/media/news/dom-rf-predlozhil-usovershenstvovat-mekhanizm-krt-dlya-povysheniya-kachestva-zhizni-v-strane

11 86 projects of integrated development of territories have been approved in Moscow. Complex of urban planning policy of the city of Moscow. URL: https://clck.ru/32FFQx

12 The regions have agreed on 28 KRT projects on the lands DOM.RF with a gravity potential of about 7 million sq. m. DOM.RF. URL: https://www.xn--d1aqf.xn--p1ai/media/news/regiony-soglasovali-28-proektov-krt-na-zemlyakh-dom-rf-s-gradpotentsialom-okolo-7-mln-kv-m

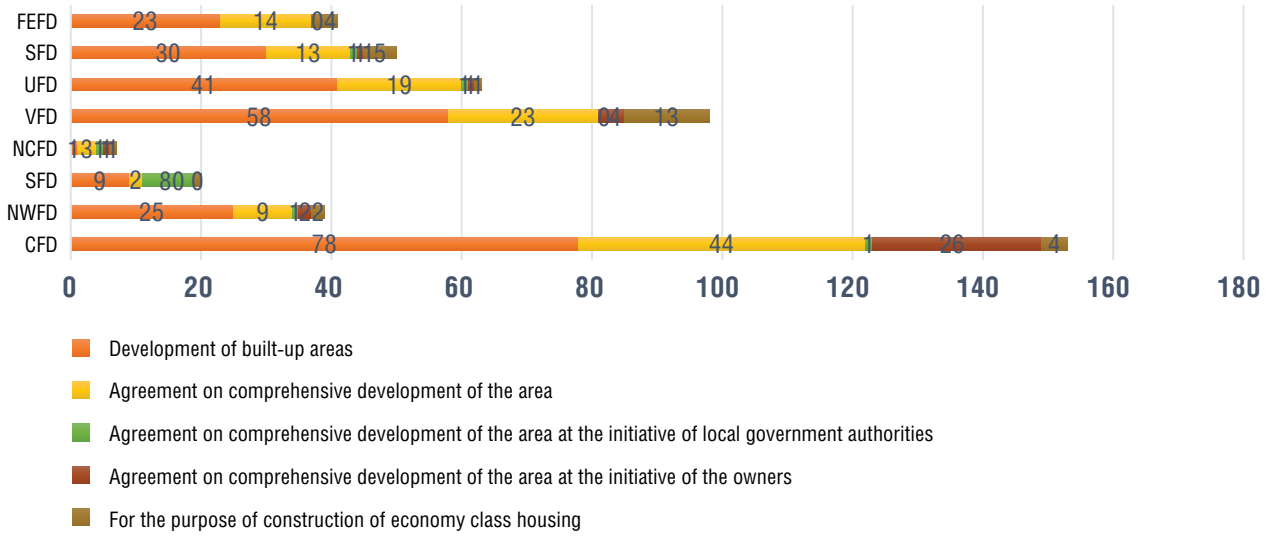

Fig. 1. Quantitative indicators of involvement of constituent entities of the Russian Federation in the integrated area development programme

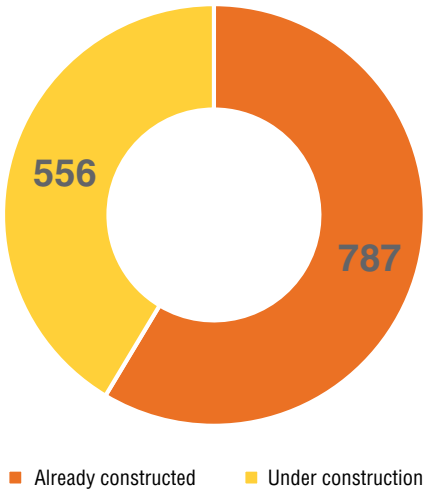

Fig. 2. The breakdown of IDA projects by the stage of construction

Mordovia. The Ural Federal District with 63 IDA projects is also among the top three. It is noteworthy that all 6 subjects of the Russian Federation, included in the Ural Federal District, are implementing projects under IDA contracts. None of the federal districts of Russia can boast full involvement anymore. The worst situation is in the North Caucasian Federal District, where the total number of IDA projects is 7 (Table 1).

In an attempt to analyze the breakdown of IDA contracts concluded by constituent entities of the Russian Federation, let us consider the top 10 (Table 2). The leading position with 225 houses under construction and already commissioned buildings is taken by the Moscow Region, followed by the Nizhny Novgorod Region — 126 houses, the Republic of Bashkortostan — 104 houses. At the bottom of the list is the Belgorod Region with 36 houses being sold under agreements on comprehensive development of areas. 19 subjects of the Russian Federation are outsiders in the rating, with not a single IDA contract concluded in these regions. The Jewish AR (Autonomous Region), Chukotka AR and Nenets AR, Kamchatka Krai, Republics of Adygea, Altai, Ingushetia, Komi,

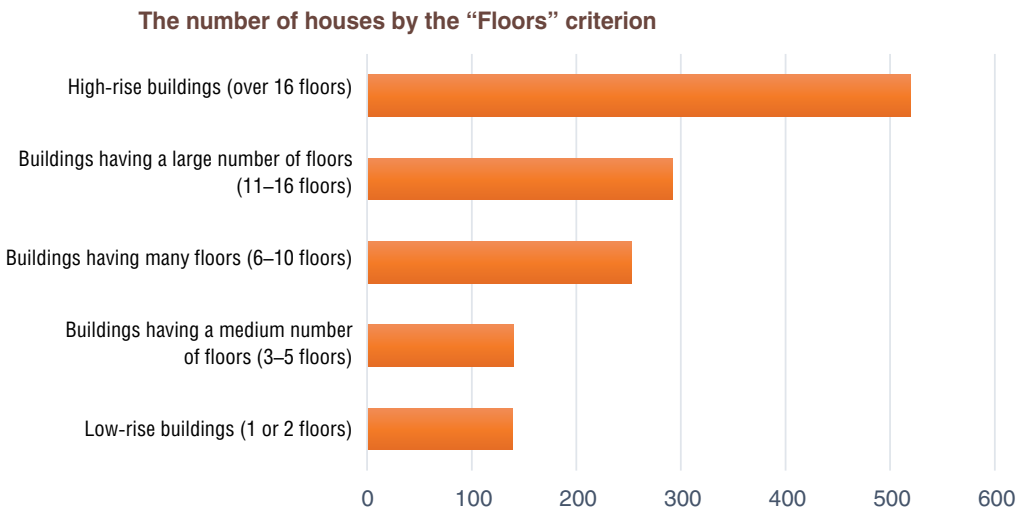

Fig. 3. The breakdown of IDA projects by the number of floors

Table 1. Involvement of Russian regions in the IDA programme

Regions not implementing projects under the IDA programme	Federal District	Development of built-up areas	Agreement on comprehensive development of the area	Agreement on comprehensive development of the area at the initiative of local government authorities	Agreement on comprehensive development of the area at the initiative of the owners	For the purpose of construction of economy class housing	Number of projects in total
Kostroma, Smolensk, Tambov regions	CFD	78	44	1	26	4	153
Murmansk region, Pskov region, Komi Republic, Nenets AR	NWFD	25	9	1	2	2	39
Republic of Adygeya	SFD	9	2	8	0	1	20
Republic of Ingushetia, Karachay-Cherkessia Republic	NCFD	1	3	1	1	1	7
Republic of Mordovia	VFD	58	23	0	4	13	98
–	UFD	41	19	1	1	1	63
Republic of Altai, Republic of Tuva, Omsk region, Tomsk region	SFD	30	13	1	1	5	50
Kamchatka Krai, Magadan Region, Jewish AR, Chukotka AR	FEFD	23	14	0	0	4	41

Table 2. Breakdown of constituent entities of the Russian Federation by the number of IDA projects being implemented

Subject of the Russian Federation	Number of homes built or commissioned under the IDA programme
Moscow region	225
Nizhny Novgorod region	126
Republic of Bashkortostan	104
Novosibirsk Region	77
Sverdlovsk Region	61
Irkutsk region	59
Tyumen region	54
Krasnodar Region	44
Saint Petersburg	37
Belgorod region	36
Orenburg region	29
Altai Krai	27
Leningrad region	25
Republic of Sakha (Yakutia)	22
Bryansk region	21
Republic of Tatarstan (Tatarstan)	20
Khabarovsk Krai	18
Republic of Buryatia	17
Chelyabinsk region	17

Mordovia, Tyva, Karachay-Cherkess Republic, as well as Kostroma, Magadan, Murmansk, Omsk, Pskov, Smolensk, Tambov and Tomsk regions are among them.

Escrow accounts introduced by the state, according to the Federal Law of December 30, 2004 No. 214-FZ (ed. of March 14, 2022) "On Participation in Shared Construction of Apartment Buildings and Other Property and on Amendments to Certain Legislative Acts of the Russian Federation", are designed to facilitate and accelerate the process of buying and selling real estate and reduce risks for both parties making such deals. Therefore, it is noteworthy that of the total number of IDA projects 607 projects against 736 are implemented using escrow accounts (Fig. 4). The unobvious share ratio can be explained by the fact that at the moment, escrow accounts for large projects are not a flexible enough solution accompanied by numerous problems and issues.

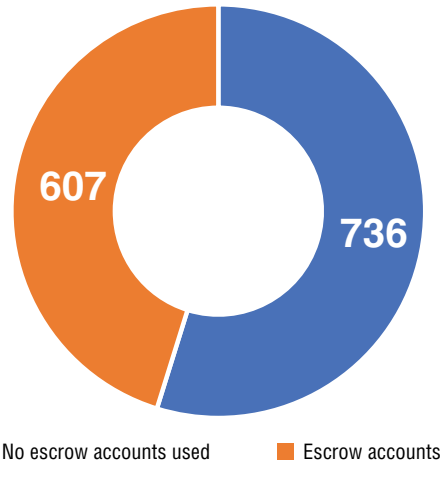

Fig. 4. Proportion of IDA projects in terms of use of escrow accounts

In practice, developers face a number of problems that have existed since the introduction of the legislative mechanism in question. They still have no solution, although they have a significant impact on the investor's decision to apply the mechanism of IDA when implementing an investment and construction project, which creates the need to consider the application of a public private partnership (PPP) for the implementation of IDA projects in Russia to improve the management of the programme development period. Having studied the mechanism of public private partnerships in developed economies (USA, UK, France, Germany), the authors identified the following distinctive features of its regulation [2–5]:

- specialized structures dealing with the problems and support of PPPs;
- PPP agreements provide for the distribution of risks between the state and business communities with guarantees for both parties;
- the owner of the infrastructural facility is usually the state, which, in turn, guarantees the conditions for the provision of services and the payment of remuneration to the investor, according to the terms of the contract.

Having developed the concept of rising the investment attractiveness of IDA projects, we conclude that it is advisable to apply the experience accumulated by the foreign countries in the field of PPPs inn the course of implementation of IDA projects in Russia. The main trends in the development of the IDA mechanism, taking into account the application of PPPs, may be as follows:

- establishing the possibility of concluding concession agreements or public private (municipal-private) partnership agreements within the framework of IDA contracts for the construction of public utilities, transport and social infrastructure facilities;
- development of model contracts for IDA projects involving PPPs, including a specific set of documentation for the preparation, support and financing of projects to ensure a better understanding of the risks assumed by the parties;
- construction of social infrastructure facilities within the framework of an IDA contract should include their mandatory buy-out by the municipality;
- creation of additional instruments of support for citizens to be resettled from areas that are offered using the bidding procedure;
- within the framework of the IDA, at the initiative of the rightholder the municipality should have an opportunity to provide plots, adjacent to the applicant's plots, for the construction of social facilities.

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Перспективы государственно-частного партнерства по комплексному развитию территорий в регионах

В данной статье выделяются и описываются проблемы государства, связанные с реализацией проектов комплексного развития территорий. Рассмотрена нормативно-правовая база реализации проектов комплексного развития территорий. Проанализирован опыт российских девелоперов в реализации проектов комплексной застройки территорий. Проанализированы результаты реализации ряда проектов комплексного развития территорий по Российской Федерации, определена активность участия регионов в подобных программах. Рассмотрена база текущих проектов, реализующихся в Российской Федерации в области комплексного развития территорий. По результатам анализа разработана потенциальная классификация проектов в рамках комплексного освоения территорий. Сформированы причины необходимости перехода к комплексному строительству. При этом выделены факторы, снижающие привлекательность механизма комплексного развития территорий для застройщиков в Российской Федерации. Выделены региональные практики реализации проектов и рассмотрены локальные особенности с учетом местного рынка недвижимости.

Определены преимущества комплексного развития территории для представителей государственной власти, муниципалитетов и конечных пользователей жилого и нежилого фонда. В работе также рассмотрен взгляд крупных застройщиков на проблемы и вызовы комплексного развития территорий. Как возможный ответ на эти вызовы в статье рассмотрены модели взаимодействия государства и частного бизнеса в зарубежных странах: Великобритания, Германия, США. Выделены общие черты и особенности моделей государственно-частного партнерства. Учтены особенности применения на практике подобных моделей, описаны трудности, с которыми сталкиваются застройщики в процессе работы. В результате авторы определили основные направления для развития проектов комплексного развития территорий с учетом государственно-частного партнерства.

Ключевые слова: *капитальное строительство, комплексное развитие территорий, комплексное освоение территорий, государственно-частное партнерство, рынок недвижимости, застройка территорий*

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Об авторах: **Стерник Сергей Геннадьевич** — доктор экономических наук, профессор, ведущий научный сотрудник; **Институт народнохозяйственного прогнозирования Российской академии наук (ИНП РАН)**; 117418, г. Москва, Нахимовский пр-т, д. 47; профессор; **Департамент корпоративных финансов и корпоративного управления Финансового университета при правительстве РФ**; 125167, г. Москва, Ленинградский пр-т, д. 49/2; профессор кафедры организации строительства и управления недвижимостью; **Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ)**; 129337, г. Москва, Ярославское шоссе, д. 26; РИНЦ ID: 596056; Scopus: 6507292791; ORCID: 0000-0003-1411-1011; sergey-sternik@yandex.ru;

Сафронова Наталья Борисовна — кандидат технических наук; доцент кафедры организации строительства и управления недвижимостью; **Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ)**; 129337, г. Москва, Ярославское шоссе, д. 26; Scopus: 57189617319, ResearcherID: N-3804-2018, ORCID: 0000-0002-0882-0017; safronovanb@mgsu.ru;

Гаценко Дарья Константиновна — инженер по строительству; **Группа компаний «Ташир»**; 109028, г. Москва, Подколокольный пер., д. 13, стр. 1; darya.gacenko@gmail.com;

Лебедева Алла Александровна — инженер отдела строительно-технической экспертизы; **СКБ-Инжиниринг**; 105187, г. Москва, ул. 1-я Измайловского зверинца, д. 19а, стр. 12, пом. III, оф. 2; alla95207@gmail.com.

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Yaskova N.Yu.
Zaitseva L.I.

Construction: overcoming growth limits

Nowadays construction ensures the viability of the Russian economy and performs the spatial restructuring of buildings and structures aimed at the outstripping development and creation of a comfortable living environment. Current major changes in the geopolitical landscape could not but affect the focus and requirements for the development of the industry. The establishment of new transport and logistics corridors required incomparably higher rates of road construction; the import substitution programme facilitated industrial construction; the focus on creating a comfortable environment forced the modernization of the housing infrastructure; new horizons of agricultural development facilitated the creation of processing industries, etc. Despite the unprecedented pressure of sanctions housing construction continued to develop. At the same time, there has been a structural shift towards individual housing construction. In general, we can say that construction has become a powerful factor ensuring not only sustainability, but also the accelerated development of industries in need of import substitution. In this regard, the existing model of investment and construction activity should be brought in line with the current objectives of national development. The author believes that the mission of advanced development and overcoming the limits of construction growth is to ensure the technological sovereignty of investment and construction activities. It is based on the proactive use of foresight approach tools, advanced development of industry-specific research schools, establishment of a single centre for research and engineering management, development of the countercyclical policy, reorientation of investment and construction activities towards friendly countries, training and re-training of personnel as well as generation of a new type of project teams.

Keywords: *construction, investment cycle, foresight approach, innovation cycle, technological sovereignty, research base, research schools, projects of technological modernization*

Yaskova Natalya Yurevna,
Doctor of Economic Sciences, Professor, Head of Department of Investment and Construction Business; Russian Presidential Academy of National Economy and Public Administration (RANEPA); 82 Vernadsky Avenue, Moscow, 119571, Russian Federation; ID RISC: 490267, Scopus: 56209112800, ResearcherID: O-7581-2018, ORCID: 0000-0002-3245-1549; yaskova-ny@ranepa.ru

Zaitseva Larisa Igorevna,
Associate Professor, deputy head of the Department of Investment and Construction Business and Real Estate Management, Russian Presidential Academy of National Economy and Public Administration, 119571, Moscow, 82 Vernadsky Avenue; ID RISC: 1027747, Scopus: 57194457897, Researcher ID: P-9941-2019, ORCID: 0000-0002-8325-4342; zaytseva-li@ranepa.ru

INTRODUCTION

Being one of the most important infrastructure-focused industries of the Russian economy, construction ensures the viability of the Russian economy and performs the spatial restructuring of buildings and structures aimed at the outstripping development and creation of a comfortable living environment. Practical shifts in the modern geopolitical landscape could not but affect the focus and requirements for the development of the industry. The reorientation of the economy towards new transport and logistics corridors required incomparably higher rates of road construction; the import substitution programme facilitated industrial construction; the focus on creating a comfortable environment forced the modernization of the housing infrastructure; new horizons of agricultural development facilitated the creation of processing industries, etc. Housing construction continued to develop at a rapid pace. At the same time, there was a structural shift towards individual housing construction. In short, under the growing pressure of sanctions and reputational blockade of the Russian economy, it is construction that has become the most powerful factor ensuring not only sustainability, but also the accelerated development of industries in need of import substitution, as well as determining the future parameters and advantages of the Russian economic model. At present, its vulnerability is a consequence of contradictions and development risks accumulated over the past decades. The nature of external threats and internal problems, some of which are still latent, set new substantive tasks to be solved by the construction industry. Among them are the effective acceleration and synchronization of investment and construction processes, technological modernization, product restructuring, spatial maneuverability and others.

MATERIALS AND METHODS

The development of a new investment and construction model under the current conditions is not just a tribute to the research and technology agenda, but also a matter of survival of Russia as a sovereign country and the centre of power for the future structure of the global civilization. As a matter of fact, the construction industry is one of the most import-independent industries[1]. Local production of building materials, elements and structures has been a strategic priority of national development over the past 10 years[2, 3]. Meanwhile, whatever we have is necessary, but insufficient, both in terms of the quality of materials (functional properties, ecological and aesthetic requirements), and potential production volumes. The technological lag has been identified in design, manufacture of engineering equipment (elevators, air conditioning, etc.), building machinery and other segments of

1 Russian developers do not depend on imports. URL: https://lenta.ru/news/2022/08/01/import/

2 Draft Strategy for the development of the construction industry and housing and communal services of the Russian Federation until 2030 with a forecast for the period up to 2035. URL: https://www.minstroyrf.gov.ru/docs/18723/

3 On the strategy for the development of the construction materials industry for the period up to 2020 and further prospects up to 2030 : Decree of the Government of the Russian Federation dated May 10, 2016 No. 868-R. URL: https://www.garant.ru/products/ipo/prime/doc/71294822/

investment and construction activities [1, 2]. Import in these segments reaches 30 to 60% of volumes in value terms[4].

Methods of overcoming the technological gap amid the geographical expansion and restructuring of the domestic market are concentrated in the foresight approach [3, 4]. Basic postulates, namely, victory over inflation, tight monetary policy, over-accumulation of reserves, passivity of development funds, targeted focus on export expansion, offshorization, etc, are being proactively replaced by reducing the benchmark interest rate, improved availability of development resources, subsidy mechanisms, as well as reorientation of trade flows towards friendly countries, industrial and technological cooperation with countries in Southeast Asia and China, expansion of trade with unfriendly countries according to the "raw materials in exchange for critical imports" formula, etc. Industrial assembly projects, to be implemented in cooperation with companies from friendly countries in Siberia and the Far East become preferable. These include the arrangement of production of cars, construction and road machinery, mining equipment, electronics and other high-tech products. At the same time, the investment cycle can be effectively implemented only when mechanisms of the multi-channel financial system are used and the system of clearing operations is developed. If the local production of components is launched in the shortest term possible, the system cooperation between domestic manufacturers, engaged in the development and production of new high-tech products, will trigger a new innovation cycle. For example, construction of production facilities to produce engineering equipment required in oil recovery, refining, oil and gas chemistry, etc. will require synchronization of efforts in research, machine building, construction, mining and transport enterprises, credit and financial institutions, state authorities, especially those of strategic orientation. In this case, road maps, defining formats of future development, will not work. The fundamental task of launching the manufacture of production facilities, that are critically important for the sovereign economy, as our country's experience at different stages of its development has shown [5], cannot be solved without developing a unified system for the management of research and technology progress. At the same time, an integrated information space and platform-based solutions for identifying the needs and opportunities of the state, research and business communities can function as a full-fledged resource for analysis and selection of priority projects. In this regard, let us emphasize the importance of applied science in the expertise of strategically important projects. Understanding the details and problems of practical implementation of the results of fundamental research will help to overcome the cognitive traps of technological development. For the construction industry, this means that it is necessary to.

1. Ensure synchronization of strategic goals of investment and construction activities with plans of all participants of the development process from state authorities in charge of territories and industries to economic entities of all types and levels.

2. Restructure production capacities towards development and higher specialization in all types of linear and industrial construction. The scaling of high-tech equipment assembly projects and changing the location of newly launched production facilities will require a fundamentally new approach to project design, new types of contracts and competent personnel;

3. The country needs to:

- develop a strategy for the technological modernization of construction, in line with the focus and scale of the country's development;
- prevent reproduction of technically, environmentally and organizationally obsolete construction methods;
- develop new construction standards taking into account the realistic potential of import substitution, potential of additive and hybrid technologies, new materials (strength, weight, thermal insulation, etc. characteristics), equipment (energy costs, productivity, maintainability, etc.);
- optimize construction and technical expertise and control;
- establish a new design cluster, taking into account the potential of digitalization and information modeling;
- make sure that professional personnel has both basic knowledge and advanced competencies, etc.

The solution to many problems, arising in these areas, is available in the Draft strategy of development of the construction industry, housing and utilities in the Russian Federation through 2030 with a forecast for the period up to 2035[1]. Meanwhile, its framework turned out to be significantly narrower than the problems of 2021 and 2022. The enormous pressure of sanctions has identified a number of vulnerabilities in the proposed model of strategic development of the industry. Therefore, the growth limits, outlined in the strategy, turned out to be insufficient to solve the problems of sustainable development of the country amid the confrontation with the "collective West". Let's take a look at the "Import Substitution" section. It is obvious that the declared objectives and subsequent actions, focused on designing the necessary engineering equipment tend to rely on the programme of further dependence on importation. The development of Russia's production facilities is formal, and the efforts of the consumers of this equipment are aimed exclusively at finding suppliers from friendly countries. Neither the Ministry of Construction of Russia, nor the Ministry of Industry and Trade of Russia, nor the Ministry of Education and Science of the Russian Federation has a clear and reasonable position with regard to the development of advanced production capacities in the area of construction machinery, equipment, materials!!! Individual projects of major developers or research and educational centres are not able to solve the problem comprehensively, cost-effectively for the solution to be environmentally safe. And, if we try to identify the causes of the current situation, we'll find out that *no research activity enjoys any support*, researchers have no skills of complex analysis and correct synthesis of goals, they lack the ability to simulate and synchronize activities, goals, projects, resources, processes and, most importantly, eliminate errors.

The analysis of existing research schools showed that all of them have their own tools, educational base, etc., but most importantly, they rely on the past and proceed from the present. The foresight approach is based on the logic of "from the future to the present"; it adds absolutely new meanings if possible, proposing a new development logic and attracting new teams. Resource constraints, taken from the past and present at the stage of the dream formation should not be taken into account. It is important to feel the gap and "catch" the moment of overcoming resource constraints. No less important in the foresight approach is singular thinking, aimed at maximum substitution and multiple acceleration of processes with a corresponding increase in efficiency. This means that the nature of changes gives way to breakthrough technologies capable of "overturning" the established way of life. Accordingly, new values and meanings should emerge, and project teams with hybrid competencies should be made. In this regard, so-called "humanitarians" are no less important than "technicians", "information specialists", "mathematicians", etc. In the new approaches, the sufficiency of human capital (SHC)

4 Import of the most important goods: results of the first half of 2021. URL: https://journal.open-broker.ru/research/import-vazhnejshih-tovarov-v-rf/

becomes almost the main requirement, allowing to analyze the project in different projections: from economic and social to ecological and aesthetic ones. In this regard, a new type of thinking "beyond time" and "beyond industry" is needed. This will make it possible to assemble an image of the final product and aim not at overcoming technological backwardness, but at technological advancement and leadership.

A discussion of the postulates of new foresight-focused thinking, applied to the subject area of construction management (ICAM), has identified the need to update the research foundations of ICAM. The foundations of the research school of real estate management and construction organization (EM CO) were developed by the Moscow State University of Civil Engineering at the end of the twentieth century. They were implemented in the curricula, a series of textbooks and guidelines for specialized universities (designated for bachelors, masters and postgraduates) [6, 7]. Subsequently, they were supplemented and developed by the Department of Investment and Construction Business and Real Estate Management of the Russian Presidential Academy of National Economy and Public Administration [8, 9]. The research school of construction management expanded the boundaries of the research school of real estate management and construction organization to ensure:

- the development of the project format for construction activities, localized in space and time. The latter was to be studied with the requirement to take into account singularity;
- the cyclic synchronization of goals, projects, resources, development territories and spheres of activity *beyond industry-specific limits*;
- the problem of the system "Man – Society – Nature", the holistic nature of which under no circumstances can be violated to avoid triggering destructive processes;
- constantly changing construction processes, having dynamic goals corrected by sequential evaluation (preferably algorithmic) of the action programme in the format of "maps of the future";
- a search for a consensus of interests among the subjects of life and development;
- the symmetry format of rights and responsibilities. And responsibility of all before all, without indulgence and permissiveness;
- the mode of partner interaction and out-of-court dispute resolution;
- the dominance of inclusiv.rules and mechanisms;
- proactive import substitution as a result of the strategic focus on strengthening competitive positions and export substitutability;
- ability to materialize and capitalize intangible resources, etc.

RESULTS

Problems of the ICAM research school were identified, the focus was shifted towards resolving development contradictions accumulated not only in the recent history, but also in the final stage of the Soviet economic model. Among them is not only the technological backwardness of investment and construction methods, heterogeneous spaces and employees and prohibitively low quality and pace of construction. These are the contradictory interests of developers, owners, large, small and medium-sized businesses, banks, authorities, and finally … consumers. For example, a model, generated in the housing sector, may generate objective contradictions due to the exorbitant fine for construction schedule overruns. The decisive factor of galloping housing construction costs was the profit of authorized banks, investors and developers, not directly involved in the construction process [10]. The record rates of housing construction, supported by mortgage instruments, are temporary in nature, and they cannot resolve contradictions arising between the parties involved in construction activities in the housing sector. This is evidenced by the avalanche-like accumulation of economic disputes requiring litigation[5] [11, 12]. Infrastructure construction is not an exception. Existing contradictions are accumulated, and the accelerated pace of construction is an evidence not of technological renewal, but of the removal of resource constraints, state support and the strategic maneuver implemented in an expeditious manner. The latter was a forced reaction to geopolitical changes. Transcontinental transit to China has gained in importance due to the economic confrontation with Europe, although it did not reduce the importance of its own interregional transportation. The modernization of the Samara-Uralsk highway, being part of Russia's international obligations under an agreement with Kazakhstan and China, remains on the list of priority road construction projects. It includes the extension of the road beyond Kazan in the direction of Ekaterinburg – Tyumen – Omsk, as well as Kazan – Volgograd – Rostov-on-Don. The transport corridor project to the Transcaucasus and further through Iran to the ports of the Persian Gulf are also strategically important for the country's economy, since it will ensure access to Russia's trade with the countries of South Asia that are inaccessible by land.

The scale of the strategic maneuver in the restructuring of transport flows will require unprecedented large volumes of project resources in the construction industry. These are construction materials: sand, crushed stone, asphalt concrete and bitumen, i.e. domestically produced resources. As for machines and mechanisms, the situation with their supply is just the opposite. Imports account for 80–90%[6]. This is a consequence of the practical failure of the previous programme of import substitution. Avtoban, a construction and investment holding company, according to its general director A. Andreev, has been trying to replace imported equipment for the last five years. If rollers and graders can somehow compete with imported machines, there are no similar loaders, recyclers and other machines. Moreover, domestic machinery is not reliable. It often needs to be repaired, and if it is far from production and logistics bases, replacement of units and assemblies is simply impossible.

All-Russian Forum "Infrastructure construction: a course for import substitution" was held on April 26, 2022. The dialogue between representatives of the government authorities (Ministry of Industry and Trade, Ministry of Construction, Federal Treasury), builders (Avtodor and others), foreign and neighbouring countries (China, Belarus), researchers, manufacturers and suppliers of construction machines allowed to draft proposals, which were submitted to the Russian government. An attempt was made to compile a list items to be produce by domestic manufacturers. In this regard, the dialogue with Rosspetsmash (Russsian Special Machinery) Association was intensified. No accelerated machinery substitution is possible without state support, even in terms of leasing. At present the Ministry of Industry and Trade and the Ministry of Finance reduced the allocations for the preferential

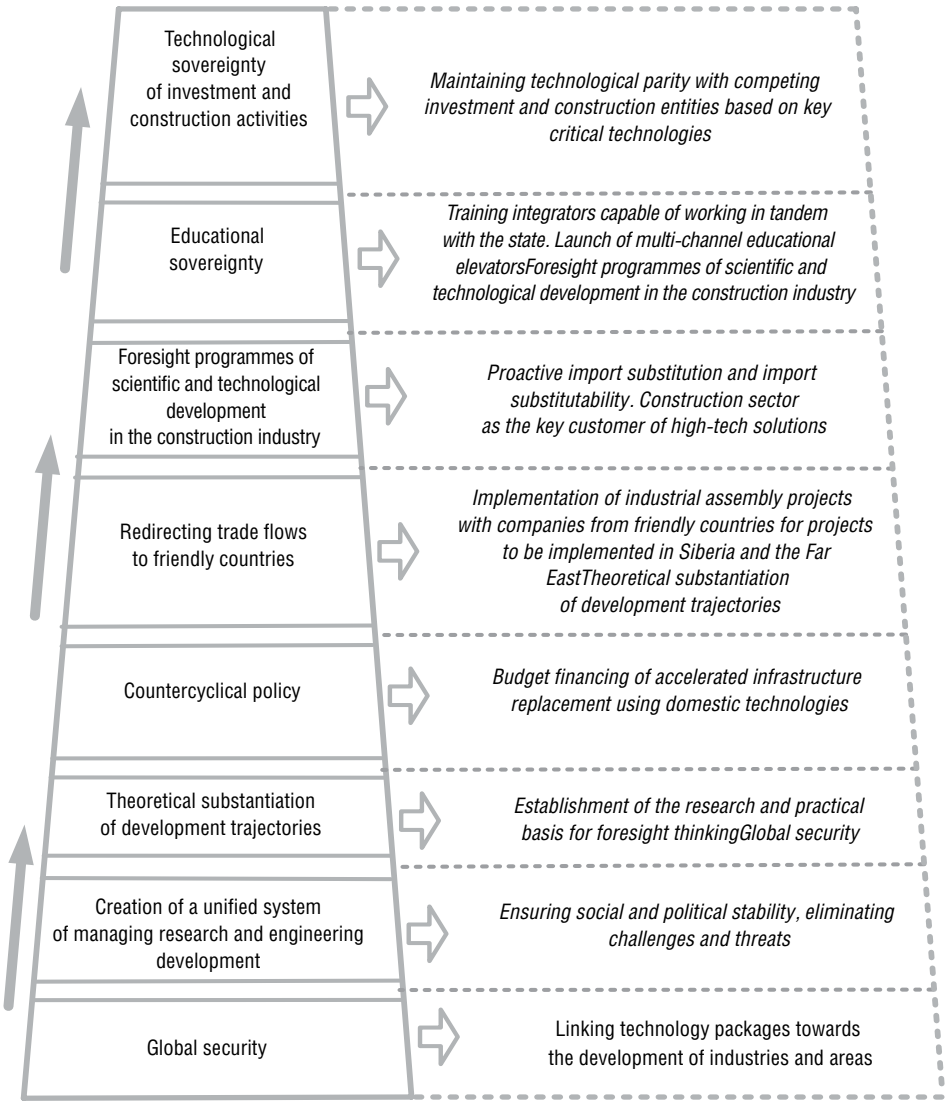
5 Study of economic disputes: 65% of claims are satisfied in the first instance. URL: tory/222250/

6 Replacement effect: a new industrialization strategy has been prepared in the Russian Federation. URL: https://iz.ru/993781/dmitrii-grinkevich-aleksandr-volobuev/effekt-zameny-v-rf-podgotovili-novuiu-strategiiu-industrializatcii

programme of special equipment leasing. Instead of such allocations it is proposed to create a specialized organization for the purchase of domestic road-building machinery, including the use of leasing mechanisms. The experience of "Rosagroleasing" has proven effective. For the sake of objectivity, we should emphasize that no immediate replacement is possible. Undoubtedly, according to experts, within the next three years most positions will be replaced by Chinese, Indian and Korean counterparts, but the earlier the new innovation cycle is launched (development, innovative research, testing) for the production of domestic equipment, the closer to the technological sovereignty the construction industry will be[6]. A generalized model of construction sovereignty is shown in Figure.

Technological sovereignty in the industry does not mean that all positions of construction machinery and equipment must be replaced. It is necessary to select the critical ones, and identify the type of local production. Any reliance on a manufacturer, located in a unfriendly country, is especially dangerous if it is impossible to perform construction work without it. These items are subject to import substitution in the first place. It is naive to think that the launch of a new innovative cycle of unique machinery or equipment is possible on the technological basis or with the involvement of companies from unfriendly countries. Moreover, the repetition of existing specimens will aggravate the technological gap. That is why the establishment of a novel domestic research base is probably the most responsible and timely step.

Investments in science and education must be accompanied by the introduction of new methods of foresight thinking. It is time to return to the three-tier system of scientific support of new technologies. Their ideas should originate from basic science, where most creative and highly qualified specialists should be concentrated[7, 8]. New innovative teams can function within the framework of the Russian Academy of Sciences, departments of universities. At the second level, it is advisable to



The model of technological sovereignty of construction

7 World trends in education in the Russian context — 2022. URL: https://ioe.hse.ru/edu_global_trends/

8 Report of the Government of the Russian Federation to the Federal Assembly of the Russian Federation on the implementation of state policy in the field of education. URL: http://static.government.ru/media/files/GcesxuJAl13AntFYxDYzpnoNgsv7T1vX.pdf

create specimens of new machines. This is possible at industry-funded/corporate research institutes and design bureaus. At the third level, design institutes should be ready to find the most convenient and efficient form of implementing large-scale production of new machines on the basis of test results.

In addition to the three-tier system, being the result of interaction between universities and each subject of research, it is necessary to draft training programmes for designers of new machines, problem setters, engineers-experimentalists, logisticians, experts and engineers in charge of new machines. The same pattern must be applied to other types of construction that require import substitution. Specialists, that are being trained, should obtain information about their employment and incentives to train (higher scholarships, part-time opportunities, etc.).

Conclusions. The effective countercyclical policy, pursued amid unrelenting sanctions, means the ability to overcome technological dependence through foresight-programmes of scientific and technological development. Construction, being the most important asset-creating industry, that is responsible for the structural and technological maneuver of the Russian economy, needs radical technical and technological transformations. Models of investment and construction activities also require renovation. There are still no cardinal breakthroughs in the financing of construction projects. Essentially, the project finance "factory" is idle; no additional triggers of breakthroughs have appeared, and import substitution has not yet been implemented in the field of research. Amid sanctions against the country's largest banks, the only operational solution to support the industry in an attempt to overcome the limits of growth is an increase in budget financing. Obviously, we are not talking about all projects, but only those of strategic importance to ensure Russia's economic and technological sovereignty. In the construction industry, it is an infrastructural breakthrough supported by the expanding range of domestic technologies.

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Строительство: покорение пределов роста

Строительство в настоящее время не только обеспечивает жизнеспособность российской экономики, но и осуществляет пространственную реструктуризацию капитальных фондов в целях опережающего развития и создания комфортной среды жизни и деятельности. Существенные изменения современного геополитического ландшафта не могли не коснуться целевого фокуса и требований к развитию отрасли. Создание новых транспортно-логистических коридоров потребовало несопоставимо более высоких темпов дорожного строительства, программа импортозамещения активировала промышленное строительство, нацеленность на создание комфортной среды вынудила модернизировать жилищно-коммунальную инфраструктуру, новые горизонты развития сельского хозяйства сподвигли к созданию перерабатывающих производств и др. Несмотря на беспрецедентное санкционное давление жилищное строительство продолжило развиваться. При этом наметился структурный сдвиг в сторону индивидуального жилищного строительства. В целом можно констатировать, что строительство стало мощнейшим фактором, обеспечивающим не только устойчивость, но и ускоренное развитие секторов, нуждающихся в импортозамещении. В этой связи сложившаяся модель инвестиционно-строительной деятельности должна быть приведена в соответствие с актуальными целями развития страны. Основной фокус опережающего развития и покорения пределов роста строительства автор видит в обеспечении технологического суверенитета инвестиционно-строительной деятельности. В его основе — активизация инструментария форсайт-подхода, обновление имеющихся в отрасли научных школ, создание единого центра управления научно-техническим развитием, разработка контрциклической политики, переориентация инвестиционно-строительной деятельности на дружественные страны, подготовка и перепрофилирование кадров, а также формирование нового типа проектных команд.

Ключевые слова: *строительство, инвестиционный цикл, форсайт-подход, инновационный цикл, технологический суверенитет, научная база, научные школы, проекты технологической модернизации*

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Об авторах: **Яськова Наталья Юрьевна** — доктор экономических наук, профессор, заведующая кафедрой инвестиционно-строительного бизнеса и управления недвижимостью; **Российская академия народного хозяйства и государственной службы при Президенте Российской Федерации**; 119571, г. Москва, пр-т Вернадского, д. 82; РИНЦ ID: 490267, Scopus: 56209112800, ResearcherID: O-7581-2018, ORCID: 0000-0002-3245-1549; yaskova-ny@ranepa.ru;

Зайцева Лариса Игоревна — кандидат юридических наук, доцент, заместитель заведующего кафедрой инвестиционно-строительного бизнеса и управления недвижимостью; **Российская академия народного хозяйства и государственной службы при Президенте Российской Федерации**; 119571, г. Москва, пр-т Вернадского, д. 82; РИНЦ ID: 1027747, Scopus: 57194457897, ResearcherID: P-9941-2019, ORCID: 0000-0002-8325-4342; zaytseva-li@ranepa.ru.

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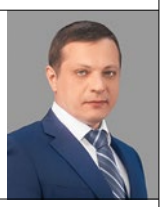
Volgin V.V.

Modeling locally integrated management in the system of spatial territorial development of industrial parks of the “greenfield” type



Volgin Valentin Valentinovich,
Vice-Rectors; Moscow State University of Civil Engineering (National Research University) (MGSU); 26 Yaroslavskoe shosse, Moscow, 129337, Russian Federation; ResearcherID: AAE-8862- 2022, ORCID: 0000-0001-7130- 3410; VolginVV@gic.mgsu.ru

The analysis of the industry's development over the last year, as well as over the period of regular collection of statistical information (since 2018), indicates the continued positive dynamics of development of industrial parks in Russia, despite the unfavourable economic situation in recent years. The pace of industrial development has proven the important role of industrial parks as an element of industrial and investment infrastructure, as well as an effective tool for territorial development.
An investment project of an industrial park of the “greenfield” type encompasses justification of economic feasibility, amount and scheduling of capital investments, including the required project documentation, as well as a description of practical steps to make investments in the system of spatial-territorial development. The lifecycle of the investment construction project, starting from the business idea to the commissioning of a facility, has different stages, interrelated with each other. The dates of the project implementation depend on the characteristic features and type of the future facility, conditions of financing, and tentatively make up to 5 years [1–3].
The successful existence and implementation of an investment project throughout its lifecycle is possible, above all, thanks to the professionalism and competence of all project participants, from the customer service, investor and management company to contractors in charge of certain types of work.
Keywords: *greenfield industrial park, investment and construction project, revitalization, sustainable development of urban environment, integrated model, redevelopment*

GENERAL PART

The effective implementation of large investment construction projects is a complex integrated task. Currently, the implementation of projects in Russia successfully adopts a managerial approach: a step-by-step process of project implementation is introduced, comprehensive monitoring and continuous control of the progress of work at all stages of the investment project [4] are performed, taking into account the principle of revitalization of the industrial area of development.

The standard step-by-step process of implementation of a greenfield industrial park project has five key stages: business plan – pre-project stage – design stage – construction – operation.

Each stage consists of a number of pre-set activities. Stages have a standard structure; at each stage, a strictly defined set of results must be delivered; they allow the investor to make key decisions about the further fate of the project, approve of its schedule, budget, and set the priorities.

As the project is implemented, at each subsequent stage, the accuracy of the assessment of the main parameters of the project (the project budget, the net present value) should go up (refer to lines on Fig. 1).

This figure describes an approach to the implementation of three stages of an investment construction project:

- the pre-project stage;
- the design stage;
- the construction stage.

The term “regeneration” is used in the theory of real estate management and is frequently used in the urban development section governing historic development. In the expansive context of a partial or complete change in the functional purpose of real estate, regeneration acquires the properties of the concept of redevelopment. Its functions are identified as follows.

1. Transformation of real estate facilities having any location.

2. All forms of expanded reproduction of real estate in accordance with the model “Construction – Renovation – Liquidation”.

3. Complex nature of restorative and developmental functions of real estate.

4. Functional mobility and adaptability of facilities to the adjacent territory.

Having made the analysis, the hierarchy of existing views on the concepts that reflect the processes that are underway in the established development, are shown in figure 2.

Following the content of the tasks about the main forms of restoration and renewal of the urban environment, we have found that in all cases their implementation is based on method, organizational and managerial mechanisms of redevelopment.

To clarify the content of the concept of revitalization as the notion that most fully reflects the social orientation of rehabilitation and development of industrial property in the territories of cities, let us study their typology.

Revitalization means restoration of the viability of urban industrial spaces through balancing

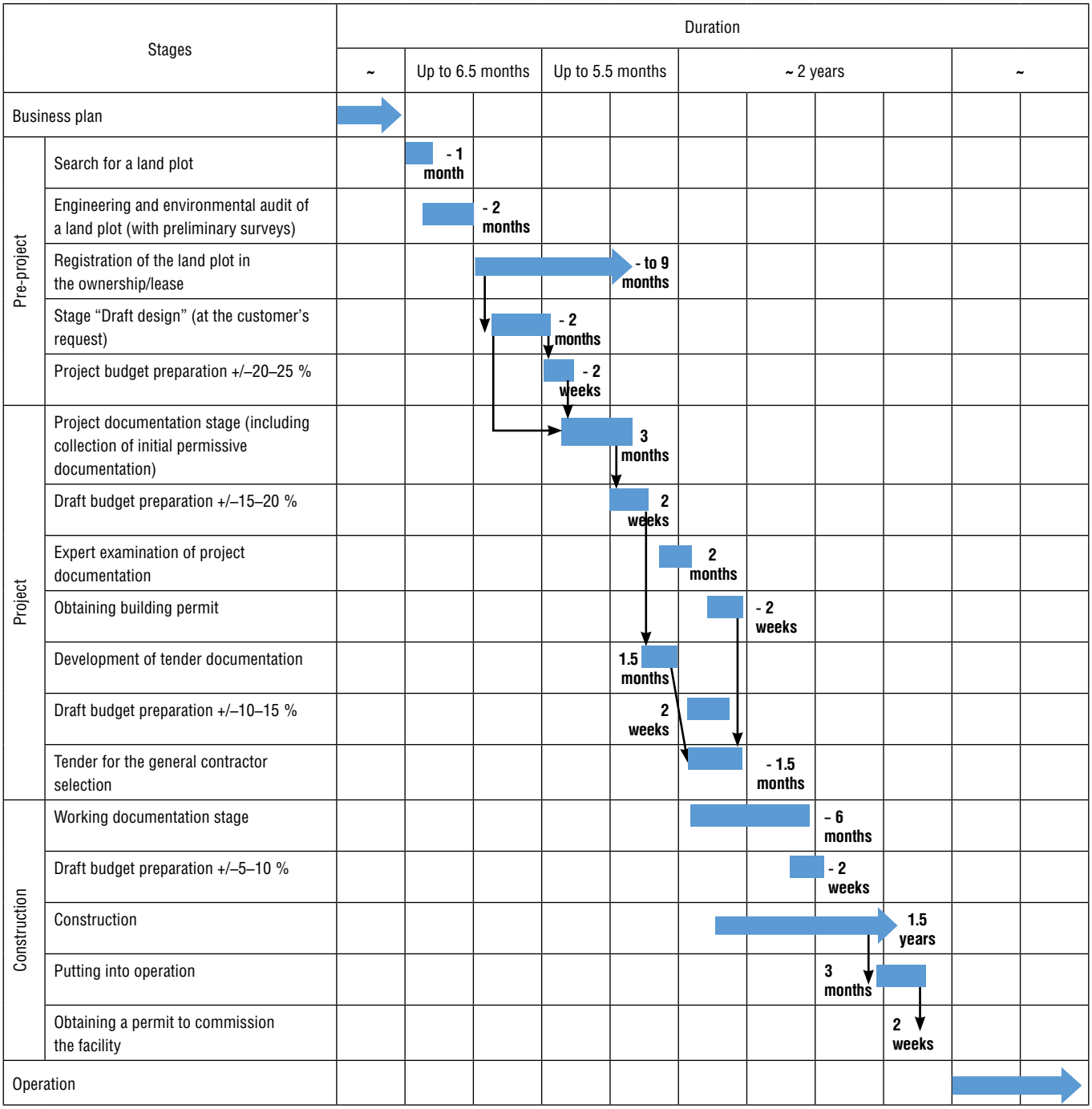


Fig. 1. General schedule for the implementation of the investment project of the Greenfield Industrial Park (IP)

the functional structure of real estate and the biosphere compatibility of urbanized territories with transport facilities and utility infrastructure. Processes of revitalization have functions of urban planning, urban development, and urban regulation in terms of the organization of reproductive processes of renewal (reconstruction, modernization and overhaul) of existing industrial buildings.

The analysis of historically established criteria for attributing cities to the some clearly expressed type allows to systematize them and substantiate the main features that determine the essential differences of urban spaces. Earlier studies have proven that the geographical location of settlements and the nature of their relationship with the outside territories largely predetermines the nature of employment (agriculture — in the case of adjoining fertile land resources; craftsmanship — in the presence of deposits; trade — if the intersection of transit routes is available, etc.). Localization within the country also conditioned the emergence of certain stereotypes of life activities (patriotism – egocentrism; money as the highest of values or justice and service; attitude to natural resources as a common good or private property; the role of the state as the basis of law and order or initiator, protector, judge, etc.). The advantages of location, and, hence, the resource basis for development, attracted residents, multiplying the number of city dwellers.

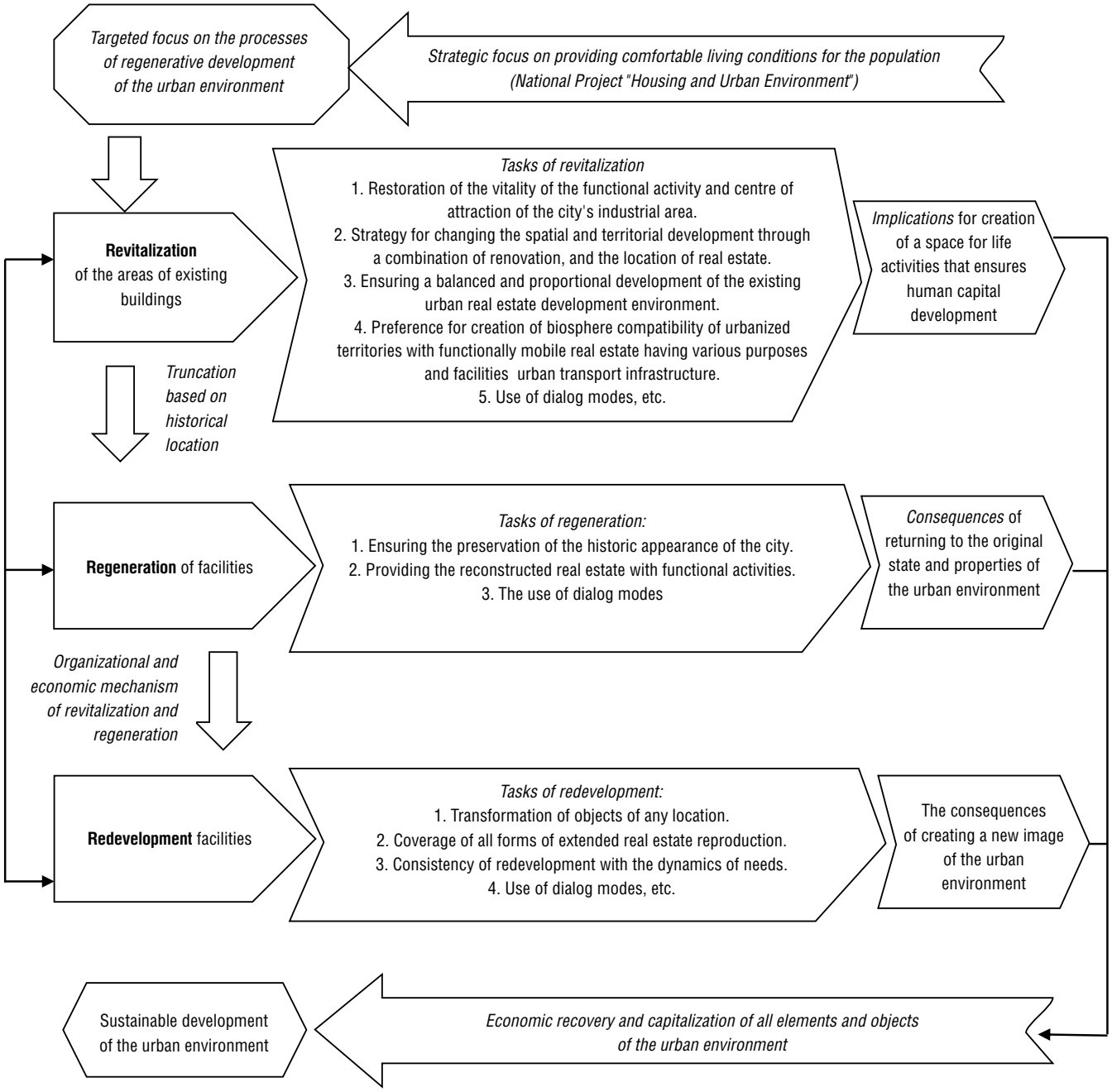


Fig. 2. The main forms of restoration and renewal of industrial areas of the urban environment

The development of the sphere of production, determined by the spheres of resource sufficiency and accessibility, is objective.

RESEARCH SECTION

The implementation of the main tasks of revitalization of the life space in a historically developed city is impossible without taking into account the object-subject relations that develop in the real estate sphere. Their immanent properties are formed, first of all, under the influence of peculiarities of real estate facilities as the material basis for the established structure of real estate. The peculiarities of the real estate sphere should include [5, 6] the profile of characteristics, that is generally accepted nowadays:

- diversity of types of real estate, segmented not only by location, functional purpose, number of storeys, degree of wear and tear etc., but also by the level of capitalization and prospective advantage;
- multiplicity of the facility composition with the internal interconnection and interdependence of constituent facilities. For example, the real estate structure of industrial zones and territories determines the configuration of energy, transport, housing and utilities infrastructure, while natural

or cultural heritage facilities objectively limit, and in some cases expand the views from new construction facilities;

- the functional determinism and relative inertness of real estate facilities, which requires either multi-functionalism or redevelopment, taking into account the dynamics of the structure of needs;
- the possibility of using different economic models of involving real estate in the economic turnover. It can be equity construction or project financing of new construction, purchase of property, lease, trust management, co-working, etc.;
- features of the liquidity of real estate facilities as an investment asset. On the one hand, a reliable asset is always in demand, on the other hand, given the capital intensity and the long payback period, the period of operation of the facility can be long;
- diversity of business entities involved in real estate operations. At the same time, not only legal entities, but also natural persons participate in the management cycle of real estate, taking into account the organizational and legal forms of ownership of a business entity. It is their dynamically changing needs that give impulses to changes in the structure of real estate.

Participants in the processes of cyclic development of real estate conduct their activities in different spheres (Fig. 3). As follows from the figure, a large number of spheres of investment and construction activity, serving all stages of the real estate life cycle, form the work front of participants. This indicates profound specialization of in-house units of large development companies, as well as a fairly wide range of activity segments of small and medium-sized construction companies. In any case, as studies have shown [7–9], the scale of activity is determined by specific volumes and the structure of real estate needs changing in the cyclic dynamics.

All spheres of activity are broken down by the stages in the lifecycle of industrial real estate facilities [10], which, according to the system-wide attributes, are usually subdivided into.

1. Land plots for development that are partially developed. These may be lands of settlements, special purpose lands (designated for industrial enterprises, energy and transport facilities, television, radio broadcasting and informatics, service industry, etc.).
2. Buildings and structures located above and underground.
3. Natural resources that are being developed or are subject to development.
4. Detached water bodies/water areas.
5. Special aerospace facilities, etc.

In turn, buildings and structures are subdivided into aboveground, located on a certain plot of land, and linear types of real estate, which have a length of up to tens of thousands of kilometers (pipelines, power lines, railroad tracks, etc.) All types of facilities are divided into commercial and non-commercial ones. In the generally accepted classification, land plots of noncommercial purpose are subdivided into lands of socio-cultural and research-educational purposes.

Land plots of commercial purpose are subdivided into residential real estate, industrial real estate and multifunctional real estate (retail trade, hotels, etc.).

Linear facilities and roads can also be commercial and noncommercial. For example, pipelines, power lines, railroads, etc. for strategic purposes are non-commercial in nature. At the same time, linear facilities of general business turnover serve commercial projects. Forest lands, water areas, etc., being originally objects of public use, are now also partially commercialized.

It is noteworthy that the structural diversity of real estate is often spontaneous. The development of living spaces is not always comprehensive, systemic and evenly distributed in time. Discontinuity and fragmentation, as a consequence of geopolitical and economic processes, are essentially characteristic of all historical periods of development of modern civilization. Epochs and modes of life left buildings and constructions inherent in their modes of life, which did not always fit into the changed structures of needs. Their dialectics, commensurate with changes in public space, restructured not only the spatial sphere of real estate, but also significantly expanded its functional purpose. The study of the classification criteria used in the research literature [11] shows their infinite variety depending on the purposes of research. Meanwhile, for the implementation of urban planning activities, focused on the provision of sustainable development of territories of historic cities, from the author's point of view, it is important to consider the logical subordination of the criteria of real estate decomposition. This is due primarily to the fact that the target aspect and character of real estate is determined not only by the emerging requirements, but also by its past, objectively predetermined by the spatial localization and various functional projections. In other words, the hierarchical structure of the criteria is based on objective functional properties determined by the spatial localization.

Reproductive processes of complex development of industrial areas include construction, renovation (demolition of obsolete, dilapidated and emergency items of real estate, and their replacement by newly built facilities), urban planning as formation of a multifunctional urban environment. Reproductive processes of renovation of existing industrial development include the whole variety of repair and reconstruction measures throughout the life cycle of the property: reconstruction, modernization, overhaul, restoration, current repairs and arrangement of urban life in accordance with modern safety and comfort requirements [12, 13] (Fig. 4.)

Functional properties of spatial localization, allowing the formation of the target space and setting options for the functional purpose of real estate, influence the nature of the use of real estate facilities, which, in turn, predetermine the type of real estate liquidity. The hierarchical relationship between the criteria of real estate decomposition is presented in Fig. 5.

Organizational principles of revitalization, as well as laws, are divided into general and particular.

Principles of the general structure include: compatibility and conformity of the element; differentiation and integration of functions; update of functions and concentration of functions; mobility (changeability) of functions (in our case — functional mobility of real estate); neutralization of dysfunctions; Le Chatelier principle (any attempts to change properties are caused by resistance, by force equal to influence); proportionality; functional additionality (with required complementarity).

The principle of the update of functions consists in the fact that if necessary, in critical situations it is necessary to implement an important function for its survival (possibly sluggishly implemented earlier), all resources and capabilities of functional elements are mobilized, etc.

The principle of functional mobility (changeability) means that in the same situations critical for an important function, other functions are mobilized, which “unload” and provide whatever is necessary.

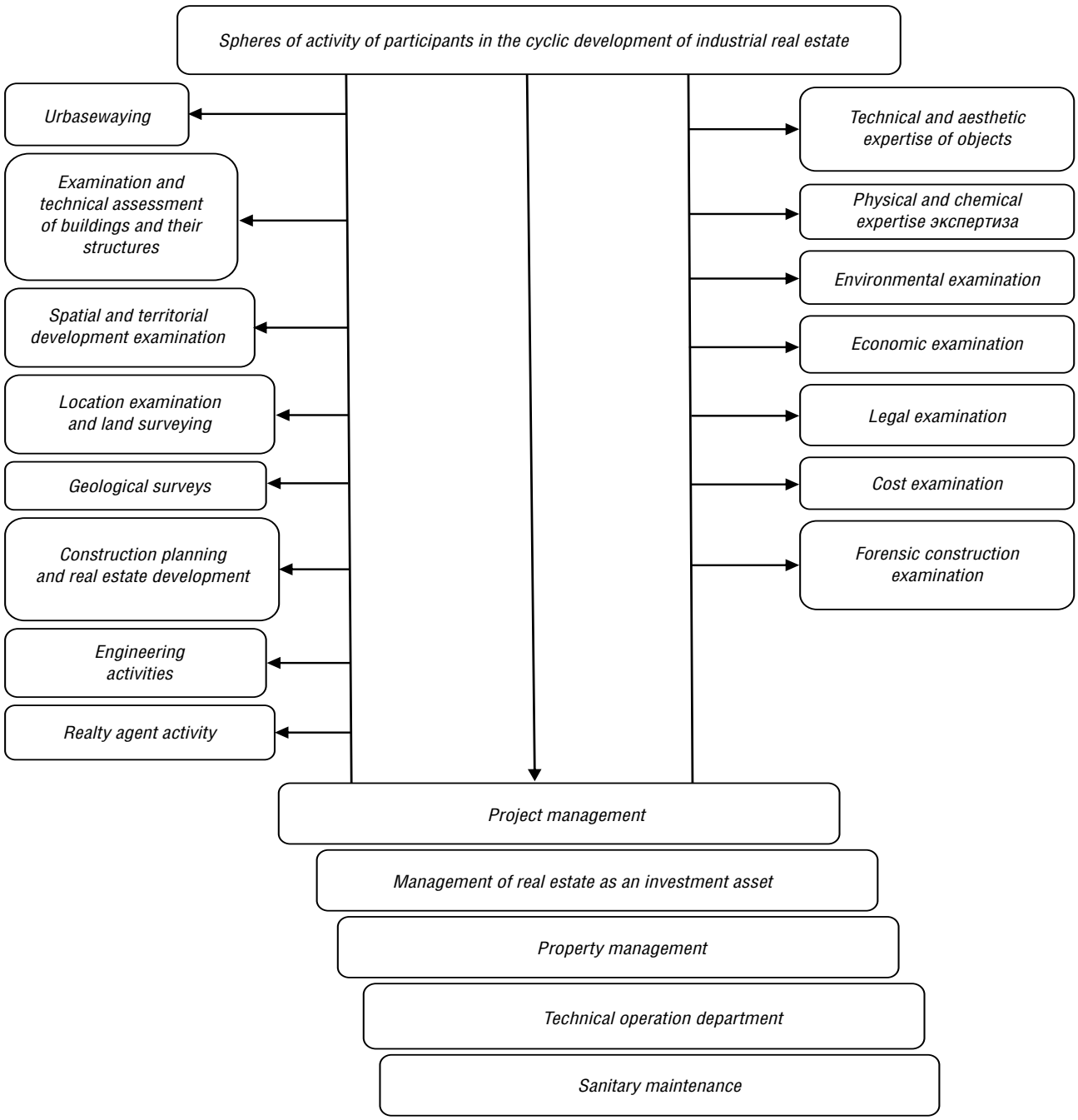


Fig. 3. Spheres of activity of participants in the cyclic development of industrial real estate

The principle of neutralization of dysfunctions consists in the fact that destructive actions of individual elements are blocked, suppressed by others, thereby increasing the viability.

The principle of complementarity consists in the fact that the main element can include elements with different, often mutually exclusive properties, mainly if these differences contribute to the achievement of the system's goals in the best way[1].

Complementarity relationships are assumed to be informational only and are intended to determine the ability to perform the same engineering operations.

Consideration of the theory of functional-statistical modeling, as well as the features and experience of modern construction and operation of real estate in the domestic and foreign practice allows for a fundamental model of functional reliability modeling.

In the most general form, the system-wide conceptual model can be represented graphically (Fig. 6).

Three types of functional relationships can be distinguished: *Z*(I–II), Z(II–III), Z(III–I)/.

This approach is based on a three-dimensional model of the functional system consisting of a set of functions (targets), which should be highly effective due to the combination:

1 System regularities and principles — General theory of systems. URL: istemnye_zakonomernosti_printsipy (rus.).

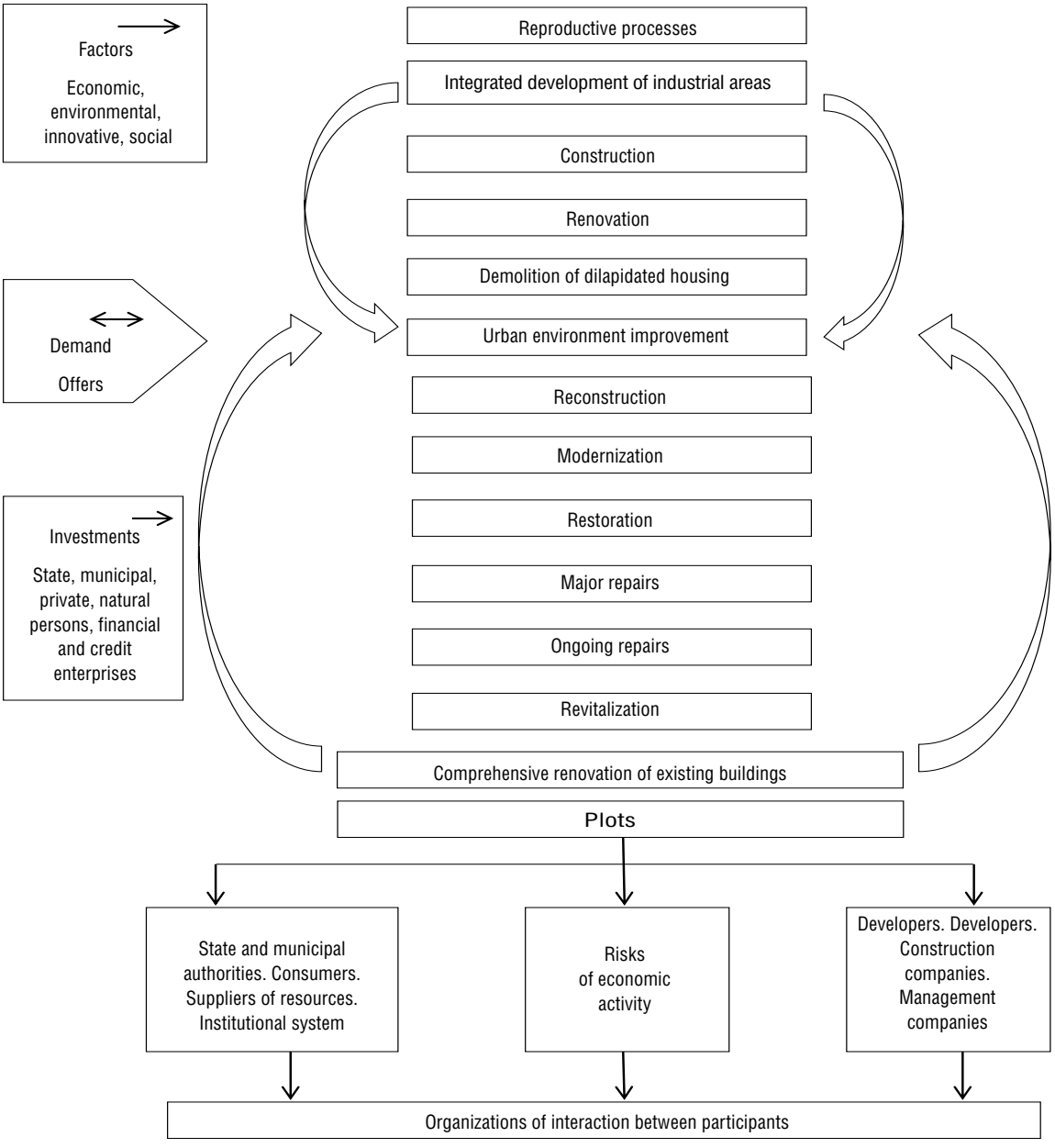


Fig. 4. Reproduction processes underway in the course of managing industrial realty

Level of objective structure	Functional properties of spatial localization — assessment of the potential of land, water, forest, raw material resources, taking into account available buildings and structures
Target level **(Basic module)**	The space of commercial and non-commercial purposes of the available real estate structure – evaluation of the degree of balance
Forecasted level **(Set of calculation methods)**	Scenarios and variants of functional use of real estate facilities – assessment of possible structures and their optimization
Selective level **(Resource and organizational module)**	System characteristics of the real estate facilities and their type of use — evaluation of the lifecycle, serviceability, attribution to the spheres of urban economy, ability to change, etc.
Operational level **(Implementation-operational module)**	Real estate capitalization – evaluation of the advance development potential of the real estate sector
Liquidation level **(Renovation module)**	Identification of damaged capital assets and capital assets in need of replacement and specification of the tasks of imbalance liquidation

Fig. 5. Hierarchical relationship between the decomposition criteria of industrial real estate facilities

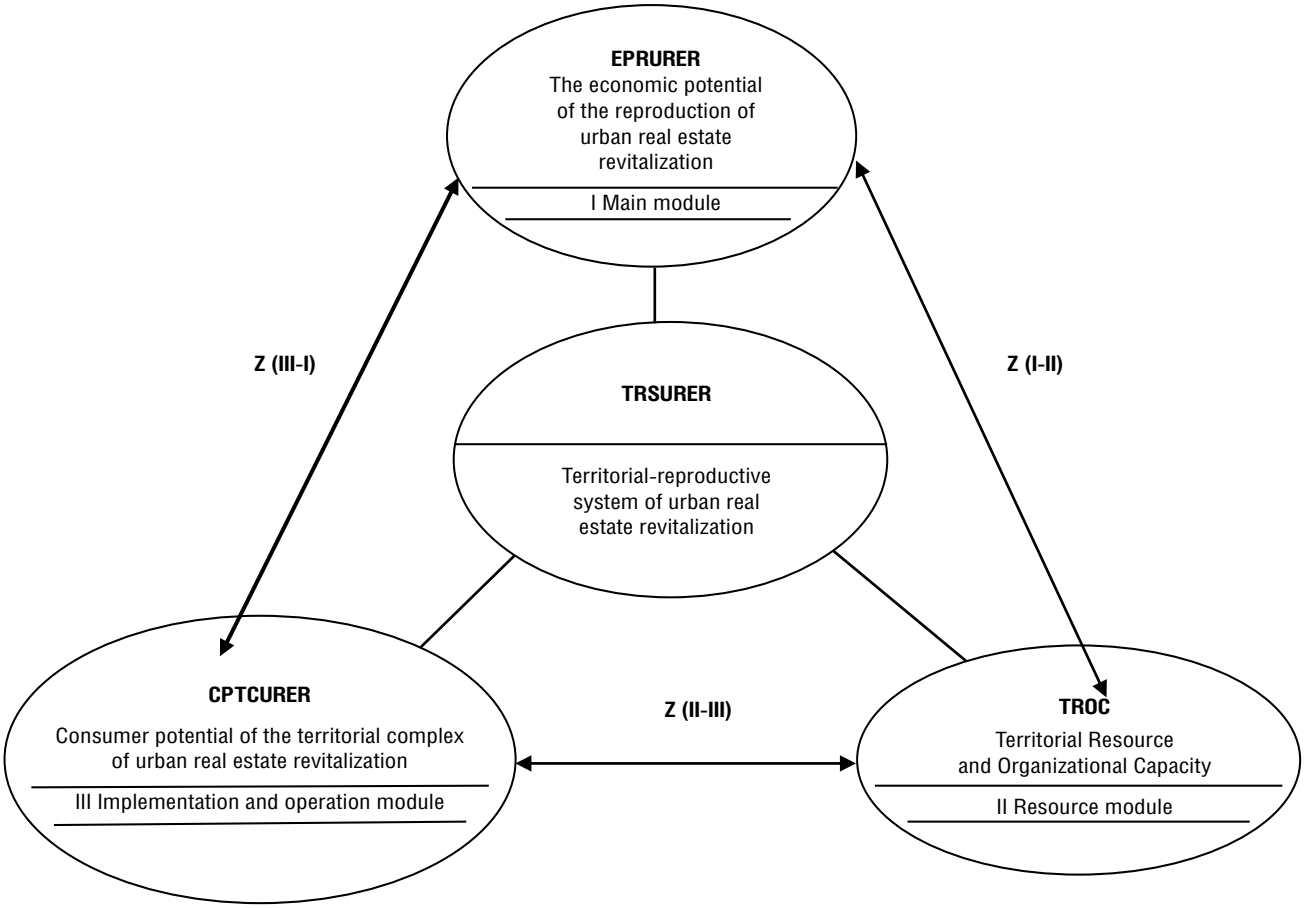


Fig. 6. A system-wide conceptual model applied to the socio-managerial and engineering system of industrial real estate development of an industrial park

Firstly, let's focus on these functions-stages of spatial-territorial development, as the basis for structuring and modeling of management life cycles. The number of (*i-j*) stages by types and spheres of construction here is the subject of forecasting and methodological modeling.

Secondly, the functions-tasks of spatial-territorial development are considered as solutions to private local goals.

Thirdly, these function-objects or types of reproduction and management objects are highly effective.

FINAL PART

The proposed function-based reliable approach to the analysis of the space of integrated development of industrial real estate ensures the analysis of the object of research in the form of a set of functions (target settings) and algorithms, while the research hypothesis and paradigm include: "the hard core" (according to the criterion set by the strategic block of sustainable urban development) and the conceptual part: the "protective shell" or modified (modifiable) part of the paradigm corresponding to the basic principles of real estate revitalization.

The analysis of the research, conducted by the authors in terms of the main methods of industrial construction allows to define conceptual approaches to the development of the strategy of performance management to classify the approaches and stages of assessing the performance of the developer, taking into account the risks, to simulate the management process.

Cycles of a single reproduction process are considered as relatively independent organizational and production subsystems of urban reproduction, the purpose of which is to ensure the integrated development of new land and property complexes and reconsider the existing urban development [14]. The main area of integrated development is the master plan for the development of the city. Renewal of the existing urban development involves the qualitative and quantitative transformation of its structure and composition in accordance with modern urban planning , environmental, and economic requirements.

Industrial construction has a number of features, which are associated with the specific features inherent in the products of construction.

Buildings and constructions differ from most industrial products first of all by their great durability, large dimensions, immovability. They are the most durable items and last for many decades. Buildings of large size require considerable time for their erection, large expenditures of labour time and materials and a large complex of various construction and installation works.

Given the nature of the product of labour in construction, its most important features are the lack of stationarity and the presence of seasonality in the production, long production cycle, and specificity of multifaceted objects constructed for different purposes.

Hence, construction products are created as a result of complex engineering process in which enterprises engaged in different types of activity participate. Such production interaction

allows to unite all these enterprises into a single inter-production construction complex, which is a system of cooperating enterprises and productions, united by stable production, engineering and economic ties.

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Моделирование локально-интегрального управления в системе пространственно-территориального девелопмента индустриальных парков типа «гринфилд»

Анализ развития отрасли за последний год, а также за период регулярного сбора статистической информации (с 2018 г.), свидетельствует о сохранении положительной динамики развития индустриальных парков в России, несмотря на неблагоприятную экономическую конъюнктуру последних лет. Темпы развития отрасли подтверждают важную роль индустриальных парков как элемента промышленной, инвестиционной инфраструктуры, а также действенного инструмента территориального развития.

Инвестиционный проект индустриального промышленного парка типа «гринфилд» (PTNip) — обоснование экономической целесообразности, объема и сроков осуществления капитальных вложений, в том числе необходимая проектная документация, а также описание практических действий по осуществлению инвестиций в системе пространственно-территориального девелопмента.

Жизненный цикл инвестиционного строительного проекта, от бизнес-идеи до ввода объекта в эксплуатацию, включает различные этапы, взаимоувязанные между собой. Сроки реализации проекта напрямую зависят от специфики и типа будущего объекта, условий финансирования и ориентировочно составляют до 5 лет [1–3].

Успешное существование и реализация инвестиционного проекта на протяжении всего его жизненного цикла обеспечивается, прежде всего, профессионализмом и компетентностью всех участников проекта: от службы заказчика, инвестора и управляющей компании до подрядчиков по отдельным видам работ.

Ключевые слова: *индустриальный промышленный парк типа «гринфилд», инвестиционно-строительный проект, ревитализация, устойчивое развитие городской среды, интегрированная модель, редевелопмент*

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Об авторе: **Волгин Валентин Валентинович** — проректор; **Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ)**; 129337, г. Москва, Ярославское шоссе, д. 26; ResearcherID: AAE-8862-2022, ORCID: 0000-0001-7130-3410; VolginVV@gic.mgsu.ru.

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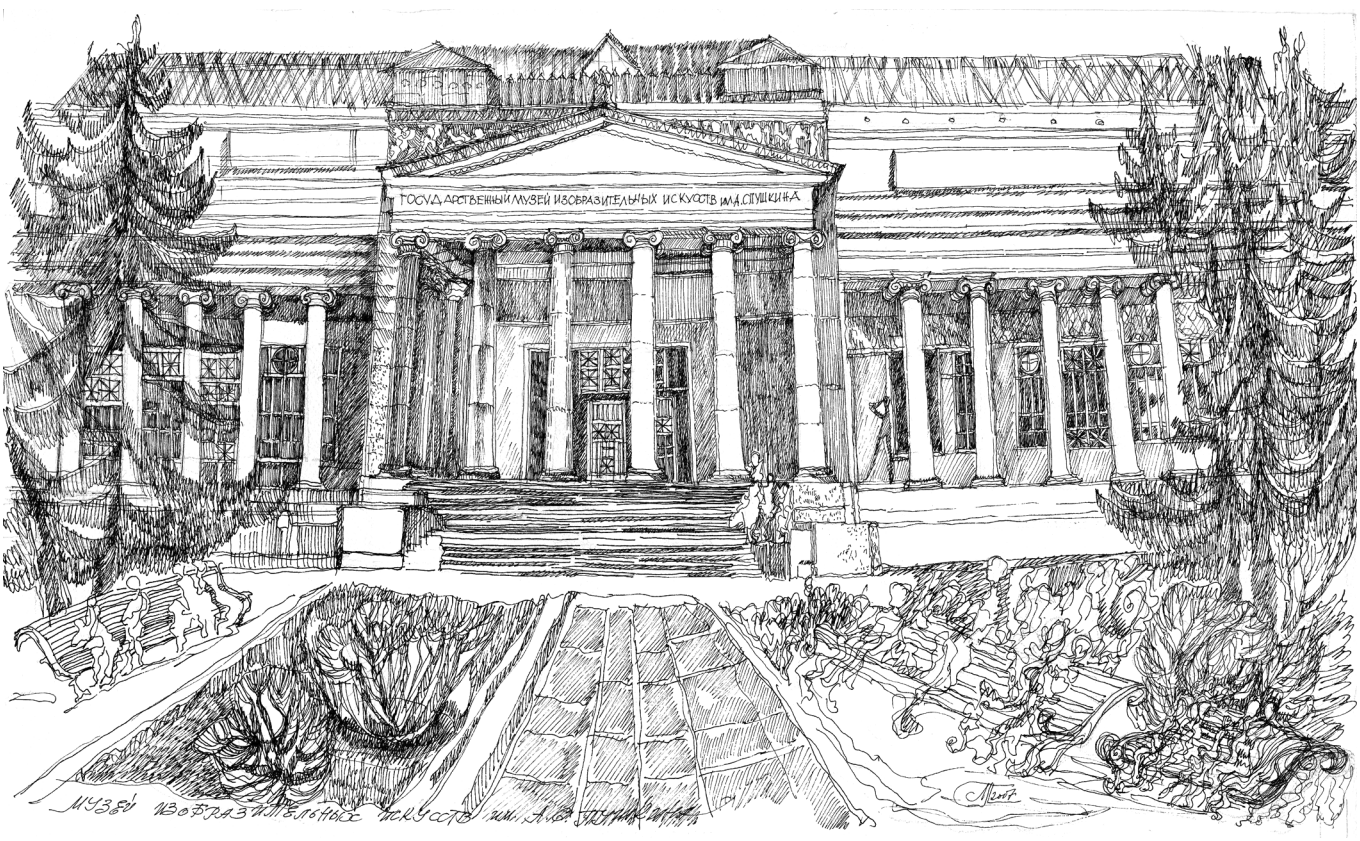

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Voyloshnikov M.V.
Kulakov K.Yu.
Krivets V.V.

Systemic causes of discrepancies in the valuation of an industrial asset by the independent approaches and the recommendations for the valuation results harmonizing

The assessment of the value of industrial assets is carried out to make decisions when forming complexes of these assets as part of the businesses of acting enterprises, as well as when creating the assets themselves, when purchasing them, when decommissioning for recycling and for the other assignments. The valuation error and the discrepancy between the value of these assets found by independent approaches indicates the quality of the valuation. The base of the error determining in estimating the value should be adjusted depending on the age of the industrial asset and it accumulated depreciation, since the value of asset within it lifetime decreases to zero with age and therefore this cannot serve as a base for finding of the value relative error. The causes for the discrepancy between the value of an industrial asset and its value found by independent approaches are both the approximateness of the initial data, which, when assessed, replace the characteristics of the general system, in which the assessed asset enters as the subsystem, and the methodological differences of the value normative concept and the value as the set of methods of it determining by the independent approaches. For adjusting the results found by each independent approach, an analysis is carried out of their compliance with the adequate methodological concepts of valuation and the performances of industrial asset. Taking into account the property of accumulation of the depreciation and the limited durability of the asset, the distribution of it values got by the cost and the income approaches, when harmonizing they, can be rationalized using the considered method. After an expert determining of the weight coefficient of the result got by the comparable sales approach, the contributions of the independent results got by cost and income approaches are adjusted in proportion to the transfer of accumulated net income to the value of property complex to which the industrial asset belongs as element of the system.
Keywords: *industrial asset, property complex, purpose of an asset, durability of an asset, value change, independent approach, property complex, element of a complex, system communication, data error, concept of value, determining of value, conformity of definitions, harmonization of value, transfer of value, economic obsolescence*

Voyloshnikov Michael Vladilenjvich,
Doctor of Technical Sciences, Professor, Chief Researcher, Member of the SRO of Appraisers Association "Expert Council"; Maritime State University named after admiral G.I. Nevelskoy (MSU named after adm. G.I. Nevelskoy); 50a Verkhneportovaya St., 690059, Vladivostok, Russian Federation; ID RISC: 289716; michael.vladlen@gmail.com

Kulakov Kirill Yurevich,
Doctor of Economics, Professor, President of the Union of Financial and Economic Forensic Experts, Vice President of the "Association of SRO Appraisers", Vice President of SRO Regional Association of Appraisers, Chairman of the Committee of the National Association of SRO Appraisers for Cadastral Valuation and Challenging the Cadastral Value; Moscow State University of Civil Engineering (National Research University) (MGSU); 26 Yaroslavskoe shosse, Moscow, 129337, Russian Federation; ID RISC: 360164; kkulakov@bk.ru

Krivets Valeriya Victorovna,
Candidate of Economic Sciences, Associate Professor, Member of the SRO of Appraisers Association "Russian Society of Appraisers", President of the Association "Club Professional"; 177-9 Svetlanskaya St., 690001, Vladivostok, Russian Federation; krivet@mail.ru

INTRODUCTION

In order to increase capitalization, the company creates complexes of assets, uses them productively and disposes of them. The separate Industrial assets included in the company's property complex have limited durability, they are acquired, used, and disposed of as the value is transferred to the accumulated net income. The company operates on the basis of financial self-sufficiency, while net income and profit are kept in the property complex of assets and serve its value growth.

Due to external or other circumstances the complex of assets in the long term is also restructured. But the limitation of durability, which is associated with indicators of accumulated irremovable wear, is a property of only a part of the property complex — its industrial asset, while the whole — the property complex does not have internal limitations of durability in the terms of systemic approach models [1], and the value of the complex grows as assets are accumulate.

An example of an estimated industrial asset (the separate one in the set of property complex) is to be real estate [2], machinery or equipment [3], or the intangible asset [4, 5]. At the same time, it would be unnatural to classify complex objects as industrial assets and it would be illogical to consider complex real estate in the sum of its parts, for example, a building and a built-up area as the industrial asset. In this example, only a building could be classified as an industrial asset, assuming it assignment, while the site is a universal part of a complex facility.

Among the methodological elements that influence the applied approaches for the valuation of industrial assets, one can also indicate the characteristic decrease of an industrial asset value with age, considering the limited durability of the asset, which is not completely characteristic of complex objects, such as an integral operating enterprise, or as real estate, the value of which usually does not decrease less than the value of the occupied site (up to the cost of clearing the site — in some estimates).

Limited durability is not an obligatory characteristic of a property complex whose assets are replaceable and economically viable. It is characteristic that durability is an important property of the industrial asset in the set of property complex of the acting company, and this property must be taken into account when determining the asset value.

The concept of an industrial asset, which is other than the complex one, that is, the integral property complex of acting company, is associated with the characteristic of the asset assignment, usually indicated in the asset passport or in it

performances specification. Examples of the characteristics of purpose of the industrial asset can be: assignment of a building, type of vehicle or machine, assignment of an equipment object, of a particular intellectual product, and so on.

On the other hand, the assignment of a complex asset (i.e., an integral property complex), characterizing the type of activity of the enterprise, usually corresponds to the code according to the Classifier of Economic Activities. For any type of economic activity in the set of property complex of company there are the industrial assets of various assignments — both the real estate and the equipment.

In some cases, a synonym for the name: an industrial asset could be considered a close concept of the separate asset, although the term "the industrial asset" seems to be more correct, since the separate could mean one valued outside the property complex, which is not typical.

It has to be indicated that among the features of an industrial asset valuation, the value of which can be determined by the independent approaches, including the income one (in accordance with the Standard for Valuation or with the methodic papers [6–16]), the opportunity is assumed of the asset independent financial accounting.

When harmonizing the results of valuation by independent approaches, it should be taken into account that there is an uncertainty factor, which, when assigning weight factors or the coefficients (weights) to the results of valuation by independent approaches, is decided by experts, and there are no rigorous mathematical methods for distributing weights, which is an uncertainty factor. The uncertainty of the correlation of got results of valuation by independent approaches is theoretically unavoidable, in particular, it is impossible to create a strictly evidential mathematical method for determining weight coefficients, and any expert methods for assigning these coefficients are subjective to one degree or another. Expert assignment of weight coefficients in solving of the economic problems with uncertainty, both when finding the indexes of value so when the indicators of economic efficiency, is a normal way of independent results coordinating, taking into account the uncertainty factor, this usually has the form of composite economic index (the formula 23.13 [3]). And if the weight coefficients serve as characteristics of the confidence probability, which is also a rather subjective indicator, then the harmonizing of the results of valuation meets the Laplace criterion known in math.

THE GROUND OF COMPARISON WHEN DETERMINING THE VALUATION RELATIVE ERROR

The error of asset valuation can be determined in absolute value (in monetary units) by variant calculations and in relative units — without dimension. The dimension of the absolute error of valuation is to be eliminated when using the monetary comparison index. To find the valuation error by relative value, it would be necessary to define the concept and to use the defined index of the comparison base in units of value, without confusing the base for determining the relative valuation error with the indicator of the valuation base — the market value.

Since, unlike the property complex, which is an renewable set of all assets of the acting company, the durability of the industrial asset is usually limited and the value of each asset within the limits of it durability usually reduces almost to zero, then the basis for estimating the error in these cases should not be the value sought and the any sustainable index, when the value changes over time, for example, the index of sum of the value gradually reduced and the accumulated depreciation of the asset, or the total of costs for creating of the asset analogue in market prices, i.e. it replacement cost.

With limited durability, the market value of the industrial asset in the present prices by the time is reduced to almost zero, since the residual liquidation value, that is the utilization one, and the cost of disposal are commensurate with estimation error of zero value compared to the market cost of creating an asset (the replacement cost).

On the other hand, it must be taken into account that depreciation accumulates with age of the asset. Since it is assumed that the error in relative value should not grow indefinitely as wear accumulates and value decreases, then, accordingly, the absolute (monetary) error of the value determining should decrease to zero in proportion to the decrease of value as it is, if value is taken as the comparison base when finding the relative error of the value determining.

But in this case, a methodological contradiction would arise, consisting in the fact that in terms of monetary (absolute) error of estimate of the value, which decreases by the age to zero, which is also the error in determining accumulated depreciation, formally cannot be zero, because the comparison base for determining the relative error of depreciation would be growing by the asset age the depreciation, which tends to the maximum, when the value tends to zero.

Therefore, the value of an industrial asset, which becomes cheaper to zero within the limits of durability, cannot be a basis for comparison to determine the relative error of value estimate. In other words, when determining the error in terms of a relative value it is advisable as a base of comparison to take some economic indicator that is not corresponded with durability of the industrial asset and does not change significantly by the age of the asset that is by the depreciation accumulation, for example, consider the error of the value estimate in relation to the asset replacement value (the market costs for creating a new analogue) or the sum of the market value and the accumulated depreciation as the comparison base of the relative error.

Should be explained with an example. Let's say by the cost approach the value of asset is rated 100 thousand US dollars, by the income approach — 200 thousand US dollars, and by the comparable sales one — 300 thousand US dollars, and the replacement costs is 5 million US dollars. Despite the apparent spread of values: 100, 200 and 300 thousand US dollars, with an average estimate of 200 thousand US dollars, this value is a quite satisfactory approximation of zero value of the asset compared to its replacement costs (5 million US dollars), or compared to the sum of the value of the asset and its accumulated depreciation, which for the considered example is almost equal to the replacement costs, and this serves as a hint that the asset value corresponds to zero or to the residual liquidation value, and the spread of values is quite acceptable if the replacement costs is taken as the basis for comparing the relative error, or the found sum of value and accumulated depreciation is taken as this basis.

In terms of reliability for such an example the estimate by independent approaches could raise much more doubts, in which the results would be: 190, 200 and 210 thousand US dollars, which could mean an incredibly high accuracy of the assessment compared to the replacement value (5 million US dollars), or compared to the sum of the found value (200 thousand US dollars) and accumulated depreciation, and this would lead to the incorrect conclusion that the value of asset is equal to 200 thousand US dollars,

when in reality it corresponds to zero or to residual liquidation value, and 200 thousand US dollars is a value commensurate with the absolute error of value estimate, which, when determining the relative error, should have been attributed to the replacement costs or to the sum of the market value and accumulated depreciation, which indicated by data of considered example.

Thus, when finding the estimation error by it relative value, it is necessary to specify correctly the base of this error from the standpoint of the systemic approach, in which an industrial asset is evaluated not by itself, but as an element of cyclic system: creation, installation, equipment and it launch, productive use, maintenance, write-off and disposal, and the relative error base is that associated with the estimated value index, which somehow remains unchanged or sustainable during the specified systemic cycle.

THE CAUSES OF VALUATION ERROR

When studying the quality and accuracy of the industrial asset value assessing it is necessary to take into account both natural errors arising from inaccurate data and the methodological discrepancies.

The inaccuracy of the data: the constraints and the assumptions of evaluation, including the data used in the creation of mathematical models, programs, databases, etc., used in the value determining, underlies the natural errors of its finding and is of a systemic nature, since the asset is examined when determining the value as an element of a certain more general system and, at the same time, as a system consisting of it elements — the subsystems.

Theoretically, the list of examples of a more general system than the asset being valued is unlimited. As examples of the characteristics of more general systems than the asset being valued, when evaluating a land plot or an object on a site, one can indicate: address, cadastral quarter, municipality, subject of the federation and so on. An industrial asset is valued in the system of all the links — in the set of property complex or as part of one or another operating technology, as a product of serial or individual production, as an investment object within the framework of a corresponding innovative project, as a certain type in one or another asset classification system and etc.

For practical purposes, when determining the value of an asset, one has to adhere to the constraints and the assumptions, corresponded with the characteristics of more general system, to which the asset being valued belongs as the subsystem. These constraints serve as the initial data for evaluation, and the reason for the data error is their known relativity, which arises as a result of the break of methodological links between the industrial asset and the more general system to which it belongs in a functional, technological, economic, legal or other respect, and the number of variants of this system is in principle unlimited.

A typical example of a system that is more general than the industrial asset being valued, to which it belongs, can be indicators of the property complex to which the asset or the object of equipment being valued belongs. In turn, this property complex is included in the composition of the more general system as it element, for example, in the composition of a particular industry sector or regional economy. In this inductive sequence it would be possible to enlarge systems and complex objects that include an industrial asset. And in the practical determining of asset value, such a sequence of entry into more general systems is substituted by the valuation constraints, that is, the initial data in the form of certain numerical indexes, in the form of models created for valuation and used, or in the form of rules and limits of applicability of the initial data and these constraints, as indicated above, are largely conventional due to the variety of options and degrees of generalization of systems in which the valuated object is included as an element, and the specified relativity causes the data errors — the inaccuracy of the constraints and the assumptions of valuation.

In turn the industrial asset from the systemic point of view also acts as a complex object consisting of subsystems. In particular, a property complex consists of separate industrial assets, while real estate consists of a built-up area and a building, also consisting of separate parts and rooms, and, further in deductive sequence, parts of an asset include separate structural elements and so on.

In practical tasks, when determining value the data of the constituent parts of this asset for each level of detail are also used as the constraints in addition to the characteristics of more general systems to which the industrial asset belongs as an element, and the relativity of the chosen level of detail and the corresponding breaks of methodological links of the industrial asset and its subsystems are the cause of the error of these data, just as the cause of the error is the relativity of data when they replace the methodological links of valuated asset with the general systems to which the asset belongs as an element, which is considered above.

That is, the inaccuracy of the data factors for estimating value are the following:

- the degree of relativity (the conventionality) and corresponded approximation of data, i.e. the constraints and the assumptions, including those adopted in the assessment methods and models used, which, when determining the value, replace the methodological links of the industrial asset with more general system to which it belongs as an element;
- the approximate nature of the parameters assigned when determining the asset value, which replace the methodological links of the asset with it subsystems.

To assess the impact of data or parameter errors on the accuracy of finding the value of industrial asset, one can use the variant calculations of value when varying data and parameters within their errors. At the same time, the cause of error in the results of these variant calculations will not be the discrepancy between the methodological assumptions of independent approaches for the same and combination of data (the constraints and the assumptions).

THE ANALYSIS OF CAUSES OF THE DISCREPANCIES OF VALUATION BY THE INDEPENDENT APPROACHES

Different values found by independent approaches may indicate the methodological discrepancy between these results, which cannot be considered as valuation error, corresponded with approximation and inaccuracy of data and models, used to valuate an industrial asset.

The analysis of characteristic forms of dependences of the value of industrial asset on its age when valuated by independent approaches (Fig. 1) indicates that in wide ranges of age variation, correlated with the accumulation of the irremovable depreciation, the values found by the independent approaches differ by the ranges commensurate with these values as they are.

For some ages within the limits of durability of the industrial asset the independent approaches together can give a similar value: the same estimates of value can be determined by the income and the comparable sales approaches at a certain age of the asset (marked *A* on the chart, Fig. 1), and for other age of the asset the common value is given by cost and income approaches (on

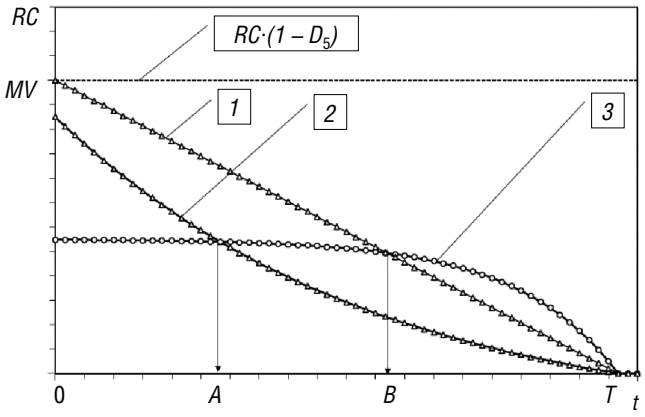

Fig. 1. Dependences of the industrial asset the values MV on the age t within durability T when finding by: 1 — the cost approach; 2 — the comparable sales approach; 3 — the income approach; A, B — the age values for intersections of graphs of estimates by independent approaches; RC·(1 – D_5) — the replacement cost deducted the external obsolescence

the chart *B*). As can the schematic graphs indicate three independent approaches can give the same zero value for the conditions for an asset decommissioning, for example, when determining the residual liquidation value (the utilization one).

For the age of an industrial asset corresponding to the values *A* and *B* (Fig. 1) the results of value estimation in one or another pair of independent approaches are close. These ages of the asset and the range of values between them may just correspond to the characteristic sales on second-hand market. And for other values of age (less than *A* and more than *B*, as well as between *A* and *B*) according to the schematic graph, the discrepancies in the estimates by independent approaches are characteristic.

That is, if there is one or another preferred approach outside the range of values of the "market" age of the industrial asset (from *A* to *B*) then the values estimated by the other approaches would probably degrade the quality of the estimate compared to this preferred approach estimate.

The discrepancies in values found by independent approaches have systemic causes that go into the problem of correspondence of market value two methodological definitions:

- on the one hand, the definition of value as the result of a consistent assessment by independent approaches in accordance with standards, in particular, with the Standard for Valuation "General concepts of valuation, approaches to valuation and assumptions for conducting valuation", what could be considered a methodical (algorithmic) definition of value;
- on the other hand, value in its normative definition under Russian Federal Law of July 29, 1998 No. 135–FZ "On valuation activities in the Russian Federation" and under the corresponded Article of Standard for Valuation "The purpose of the valuation and types of value" as "… the most probable price at which the object of appraisal can be alienated on the open market in a competitive environment, when …", or other standards, including all terms of the normative definition used.

In contrast to considered error of value estimate due to inaccuracy of data and the systemic relativity of the asset coordination as the element in the general system, as well as the conventionality of links of the asset with it subsystems, the cause of observed discrepancy of values found by independent approaches arises due to the methodic difference of value definitions given above, i.e. the value definition as a result of the coordinated use of three (or other number) independent approaches, which should naturally lead to finding the value in definition of it normative concept.

In practical evaluation, the correspondence of these two definitions of the value is considered as an axiom and no exact proof is known that the consistent application of the three standard approaches gives value in its normative definition.

At the basis of the observed discrepancies of values found by independent approaches, there is a methodological difference between these approaches. Indeed, if only one approach would have been prescribed by the valuation standards, then the discrepancies in the obtained values would not emerge, and there would be no reason to doubt the conformity of value as the consistent use of three independent approaches, on the one hand, and value in its normative definition by the federal law and valuation standards, on the other one.

In a historical retrospective the periods are known in which it would has been logical to correlate the value with the presumptions of the cost approach, since the sale of property with profit, in particular, did not correspond to the morality of the religious worldview common in the Middle Ages, in which profit acts as illicit enrichment, which quite closely corresponds to the philosophy — Thomas Aquinas. Such ethical canons could mean the impermissibility of speculative profit and the acceptability of only the cost approach when finding value as the sum of costs spent. Although, it would probably be accepted as the allowable wear of the goods and the own contribution of labor to the material costs incurred. If for these conditions it is assumed that estimating by the income approach is unacceptable, then the cost approach, which includes the comparable sales one — to determine the initial costs, would remain as the only acceptable way to determine value. At the same time, there would be no doubts about the compliance of the normative concept of value as the sum of costs and the value methodical determination by costs summation of acquiring or creating an industrial asset minus it depreciation.

It can be seen that the question of a possible discrepancy between the normative concept of value and it methodological definition as the result of harmonized use of the independent approaches emerges simultaneously with the question of the correspondence of the independent approaches to each other. These two interrelated issues essentially represent a single problem, in which the correspondence of value as a concept and as a standard algorithm for its determination is characterized by a divergence of results when applying independent approaches.

Both the indicated methodological discrepancy in the assessment by independent approaches and the error in determining value due to inaccurate data are natural properties of the value index of an industrial asset.

To observe the discrepancy between the results of valuation when plotting the schematic graphs (Fig. 1) the characteristic forms of dependences of value on the age of the industrial asset were taken into account when it was evaluated using the cost, the comparable sales and the income approaches.

THE CHARACTERISTIC DEPENDANCE ON ASSET AGE OF VALUE DETERMINED BY COST AND COMPARABLE SALES APPROACHES

It is logical to make a general analysis of the dependencies of asset value on the age, taking into account the commonly used formulas. The cost approach value *MV* of the industrial asset in dependence on it reconstruction costs *RC* and the indexes of depreciation one can find according to the known formula [7]:

$$MV\left(D(t)\right) = RC\left(1-D_2\right)\times \\ \times\left(1-D_4\right)(1-D_5)-D_1-D_3, \quad (1)$$

where D_2, D_4 and D_5 — the irremovable depreciation physical, functional and external; D_1 and D_3 — the removable depreciation: physical and functional, usually valued in terms of money, as opposed to permanent depreciation, determined by relative value.

The irremovable depreciation physical D_2 and functional D_4 accumulate with the age of an industrial asset, for example, according to a linear or other proportional dependence, which corresponds to the method of depreciation determining often used in practical assessment, having into account the durability (life) of an asset and it age, and also corresponds to depreciation in the book keeping. The indicated proportion could be attributed in total to the accumulated irremovable physical and functional depreciations, given that the irremovable one of each of these types is applied to the remainder after subtracting the irremovable depreciation of the other type as: $(1 - D_2)(1 - D_4)$.

Need clarification regarding the external obsolescence D_5, which, unlike the irremovable physical D_2 and functional D_4 ones, does not tend to accumulate with the age of the asset, and, depending on external economic factors, equally affects the value of industrial assets that are similar functional and structural when other of their ages, as shown by the horizontal line: $RC \cdot (1 - D_5)$ on a schematic graph (Fig. 1).

The durability T of the industrial asset in this schematic graph is harmonized for three independent approaches. With respect to the cost approach, this schematic diagram assumes that the irremovable physical and the functional depreciations accumulate proportionally with the age of the asset t within it durability T.

It is taken into account that the removable depreciation of an industrial asset, i.e. the deferred costs for its maintenance, repair and modernization are eliminated at a certain periodicity. That is, the depreciation of this type is not characterized by accumulation and does not have a noticeable effect on the general shape of the dependence of asset value on it age.

The accuracy of determining the depreciation and value of a non–new asset when estimated by cost approach significantly depends on the correct prediction of the asset durability. The costs as the asset ages is replaced by it depreciation (part of the reconstruction value transferred to accumulated net income at the property complex to which the asset belongs). The market value, which represents the difference between reconstruction costs and accumulated depreciation, finally becomes significantly less than both reconstruction costs and accumulated depreciation.

In practical valuation, the use of the cost approach to determine value is preferable with little depreciation for the brand new and the relatively new industrial assets due to the following reasons.

1. With the age of the industrial asset the information about the costs for its creation is usually lost and there may be the methodological difficulties to find the reconstruction costs or the replacement ones (to produce functional analogue).

2. With the age of the industrial asset commensurate with its longevity, the determination of value by cost approach is to be inaccurate, since the accumulated depreciation is commensurate with the value of the new asset, and finding the value is therefore characterized by the methodological difficulty, considered in mathematics as the “small difference of large values”, which has to be conceptually inaccurate.

3. Depreciation of the industrial asset is manifested not only in a decrease in value, but also in the accumulation of differences of value of initially identical assets. The depreciation can be relatively small with proper maintenance and with sufficient maintenance costs, i.e. with the increase of the asset predictable life. There may also be circumstances of the opposite nature.

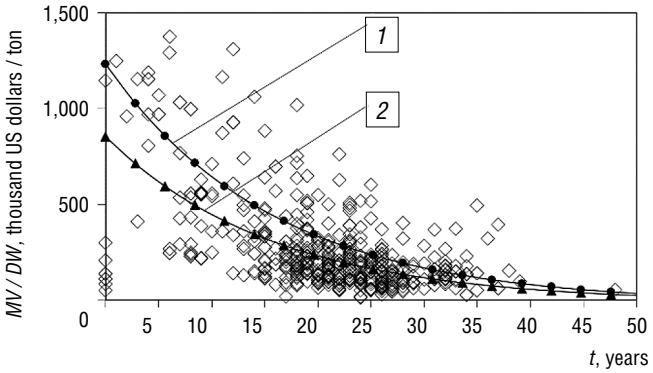

Fig. 2. The regression dependencies of specific value per unit of deadweight (MV/DW) on the age within the durability of universal bulk cargoes ship (the lines for the deadweight DW: 1 — 7,900 ton, 2 — 15,800 ton)

The presented graphs show regression dependence (Fig. 2) corresponding to the application of the comparable sales approach and similarity with analogues in terms of specific value (*MV*/*DW*) per unit of it size (the deadweight *DW*) on the ship age *t* and on the deadweight *DW* of ship for bulk cargoes [3].

The graphs (Fig. 2) show the similarity of the regression dependences of the specific value on the age *t* of ships of the considered classes with the form of the curves of value of industrial asset on it age corresponding to the comparable sales approach indicated on the schematic graph (Fig. 1).

Considering the indicated examples of specific value curves for bulk cargoes carrier ships, the dependence of the specific value of the industrial asset on the age on the schematic graph is shown in accordance with the function:

$$MV_M = DW\left(X \cdot DW^Y e^{Z \cdot DW}\frac{(1+i)^{T-t}-1}{(1+i)^T-1}\right), \quad (2)$$

which is indicated for merchant cargo ships when approximating statistical observations. In this case, in formula (2) the characteristic of the size of ship is used — the deadweight *DW* and the ship age *t*, as well as it durability *T*, and the regression factors are coefficients and degrees: *X*, *Y* and *Z* (that is, the scale effect factor: $XDW^Y e^{Z \cdot DW}$) and the index of discount rate *i*, characterizing the decrease in the value of the industrial asset as it is transferred to accumulation in the property complex of assets, in the system of which this asset is included as an element.

Apparently, similar or close formulas for value estimating by comparable sales approach depending on the age of the industrial asset and on one or another it comparison characteristic, as which the deadweight *DW* was chosen in the example for cargo ship, can be determined for various industrial assets as well in any industrial sectors, taking into account the assumption that value is transferred to investments in the property complex of assets in the form of net income as assets depreciate.

THE FORM OF DEPENDENCE OF VALUE ON AGE WHEN EVALUATING THE INDUSTRIAL ASSET BY INCOME APPROACH

The value of the industrial asset can be found by the income approach by known formula as the present value of the discounted cash

flow of the expected net operation income *NOI* and reversion *Rv*. Assuming the neglect of secondary factors and using the simplifying assumptions, such as the insignificance of the amendment to value of the cash flow at the middle of the billing period, if: $(1+i)^{1/2} \approx 1$, as the smallness of working capital to equip the asset (to install, launch, etc.) required in the form of advance payment and the smallness of other costs that might be required as part of the investment, the formula of industrial asset value determining, as is known [7], is:

$$MV_I = \sum_{n=1}^{T-1} \frac{NOI_n}{(1+i)^{n-1}} + \frac{Rv}{(1+i)^{T-1}}. \quad (3)$$

For the industrial asset, the cash flow is, in principle, stable in the present prices $(NOI_t = NOI)$ due to the sustainability of the characteristics of this asset, and for this reason, net operating income in the present prices does not predictably change over the years, unlike cash flows for property complexes, the value of which, and, accordingly, the cash flow predictably increases by the time as a result of investing profits in fixed assets or of investing other finance in fixed assets, for example, in accordance with a certain plan business project.

Using the methods based on the capitalization of discounted cash flows, the predictable volatility of these flows is not typical for individual industrial assets, which net operating income is predictably sustainable corresponded with their sustainable own characteristics and can only change unpredictably due to external causes, which is the risk factor usually taken into account by the discount rate *j*, which is correlated with the total of risks.

Under the assumption of time independence of net operation income, which is characteristic for individual industrial asset $(NOI_t = NOI)$ the equation of present value of discounted cash flow (3), neglecting the reversion *Rv* in the order of a simplifying assumption, can be represented by the known direct capitalization formula

$$MV_I = NOI/R, \quad (4)$$

where

$$R = i + f = \frac{i+i}{(1+i)^{T-t} - 1}.$$

It can be seen that, in accordance with the income approach, the cause for change of the industrial asset value with its age *t* within the durability *T* is the growth of the compensation fund factor *f*, which is included in the total of the capitalization rate *R*.

According to the graph of capitalization rate *R* dependence on the age of industrial asset within the limits of asset durability (Fig. 3) it is indicated that the denominator in the direct capitalization formula (4) changes noticeably if the asset age *t* approaches durability *T*, which predetermines that form dependence of asset value on it age, determined by income approach, which is performed on the schematic graph (Fig. 1).

If to compare the valuations by income and cost approaches in terms of their adequacy for new or not new industrial assets, then for the valuation of a new asset whose accumulated depreciation is small or zero, the cost approach would be recommended, and the income approach in this case is not entirely logical, since the operating experience of new asset is insufficient and no much income and cost accounting data has been accumulated.

At the same time, for a non-new industrial asset the assessment of value by the income approach would be appropriate, because the economic indexes for the operation of such an asset are likely to be collected in sufficient volume, are available and reliable.

On the other hand, the accumulated depreciation with a large age of the industrial asset in relation to its durability is commensurate with replacement costs, which puts into question

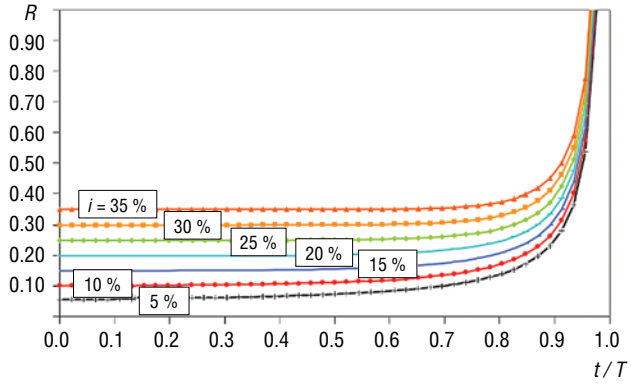

Fig. 3. Dependence of the capitalization rate of net operation income R on discount rate I and on the age of the industrial asset in proportion of the durability (t/T)

the applicability of the cost approach for valuing this asset, and this also contributes to a shift in preferences in favor of using the income approach for valuing not new asset.

THE METHODOLOGICAL INTERRELATION OF COST AND INCOME APPROACHES

There is a methodological similarity and an associated difference between the cost and income approaches when they are used to determine the value of industrial assets. This can be used to determine logically the weighting factors for the harmonizing values found by the cost and income approaches.

Having into account the simplifying assumptions, when opening the brackets, neglecting the multiplication of the indexes of unavoidable physical and functional depreciations: $(D_2 \times D_4)$ and assuming a small influence of the removable depreciation: $(D_1 + D_3)$, reset periodically during maintenance, repair and modernization, on the form of dependence on the age of the industrial asset on its value, estimated by the cost approach: $(1-D_2)\cdot(1-D_4) \approx (1-D_2-D_4)$, the formula of the cost approach (1) of the industrial asset has the form:

$$MV_C \approx MV(0)\cdot(1-D_2-D_4), \quad (5)$$

where $MV(0) = RC\cdot(1-D_5)$ — the value of a new industrial asset, which differs by the external depreciation D_5 (the obsolescence) from the costs of the asset creation, i.e. from the reconstruction costs *RC* of the asset, since the value of the new asset *MV*(0), when the accumulated depreciation is equal to zero, is estimated minus the obsolescence D_5, acting in proportion to the value of similar assets, regardless of their age, including to the value of new ones.

Denoting the analogue of the accumulated irreducible depreciation as the generalized index of part of the asset value: $D(t) = (D_2 + D_4)$ transferred in the form of a cash flow into savings and investing in the property complex of assets to which the valued industrial asset belongs as an element of the system, it is possible to define the dependency of industrial asset value on the age got by the cost approach as

$$MV_C \approx MV(0)\times(1-D(t)). \quad (6)$$

The dependence of asset value on it age *t*, considering the value transfer factor to the cash flow, taking into account that the value of the new industrial asset (at $t = 0$), determined by cost approach is equal the present value of the expected net income and proceeds from the subsequent sale of an asset:

$$MV_I = \sum_{n=1}^{t} \frac{NOI_n}{(1+i)^{n-1}} + \frac{MV(t)}{(1+i)^t},$$

looks like

$$MV_I(t) = MV(0)(1+i)^t - NOI(1+i)^t \sum_{n=1}^{t} \frac{1}{(1+i)^{n-1}}. \quad (7)$$

The comparison of formulas (6) and (7) allows to determine the index of the accumulated depreciation analogue $D(t)$, as:

$$D(t) = 1 - (1+i)^t + i\sum_{n=1}^{t} \frac{1}{(1+i)^{n-t-1}} \quad (8)$$

or, using the direct capitalization formula (4), the index of the accumulated depreciation analogue $D(t)$ one can find as:

$$D(t) = 1 - \frac{1 + 1/\left((1+i)^T - 1\right)}{1 + 1/\left((1+i)^{T-t} - 1\right)}$$

or the accumulated depreciation analogue $D(t)$, that is, the discounted for the valuation day t part of value, transferred in the saved and invested net income, is:

$$D(t) = \frac{1-i}{i+f} = \frac{1-i}{R}. \quad (9)$$

The found index of the accumulated depreciation analogue $D(t)$, that is the part of its value by relative value (relative to the value of the new asset) transferred to the accumulated net income over a period within the age of the industrial asset t, depending on the age of the asset and on it durability T is on the graph (Fig. 4).

The graph shows that the transfer of the value of the industrial asset to the saved and invested net income of the property complex, of which the asset is the element and the subsystem. This saved and invested net income is relatively equal to the index of accumulated depreciation analogue $D(t)$, depended as on the asset age t within it durability T so on the discount rate i.

It should be noted that for the extreme ages of industrial asset within the limits of it durability there is also the correspondence of income and cost approaches' results of value estimate with one got by the comparable sales approach.

1. Of the result of value estimate got by a cost approach — at zero or small age, i.e. for a new industrial asset whose accumulated depreciation is insignificant. This may give ground for equal preferences of the applicability of cost and comparable sales approaches, given the similarity of these approaches when valuing a new asset, taking into account the low applicability of the income approach in the absence of data.

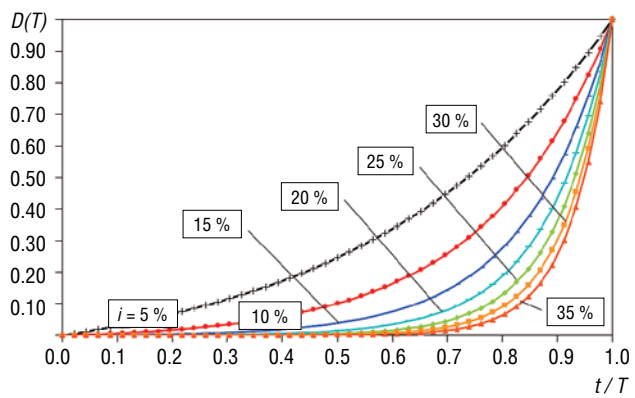

Fig. 4. The dependence of the accumulated depreciation analogue D(t) of the industrial asset on the ratio of age and durability of the asset (t/T) and on the discount rate i

2. Of the result of value estimate found by income approach — with the greatest age of the asset within the durability range, the income from which can be obtained by selling the asset, for example, at a residual liquidation or other value, found, in particular, by a comparable sales approach. This indicates the methodological similarity of income and comparable sales approaches for an asset that is close to its ultimate life, the use of a cost approach for valuation, which is not preferred due to the comparability of the replacement cost and accumulated depreciation.

DIMENSIONAL REDUCTION OF THE PROBLEM OF WEIGHT FACTORS FINDING CONSIDERING THE METHODOLOGICAL INTERDEPENDENCE OF COST AND INCOME APPROACHES

The harmonization of industrial asset values, found by independent approaches: the cost one MV_C, the income MV_I and the comparable sales MV_M with use of the weight factors (a_C, a_I and a_M), is being done as:

$$MV = MV_C \times a_C + MV_I \times a_I + MV_M \times a_M,$$

where the total of the weight factors is equal to one:

$$a_C + a_I + a_M = 1.0. \quad (10)$$

As it is indicated above, with minimal depreciation and with a low age of the asset, i.e. the cost approach is preferable for determining of the asset value under the assumptions that: $t \approx 0$, $D(t) \approx 0$ and $MV(t) \approx MV(0)$, and with the maximum accumulated depreciation the use of income approach is preferable an its turn, i.e. under the assumptions that: $t \approx T$, $D(t) \approx 1$ and $MV(t) \approx 0$ that is when most of the initial value $MV(0)$ of the asset was transferred to saved and invested net income of the property complex, to which the valuated asset belongs as an element of the system.

The weight factors for the values of industrial asset, found by income a_I and cost a_C approaches, considering the specified assumptions of preferred choice with respect to each of these approaches can be found using the index of accumulated depreciation analogue $D(t)$.

Thus, it is possible at final harmonizing of the values: MV_C, MV_I and MV_M to transform the issue of determining of weight factors, which will be reduced to an expert determination of the weight factor a_M of the account of asset value, found by comparable sales approach MV_M.

Deducting the weight factor a_M, considering at final harmonizing of value MV_M, found by the comparable sales approach, the dependence of the weight factor a_I for the account of the final harmonizing of found by cost approach value estimate MV_I, corresponded with the discounted for the valuation day t part of value, which is the accumulated depreciation analogue $D(t)$, transferred in the saved and invested net income, and the dependence of the weight factor a_C for the account of value MV_C, found by the cost approach, as remainder of one deducting the factors: a_I and a_M look like (Fig. 5 for the discount rate value 20 %):

$$a_I = (1 - a_M) \cdot D(t)$$

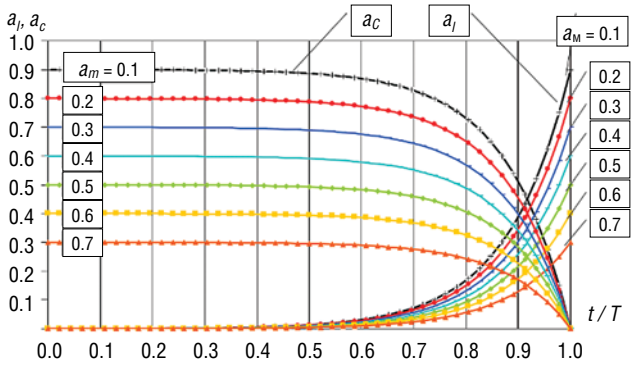

Fig. 5. The dependences of weight factors, used in the final harmonizing of the values: the factor a_C for the account of value MV_C found by the cost approach, and the factor a_I for the value MV_I, found by income approach, on the industrial asset age (t/T) in relation to its durability, as well as on of the weight factor previously found a_M for the value MV_M, determined by comparable sales approach

and

$$a_C = (1 - a_M)\left(\left(1 - D(t)\right)\right). \quad (11)$$

When using the weight factors: a_I and a_C, found by the formulas (11), in the dependence on expert weight factor a_M, used for account at final harmonizing of value MV_M, determined by comparable sales approach, and in the dependence on the accumulated depreciation analogue $D(t)$ of industrial asset the coordination (10) of the asset value looks like:

$$MV = MV_C\left(1 - a_M\right)\left(1 - D(t)\right) + MV_I(1 - a_M)D(t) + MV_M \cdot a_M. \quad (12)$$

The resulting dependencies of industrial asset harmonized value, found by the independent approaches on the asset age (t/T) on expert assigned weight factor well a_M, used for account of the value, found by comparable sales approach MV_M, are indicated on the graphs (Fig. 6) for the discount rate value 20 %.

Analysis of results of matching the value of industrial asset values found by the cost, the income and the comparable sales approaches: MV_C, MV_I and MV_M, indicates that the increase of weight

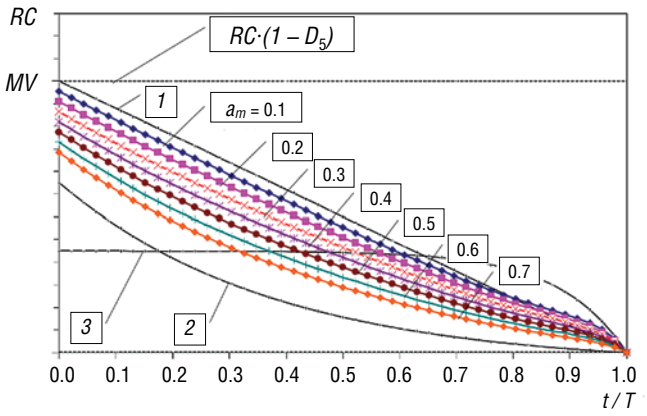

Fig. 6. The dependences of the harmonized value of industrial asset; the dependences on the age of the industrial asset of it values, found by independent approaches: 1 — the cost approach; 2 — the comparable sales; 3 — the income one on the asset age (t/T) in relation to its durability, as well as on the weight factor previously found a_M for the value MV_M, determined by comparable sales approach

factor a_M, used for the account of value MV_M, got by comparable sales approach, could be characterized by the total value decrease.

With the increase of age t within it durability T of the industrial asset the depreciation of the asset increases as well as the accumulation of a part of its value, transferred to the net income of the property complex, the subsystem and element of which this asset is, in the process of value matching in accordance with the formulas (10)–(12), the preliminary for the new asset value estimate MV_C, found by cost approach, for which: $t \approx 0$, $D(t) \approx 0$ and $MV(t) \approx MV(0)$, gradually in a certain methodological sequence is replaced by the value MV_I, found by income approach.

And with the maximum accumulated depreciation of an industrial asset, which is characterized by the indicators: $t \approx T$, $D(t) \approx 1$ and $MV(t) \approx 0$, the preferred result in the final matching of values is the result, got by income approach MV_I.

The final harmonizing of the value estimates: MV_I and MV_C, got by income and cost approaches proportional to $D(t)$ and $(1 - D(t))$ of values, acts in the rest after expert accounting of factor a_M of industrial asset value estimate by comparable sales approach MV_M.

CONCLUSIONS AND RECOMMENDATIONS

1. The concept of industrial asset, which serves as the element of a complex system, is associated with its functional characteristics, such as: the assignment, type of vehicle or machine, assignment of an equipment object, one or another intellectual product, and etc. Unlike an industrial asset, a complex object, for example, an integral property complex of the acting company, which includes this asset, enters as an element of the system, which can be characterized not by the functional assignment, as industrial assets included in it, but by the type of the economic activity.

2. The industrial asset has a limited economic durability and by the time its value in the form of income is transferred to accumulations in the property complex in which the asset is included, that is the asset value as the annual net income is invested in the property complex. Estimation error and discrepancy found by the independent approaches of values can be the indicators of the valuation quality. When determining the relative valuation error of value estimate the comparison base is used, which somehow or other remains unchanged or sustainable during the systemic cycle of the asset: creation, installation, equipping and launching, productive use, maintenance, decommissioning and disposal.

3. Methodological discrepancies in determining the value of the industrial asset by independent approaches are associated with possible inconsistencies of normative concept of the value according to federal law and according to valuation standards, on one hand, and the value methodological definition as the result of harmonized use of independent valuation approaches according to standards as well. This discrepancy between the normative concept and methodological definition of value emerges simultaneously with the question of the correspondence of the independent valuation approaches among themselves within the specified methodological definition.

4. To reduce the dimension of the problem of the weight factors finding to harmonize the estimates by independent approaches one can use the methodological similarity of the estimate by the cost and the income approaches. As an economic analogue of the accumulated depreciation of the industrial asset the index of the part of value of the asset is used, and this part is transferred in the form of net operation income accumulation to investing in the property complex of industrial assets, to which the valuated

one belongs as an element of system. For the final harmonizing of value estimates in dependence on the age of industrial asset within its durability, the weight factor of the results of valuation by income approach is commensurate with the accumulated depreciation analogue, and for harmonizing of the result got by cost approach the factor proportional to the deducting residue of the accumulated depreciation.

5. The ratio of the weight factors for the results of valuation by cost and income approaches is a function of analogue of the accumulated depreciation, in turn depending on the age of the industrial asset, on its durability and on the risk and efficiency index characterizing the property complex to which the industrial asset being valued belongs as an element (the subsystem of system), and the sum of these two weight factors for the evaluation by cost and income approaches corresponds to the remainder of one after subtracting the expertly assigned weight factor adopted for the comparable sales approach. Having into account the recommendations under consideration, the task of determining the weight factors with the final harmonizing of value estimates, found by the independent approaches, can be reduced to an alternative choice for the industrial asset: finding the value for a serial asset (or in a developed market) by a comparable sales approach, which is quite common, or under other market conditions finding the value estimates by cost and income approaches, taking into account the distribution of the weight factors in accordance with the recommendations, considering the depreciation analogue of industrial asset (the asset value transfer as it net income to property complex, to which this asset belongs as the subsystem) according to specified formulas (11).

6. The dimension of the problem of choosing two the weight factors is reduced to match found by income, cost and comparable sales approaches of three of the values of industrial asset, which is included as an element in the overall system, when to match the values obtained by cost and income approaches there is the dependence of their weight factors on the accumulated depreciation analogue (the age and durability of the asset, as well as on the level of efficiency and risks of the system in which the industrial asset is included as the subsystem, for example, on found index of the discount rate characteristic of the property complex).

Given that one of the three weight factors is the remainder of one after subtracting of two of they, then when valuating by three approaches it is recommended the expert determination of the weight factor for value found by comparable sales approach, and the second weight factor and a third one (remainder of one after subtracting two factors) one can find by specified equation.

7. Besides considered methodological correspondence of the cost and income approaches, when evaluating an industrial asset, one can also see these approaches pair correspondence with the comparable sales approach under the appropriate conditions:

- with the result of value estimate, found by the cost approach at zero or small age, i.e. for a new industrial asset, the accumulated depreciation of which is insignificant, when the determination of accumulated depreciation is not required, and the value of the asset found by the cost approach is equal to the replacement cost, determined, in particular, by comparable sales approach with insufficient data for use of the income approach (not enough income experience for new asset);
- with the result got by income approach — with the greatest age of the asset within the limits of durability, the income from which can be obtained by selling the asset, for example, at a residual liquidation or other value, found, in particular, by the comparable sales approach, when the use of the cost approach for valuation is not enough accurate due to the proportionality of the accumulated depreciation and the replacement cost for a non-new industrial asset.

8. In practical tasks of evaluating of serial standard assets, as is known, it makes sense to determine value by methods of comparable sales approach, and for those assets for which the use of the comparable sales approach is difficult, for example, due to the lack of market analogues, usually valuation uses methods of cost and income approaches. In both options, at the stage of choosing the approaches for valuation, it is possible to avoid or to minimize the further problem of expert finding the weight factors — both when assessing only by comparable sales approach, which is logical for serial standard assets, when the weight factor for the value estimate by this approach corresponds to one, and for other assets when valuated by cost and income approaches and using the weight factors as a function of the age of the industrial asset, of it durability and of the efficiency index of the system in which the industrial asset is included as the subsystem. In the second case, the task does not emerge of expert finding of the weight factor for the evaluation result by comparable sales approach.

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Системные причины погрешности и расхождений при оценке стоимости промышленного актива независимыми подходами и рекомендации для согласования результатов оценки

Оценка стоимости промышленных активов производится для принятия решений при формировании комплексов этих активов в составе бизнесов действующих предприятий, а также при создании самих активов, при их приобретении, при списании на утилизацию и в иных обстоятельствах. Погрешность оценки и расхождение результатов, найденных независимыми подходами, могут выступать показателями качества оценки. База определяемой погрешности оценки стоимости должна в зависимости от возраста промышленного актива и его накапливаемого износа корректироваться, поскольку непосредственно стоимость актива в пределах его долговечности с возрастом снижается до нуля и поэтому не может служить базой относительной погрешности оценки. Причинами несоответствия стоимости промышленного актива ее значениям, найденным независимыми подходами, являются как приближенность исходных данных, которыми при оценке заменяются характеристики общей системы, в которую оцениваемый актив входит как подсистема, так и методологические различия стоимости как нормативного понятия и стоимости как совокупности методов ее нахождения с использованием независимых подходов. Для согласования результатов, найденных каждым независимым подходом, производится анализ их соответствия адекватным методологическим принципам оценки и свойствам промышленного актива. С учетом свойства накопления износа и ограниченной долговечности актива распределение стоимостных значений, полученных затратным и доходным подходами, при согласовании этих значений может быть рационализировано с использованием предложенного метода. После экспертного определения весового коэффициента для учета результата, полученного сравнительным подходом, при итоговом согласовании вклады результатов оценки независимыми затратным и доходным подходами рассчитываются соразмерно переносу накапливаемого чистого дохода в стоимость имущественного комплекса, к которому оцениваемый промышленный актив принадлежит как элемент системы.

Ключевые слова: *промышленный актив, имущественный комплекс, назначение актива, долговечность актива, изменение стоимости, независимый подход, имущественный комплекс, элемент комплекса, системная связь, погрешность данных, понятие стоимости, определение стоимости, соответствие определений, согласование стоимости, перенос стоимости, экономический износ*

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Об авторах: **Войлошников Михаил Владиленович** — доктор технических наук, профессор, главный научный сотрудник, Член СРО оценщиков Ассоциация «Экспертный совет»; **Морской государственный университет имени адмирала Г.И. Невельского (МГУ им. адм. Г.И. Невельского)**; 690059, г. Владивосток, ул. Верхнепортовая, д. 50а; РИНЦ ID: 289716; michael.vladlen@gmail.com;

Кулаков Кирилл Юрьевич — доктор экономических наук, профессор, президент Союза финансово-экономических судебных экспертов, вице-президент Ассоциации «Объединение СРО оценщиков», вице-президент СРО Региональная ассоциация оценщиков, председатель Комитета Национального объединения СРО оценщиков по кадастровой оценке и оспариванию кадастровой стоимости; **Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ)**; 129337, г. Москва, Ярославское шоссе, д. 26; РИНЦ ID: 360164; kkulakov@bk.ru;

Кривец Валерия Викторовна — кандидат экономических наук, доцент, президент, Член СРО оценщиков Ассоциация «Русское общество оценщиков»; **Ассоциация «Клуб Профессионал»**; 690001, г. Владивосток, ул. Светланская, д. 177-9; krivet@mail.ru.

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Kisel T.N.
Mishlanova M.Yu.
Galeev K.F.

A study of risks borne by participants in investment and construction projects AMID the introduction of BIM technologies

Building information modelling (BIM) is a key area of construction digital transformation. Currently, the construction industry is getting ready for the mandatory application of BIM in the course of implementation of construction projects co-funded by the government. To determine the barriers, preventing the introduction of BIM, a study was conducted among participants of investment and construction projects to identify the risks of introducing BIM and analyze the risks in the context of the scope of activities conducted by the respondent's employer. The study was focused on investment and construction enterprises willing to introduce BIM. The source data were collected using the polling method (the questionnaire survey). The survey involved 180 respondents — representatives of investment and construction companies, including developers, designers, customers, investors, state and municipal institutions, etc. The study revealed such major risks as the unpreparedness of contractors to use information models (50 %), the risk of lower corporate efficiency during the period of implementation and adaptation of BIM (54 %), and the unpreparedness of the state (its representatives, authorities and government agencies) (48 %). The analysis of respondents' answers, broken down by the scope of corporate activities, proved a correlation between the scope of corporate activities, conducted by the respondent's employer, and the significance of risks. This can be explained by corporate functions and interaction with partner organizations.
Keywords: *construction, building information modelling, investment and construction project, risks, survey*

Introduction of building information modelling (BIM) is the most important focus of digital transformation in the construction industry [1]. According to various sources[1] [2–4], BIM allows reducing construction time and costs both at the construction stage and during operation; it boosts the economic efficiency of an investment and construction project, etc. Given the share of construction in the Russian economy (its GDP share is 5.6 %), construction efficiency improvement can have a substantial economic effect throughout the country; it can improve the efficiency of the budgetary funding of investment and construction projects.

Hence, gradual introduction of BIM in Russia is supported by the federal government. Since 2014, the spread of BIM has enjoyed consistent support. Since 2022, pursuant to Decree No. 331, issued by the Government of the Russian Federation on March 5, 2021, all capital construction projects, co-funded by the state, use BIM on a mandatory basis. However, for a number of reasons, including the unpreparedness of the construction industry, as well as some external factors, such as economic sanctions against Russia and the exit of several major BIM software developers from the Russian market, the introduction of this requirement was postponed for one year. At the same time, a study of obstacles and risks of BIM implementation, to be conducted among participants of investment and construction projects, remains relevant. The federal government and the professional community believe that the identification of such risks and obstacles can support corporate governance, reduce the significance of such risks and help to overcome them in the course of time. The authors of the article conducted a study, aimed at identifying the risks of BIM implementation among participants of investment and construction projects, and analyzed these risks in the context of each respondent's scope of activities. The questionnaire method was used to collect the source data for the subsequent analysis[2]. 180 respondents took part in the survey, all were representatives of investment and construction companies engaged in various types of activities. The sampling structure is presented in Table 1.

A substantial share of respondents represented design companies and educational institutions (in total, more than 50 % of the respondents). The survey was conducted during the First United Eurasian Congress of the BIM Society. It demonstrated high awareness of respondents' of BIM development problems in Russia. Data were collected via online and paper questionnaires. Sampling can be characterized as spontaneous.

Respondents were asked about the main risks of BIM implementation. A respondent could give several answers to each question or choose to give an answer of his/her own. The authors used the results of Russian[3, 4] [5–7] and foreign studies [8–11] to interpret the responses.

The breakdown of respondents' answers is presented in Fig. 1.

Results of the study of problems of information modelling technologies implementation by Russian

1 Concurator assessment of the use of BIM technologies in construction. Study report. 2016. URL: http://concurator.ru/information/bim-value/

2 Results of the study of the problems of introducing information modeling technologies in investment and construction projects of Russian companies: report. Moscow, MGSU; 2022. URL: https://mgsu.ru/news/2022/Otchet_rez_issled_problem_TIM.pdf.

3 The level of use of BIM technologies in Russia. Study report. 2017. URL: http://concurator.ru/information/bim_report

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Kisel Tatiana Nikolaevna,
Candidate of Economic Sciences, Associate Professor, Associate Professor of the Department of Management and Innovation; Moscow State University of Civil Engineering (National Research University) (MGSU); 26 Yaroslavskoe shosse, Moscow, 129337, Russian Federation; ID RISC: 655408, ORCID: 0000-0002-6898-4822; silantievatn@mgsu.ru

Mishlanova Marina Yurievna,
Candidate of Technical Sciences, Associate Professor, Associate Professor of the Department of Economics and Management in Construction; Moscow State University of Civil Engineering (National Research University) (MGSU); 26 Yaroslavskoye shosse, Moscow, 129337, Russian Federation; ID RISC: 386390, ORCID: 0000-0002-2394-0746; mishlanova_m@mail.ru

Galeev Karim Faatovich,
Lecturer of the Department of Economics and Management in Construction; Moscow State University of Civil Engineering (National Research University) (MGSU); 26 Yaroslavskoye shosse, Moscow, 129337, Russian Federation; ORCID: 0000-0002-3850-2976; karim-galeev@list.ru

Table 1. Survey sampling structure

Type of corporate activity	Share, %	Type of corporate activity	Share, %
Architect	1.7	Public authority	2.8
Designer	27.2	Educational institution	27.2
General contractor	2.8	BIM software developer	6.7
Builder	3.9	Manufacturers and suppliers of construction products and equipment	2.8
Government/Mnicipal institution	8.3	Construction owner's representative	4.4
Developer	5.6	Operating organization	1.7
Investor	2.2	Other entities	2.8

Source: Results of the study of problems of information modelling technologies implementation by Russian companies in the course of delivery of investment and construction projects: a report. Moscow, NRU MGSU, 2022 [6].

companies in the course of delivery of investment and construction projects: report. Moscow, NRU MGSU, 2022[2].

More than a half of the respondents (59 %) emphasized the unpreparedness of contractors to use information models as the main risk of BIM implementation and about a half (48 %) specified the unpreparedness of the state (representatives of the state, government authorities and organizations). The risk of implementation associated with corporate effectiveness reduction during the extensive period of implementation and adaptation of BIM was mentioned by 54 % of respondents. Other risks, being less substantial, still matter. 8 % of the respondents chose the answer that read as "an increase in the competitiveness of a construction company will not be a direct consequence of introduction of information modelling technologies". In addition to these risks, respondents chose personnel and financials-related risks.

BIM implementation risks were analyzed by the respondents on the basis of the survey results. Towards this end, all respondents were divided into groups depending on the types of activities (to make the data suitable for analysis), or the functions performed by the companies:

- the group of architects and designers was titled as "designers" with a share of 28.9 % in the sampling;
- general contractors, contractors, developers, and customer's representatives were titled as "builders" with a share of 11.1 %;
- state/municipal institutions and authorities were titled as "the state" with the share of 11.1 %;
- developers and investors were titled as "investors" with the share of 7.8 %;
- representatives of educational institutions and software developers were "universities" and "software developers". Other respondents were excluded from the analysis, as their share in the sampling was small and it did allow for any reasonable conclusions about the influence of corporate activities on major risks that could accompany BIM implementation.

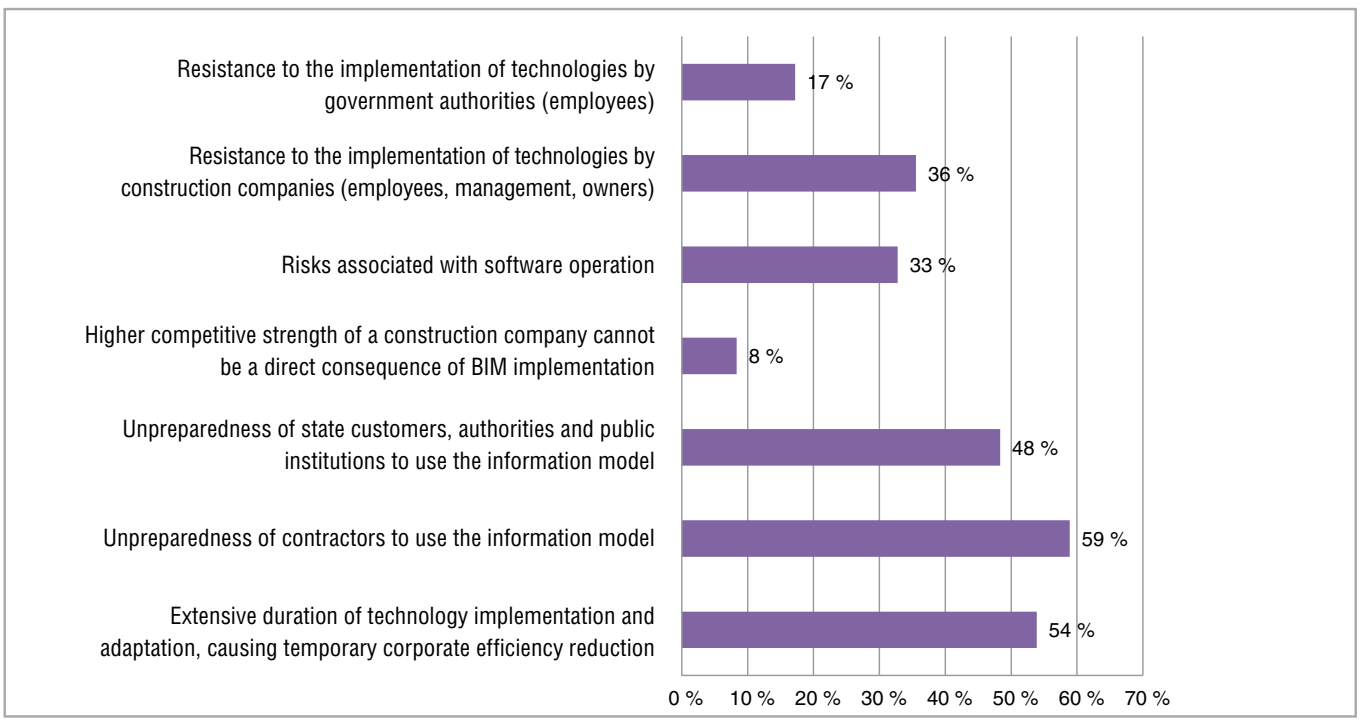

Fig. 1. Principal risks of BIM implementation (based on the results of the survey)

Results of the analysis of the impact made by each type of respondent's company on major risks accompanying BIM implementation are presented in Table 2.

The analysis showed that the nature of the respondent's corporate activity influences his opinion in terms of significance of BIM implementation risks. For example, respondents from the "state" group tend to assess the risk of implementation and adaptation, causing a temporary reduction in the effectiveness of corporate activities as substantially higher than construction companies (75 % and 42 to 64 %, respectively). The unpreparedness of contractors to use information models is most often chosen as a risk by "software developers" (83 %), "investors" (71 %), and "universities" (61 %). Unpreparedness of representatives of state, government authorities and state institutions to use information models was most often chosen by designers (61 %). However, representatives of the "state" group also recognize this risk as highly substantial (55 % of cases).

Risks associated with the correct operation of software were mentioned by "universities", "the state" (45 % each), and "designers" (37 %), responding from their practical experience. Representatives of corporate investors as well as software producers did not choose this risk: both groups assessed the risk at 0 %. It is likely that investors have no experience in dealing with this risk. Software vendors may underestimate the significance of errors in BIM software. In this case, it is fair to pay attention, first of all, to the opinion of designers, being the respondents who have much experience in the practical application of information models.

Respondents chose differing answers to the question about the risk of resistance to the introduction of technology by construction companies (employees, management, owners): this risk was considered as the least substantial by "designers" (27 %), while "software developers" chose it in 67 % of cases.

The group "state" (10 %) hardly agreed with the fact that government authorities and management (employees) resisted the introduction of this technology, and other groups of respondents also mentioned this risk rather rarely (from 16 to 25 %).

It is interesting to note that "software developers" (0 % of respondents from this group mentioned this risk) disagreed with the statement that an increase in the competitiveness of a construction company would not be a direct consequence of the implementation of BIM, which had a generally low value for the entire sampling. In our opinion, this is related to the functions performed by respondents in this group which probably concentrates on the fact that the use of such tools is bound to an increase in the efficiency of companies. At the same time, representatives of other groups of respondents, while understanding the importance of the tool itself, did not forget that its effective use requires changes in business processes, retraining or hiring personnel, etc. In the case of poorly organized processes of software application, the effectiveness of the tool may be reduced.

Hence, the analysis of the findings has shown that the scope of corporate activities affects the identification of factors of BIM implementation as risks. Information about the respondents' opinion about the significance of certain risks can be used by the authorities and management, professional associations and communities in the targeted work focused on risk reduction.

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Table 2. Assessment of BIM implementation risk significance by respondent groups

Risks/Respondent Group	Universities, %	State, %	Investors, %	Builders, %	Designers, %	Software developers, %
Duration of implementation and adaptation of technology, causing a temporary reduction in the productivity of employees and a general reduction in the corporate efficiency	43	75	64	50	53	42
Unpreparedness of contractors to use information models	61	50	71	50	55	83
Unpreparedness of representatives of the state, government authorities and public institutions to use information models	43	55	57	42	61	42
Higher competitive strengths of a construction company will not be a direct consequence of BIM implementation	10	10	14	8	6	0
Risks associated with software	45	45	0	17	37	0
Resistance to BIM implementation by construction companies (employees, management, owners)	47	30	29	42	27	67
Resistance to BIM implementation by government authorities (employees)	22	10	21	25	16	17

Source: compiled by the authors.

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Исследование рисков участников инвестиционно-строительных проектов в условиях внедрения технологий информационного моделирования

Технологии информационного моделирования (ТИМ) являются ключевым направлением цифровизации строительства. В настоящее время в строительной отрасли идет подготовка к введению требования об обязательном применении ТИМ на объектах с привлечением государственного капитала. Для определения барьеров внедрения ТИМ проведено исследование, направленное на выявление рисков внедрения ТИМ среди участников инвестиционно-строительных проектов и анализ рисков в разрезе вида деятельности организации респондента. Объектом исследования стали предприятия инвестиционно-строительной сферы, заинтересованные в вопросах внедрения ТИМ. Первичные данные для анализа были собраны с применением метода опроса (анкетирования). В опросе приняли участие 180 респондентов — представителей компаний инвестиционно-строительной сферы различных видов деятельности, в том числе девелоперов, проектировщиков, заказчиков, инвесторов, государственных и муниципальных учреждений и т.д. В ходе исследования выявлено, что наиболее значимыми рисками являются: неготовность контрагентов работать с использованием информационной модели (50 %), риск снижения эффективности деятельности организации в течение длительного периода внедрения и адаптации ТИМ (54 %), а также неготовность со стороны государства (государственных заказчиков, органов власти и госучреждений) (48 %). Анализ ответов респондентов по видам деятельности организаций показал, что существует зависимость между видом деятельности организации респондента и значимостью рисков. Это объясняется особенностями функций, выполняемых организациями различных видов деятельности, а также спецификой взаимодействия с контрагентами.

***Ключевые слова**: строительство, информационное моделирование здания, инвестиционно-строительный проект, риски, обследование*

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Об авторах: **Кисель Татьяна Николаевна** — кандидат экономических наук, доцент, доцент кафедры менеджмента и инноваций; **Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ)**; 129337, г. Москва, Ярославское шоссе, д. 26; РИНЦ ID: 655408, ORCID: 0000-0002-6898-4822; silantievatn@mgsu.ru;

Мишланова Марина Юрьевна — кандидат технических наук, доцент, доцент кафедры экономики и управления в строительстве; **Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ)**; 129337, г. Москва, Ярославское шоссе, д. 26; РИНЦ ID: 386390, ORCID: 0000-0002-2394-0746; mishlanova_m@mail.ru;

Галеев Карим Фаатович — преподаватель кафедры экономики и управления в строительстве; **Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ)**; 129337, г. Москва, Ярославское шоссе, д. 26; ORCID: 0000-0002-3850-2976; karim-galeev@list.ru.

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Trukhin Yu.G.
Trukhina N.I.
Vyazov G.B.

Features of the present stage of development of integrated development of areas and practical approaches to real estate management

The development of urban housing is governed by the programme of integrated development of areas (IDA), if new construction, renovation or reconstruction of old buildings are undertaken in the areas of historic urban residential development. Nowadays Construction Rules and Regulations must be updated to meet the needs of housing construction in terms of the high-density development of city centres, surveys needed to find out the hydrogeological parameters, methods of analysis of structural reliability and safety of buildings, periodicity and instrumental accuracy of examination of buildings and structures, regulations of operation анв rules of demolition of old and uncomfortable housing. The purpose and intention of the integrated development of areas is the elimination of buildings, if their repair or reconstruction do not encompass any comfortable planning solutions or a comfortable living environment. Methods of analysis of the technical condition of housing and control parameters for software computations, recommendations to strengthen the bearing structures of a building, costs of the necessary work packages were developed to attain the objective.
Keywords: *integrated development of areas, renovation of housing, examination of buildings, hydrogeology, strengthening of foundations, soil stabilization, building demolition procedures, comfortable housing, economic evaluation*

Trukhin
Yury Gennadievich,
Candidate of Technical Sciences, Associate Professor, Associate Professor of the Department of Real Estate Cadastre, Land Management and Geodesy; Voronezh State Technical University (VSTU); 84 20th Oktyabrya St., Voronezh, 394006, Russian Federation; ID RISC: 1031921, Scopus: 57216910384, ORCID: 0000-0002-3342-9773; sts0001@list.ru

Trukhina
Natalya Igorevna,
Doctor of Economics, Professor, Head of the Department of Real Estate Cadastre, Land Management and Geodesy; Voronezh State Technical University (VSTU); 84 20th Oktyabrya St., Voronezh, 394006, Russian Federation; ID RISC: 700100, Scopus: 57192378863, ORCID: 0000-0002-7906-4570; ntruhina@list.ru

Vyazov
Gennady Borisovich,
Candidate of Economic Sciences, Deputy leader; Department of Construction Policy of the Administration of the Urban District of Voronezh; 4 Koltsovskaya St., Voronezh, 394006, Russian Federation; ID RISC: 868314; gbvyazov@cityhall.voronezh-city.ru

INTRODUCTION

The Programme of integrated development of areas (IDA), developed for the cities of the Russian Federation[1], has identified a number of issues whose solution requires careful consideration. These issues are determined by the objectives of integrated development of built-up areas in the Russian cities, regardless of their geography, dimensions or population. Residents of large urban areas have long felt the effects of a number of factors on their living conditions. In an attempt to briefly formulate the goals of IDA, it is necessary to say that its main goal is to improve the quality of life of Russian citizens, moving into new comfortable homes located in landscaped residential areas that have social amenities, a good convenient system of parking lots and transport accessibility.

GENERALIZATION OF THE MODERN EXPERIENCE

The development of urban housing is implemented in accordance with the Programme of Integrated Development of Built-up Areas (IDBA), if new construction, renovation or reconstruction of old buildings are undertaken in the areas of historic urban residential development. Stages of modern urban construction and processes, associated with the operation of residential real estate, require not so much revision of numerous construction rules and regulations (SNiP, SP, GOST) relating to the design, construction work performance and operation of residential buildings, as the rigorous implementation of long-established norms. The main reason for these changes are the requirements arising from the analysis of the experience of construction in the large cities and the past emergency situations in old existing buildings, where the new "infill" facilities are built, destructively affecting surrounding homes and buildings. Effective rules and regulations, governing construction works, prohibit deep foundation works, excavation of pits, installation of pile structures, erection of high buildings in the vicinity (less than 30–50 m) of the existing buildings without the preliminary examination and control of the technical condition of these facilities during the work performance. They result in a number of protective construction measures designed to preserve existing facilities and conditions of their operation[2].

A serious problem that requires ongoing attention and strict observance of the applicable standards and regulations at the stages of survey and design of building foundations is the consideration of changes in the hydrogeological conditions and conditions of soil bases. The existing loads, coming from the foundations of buildings, disturb the balance of the existing hydro-geological pressure in soils, which is associated with the zone of low-rise buildings that have more storeys. And this trend is true for all modern urban construction projects, based on the economic attractiveness of developer's investments. However, data on and parameters of foundation soils, identified in the process of geological surveys, often miss information about the presence or migration of excess moisture, filtration coefficients, aquifers and their pressure gradients. This creates a factor of unexpected watering of foundation soils and changes in their physical and mechanical characteristics, as well as bearing

1 On Amendments to the Town Planning Code of the Russian Federation and Certain Legislative Acts of the Russian Federation in order to Ensure the Integrated Development of the Territories : Federal Law No. 494-FZ dated December 30, 2020.

2 TSN 50-302-2004. Establishment (design) of foundations for civil buildings and structures. 2004.

properties. Surveys of the facilities, located close to those under construction, should reflect the hydrogeological situation of their foundation soils, and designs should contain the measures to protect the facilities from possible effects of changes[3].

The widespread use of underground spaces in modern projects of residential buildings, that serve as parking areas, is a necessary forward-looking solution to the growing shortage of urban areas, but the experience of their construction, given that the design solutions are far from being perfect, shows that the technology of their construction has a negative impact on the technical condition of the neighbouring buildings. The technological significance of this phenomenon is that during the excavation of deep pits, pressure is eliminated from foundation soils, and its subsequent growth, that accompanies the construction of the superstructure of a new building, compared to the settle-out pressure from the surrounding buildings. Hydrogeology responds to these changes rather quickly and unexpectedly. Only continuously monitored aquifers in foundation soils can capture and record these dangerous changes.

Against the background of intensive urban construction, as well as natural and man-made changes, in recent decades (30–40 years), there has been a trend to reduce the number of examinations of the technical condition of real estate facilities and it affects residential buildings to the greatest extent. Given that a large number of visible factors affect the current situation, and the main of them include the uncertainty in terms of the responsibility for the technical condition of housing in the cities. Owners of apartments in multi-storey buildings, i.e. residents, do not have the knowledge to make decisions; they do not understand their responsibility and the need for the ongoing control over the condition of their building. Management companies do not have enough experts, they cannot and do not want to spend money neither on current, planned repairs, nor on the instrumental examination of the bearing structures of a building, including its foundations inaccessible for examination. Similar policy is implemented by the Fund of Capital Repairs. The number of examinations of the technical condition of residential buildings, expressed as a percentage of the total funding that is subject to major repairs, according to the statistical reporting data of Rosstat (Federal Service of State Statistics) for 2020–2021, does not exceed 0.2–0.5 % a year in a major city with one million residents. During the same period, restoration of foundation structures reached 0.02–0.1 %, which 10 times less than the cost of survey works themselves.

When making conclusions on the basis of the above evaluation, one should assume that the technical condition of foundations can either be assessed as “perfectly perfect”, otherwise the overhaul of the housing stock has no engineering or technical substantiation whatsoever. Obvious facts confirm that the most heavily funded types of capital repairs are the filling and painting of cracks in facades every 2–3 years. The cause of cracking bearing walls is the subsidence of soils below the foundations of buildings, but these causes can be recorded, instrumentally assessed, but their elimination procedures can only be selected by the technical examination specialists. It should be understood that the real cost of capital repairs of residential buildings will soon accrue, since the elimination of more serious destructions will be needed. Such processes are ubiquitous and lengthy; they accelerate the general destruction of housing in the cities, because without the examination of buildings or restoration works, fasade painting become meaningless.

PROBLEM SOLVING APPROACHES AND METHODS

One can do away with the current practice of planning capital repairs in respect of urban housing on the basis of visual inspections by the employees of management companies that have no proven professional skills, since this work must be performed by professional licensed organizations, capable of performing instrumental surveys [1].

The results of many years of uncontrolled development and operation of residential buildings determined the composition of urban areas adjacent to the city centre or its historic part, consisting of buildings of the post-war construction period of 1950–1975. The first standard series of 3–5 storey brick houses with small apartments, prefabricated reinforced concrete panel series of 5–9 storey buildings are characterized as high and limited-performance facilities, having the lowest value of the indicator of the comfort of living. They are located in the areas adjacent to the main streets and near the borders of historic centres; therefore, these areas should be included in the IDA plans and are lucrative for modern developers [2–4].

However, the process of developing IDA programmes is very complicated and the pace of work is hampered by the lack of accurate data on the technical condition of residential buildings. The developer, acting as a co-investor, must make a decision about the effectiveness of the development project, based on the ratio of residential, social, cultural, educational and recreational functions, as well as the most important indicator, that is, the area of parking lots. Obviously, the cost of all the above-mentioned types of facilities can only be covered by means of construction of new comfortable and attractive housing to be built in this area. We must understand that it is impossible to create a new and beautiful development surrounded by old and dilapidated housing.

The Programme of Integrated Development of Areas provides a unique opportunity to make proper management solutions and free our beautiful cities from the outdated 80-year-old legacy. Developers can act gradually and systematically to transform all residential areas, remembering that a huge portion of our population continues to reside in the “Khrushchev quarters”, realizing their role in saving the lives of people in the “50s” of the past century [5–7].

A serious problem is the process of resettlement of residential buildings, namely those buildings that are designated for demolition. The mechanism of resettlement is very important, because it triggers violent reactions of the population and can cause a strong negative reaction, and the project implementation can be put to a halt. This issue requires close attention and smart decision in the near future [8–10]. The danger is a simplified approach, when the practice of polling the opinions of tenants of the house chosen for demolition by the staff of management companies, is unacceptable, and their competence in resettlement rules is simply doubtful. The result of such surveys is obvious [11, 12].

A practical approach to IDA programmes is to evaluate the technical condition of the facilities to make a decision about their demolition, reconstruction, or overhaul, as the technical and legal grounds underlying decisions on renovation programmes.

RESULTS

As a result of research, the authors developed the software and control methods, applied to the key parameters of building

3 On approval of the Regulations on recognizing premises as residential, residential premises unfit for habitation, an apartment building as emergency and subject to demolition : Decree of the Government of the Russian Federation No. 47 dated January 28, 2006 (as amended on April 6, 2022).

structures that allow to quickly and reliably identify the ultimate bearing capacity of a building, taking into account factors of its real condition and strength characteristics. The estimated cost of strengthening building elements and improving its consumer functionality determines the inexpediency of its repair or reconstruction and, hence, such facilities are subject to demolition. However, the main reason for such a decision is determined by the impossibility to ensure the indoor comfort, if large financial investments cannot achieve the result and deprive the residents of any prospects for improving their living conditions.

One of important tasks of successful integrated development of urban areas is to facilitate the renovation of the housing stock. Its purpose is to demolish those types of buildings whose repair or reconstruction cannot generate any comfortable planning solutions and a comfortable living environment. It is a chance to have unoccupied spaces for the construction of modern comfortable housing, get residents to move from demolished houses and build new housing.

CONCLUSIONS

The task of rapid and long-term future-oriented examination of all urban housing should be performed by the technical control departments to be established at urban construction departments. The new structures are to be equipped with modern measuring facilities and software to control the structures to be examined and analyze the bearing capacity of frameworks. And most importantly, highly qualified employees who have mastered the methods of such control and are capable of quickly drafting engineering design solutions needed to strengthen defective structures to immediately evaluate the technical condition of the facility and the expediency of its further operation.

The practice of preserving old and dilapidated housing for centuries until its complete destruction does not meet modern requirements. Pursuant to the Decree issued by the RF Government, this type of residential buildings includes standard buildings built in 1945–1965; they have small-sized apartments. Even the visual examination of the area to be renovated makes it possible to assess the condition of such buildings, whose foundations have deformations, and cracks are continuous in the corners of window openings on the facade of buildings.

Financial contributions in the repair and reconstruction of such facilities are large and cannot ensure comfortable living conditions for owners. The renovation of the housing stock is aimed at solving these problems in accordance with the RF Government Decree on the integrated development of the areas of its subjects.

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Особенности современного этапа развития КРТ и практических подходов к управлению недвижимостью

Развитие городского жилищного фонда осуществляется в соответствии с Программой комплексного развития территорий (КРТ), где в зонах исторически сложившейся городской жилой застройки ведется новое строительство, реновация или реконструкция старых зданий. Современное жилищное строительство в процессе своего развития требует корректировки и уточнения Строительных норм и правил, регламентирующих плотную застройку центров городов, изысканий для уточнения параметров гидрогеологических условий, методов расчета конструктивной надежности и безопасности зданий, требований периодичности и инструментальной точности обследований объектов, требований по регламенту эксплуатации и правилам сноса старого и некомфортного жилья. Целью и смыслом комплексного развития территорий является удаление из сложившегося жилого фонда тех типов зданий, ремонт или реконструкция которых не обеспечат создание удобных планировочных решений и возможности реализации комфортной среды для проживания. Для реализации цели разработаны методы оценки технического состояния жилого фонда и параметры контроля для программного расчетного обеспечения с рекомендациями по усилению несущей части здания и финансовыми показателями стоимости необходимого комплекса работ.

Ключевые слова: *комплексное развитие территорий, реновация жилого фонда, обследование зданий, гидрогеология, усиление фундаментов, закрепление грунтов, правила сноса зданий, комфортное жилье, экономическая оценка*

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Об авторах: **Трухин Юрий Геннадьевич** — кандидат технических наук, доцент, доцент кафедры кадастра недвижимости, землеустройства и геодезии; **Воронежский государственный технический университет (ВГТУ)**; 394006, г. Воронеж, ул. 20-летия Октября, д. 84; РИНЦ ID: 1031921, Scopus: 57216910384, ORCID: 0000-0002-3342-9773; sts0001@list.ru;

Трухина Наталья Игоревна — доктор экономических наук, профессор, заведующая кафедрой кадастра недвижимости, землеустройства и геодезии; **Воронежский государственный технический университет (ВГТУ)**; 394006, г. Воронеж, ул. 20-летия Октября, д. 84; РИНЦ ID: 700100, Scopus: 57192378863, ORCID: 0000-0002-7906-4570; ntruhina@list.ru;

Вязов Геннадий Борисович — кандидат экономических наук, заместитель руководителя; **Управление строительной политики администрации городского округа города Воронежа**; 394006, г. Воронеж, ул. Кольцовская, д. 4; РИНЦ ID: 868314; gbvyazov@cityhall.voronezh-city.ru.

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Gorbaneva E.P.
Kosovtseva I.A.
Kstenin T.V.

Optimization of economic outcomes of energy saving actions taken throughout the entire lifecycle of a capital construction facility

The current consensus on the lack of alternatives to the energy-saving vector of economic development has led to the development of national and international energy saving programmes and numerous studies on improving the energy efficiency throughout the entire life cycle of projects in architecture, engineering, construction and operation of buildings. However, research projects have revealed a wide gap between projected and real energy consumption, which disrupts energy modernization strategies and policies. According to the recent studies, this gap is caused by social, technical and technology-related factors. The accuracy of assessing the economic efficiency of energy saving actions is also affected by macroeconomic uncertainties, which overcomplicate energy-focused economic modernization. Integration of technologies towards information modeling of the entire life cycle, energy saving, cost reduction can improve the state of affairs in architecture, engineering, construction and operation of buildings and structures. Methods used to increase the accuracy of prognosticated economic consequences of energy saving actions are the subject of this study. The authors have developed algorithms for the quantitative description of contributions, made by architectural/planning solutions, energy-saving technical and technology-focused solutions, and predictive macroeconomic conditions to the energy efficiency assessment throughout the entire life cycle of a construction project. The resulting information model of the project life cycle, available at the design stage, allows optimizing geometric parameters of architectural and planning solutions in terms of the energy consumption/cost ratio. At the reconstruction stage, information models optimize technical and technological solutions aimed at energy saving. At the stage of operation, planned energy-saving actions can be optimized using the results of dynamically monitored thermal properties of building envelopes and macroeconomic conditions. In addition, the information model of energy efficiency allows for the quantitative analysis of the economic effect of investments in the replacement of building envelope elements to optimize current management solutions in terms of the cost/effect ratio.

Keywords: *building information model, project lifecycle, energy saving, optimization, economic efficiency, capital construction facility*

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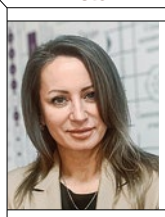


Gorbaneva Elena Petrovna,
Candidate of Technical Sciences, Associate Professor of the Department of Technology, Construction Organization, Expertise and Real Estate Management; Voronezh State Technical University (VSTU); 84 20-let Oktyabrya St., Voronezh, 394006, Russian Federation; ID RISC: 717804, Scopus: 57196442554, ResearcherID: GSO-3594-2022, ORCID: 0000-0002-4105-350X; egorbaneva@vgasu.vrn.ru

Kosovtseva Ilona Andreevna,
Assistant Professor of the Department of Technology, Construction Organization, Expertise and Real Estate Management; Voronezh State Technical University (VSTU); 84 20-let Oktyabrya St., Voronezh, 394006, Russian Federation; ID RISC: 841698, ResearcherID: GRY-6442-2022, ORCID: 0000-0002-3642-3414; ilona.kosovceva@vgasu.vrn.ru

Kstenin Timofey Vadimovich,
Master Student of the Department of Technology, Construction Organization; Expertise and Real Estate Management; Voronezh State Technical University (VSTU); 84 20-let Oktyabrya St., Voronezh, 394006, Russian Federation; ResearcherID: GSO-3588-2022, ORCID: 0000-0002-2928-0099; timakstenin@gmail.com

INTRODUCTION

According to various estimates, an increase in the energy efficiency of the Russian housing sector, that consumes one quarter to one third of primary energy, is an absolute must for the development of design, construction, architecture and building operation sectors, characterized by an increase in the negative environmental impact, depletion of non-renewable (primarily, hydrocarbon) natural resources, and the ever-growing price of energy from renewable sources, the integral economic and environmental efficiency of which is currently negative [1]. As a result, binding documents contain a wide range of energy saving actions for the housing and utilities sector. Hence, according to the state report, issued by the Ministry of Economic Development, the goal of the housing and utilities sector is to have energy savings worth 19.8 million tons of reference fuel by 2030. This goal is attainable by tightening the requirements for energy resources consumption in public areas and energy efficiency criteria for apartment buildings and other structures. To achieve this goal, the Fund for Assistance to the Reform of Housing and Utilities (hereinafter "the Fund") resumed the provision of financial support of the overhaul of apartment buildings (OAB) suspended in 2018. The amount of resources in the housing and utilities sector is to reach its maximum value through the comprehensive overhaul of multi-apartment residential buildings coupled with the introduction of energy efficient technologies. However, these energy saving actions, planned for the housing and utilities sector, demonstrate extremely low efficiency. For example, in 2019, the total consumption of fuel and energy resources was down 5.16 million tons of reference fuel. However, the climatic factor had a positive affect on reduction of the energy intensity of the sector worth more than 7.28 million tons of reference fuel. Consequently, the contribution of technical, technological, organizational and other actions turned out to be negative.

MATERIALS AND METHODS

The application of technical and technological methods of boosting the energy efficiency of buildings is very costly, and as a result their payback period is quite long in most cases. The impossibility of projecting macroeconomic conditions even in the medium term gives rise to uncertainties in assessing the energy saving potential [2], which slows down decision-making on investments in energy modernization [3, 4]. To overcome this problem, numerous attempts were made to optimize methods of

predicting the economic results of energy saving actions [5–7]. As a result of the research, two classes of reasons for major errors in the description of the economic potential of energy saving were identified [8, 9]. Firstly, these are the reasons associated with socio-economic factors and called the rebound effect [10] and the prebound effect [11, 12] that explains the productivity gap.

Errors in the economic forecast are also associated with errors in physical models of energy losses [13, 14] and errors in the data used to implement these models [15].

This work focuses on formation of an algorithm that describes the economic potential of energy saving free from these shortcomings.

The integral quantitative characteristic of efficiency can be represented as

$$EFF = \sum_{t=1}^{t_t} PB_t \Big/ PQ_{tot}. \quad (1)$$

In formula (1), the following notations are used:

- t_t is the total number of periods (months, quarters, years, depending on the terms of assessment) in the total life cycle;
- t_t numbers the periods in the life cycle;
- PB_t is the price of technical and technological actions aimed at improving the energy efficiency in the t-th period;
- PQ_{tot} as the total savings accumulated through the implementation of energy saving actions.

The value of selling price PB_t is determined in accordance with the construction or reconstruction project, whose matrix is presented as Table as part of the information model of the whole life cycle.

The maximum number of modifiable elements is determined as the sum of $J_{max} = J_d + J_w$ attainable in the case of complete simultaneous replacement of elements. In the case of successive performance of activities in each interval, condition $J < J_d + J_w$ is fulfilled. The implementation cost of actions, aimed at improving the energy efficiency in the t-th period, can be calculated by summing up the purchase cost of elements, their dismantling and installation, insulation of walls, roofs and floors:

$$PB_t = \sum_{i=1}^{J_t^w} n_i^t \left(c_i + c_i^m + c_i^d\right) + \sum_{i=1}^{J_t^d} n_i^t \left(c_i + c_i^m + c_i^d\right) + \sum_{i=1}^{J_t^c} n_i^t \left(c_i + c_i^m + c_i^d\right) + S_t^{wall} C_{wall}^t + S_t^{roof} C_{roof}^t + S_t^{base} C_{base}^t. \quad (2)$$

In formula (2), the first three sums take into account the shares of windows, doors and air conditioning units in the implementation cost of technical and technological actions, respectively. The number of addends in these sums (J_t^w, J_t^d and J_t^c) is determined by the number of elements modified in the t-th period. The cost of elements and work items is determined during the same period, which requires an ongoing update of the library of standard sizes. In the course of construction periods, when condition $t < t_{bild}$ is fulfilled, if t_{bild} is the term of construction, dismantling and reclamation costs c_i^d are equal to zero. Same as in the case of individual elements, characteristics (areas and modification costs) of walls, roofs and basements are determined for each period, which requires an update of basic structures of an information model.

Unlike energy-saving costs that are limited in time, the savings that they ensure are accumulated in the course of the life cycle.

Matrix of the information model of the whole life cycle, that determines the implementation price of technical and technological actions aimed at improving the energy efficiency of windows and doors

Implementation period	Size number	Number of elements	Reconstructed areas
t_1	k_1	$n_{k_1}^1$	S_1^{wall} S_1^{bas} S_1^{roof}
	k_2	$n_{k_2}^1$	
	…	…	
	k_{J_1}	$n_{k_{J_1}}^1$	
t_2	k_1	$n_{k_1}^2$	S_2^{wall} S_2^{roof} S_2^{bas}
	k_2	$n_{k_2}^2$	
	…	…	
	k_{J_2}	$n_{k_{J_2}}^2$	
…	…	…	
t_m	k_1	$n_{k_1}^m$	S_m^{wall} S_m^{roof} S_m^{base}
	k_2	$n_{k_2}^m$	
	…	…	
	k_{J_m}	$n_{k_{Jm}}^m$	

Assuming that the macroeconomic situation is stable and energy saving amounts are invested in full, the time dependence of specific accumulated savings per unit area of an enclosing structure was studied in [16], and the energy efficiency criteria in [17–20].

Let's consider the benefits of energy saving actions for a set of individual elements in a dynamically changing macroeconomic environment (windows, doors, air conditioning units, walls, etc.), which can be represented as:

$$PQ_i(t_0) = PQ_i(0)\sum_{j=0}^{j_{max}}\prod_{m=1}^{j}(1+k_m). \quad (3)$$

In formula (3), the following notations are used:

- t_0 is the time period for energy saving work (construction of a structure, replacement of individual elements, overhaul, etc.);
- $PQ_i(t_0)$ is the benefit of energy saving actions accumulated during the following period $\Delta t = t_{fin} - t_0$ where $t_{fin} = min[t_{tot}, t_{elem}]$ is the smaller of the following time periods: t_{tot} as the complete project life cycle and t_{elem} as the life cycle of a modified element;
- $PQ_i(0)$ is the basic benefit of energy saving actions obtained during the initial period;
- j_{max} is the number of scheduled periods within Δt, the term of benefits accumulated by energy saving actions;
- k_m is the inflation rate for scheduled periods of benefit accumulation.

In formula (3), multiplier

$$G = \sum_{j=0}^{j_{max}}\prod_{m=1}^{j}(1+k_m)$$

is determined both by the macroeconomic environment and the period of energy saving benefit accumulation. In contrast, multiplier $PQ_i(0)$ is only determined by the nature of engineering solutions used to improve energy efficiency. If the macroeconomic situation is stable, approximation of the constant inflation rate is valid $k_m = k$ = const. In this case, formula (3) can be substantially simplified. We take into account that in this case equation (4) is true

$$\prod_{m=1}^{j}(1+k_m) = (1+k_{m_1})\times \times(1+k_{m_2})\ldots(1+k_{m_j}) = (1+k)^j. \quad (4)$$

Hence, in equation (4), the result of summation, which is reduced to calculating the sum of geometric progression, will be as follows in case of non-zero inflation:

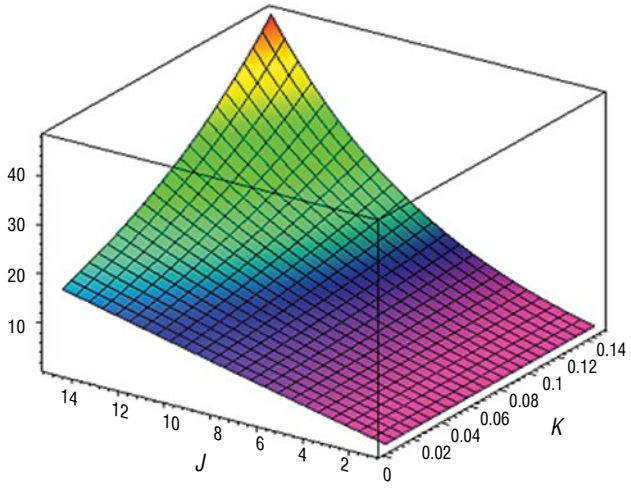
$$PQ_i(t_0) = PQ_i(0)\frac{(1+k)^{j_{max}}-1}{k}. \quad (5)$$

In zero inflation intervals, the passage to the limit $k \to 0$ in formula (5) generates the following result $PQ_i(t_0) = PQ_i(0)\cdot j_{max}$. By expanding the left side of formula (5) into McLaurin series with respect to k parameter within the accuracy of first-order members, we obtain

$$PQ_i(t_0) \approx PQ_i(0)\cdot j_{max}\left[1 + k\cdot(j_{max}-1)/2\right]. \quad (6)$$

Hence, in conditions of moderate inflation and/or short-term plans, when inequality $k \cdot j_{max} << 1$ is fulfilled, the benefit, accumulated by energy saving actions, can be considered linear in terms of the inflation index and quadratic in terms of time. This fact is illustrated in Figure.

Figure clearly demonstrates that at low inflation this dependence is close to linear regardless of duration. For values of $k > 0.02$ there is a sharp increase in G for $j > 10$, and at $k > 0.1$ a sharp increase is implemented for $j > 5$.



Graph of dependence between the multiplier (the applicate axis) and the rate of inflation (the abscissa axis), between the benefit accumulation period and energy saving actions (the ordinate axis)

Let's consider methods used to describe the contribution of technical and engineering solutions to an increase in energy efficiency, determined by multiplier $PQ_i(0)$ in formula (6). The cost of consumed thermal resources is determined by heat losses P_T, heating season duration Δt, heat losses and regional or local price of heat energy C_Q, rubles/J:

$$PQ_i(0) = C_Q\cdot\left[P_T\cdot(T_0 - \langle T\rangle)\cdot\Delta t + \Delta Q_{macro}\right]. \quad (7)$$

If the heat agent temperature difference at the inlet and outlet is proportional to the indoor and outdoor temperature difference $\Delta T^w_j = \alpha\cdot\Delta T^w_j$, the heat loss equation can be formulated as follows:

$$\Delta Q_{macro} = \left[c_{gas}\cdot\sum_{i=1}^{N_{con}} n_i P_i + c_{water}\cdot P_{water}\cdot\alpha\right]\cdot\sum_{j=1}^{N_t}\Delta t_j\Delta T_j = \left[c_{gas}\cdot\sum_{i=1}^{N_{con}} n_i P_i + c_{water}\cdot P_{water}\cdot\alpha\right]\cdot(T_0 - \langle T\rangle)\cdot\Delta t. \quad (8)$$

By substituting formula (8) into expression (7) we obtain

$$PQ_i(0) = C_Q\cdot(T_0 - \langle T\rangle)\cdot\Delta t\times \times\left[P_T + c_{gas}\cdot\sum_{i=1}^{N_{con}} n_i P_i + c_{water}\cdot P_{water}\cdot\alpha\right]. \quad (9)$$

Hence, in accordance with expression (9), the basic benefit of energy saving actions $PQ_i(0)$ is completely determined by the regional coefficient

$$C_R = C_Q\cdot(T_0 - \langle T\rangle)\cdot\Delta t, \quad (10)$$

depending on climate factors and the price of thermal energy, technical and engineering characteristics of the structure, that are quantitatively described by the multiplier

$$C_B = P_T + c_{gas}\cdot\sum_{i=1}^{N_{con}} n_i P_i + c_{water}\cdot P_{water}\cdot\alpha. \quad (11)$$

CONCLUSIONS AND RESEARCH PERSPECTIVES

The following conclusions can be drawn as a result of the research. Lengthy payback periods, typical for technical and engineering methods used to improve the energy efficiency of buildings, and

the unfeasibility of a reasonable forecast of macroeconomic conditions for the payback period lead to diverse assessments of economic efficiency of energy savings. The analysis and dynamic adjustment of the forecast is only feasible within the framework of energy efficiency information models developed for the whole life cycle of the project. The algorithm of quantitative description of the contribution of energy-saving solutions and predictive macroeconomic conditions to the energy efficiency improvement of buildings and the information modeling of the whole life cycle of the project, formulated in the paper, solves a number of practical problems. First of all, at the design stage, this algorithm allows for the energy optimization of geometric parameters of architectural planning solutions. Further, at the reconstruction stage strategic energy-saving solutions can be formulated. The dynamic adjustment Energy-saving actions can be adjusted on the basis of monitored thermos-physical properties of building envelopes and macroeconomic conditions. In terms of short-term planning, the energy efficiency information model, developed by the authors, makes it possible to perform the quantitative analysis of investments in the replacement of building envelope elements to optimize management decisions in terms of the cost/return ratio. The research needs to be continued to consolidate the algorithms, developed for capital construction projects, whose architectural planning solutions contain modules having spherical, conical and pyramidal shapes. Also of considerable practical interest is the software implementation of developed algorithms in relational database shells and the formation of dynamic libraries of thermo-physical and geometric parameters of building envelope elements for standard construction facilities.

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Оптимизация экономических результатов внедрения энергосберегающих мероприятий в течение полного жизненного цикла объекта капитального строительства

Сложившийся консенсус о безальтернативности энергосберегающего вектора развития экономики привел к формированию национальных и международных программ энергосбережения и многочисленным исследованиям методов повышения энергоэффективности полного жизненного цикла проектов сектора архитектуры, инжиниринга, строительства и эксплуатации. Однако при этом выявили значительный разрыв между прогнозируемым и фактическим потреблением энергии, что подрывает стратегии и политику энергетической модернизации. И причины этого разрыва определяются как социальными, так и технико-технологическими факторами. На точность оценки экономической эффективности энергосберегающих мероприятий оказывает влияние также и неопределенность макроэкономической ситуации. Такое положение значительно затрудняет энергетическую модернизацию экономики. В сфере архитектуры, инжиниринга, строительства и эксплуатации улучшить ситуацию позволяет интеграция технологий информационного моделирования полного жизненного цикла, энергосбережения и дисконтирования затрат и прибыли. Методам увеличения точности прогнозирования экономических последствий мер энергосбережения и посвящена данная работа. Здесь получены алгоритмы количественного описания вклада архитектурно-планировочных решений и энергосберегающих

технико-технологических решений и прогнозных макроэкономических условий в оценку энергоэффективности полного жизненного цикла проекта. Полученная информационная модель полного жизненного цикла проекта на этапе проектирования позволяет оптимизировать геометрические параметры архитектурно-планировочных решений по соотношению энергопотребление/затраты. На этапе реконструкции информационная модель позволяет оптимизировать технико-технологические решения, направленные на энергосбережение. На этапе эксплуатации по результатам динамического мониторинга теплофизических свойств ограждающих конструкций и макроэкономических условий может быть выполнена оптимизация планируемых мер энергосбережения. Кроме того, информационная модель энергоэффективности позволяет выполнить количественный анализ экономических последствий вложения средств в замену элементов ограждающих конструкций, что дает возможность оптимизировать текущие управленческие решения по соотношению затраты/отдача.

Ключевые слова: *информационная модель строительства, жизненный цикл проекта, энергосбережение, оптимизация, экономическая эффективность, объект капитального строительства*

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Об авторах: **Горбанева Елена Петровна** — кандидат технических наук, доцент кафедры технологии, организации строительства, экспертизы и управления недвижимостью; **Воронежский государственный технический университет (ВГТУ)**; 394006, г. Воронеж, ул. 20-летия Октября, д. 84; РИНЦ ID: 717804, Scopus: 57196442554, ResearcherID: GSO-3594-2022, ORCID: 0000-0002-4105-350X; egorbaneva@vgasu.vrn.ru;

Косовцева Илона Андреевна — старший преподаватель кафедры технологии, организации строительства, экспертизы и управления недвижимостью; **Воронежский государственный технический университет (ВГТУ)**; 394006, г. Воронеж, ул. 20-летия Октября, д. 84; РИНЦ ID: 841698, ResearcherID: GRY-6442-2022, ORCID: 0000-0002-3642-3414; ilona.kosovceva@vgasu.vrn.ru;

Кстенин Тимофей Вадимович — магистрант кафедры технологии, организации строительства, экспертизы и управления недвижимостью; **Воронежский государственный технический университет (ВГТУ)**; 394006, г. Воронеж, ул. 20-летия Октября, д. 84; ResearcherID: GSO-3588-2022, ORCID: 0000-0002-2928-0099; timakstenin@gmail.com.

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Sarchenko V.I.
Khirevich S.A.

Cost modeling of integrated urban development

The article addresses land and property sustainability management objectives to implement the idea of sustainable development of urban areas. It is noteworthy that a land plot serves as the urban development framework that goes through the following stages in the process of transformation: 1) idea and conception of improvements; 2) design of improvements; 3) construction; 4) operation; 5) facility liquidation. The authors emphasize that the effective reproduction of housing requires tools of spatial economic modelling of projects for the integrated development of areas. Principal components of the basic element of the urban fabric were analyzed to develop the cost model of the integrated development of urban areas. In addition to elements of basic infrastructure (social, engineering, public and business, housing, transport infrastructure, as well as infrastructure for economic activities), the model has improvement factors for each unit of infrastructure, which demonstrate the need to improve the quality of basic elements against the regulatory benchmark to increase the total capitalization of urban assets. Sources of funding the integrated development of urban areas are presented as two units of infrastructure divided into funds of households, developers (builders), construction co-investors; funds of corporate suppliers of resources; budget resources; loan resources. To ensure the integrated development of areas, not involved in urban planning activities, cost models were developed for the integrated development of areas occupied by industrial enterprises, dilapidated individual houses, country houses and mom-commercial partnerships of gardeners, as well as disturbed urban areas (shallow and flooded areas, ravines, steep slopes). The ability to take into account features of each area will facilitate the sustainable development of cities and the whole country.

Keywords: *sustainable development, urban infrastructure, cost model, cost efficiency, sources of funding*

Sarchenko Vladimir Ivanovich,
Doctor of Economics, Professor, Professor of the Department of Building Design and Real Estate Expertise; Siberian Federal University (SibFU); 79 Svobodny Ave., Krasnoyarsk, 660041, Russian Federation; SPIN-code: 1697-8392, Scopus: 57192673087, ORCID: 0000-0001-6125-6737; vsarchenko@sfu-kras.ru

Khirevich Sergey Anatolevich,
Candidate of Economic Sciences, Associate Professor of the Department of Building Design and Real Estate Expertise; Siberian Federal University (SibFU); 79 Svobodny Ave., Krasnoyarsk, 660041, Russian Federation; SPIN-code: 4102-4526, ORCID: 0000-0002-7067-5631; skhirevich@sfu-kras.ru

The implementation of the idea of sustainable development of residential housing through the attainment of social, economic, and environmental goals accompanies the process of transition from resource consumption to integrated reproduction of resources [1]. The sufficient reproduction of adequate quality housing that meets the needs of the population, coupled with the maintenance of proper performance characteristics of residential housing contribute to its safe and effective use in the present and future. In this case, regular and extended reproduction of housing and facilities of utility, social, public, business and transport infrastructure is a factor of sustainable development of urban areas [2]. The general model used for the reproduction of housing and infrastructure is presented in Fig. 1. Effective housing reproduction needs spatial economic modelling tools applicable to the integrated spatial development projects. The spatial economic modelling of such projects is an analytical tool used to assess the investment attractiveness of the area that can accommodate a project, taking into account urban planning and economic constraints, financial feasibility of the architectural and urban planning concept (master plan) of integrated development[1].

The basic approach to IDA project selection of an is the choice of such an area to be transformed, that will ensure the implementation of an economically viable project amid existing urban planning constraints (density and functionality of development), and, hence, it will raise private equity and minimize budget expenditures, on the one hand, and maximize the benefit to be obtained by the property owners, on the other hand by boosting the value (capitalization) of the area as a result of the implementation of the IDA project.

Each major element of the urban fabric has the following basic elements: social infrastructure S_i, engineering infrastructure En_i, public and business infrastructure P_i, economic activity infrastructure Ec_i, housing infrastructure H_i, transportation infrastructure T_i. As a result, the total cost C_i of integrated development of urban areas can be presented as (1):

$$C_i = \sum_{i=1}^{n} S_i k_S + \sum_{i=1}^{n} En_i k_{En} + \sum_{i=1}^{n} P_i k_P + \\ + \sum_{i=1}^{n} Ec_i k_{Ec} + \sum_{i=1}^{n} H_i k_H + \sum_{i=1}^{n} T_i k_T, \quad (1)$$

$$k_S,\ k_{En},\ k_P,\ k_{Ec},\ k_H,\ k_T \geq 1.0,$$

where k_s, k_{En}, k_P, k_{Ec}, k_H, k_T are improvement factors for social, engineering, public and business infrastructure, economic activity infrastructure, housing and transport infrastructure. They demonstrate the need to improve the quality of basic elements of infrastructure as parts of the urban fabric against the established standards to increase the total capitalization of urban assets. The value of the coefficient set for each element of infrastructure is determined by the location of the developed area, depending on its proximity to the city centre (the largest value). These values explain what components need to be improved to exceed the standard values, the extent of an increase and

1 Methodological recommendations on spatial and economic modeling of projects of integrated development of residential areas. Ministry of Construction of Russia. URL: https://view.officeapps.live.com/op/view.aspx?src=http://www.minstroyrf.ru/upload/iblock/4ae/Metodicheskie_rekomendatsii_po_prostr._ekon._modelirovaniyu_proektov_KRT_zhiloy_zastroyki.docx (rus.).

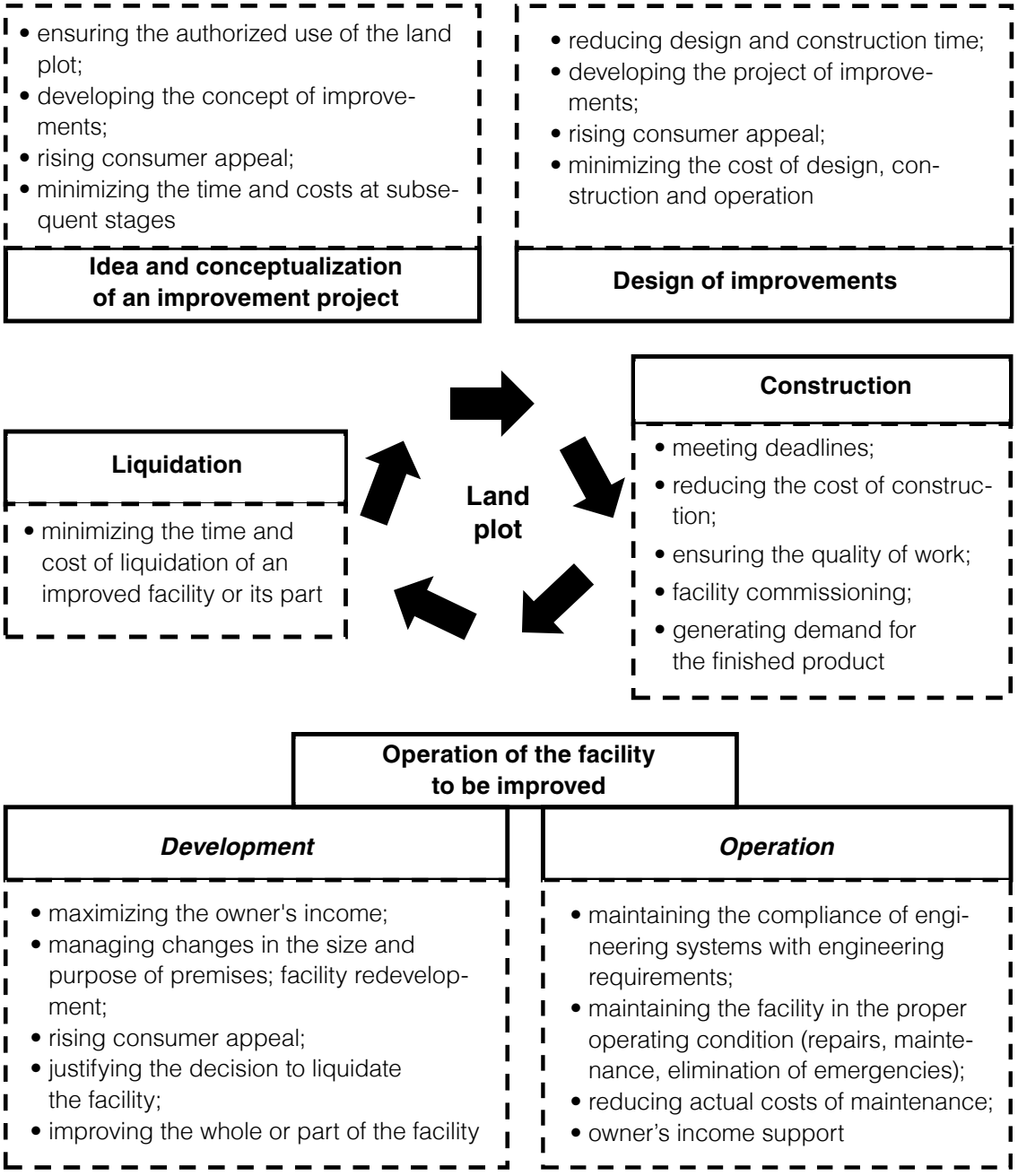

Fig. 1. Objectives of managing the sustainable development of land and property (a real estate facility)

the location of these elements to maximize the residential and commercial property margin.

Sources of funding, designated for the integrated development of urban areas, are outlined in Fig. 2 [3, 4].

If we address the reproduction of housing, public and business infrastructure, as well as infrastructure for economic activities, the major source is the funds of households and participants in shared construction, or savings, loans and state support funds. Few builders and developers contribute their cash into construction projects, while the majority uses different types of borrowed resources.

Engineering infrastructure is reproduced at the expense of consumers of housing and utility services: residents compensate for the expenses incurred in the course of reconstruction, modernization or construction of new engineering facilities in accordance with investment commitments about the implementation of municipal investment programmes undertaken by owners and at the expense of legal entities and natural persons acting as investors making investments into construction and development of the housing and utilities infrastructure. In addition, a large share of social and transport infrastructure facilities is paid for from the federal budget as the state support (the so-called infrastructure menu), regional budgets that make investments into target programmes for the development of local settlements. Some facilities of social, engineering and transport infrastructure are funded from extra-budgetary sources, including public-private partnership (PPP), the majority of which are concession agreements [5].

The analysis of spatial structure of large Russian cities has proven that industrial areas occupy 14–17 % (8–19 thousand hectares) of

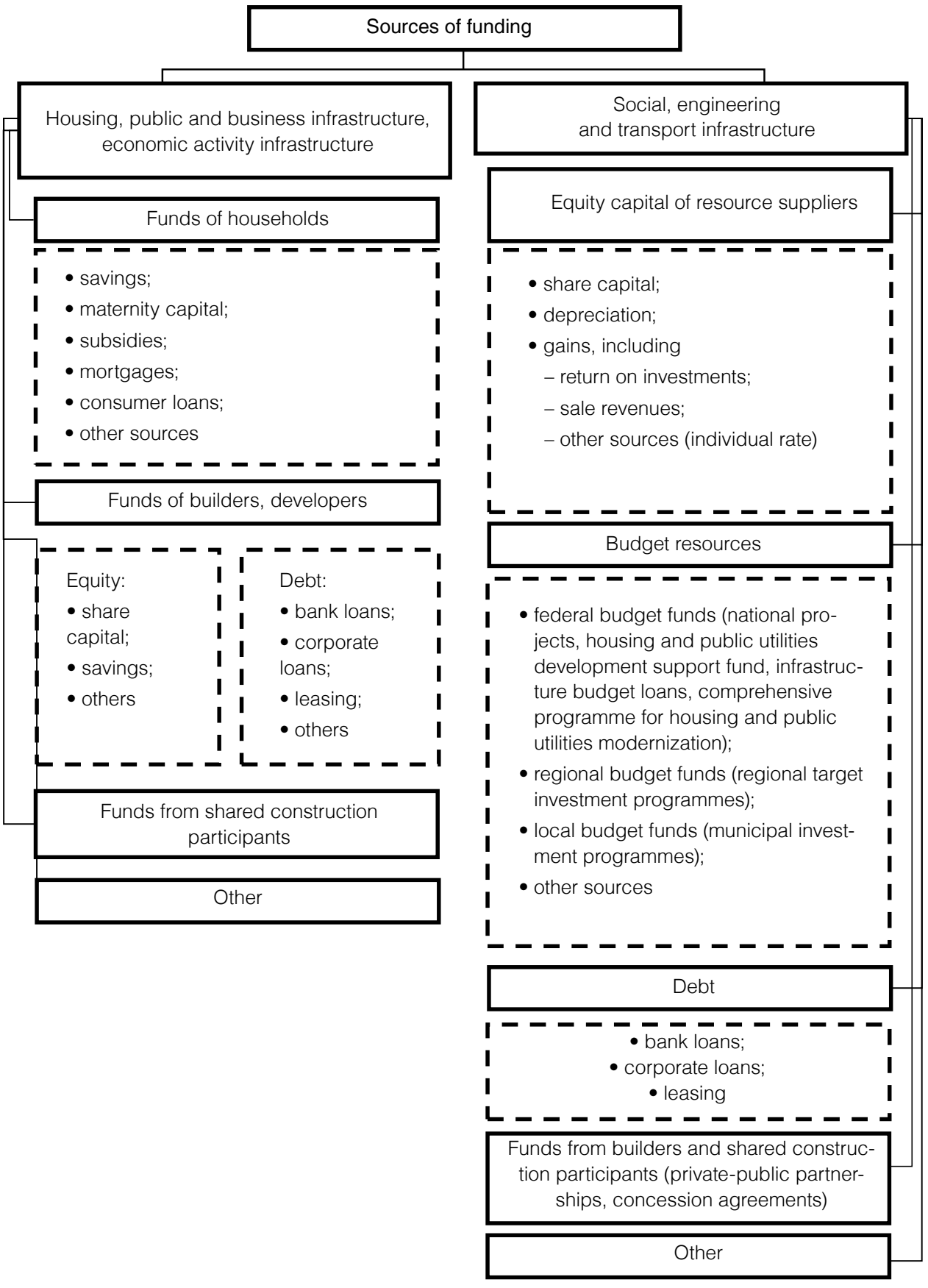

Fig. 2. Sources of funding for the integrated development of urban areas

the total city area, while dilapidated single-family houses and country house communities occupy 10–14 % (7–10 thousand hectares), and disturbed lands (waterlogged and shallow water areas, ravines, steep slopes and other areas not involved in urban planning activities) is on average 6 % of the total urban areas [6, 7].

The research has cost models for the integrated development of largest areas ignored by the urban planning projects in large cities [8, 9].

1. Cost model for the development of areas occupied by industrial enterprises:

$$C_{con} = C_{n.c} + C_{buy} + C_{dis} + C_{rec} + C_{other}. \quad (2)$$

2. Cost model for the development of areas occupied by dilapidated single-family houses:

$$C_{con} = C_{n.c} + C_{com} + C_{ev} + C_{dis} + C_{other}. \quad (3)$$

3. Cost model for the development of areas occupied by country houses:

$$C_{con} = C_{n.c} + C_{com} + C_{eva} + C_{dis} + C_{eng} + C_{other}. \quad (4)$$

4. Cost model for the development of disturbed urban areas:

it is proposed to estimate the cost of construction in shallow water and waterlogged areas according to the formula:

$$C_{con} = (C_{n.c} + C_{dr}V)k. \quad (5)$$

It is proposed to estimate the cost of construction, taking into account an increase in cost due to the development of ravine areas:

$$C_{con} = (C_{n.c} + C_e + C_{dr})k. \quad (6)$$

The cost of construction can be estimated using the following formula that takes into account an increase in price due to the development of steep slopes:

$$C_{con} = (C_{n.c} + C_e + C_{sp})k. \quad (7)$$

Formulas (2)–(7) use the following designations: C_{con} is the total construction cost; $C_{n.c}$ is the construction cost under normal conditions; C_{buy} is the cost of acquisition of an industrial enterprise from the owner; C_{dis} is the cost of demolition and dismantling of existing buildings; C_{rec} is the cost of reclamation of a land plot (in case of a hazardous production facility that was in operation there); C_{other} is other contingencies (identification and preservation of cultural heritage; archaeological research; additional court charges); C_{com} is the cost of compensation due and payable to owners of single-family houses, garden property; C_{ev} is the cost of evaluation of the property within the boundaries of areas selected for comprehensive development; C_{eng} is the cost of construction or modernization of engineering infrastructure within the area; C_{dr} is the average cost of drainage arrangement (per 1 m^3); V is the amount of drainage arrangement work, in m^3; k = 1–1.45 is the coefficient that takes into account higher construction costs due to severe working environments and longer hours of construction machine operation; C_e is the average cost of earthwork; C_{dra} is the average cost of drainage and extra efforts aimed at groundwater management; C_{sp} is the average cost of slope strengthening work.

The cost modeling of the integrated development of various urban areas, taking into account the characteristics of each area will stimulate the sustainable development not only in urban areas, but also in the country as a whole, since more than 75 % of Russia's GDP is generated by the cities. Synchronization between current and future state programmes at all government levels, private investments, and special taxation regimes will level the “shocking” effects on the country's budget in the course of development of urban areas.

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Стоимостное моделирование комплексного развития городских территорий

Для воплощения идеи устойчивого развития городских территорий в статье рассмотрены задачи управления устойчивым развитием всего земельно-имущественного комплекса. Отмечено, что основой развития в городе является земельный участок, который в процессе преобразования проходит следующие стадии: 1) идея и формирование замысла проекта улучшений; 2) проектирование улучшений; 3) строительство; 4) эксплуатация; 5) ликвидация объекта. Авторами отмечается, что для эффективного воспроизводства жилого фонда необходимо использовать инструменты пространственно-экономического моделирования проектов комплексного развития территорий. По результатам анализа базовых составляющих основного элемента планировочной структуры города была сформирована стоимостная модель комплексной застройки городских территорий, которая включает в себя помимо основных инфраструктурных элементов (социальная, инженерная, общественно-деловая, жилищная, транспортная инфраструктура, а также инфраструктура экономической

деятельности) коэффициенты улучшения для каждого инфраструктурного блока, которые отражают необходимость повышения качества базовых элементов по сравнению с нормативным для увеличения совокупной капитализации городских активов. Отдельно представлены источники финансирования комплексной застройки городских территорий по двум инфраструктурным блокам, которые подразделяются на: средства домохозяйств, застройщиков (девелоперов), участников долевого строительства; средства ресурсоснабжающих организаций; бюджетные ресурсы; заемные ресурсы. Для комплексного развития площадей, не вовлеченных в градостроительную деятельность, предложены стоимостные модели комплексного развития территорий, занятых промышленными предприятиями, ветхими индивидуальными жилыми домами, дачными и садовыми товариществами, а также нарушенных городских территорий (мелководные и подтопляемые, овраги, крутые склоны). Учет особенностей каждой территории послужит стимулом для устойчивого развития как городов, так и страны в целом.

Ключевые слова: *устойчивое развитие, инфраструктура города, стоимостная модель, экономическая эффективность, источники финансирования*

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Об авторах: **Сарченко Владимир Иванович** — доктор экономических наук, профессор, профессор кафедры проектирования зданий и экспертизы недвижимости; **Сибирский федеральный университет (СФУ)**; 660041, г. Красноярск, пр-т Свободный, д. 79; SPIN-код: 1697-8392, Scopus: 57192673087, ORCID: 0000-0001-6125-6737; vsarchenko@sfu-kras.ru;

Хиревич Сергей Анатольевич — кандидат экономических наук, доцент кафедры проектирования зданий и экспертизы недвижимости; **Сибирский федеральный университет (СФУ)**; 660041, г. Красноярск, пр-т Свободный, д. 79; SPIN-код: 4102-4526, ORCID: 0000-0002-7067-5631; skhirevich@sfu-kras.ru.

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Oleynik P.P.
Pakhomova L.A.

Definition of organizational and technological parameters for residential buildings of large–sized volumetric blocks

The article summarizes the progressive experience of volumetric block buildings construc-tion, starting from the first series and its further development in the factories construction to man-ufacture volumetric blocks. The turn of development of three-dimensional block buildings idea towards a new technical basis providing for the maximum transfer of the volume of construction and installation work from a construction site to industrial enterprises sphere is revealed. At the same time, the parallel development of modular construction is shown. Long-term development, as well as accumulated domestic and foreign experience, has led to a new direction in residential construction. Residential buildings construction of large-sized volumetric blocks is the most im-portant promising direction. A considerable experiment in this area is being conducted by the MonArch Group of companies (Moscow), which currently manufactures such blocks and carries out the construction of residential buildings of the fifth industrial generation. In this experiment, the issues of designing blocks, materials consumption for their manufacture, the selection of mounting and transport means, organization and technology of mounting blocks and their installa-tion in the design position are worked out. This article describes an approach to defining the organizational and technological parameters of residential buildings made of large blocks. Its main stages, their content and the results obtained are disclosed. At the same time, the difficulties asso-ciated with the lack of an appropriate regulatory framework, the necessary installation and transport means, as well as technological equipment are pointed out. The article argues for the need to expand scientific research and design and experimental developments aimed at reasoning and creating effective organizational, technological and managerial solutions in this urgent direc-tion of country's residential fund development.

Keywords: *large-sized blocks (modules), blocks type, types of space-planning solutions, installation cranes, installation processes*

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Oleynik Pavel Pavlovich,
Doctor of Technical Sciences, Professor, Professor of the Department of Technologies and Organization of Construction Production; Moscow State University of Civil Engineering (National Research University) (MGSU); 26 Yaroslavskoe shosse, Moscow, 129337, Russian Federation; ID RISC: 399946, Scopus: 10043771900, ResearcherID: X-4463-2019, ORCID: 0001-8425-2974; cniomtp@mail.ru

Pakhomova Liliya Alekseevna,
post-graduate student, Senior lecturer of the Department of Technologies and Organization of Construction Production; Moscow State University of Civil Engineering (National Research University) (MGSU); 26 Yaroslavskoe shosse, Moscow, 129337, Russian Federation; ID RISC: 1035400, Scopus: 57205446200, ORCID: 0002-1347-3355; liliya7172@mail.ru

INTRODUCTION

Continuous enhancement of high-quality comfortable housing construction and well-balanced development of all types of social services, provided to local residents, community infrastructure and environmental improvements are the most important urban planning tasks. For this purpose, mass construction of high- and medium-rise residential building is underway in large cities and towns, while low-rise houses are built in suburbs and rural areas.

Ever-growing residential construction is inextricably linked with expanding and more efficient research stud-ies and their faster application to production.

SUMMARIZED ADVANCED EXPERIENCE

Residential buildings of the fifth industrial generation are built nowadays. This generation, or stage, is characterized by universal and flexible space-planning and structural solutions, developed for prefabricated, cast-in-situ and industrialized construction systems, and a rise in modular residential construction [1–4].

Standard prefab residential buildings were initially designed in 1931, and in 1969 several enterprises launched production of volumetric blocks. Unfortunately, due to the limited access to erection equipment and means of transport, as well as the underdeveloped transport infrastructure, this niche of residential construction could not develop fast enough. However, this idea was adopted by other industries. Back then, major tasks of the national economy were solved to ensure its breakthrough development on the back of consolidated local production facilities, fuel and energy complexes. The fuel and energy sector, located in Western Siberia, was one of the most important drivers of the national economy, and its intensive development triggered the emergence of prefab construction method applied to oil and gas facilities.

It is noteworthy that the vast territory of the Tyumen Region is characterized by extremely harsh climate and complex geological conditions. In addition, its major portion was sparsely populated and difficult to access. Against this background, traditional construction methods were useless. As a result, the workflow was rearranged to relocate the maximum amount of construction and assembly work from construction sites to industrial enterprises to ensure the continuous assembly of standard blocks, joints and structures [5–10].

Meanwhile, the innovative technology of modular construction was successfully applied to the production of mobile service buildings and structures for employees of construction companies. For example, by 1975, domestic enterprises had manufactured more than 400 thousand sets of mobile buildings, and by 1985 their total floor area had exceeded 30 million square meters, or more than six square meters per employee. Presently, these

mobile buildings are manufactured by LLC RPK Module, Bytprom, Kraus, KMD, etc. [3, 6, 7].

Modular housing construction was developing thanks to the experience, accumulated by domestic and for-eign enterprises. For example, reinforced concrete blocks weighing up to 20 tons, having the length of 6–8 m and the width of 2.4–3.6 m, were manufactured by the concrete plant in Krasnodar and Vybor LLC in Voronezh. Their use boosted the workability of construction products, substantially increased the degree of prefabrication, reduced the construction time and onsite labour intensity [8–14].

MonArch Group, Moscow, has improved its modular construction skills and conducted an experiment to confirm the efficiency of large-sized volumetric blocks as a replacement for small-sized ones [3, 10, 15, 16]. Maximum dimensions of volumetric blocks reached 15.5 × 7.5 × 3.75 m, and their maximum weight reached 65 tons. The degree of prefabrication went up to 98 %. As a result, residential buildings could be swiftly assembled on construction sites at minimal costs (Fig.).

MATERIALS AND METHODS

Several studies, each having five interrelated stages, were conducted to simulate processes of construction of residential buildings from large-sized blocks.

Stage 1. At this stage, characteristics of large-sized blocks (modules), that are most likely to be used in modular residential construction projects, are determined and analyzed. When volumetric blocks are designed, the increment step is assumed as 0.3 in terms of length, and 0.1 in terms of width. Each block has a number indicating its weight (Table 1). The height of each block is 3.5 m. In general, there are 1,008 types of volumetric blocks . The maximum block weight is 65 tons, and its volume is 341.3 m^3.

Stage 2. Designs of standard building sections, developed by Parametrica and AMC Project architectural workshops, St. Petersburg, were used as the basis for architectural planning solutions for residential buildings. As a result, over 100 space-planning solutions were developed for residential buildings assembled from large-sized volumetric blocks, given that one large-sized volumetric block was an apartment with an average total floor area of 100 m^2 (for blocks No. 1). Five most characteristic options, whose sections had the shapes of a square, a rectangle, Г and П – letters, were selected for further research. Table 2 shows three types of solutions and their technical charac-teristics.

Stage 3. A large-sized block installation method was developed at this stage. Basic operations, including block preparation for unloading, block unloading and installation, were predesigned. For example, the block installation process includes such operations as the capture of blocks using specialized machinery, the lifting (relocation) and installation of blocks, as well as their fixing in the appropriate position. In turn, process arrangements, machinery used, all installation operations, as well

Installation of a large-sized volumetric block (a module)

Table 1. Sets of large-sized blocks, their ordinal number and weight, tons (extract)

Width, m	Length, m						
	15.0	**14.7**	**14.4**	**14.1**	**13.8**	**13.5**	**13.2**
6.5	1–65 t	2–63.7 t	3–62.4 t	4–61.1 t	5–59.8 t	6–58.5 t	7–57.2 t
6.4	29–64 t	30–62.7 t	31–61.4 t	32–60.2 t	33–58.9 t	34–57.6 t	35–56.3 t
6.3	57–63 t	58–61.7 t	59–60.5 t	60–59.2 t	61–58 t	62–56.7 t	63–55.4 t
6.2	85–62 t	86–60.8 t	87–59.5 t	88–58.3 t	89–57 t	90–55.8 t	91–54.6 t
6.1	113–61 t	114–59.8 t	115–58.6 t	116–57.3 t	117–56.1 t	118–54.9 t	119–53.7 t
6.0	141–60 t	142–58.8 t	143–57.6 t	144–56.4 t	145–55.2 t	146–54 t	147–52.8 t
5.9	169–59 t	170–57.8 t	171–56.6 t	172–55.5 t	173–54.3 t	174–53.1 t	175–51.9 t
5.8	197–58 t	198–56.8 t	199–55.7 t	200–54.5 t	201–53.4 t	202–52.2 t	203–51 t
5.7	225–57 t	226–55.9 t	227–54.7 t	228–53.6 t	229–52.4 t	230–51.3 t	231–50.2 t
5.6	253–56 t	254–54.9 t	255–53.8 t	256–52.6 t	257–51.5 t	258–50.4 t	259–49.3 t
5.5	281–55 t	282–53.9 t	283–52.8 t	284–51.7 t	285–50.6 t	286–49.5 t	287–48.4 t
5.4	309–54 t	310–52.9 t	311–51.8 t	312–50.8 t	313–49.7 t	314–48.6 t	315–47.5 t
5.3	337–53 t	338–51.9 t	339–50.9 t	340–49.8 t	341–48.8 t	342–47.7 t	343–46.6 t
5.2	365–52 t	366–51 t	367–49.9 t	368–48.9 t	369–47.8 t	370–46.8 t	371–45.8 t
5.1	393–51 t	394–50 t	395–49 t	396–47.9 t	397–46.9 t	398–45.9 t	399–44.9 t
5.0	421–50 t	422–49 t	423–48 t	424–47 t	425–46 t	426–45 t	427–44 t
4.9	449–49 t	450–48 t	451–47 t	452–46.1 t	453–45.1 t	454–44.1 t	455–43.1 t
4.8	477–48 t	478–47 t	479–46.1 t	480–45.1 t	481–44.2 t	482–43.2 t	483–42.2 t
4.7	505–47 t	506–46.1 t	507–45.1 t	508–44.2 t	509–43.2 t	510–42.3 t	511–41.4 t
4.6	533–46 t	534–45.1 t	535–44.2 t	536–43.2 t	537–42.3 t	538–41.4 t	539–40.5 t

as the management quality determine large-sized block installation methods.

Stage 4. At this stage, selection and arrangement of construction machinery are a complex procedure that ensures rational and safe construction of residential buildings. Towards this end, engineering parameters are identi-fied, using characteristics of particular types of buildings, to formulate the requirements applicable to the main instal-lation machine. The unique nature of the process of making buildings from large-sized blocks limits the choice of installation machines. The following construction machines may be applied:

- a crane on a special chassis with a lifting capacity of 650 tons with the use of removable cargo-grabbing devices – an automatic traverse (patent RU 2749677 C1);
- a tracked crane in a tower-boom design for the use of an automatic traverse with a lifting capacity of 800 tons (patent RU 2749677 C1);

Table 2. Characteristics of space-planning solutions for residential buildings made of large-sized volumetric blocks

Space-planning solutions	Basic parameters		Number of large-sized blocks		
	total area, thousand m^2	number of floors	ground floor	standard floor	engineering floor
Type 1. Single-section square	7.5	16	8	120	8
Type 2. Single-section rectangle	5.3	9	9	72	9
Type 3. Three-section П-shaped solution	10.9	5	38	152	38

- portal system using an automatic traverse (patent RU 2749677 C1).

The time study has identified the following process characteristics:

- block preparation for unloading: 0.157 persons · hour/m^2;
- block unloading: 0.222 persons · hour/m^2;
- block installation: 0.211 persons · hour/m^2.

As a result, due to the uniqueness and high cost of cranes, another parameter, or the average daily number of blocks installed, must be determined in addition to the engineering parameters, such as the lifting capacity, the crane arm length, and the hook lifting height. The studies have proven that the distribution of this parameter over time is in line with the hyperbolic law.

Hence, one can accurately calculate the crane time on the construction site:

$$T = t_a + r_1 + r_2 + r_3 + r_4,$$

where T is the crane time on the construction site, days;
t_a is the installation of the superstructure of a residential building, days;
r_1 is the installation and dismantling of the crane, days;
r_2 is the maintenance and repair of the crane, days;
r_3 is the time lost due to bad weather, days;
r_4 is weekends and holidays, days.

RESULT

Stage 5. At this stage final documents are developed, including work schedules, a construction master plan, a crane operation schedule, an integrated machinery operation schedule, etc.

The construction schedule consolidates the above processes, the sequence and time of their implementation, while the construction master plan encompasses the arrangement of construction machines, including the location of parking lots and the unloading area for large-sized blocks.

CONCLUSION

The construction of residential buildings from large-sized volumetric blocks has the strongest potential in terms of development of industrial housing construction.

The storied domestic history of prefab construction can serve as the basis for standardization and unifica-tion of blocks, further conversion of material resources into blocks, choosing special assembly and transport ma-chines to make sure that the construction process remains continuous.

Growing numbers of residential buildings, made from large-sized volumetric blocks, substantiate the need to expand scientific research, design and experimental developments to devise effective organizational, engineering and management solutions.

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Определение организационно-технологических параметров жилых зданий из крупногабаритных объемных блоков

В статье дано обобщение прогрессивного опыта строительства объемно-блочных зданий, начиная с первых серий, и дальнейшее его развитие по строительству предприятий по изготовлению объемных блоков. Раскрыт поворот развития идеи объемно-блочных зданий в сторону новой технической основы, предусматривающий максимальный перенос объемов строительно-монтажных работ со строительной площадки в сферу промышленных предприятий. Одновременно показывается параллельное развитие модульного строительства. Многолетние развитие, а также накопленный отечественный и зарубежный опыт привели к новому направлению в жилищном строительстве. Возведение жилых зданий из крупногабаритных объемных блоков является важнейшим перспективным направлением. Масштабный эксперимент в этой области проводит группа компаний «МонАрх» (г. Москва), которая к настоящему времени изготавливает такие блоки и осуществляет строительство жилых зданий пятого индустриального поколения. В этом эксперименте отрабатываются вопросы проектирования блоков, расхода материалов на их изготовление, выбора монтажных

и транспортных средств, организации и технологии монтажа блоков и их установки в проектное положение. В данной статье изложен подход к определению организационно-технологических параметров жилых зданий из крупногабаритных блоков. Раскрыты основные его этапы, их содержание и полученные результаты. Одновременно указывается на трудности, связанные с отсутствием соответствующей нормативной базы, необходимых монтажных и транспортных средств, а также технологической оснастки. В статье аргументирована необходимость расширения научных исследований и проектно-экспериментальных разработок, направленных на обоснование и создание эффективных организационно-технологических и управленческих решений в этом актуальном направлении развития жилищного фонда страны.

Ключевые слова: *крупногабаритные блоки (модули), типаж блоков, типы объемно-планировочных решений, монтажные краны, монтажные процессы*

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Об авторах: **Олейник Павел Павлович** — доктор технических наук, профессор, профессор кафедры технологий и организации строительного производства; **Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ)**; 129337, г. Москва, Ярославское шоссе, д. 26; РИНЦ ID: 399946, Scopus: 10043771900, ResearcherID: X-4463-2019, ORCID: 0001-8425-2974; cniomtp@mail.ru;

Пахомова Лилия Алексеевна — аспирант, старший преподаватель кафедры технологий и организации строительного производства; **Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ)**; 129337, г. Москва, Ярославское шоссе, д. 26; РИНЦ ID: 1035400, Scopus: 57205446200, ORCID: 0002-1347-3355; liliya7172@mail.ru.

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Sezemin D.E.
Grabovyy P.G.

Selection of a rational degree of specialization of Russian companies involved in construction of nuclear power plants in foreign countries

Specialization is one of the forms of social division of labour which is expressed in the concentration of construction companies on performing homogeneous types of work or erecting construction facilities having the same function. Forms of specialization play an important role in the construction process arrangement. Their economic efficiency, which is expressed, first of all, in the increase of labour productivity, rises with the narrowing of the range of works performed and a freer exchange of resources. Four forms of specialization are developing; they are industry-specific, subject or object — focused, technological and sub-industrial ones.
Industry-specific specialization provides for the identification of companies specializing in the construction of certain buildings and structures for certain industries of the national economy. Such specialization exists at the level of ministries.
Subject-focused specialization means the foundation of corporate entities specializing in the construction of buildings and structures having common volumetric and structural modules (for example, construction of nuclear power plants (NPPs), transport infrastructure facilities, etc.). Such form of specialization develops at the level of large construction companies, development companies.
Technological specialization is characterized by the orientation of construction units on performance of certain types of works, that are similar in terms of technology and arrangement, as a result of which a certain stage of construction is completed (for example, construction of the reactor compartment at a NPP, auxiliary reactor buildings, a turbine building, that encompass concreting, finishing, heating installation works, etc.). This form was developed at the level of specialized construction companies, production flows, and construction sites.
Detailed specialization is the breakdown of the overall construction process into a number of specific processes and concentration of work performance in separate units (for example, production of building structures at reinforced concrete plants; manufacturing of assembly parts at the sites of construction companies; installation of building structures, brick and masonry on assembly sites) which ultimately contributes to the transformation of a construction site in the assembly area. Detailed specialization develops at the level of specialized units, teams and gangs.
Keywords: *technological specialization, degree of specialization, NPP project management, Rosatom State Corporation, project lifecycle, Akkuyu NPP*

Sezemin Denis Evgenievich,
Candidate of Technical Sciences, Applicant of the Department of Organization of Construction and Real Estate Management; Moscow State University of Civil Engineering (National Research University) (MGSU); 26 Yaroslavskoe shosse, Moscow, 129337, Russian Federation; Director for Construction and Production Management; Akkuyu Nükleer Anonim Şirketi; Mahall Ankara, Mustafa Kemal Mah. Dumlupınar Blv. B Blok 274/7 Kat: 11; No: 117, 06530 Çankaya/Ankara/Turkey; 9540184@mail.ru

Grabovyy Petr Grigorievich,
Doctor of Economics, Professor, Head of the Department of Organization of Construction and Real Estate Management; Moscow State University of Civil Engineering (National Research University) (MGSU); 26 Yaroslavskoe shosse, Moscow, 129337, Russian Federation; ID RISC: 302471, Scopus: 57164862700; GrabovyiyPG@gic.mgsu.ru

THE GENERAL PART

During the construction of NPPs technological specialization was frequently applied mechanized excavations, construction and installation work, installation of building structures, performance of sanitary, electrical, finishing, road and other types of construction work, as well as equipment installation. From this point of view, technological specialization is the most effective instrument. At present, the greatest economic effect is obtained by the corporate participants in NPP construction, that use this principle in their operations.

At the same time, the process of specialization can have a number of negative aspects. The greater the degree of specialization, the larger (1) the number of independent corporate participants of construction, (2) the number of units and external relations due to cooperation, which ultimately worsens the quality of project management and economic performance, causes employees to waste time on communication between departments. Therefore, there is a need to determine the rational level and optimal degree of specialization of companies and subdivisions specializing in technologies or subjects.

The level of specialization characterizes the enlargement of homogeneous construction work, performed by excluding homogeneous and technologically related works (or certain types of construction) from the general activities of construction companies and assigning them to separate specialized units. The creation of these large homogeneous work performance units promotes further division of labour, separation of work, and assignment of its performance to newly established specialized companies or units, which means further degrees of specialization. This process is division of aggregated works or types of construction into components. The conditional limit of technological specialization division is the performance by a particular construction company of only one type of work (concreting, finishing, electrical, plumbing work). Assessment of the degree and selection of the rational degree of specialization helps to further increase the efficiency of construction companies and their units.

A NPP project is a set of interrelated activities designed to achieve goals within a given time and budget. A set of interrelated elements and links between them, representing a “tree” of product-oriented components represented by equipment,

work, services and information, determine the structure of such a project[1, 2].

In case of implementation of an NPP project, the level of specialization depends on the project participants, degree of their specialization, while the distribution of functions and responsibilities depends on the nature, type, scale and complexity of the project, as well as the phases of its lifecycle.

NPP project functions are clustered depending on management by project objectives; time management, cost management, quality management, risk management, contract management, project participant and personnel management, relationship and information flow management.

NPP project management is the art of leadership and coordination of human, financial and material resources using modern management methods and techniques, organizational forms of production and construction focused on the achievement of project results in terms of the composition and scope of work, cost, time, quality and satisfaction of project participants.

Development of specialization of construction companies should not be an ultimate goal, but a means ensuring the most exhaustive use of achievements of modern construction science and technology to ensure the best engineering and economic performance of specialized organizations, including higher productivity, lower cost of work, maximum profit, and less time lost [1, 2].

THE MAIN PART: ANALYSIS OF FOREIGN PROJECTS

In the current environment, the concept of international construction or construction in foreign countries as an activity carried out by a construction company(contractor) outside of its own country, has been transformed into a broader concept. Participation in a large-scale international investment and construction project, includes one or more constituents implemented with the participation of foreign companies, such as the performance of construction and installation works, delivery of materials and equipment, provision of design and project management services, as well as fundraising services[3].

Over the past decades, there has been a steady growth in international construction through the implementation of major infrastructure projects in developed and developing economies. According to the forecast, made by PricewaterhouseCoopers, by 2030, the amount of construction products in the world will grow by 85%. Revenues of major international construction companies, such as Actividades de Construccion y Servicios (Spain); HOCHTIEF AG (Germany); China Communications Construction Group Ltd. (China) and others, generated abroad, are estimated at tens of billions of euros[4].

One of the largest Russian corporations ROSATOM implements investment projects abroad (Table 1).

The Russian Federation ranks the first global NPP developer abroad, implementing projects, as it builds power units in Europe, Middle East and North Africa, as well as in the Asia-Pacific region. In the international nuclear power construction market, Russia is represented by the engineering unit of Rosatom State Corporation, which encompasses leading design and engineering companies of the industry: Atomstroyexport JSC, Atomenergoproekt JSC and others.

Implementation of NPP investment and construction projects abroad has a strong potential in terms of increasing the exportation of the nuclear power industry, taking into account the global situation, national competitiveness and current market positions.

The development of the global NPP market represents the evolutionary expansion of nuclear power generation in the countries that have experience in NPP operation and involvement of the “atomic energy club” newcomers. About 50 countries are considering the commissioning of their first NPP. There are about 160

Table 1. Foreign projects of Rosatom, the largest Russian company [3]

Russian project participant	Project country	Major projects	Investment amount, billion US dollars
Rosatom State Corporation	Belarus	Belarusian NPP	12.00
	Finland	NPP Hanhikivi	6.5–7.0
	Hungary	NPP Paksh-2	10.00
	Turkey	NPP AKKUYU	20.00
	Iran	NPP Bushehr	3.5
	China*	Tianwan NPP	1.3
	India*	NPP “Kudankulam”	2.1
	Egypt	NPP El Dabaa	20.00
	Bangladesh	NPP Ruppur	11.00

* Supply of nuclear and turbine island equipment

1 Town Planning Code of the Russian Federation (as amended on April 24, 2020) : Federal Law No. 190-FZ: [adopted by the State Duma on December 22, 2004: approved by the Federation Council on December 24, 2004]. URL: http://docs.cntd.ru/document/901919338

2 Civil Code of the Russian Federation (Part Two) (Articles 454-1109) (as amended on April 28, 2020) (version effective from June 26, 2020) : Federal Law No. 14-FZ: [adopted by the State Duma on December 22, 1995]. URL: http://docs.cntd.ru/document/9027703

3 STO NOSTROY 2.3386-2013. Organization of civil engineering operations. Industrial construction. Reconstruction of buildings and structures: company standard: introduction date March 15, 2013. National Association of Builders. Official edition. Moscow, National Association of Builders, 2015; 109.

4 NPP construction abroad. URL: tations_projects/perspektivy-sooruzheniya-rossiyskikh-aes-za-rubezhom

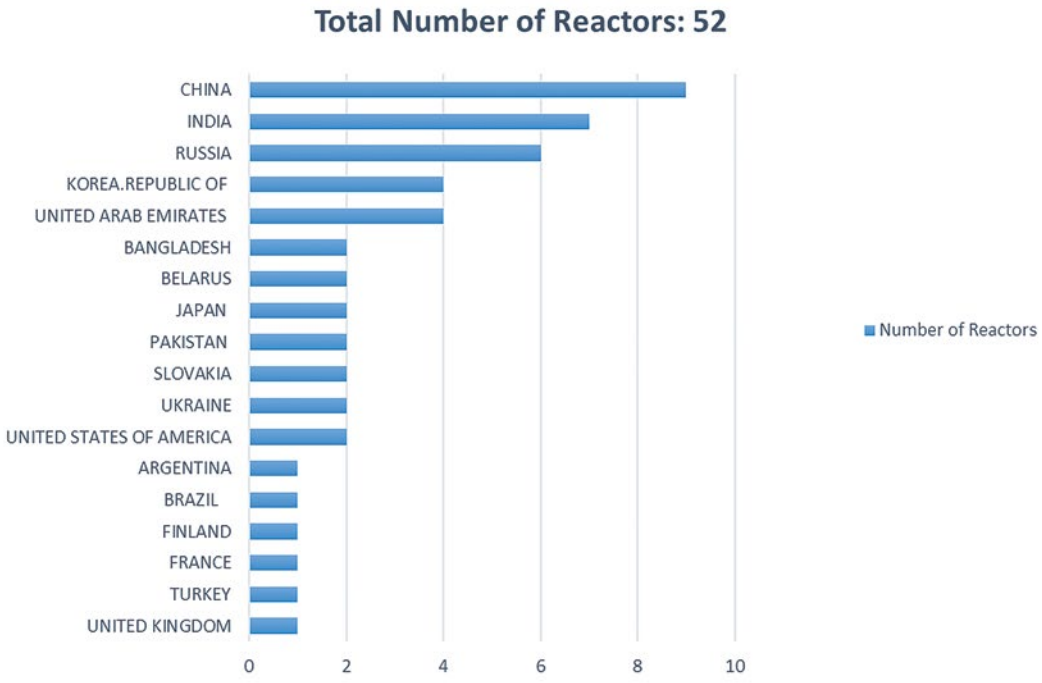

Fig. 1. Number of reactors under construction in 2019

new NPP units in the world that pass through various stages of project planning [4].

The Engineering Division of Rosatom State Corporation, headed by ASE IC JSC, has strong competencies in the management of construction of complex engineering facilities. At present, this Engineering Division specializes primarily in the construction of high-capacity NPPs in the Russian and international markets. At the moment, the Engineering Division of ROSATOM is the global nuclear engineering leader, and its share of the global NPP construction market is, at least 30%. It is active in Europe, Middle East, Asia, North Africa, Asia, and the Pacific region [5].

The Russian projects include Novovoronezh NPP-2, Rostov NPP, Kursk NPP-2, Leningrad NPP-2. About 80% of revenues, obtained by the Engineering Division, are generated by foreign projects.

The project customers are countries seeking to diversify the sources of energy and obtain cheap electricity.

Besides the construction of high-capacity NPPs, the Engineering Division of ROSATOM provides project management services, design, equipment supply [6–8].

One of strategic goals of Rosatom State Corporation is to increase the share of construction of high-capacity nuclear power plants in international markets, and the prerequisite is the unconditional performance by the Engineering Division of its contracts within the preset parameters. Compliance with NPP construction deadlines and costs, both in terms of current and future projects, is an absolute priority for the company. Achievement of this goal is ensured by:

- continually improving operational and project management processes;
- application of effective digital tools and information systems throughout the lifecycle of the project, — from pre-contract works to NPP commissioning;
- quality improvement at each stage of NPP construction;
- development of the key staff.

In addition, among the strategic objectives of the Engineering Division, as well as of ROSATOM as a whole, is the reduction of production costs and timing of NPP construction processes. The company's task is:

- to deliver NPP projects that are competitive in terms of the cost per kW of installed capacity and LCOE;
- to design and implement NPP construction projects within pre-set cost parameters [9–11].

CONSTRUCTION ARRANGEMENTS: THE CASE OF THE AKKUYU NPP PROJECT

AKKUYU NÜKLEER ANONİM ŞİRKETİ, part of ROSATOM, will build NPP AKKUYU (Akkuyu) in Mersin province.

May 12, 2010, an agreement was signed between the Government of the Russian Federation and the Government of the Republic of Turkey about the cooperation in the construction and operation of a nuclear power plant at the Akkuyu site in the Republic of Turkey.

On April 14, 2015, the "first stone" was laid at the site of the future construction of the NPP Akkuyu hydraulic engineering facilities.

On April 02, 2018, Turkish Atomic Energy Agency issued a License for the construction of NPP Akkuyu Unit 1.

On April 03, 2018, the Akkuyu NPP construction commencement ceremony was held with the participation of President of the Republic of Turkey Recep Erdogan and President of the Russian Federation Vladimir Putin.

NPP Akkuyu is the first project in the history of the nuclear industry implemented according to the BOO (Build – Own – Operate) model. According to the BOO model, the NPP supplier acts as an investor and co-owner of the future NPP. The company (Akkuyu Nuklear), supplying the technology, stays in the project throughout its lifecycle, providing financing, construction and operation technologies, training local personnel, developing industry-specific

Fig. 2. NPP Akkuyu construction site, Turkey, 2022

competencies of local specialists, participating in risk and responsibility sharing in terms of the sustainable development of the project and its commercial success.

The total cost of the investment project will be ~$ 20 billion, which includes the upfront costs of NPP construction, financing and waste management. This is the largest foreign investment in the Republic of Turkey.

NPP Akkuyu is based on a project similar to the NvNPP-2 reference project in Novovoronezh, Russia. NvARS-2 is currently operating at 100% full capacity. "Lessons learned" from NvNPP-2 help to design and construct a nuclear power plant in Mersin province. The industry practice of working with "lessons learned" is applied in the design and construction of NPP in Russia and abroad to avoid the same mistakes and inconsistencies in the present.

Akkuyu Nüklear Anonim Şirketi is the customer, the applicant for the necessary licenses, and the future operator of NPP. The key project contractor is TİTAN 2 IC İÇTAŞ İNŞAAT ANONİM ŞİRKETİ, which, in turn, enters into contracts with subcontractors, designers and suppliers. Some of them are CONCERN TITAN-2 JSC, Atomenergoproekt JSC, Atomenergomash JSC, and OKB GIDROPRESS.

TİTAN 2 IC İÇTAŞ İNŞAAT ANONİM ŞİRKETİ, is the key contractor for the construction of the plant; this company is responsible for site preparation, construction and installation works, development of working documentation and supply of all necessary materials and equipment (excluding long lead items) for all nuclear and turbine island facilities, the power generation complex and all ancillary facilities, as well as construction of buildings and roads, laying utility and engineering networks, design and supply of control and measuring equipment, landscaping and landscape design.

The Akkuyu construction site will include infrastructure and temporary buildings and facilities at a cost of ~ 800 million dollars.

As of September 2022, about 20,000 people were working on the construction site every day. More than 400 companies are involved in the project, about 80% of them are Turkish companies.

The nuclear power plant consists of a complex of general station buildings and structures, nuclear and turbine island buildings, including the reactor building, the turbine building, the emergency control room building, fresh and used nuclear fuel storage buildings. 260 buildings and structures (including tunnels and overpasses) must be constructed and commissioned as part of the first power unit of the plant. The plant will have 3,900 operating employees.

THE RESEARCH PART

For the purpose of construction of a large power generation complex, evaluation of the optimal level and degree of specialization was conducted using the case of NPP Bushehr. NPP Bushehr is constructed by the general contractor and about 30 subcontractors. The performance of three construction companies was analyzed. Akkuyu performed monolithic concrete pouring.

In these companies, the level of specialization L_S has almost reached its limit value over the last 8 years; it is 92–96% on average. In this regard, the planning of a further increase of L_S involves certain difficulties. For a more objective assessment of the level of specialization, it is advisable to use the indicator "degree of technological specialization" D_{ST}, characterizing the share of the main types of work in their total amount, if performed by the in-house personnel. The value of D_{ST} can be calculated using the formula:

$$D_{ST} = 0.01\sqrt{\sum_{i=1}^{n}\left(Q - \bar{Q}\right)^2}, \quad (1)$$

where n is the number of i-x processes of the main types; Q is the specific weight of the i-th process in the total amount of work in value terms; $\bar{Q}$ is the arithmetic mean value of specific weights of all processes.

Value D_{ST} varies in the range $0 < D_{ST} < 1$, and its rational value depends on several factors: specialization, conditions of activity of specialized subdivisions, work performance arrangements, etc.

Data on changes in the degree of specialization broken down by the years of construction are shown in Table 2.

Table 2. Degree of specialization

The company	2015	2016	2017	2018	2019	2020
Bel NPP	0.44	0.502	0.503	0.526	0.568	0.810
Akkuyu NPP	0.72	0.84	0.87	0.90	0.92	0.95
Busher NPP	0.48	0.606	0.74	0.75	0.82	0.84

Analysis of the main engineering and economic indicators of industrial and economic activities of the companies in question for the same period shows that all three companies exceeded the annual targets for the amount of construction and assembly work, production, cost and profit. At the same time, monthly graphs of the actually performed construction and assembly work shows that the basic principles of construction, such as uniformity and rhythm, were violated in these companies. Hence, during the last months of a quarter, a six months' period and a year, the amount of work performed was 1.5–2 times higher than the annual average. Given that the number of teams in construction units remained the same, such facts indicate the presence of significant untapped reserves for the further improvement of the arrangement of the NPP construction process.

Practice shows that the availability of reserves is caused by time losses at the "junctions" between the main types of work due to complicated cooperation links. External time losses are caused by untimely provision of work front, design and estimate documentation, equipment; internal losses are caused by untimely delivery of materials, failure to provide vehicles and mechanisms, violations of the labour discipline.

Time losses (Table 3) are equal to the annual under-performance of construction and assembly works by almost 100 millio.rubles.

Numerous possible options for the development of engineering specialization within a conditionally closed system (which is a set of construction companies engaged in the construction of NPP) and the need to choose the most optimal boundary values of D_{ST} at which the best engineering and economic indicators are achieved) require a substantiated approach to the problem under consideration. The impact of various factors on the degree of engineering specialization can be simulated using the economic statistical method, or identification of correlation relationships between the degree of engineering specialization of construction units and criterial indicators of their activities in a past period.

Such indicators are usually taken as the cost of building and assembly jobs, labour productivity or a set of indicators (cost price and profitability, labour productivity and profitability level, etc.). Indeed, a degree of engineering specialization contributes to the growth of labour productivity and reduction in the cost of works. However, along with positive results there are undesirable consequences of specialization, in particular, higher losses of time and resources at the "junctions" between the main types of work (or engineering operations) due to the higher complexity of cooperation links and lower reliability of construction management. Therefore, there is a need to consider the influence of D_{ST} not only on labour productivity B and level of profitability P, but also on time losses TL at the "junctions" between the main types of work performed by various construction organizations (departments).

The studies, conducted in other branches of construction, indicate that the relationship between the performance of construction units and D_{ST} is approximated by the parabolic dependence (a second-order parabola):

$$\left.\begin{aligned} B &= a_1 + B_1 D_{ST} + C_1 D_S m^2; \\ C &= a_2 + B_2 D_{ST} + C_2 D_S m^2; \\ TL &= a_3 + B_3 D_{ST} + C_3 D_S m^2. \end{aligned}\right\} \quad (2)$$

The nature of these dependences allows to identify a certain zone of rational boundary values in which at the highest labour productivity, relatively low $B_{TS.rat}$ cost of works and losses of time are possible.

The problem of determining the rational degree of engineering specialization can be solved graphically (Fig. 4, 5).

The graph (Fig. 4) shows dependences between the cost-effectiveness of labour productivity, time losses and the degree of engineering specialization at Bel. NPP, UEM and DAEM companies. As the analysis shows, the degree of engineering specialization of each company depends on the number of items of work performed, the number of employees, as well as the characteristics of the so-called range of each company. The range is understood as the zone of optimal values of the functions characterizing loss of time, labour productivity and profitability level within the boundary

Table 3. Time losses during the construction of nuclear power plants from 2015–2020

Year of construction	Labour productivity, thousand rubles/year			Profitability level, %			Time loss, %		
	Bel NPP	Akkuyu	Busher NPP	Bel NPP	Akkuyu	Busher NPP	Bel NPP	Akkuyu	Busher NPP
2015	11.9	16	10.3	26.1	12	7.4	3.7	4.1	9
2016	13.3	21.4	11.7	27.2	14.8	8.6	3.7	3.9	8.7
2017	15.3	22	14.7	27.7	15	8.2	3.6	3.7	9.1
2018	15.6	23.1	16.8	20.6	15.5	7.5	3.1	3.9	10.4
2019	15.4	19.6	13.9	20.1	15.4	7.1	4.3	4.1	10.8
2020	15.9	23.2	16.5	20	15.1	7	4.9	4.2	10.8

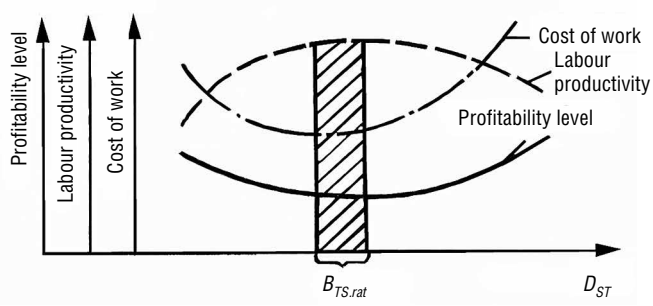

Fig. 3. Dependence of labour productivity B, cost of works C and loss of time TL on degree of engineering specialization DST

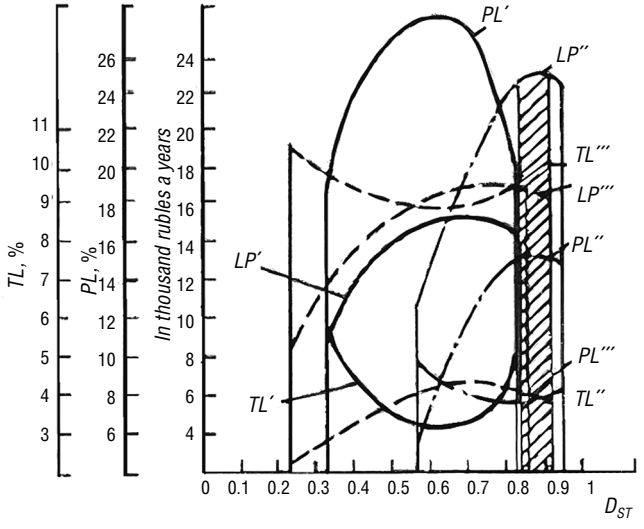

Fig. 4. Dependence of labour productivity B, profitability level P and time loss TL on degree of engineering specialization D_{ST}: — for Bel. NPP; —•—•— for Akkuyu; — — — — for Busher NPP

values of D_{ST}. This zone is also a rational zone for the number of types of work performed by the construction company. For example, for Busher, zone D_{ST} is rational (0.85–0.93).

The results of the analysis have revealed the following regularity: some rational degree of specialization corresponds to the most effective engineering and economic characteristics of the building unit. This general law was called "the law of bifurcation". This regularity can be used to analyze the activity of building companies (Fig. 5), as it demonstrates a strong correlation between engineering and economic indices with the optimum degree of specialization. Those indices, which do not depend on D_{ST}, although they show secondary factors, do not follow this regularity.

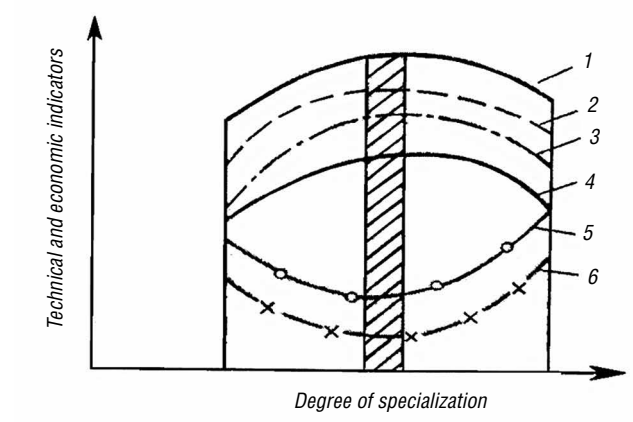

Fig. 5. The regularity of bifurcation, used to analyze the activity of construction companies: 1 — productivity (output); 2 — economic effect; 3 — profit; 4 — profitability; 5 — cost price; 6 — time loss

THE FINAL PART

Fig. 4 shows that some indicators (output, profit, profitability, cost of work, loss of time, economic effect) correspond to the best degree of specialization. If we plot the values of engineering and economic indicators on the general graph in the coordinate system, it will show that all the extremums of the functions will be located in the same zone for a certain degree of specialization. Each curve has a zone of the most favourable indicators for a construction unit, in which the output, profit, minimum time losses, etc. are the highest.

The degree of engineering specialization increases with a decrease in the number of types of work assigned to one specialized company, as well as with an increase in the amount of work of one type performed at one site. Hence, dependencies, shown in Fig. 1, make it possible to predict the recommended degree of specialization for construction and installation companies to achieve maximum output, profitability and minimum time losses. This approach makes it possible to improve the engineering and economic performance of NPP construction companies. It is no coincidence that the degree of specialization has increased by 3 times over the last 8 years at the relatively constant level of specialization in the course of NPP Bushehr construction.

The proposed approach to choosing a rational degree of specialization makes it possible for the construction units to plan this indicator for five years, a year, a quarter to assess the economic efficiency of specialization depending on its growth. Among other things, achievement of the best degree of specialization, also depends on the potential of the team, because setting reasonable boundaries D_{ST} is important not only from the economic, but also from the social point of view.

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Выбор рациональной глубины специализации российских компаний, участвующих в строительстве АЭС за рубежом

Специализация — это одна из форм общественного разделения труда, выражающаяся в сосредоточении строительных организаций на выполнение однородных работ или возведение объектов одинакового назначения. Формы специализации играют важную роль в организации производства. Их экономическая эффективность, выражающаяся в первую очередь в повышении производительности труда, возрастает по мере сужения номенклатуры выполняемых работ и обеспечения в рассматриваемом специализированном подразделении более свободного обмена ресурсами. Развиваются четыре формы специализации: отраслевая, предметная (объектная), технологическая и подетальная.

Отраслевая специализация предусматривает выделение организаций, специализирующихся на строительстве определенных зданий и сооружений для отдельных отраслей народного хозяйства. Такая специализация существует на уровне министерства.

Под **предметной специализацией** понимается создание хозяйствующих субъектов, специализирующихся на строительстве зданий и сооружений, имеющих общие объемно-конструктивные модули (например, строительство АЭС, объектов транспортной инфраструктуры и др.). Развивается такая форма специализации на уровне крупных строительных компаний, девелоперских компаний.

Технологическая специализация характеризуется ориентацией строительных подразделений на производство определенных видов работ, объединенных технологией и организацией, в результате выполнения которых завершается определенный этап строительства (например, для АЭС возведение реакторного отделения, вспомогательного здания реактора, здания турбины — бетонные, отделочные, тепломонтажные работы и т.п.). Эта форма получила развитие на уровне специализированных строительных компаний, производственных потоков, участков.

Под **подетальной специализацией** понимается расчленение укрупненного строительного процесса на ряд частных процессов и сосредоточение производства в отдельных подразделениях (например, производство строительных конструкций на заводах железобетонных и металлических конструкций, доборочных деталей — на полигонах строительных компаний; установка строительных конструкций, кирпичная и каменная кладка — на монтажном участке), что в конечном счете способствует превращению строительной площадки в монтажную. Развивается подетальная специализация на уровне специализированных подразделений, бригад, звеньев.

Ключевые слова: *технологическая специализация, глубина специализации, управление проектом АЭС, ГК «Росатом», жизненный цикл проекта, АЭС «Аккую»*

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Об авторах: **Сеземин Денис Евгеньевич** — кандидат технических наук, соискатель кафедры организации строительства и управления недвижимостью; **Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ)**; 129337, г. Москва, Ярославское шоссе, д. 26; директор по строительству и промышленному инжинирингу; **АО Аккую Нуклеар**; Махалл Анкара, квартал Мустафа Кемаль, бульвар Думлупынар, блок Б, ул. 274/7, этаж 11, № 117, 06530, Чанкая, Анкара; 9540184@mail.ru;

Грабовый Петр Григорьевич — доктор экономических наук, профессор, заведующий кафедрой организации строительства и управления недвижимостью; **Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ)**; 129337, г. Москва, Ярославское шоссе, д. 26; РИНЦ ID: 302471, Scopus: 57164862700; GrabovyiyPG@gic.mgsu.ru.

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Tkachenko V.B.

Novelties of the Russian legislation in the field of construction, economics and real estate management in the second through fourth quarters of 2022

This analytical and legal analysis reflects changes in the Russian legislation in the field of construction, economy, real estate management, management of housing and utilities considered in the first issue of this magazine [1]. The article reflects the normative legal regulation of social relations related to single-family houses, equity participation in construction, features of application of penalties (fines) and other financial sanctions, as well as other measures of liability for non-fulfillment or improper fulfillment of obligations under contracts of participation in shared construction, established by the legislation on shared construction, issues of requirements to the documentation of developers of apartment complexes, meetings of apartment building owners, the choice of management companies, identification of the status of the common property of apartment building owners, accounting and payment for the utility services provided, relations between regional operators and contractors engaged in capital repairs in an apartment building, the status of unfinished construction, the status of uncompleted construction projects, construction permit issuance, state expert examination of design documentation, the creation of a unified register of construction organizations — members of self-regulatory organizations, the procedure for paying remuneration to experts, specialists and interpreters, taking part in the judicial process, the creation and determination of the powers of the public-law company Roskadastr, changes in technical regulations on fire safety and other changes in the Russian legislation.

Keywords: *changes, revisions, legislation, regulatory acts, construction, economy, urban development, apartment building, housing and utility services (HUS), low-rise housing complexes (LHC), contract of shared participation in construction, general meeting of apartment building owners, state examination of project documentation, fire safety, construction permit, public company "Roskadastr"*

Note. *The following open sources was used to compile this review: site of the State Duma of the Federation Council of the Russian Federation[1]; Internet portal of legal information[2]; Internet portal of Rossiyskaya Gazeta[3]; reference legal system ConsultantPlus[4]; information and legal portal Garant.ru[5]; information portal RBC Real Estate[6].*

Tkachenko Vladimir Borisovich,
Candidate of Legal Sciences, Associate Professor of the Department of Construction and Real Estate Management, expert (lawyer) on property disputes, construction, real estate management, housing and communal regulation; Moscow State University of Civil Engineering (National Research University) (MGSU); 26 Yaroslavskoe shosse, Moscow, 129337, Russian Federation; ID RISC: 451978, ORCID: 0000-0002-6425-7249; Tkachenkovb@mail.ru

Federal law of April 16, 2022 № 100-FZ "On amendments to Article 190 of the Housing Code of the Russian Federation" [2]

Since March 1, 2023 the procedure and terms of signing the act of acceptance of capital repair of apartment buildings will be established by the subjects of the Russian Federation.

The Housing Code of the Russian Federation shall be amended according to which the subjects of the Russian Federation shall be empowered to adopt normative legal acts establishing the procedure and terms of signing of acts of acceptance of work performed and services rendered for capital repair of the common property in an apartment building. The accepted act regulates the procedure of interaction of participants of its signing, including commission signing of an acceptance act of services rendered and (or) works performed.

The act of acceptance is signed by the local authority and the person authorized to act on behalf of owners of premises in case the capital repair is carried out on the basis of the decision of owners.

The adopted changes do not apply to the activities of homeowners' associations, housing, housing cooperatives and other consumer cooperatives engaged in the management of an apartment building. The law enters into force on March 1, 2023.

Federal Law No. 123-FZ of May 1, 2022 "On Amending Article 39.8 of the Land Code of the Russian Federation" [3]

Land plots owned by the state or municipality may be granted on lease for the term of implementation of a large-scale investment project.

Adopting the said normative legal act the legislator points out that in the current legislation there is no binding of terms of lease of land plots to terms of implementation of large-scale investment projects. If the terms of lease of a land plot do not coincide with the terms of realization of a large-scale

1 State Duma of the Federal Assembly of the Russian Federation. URL: http//duma.gov.ru
2 Official Internet portal of legal information. URL: http//www.pravo.gov.ru
3 Rossiyskaya gazeta. URL: http//rg.ru
4 ConsultantPlus. URL: http//www.consultant.ru
5 Garant.ru. URL: http://www.garant.ru
6 RBC Real Estate. URL: http://realty.rbc.ru

investment project the investor is exposed to risks associated with the necessity to conclude new agreements.

In this connection the amendments made to legislation provide that a lease agreement for a state or municipally owned land plot may be leased without tenders for the realization of a large-scale investment project which meets the established criteria, for the term of fulfillment of such a project.

Federal Law No. 124-FZ of May 1, 2022 "On Amendments to the Urban Development Code of the Russian Federation and Certain Legislative Acts of the Russian Federation" [4]

The powers of the Government of the Russian Federation in the regulation of town-planning, land and other relations, in relation to transport infrastructure facilities and other capital construction facilities are expanded.

In particular, it is established that in 2022 the Government of the Russian Federation has the right to adopt decisions providing for: specific features for the issuance by a federal body for the management of the state fund of subsurface resources or its territorial bodies of conclusions concerning the absence of minerals in subsurface resources under a site of forthcoming development, permits for the development of land plots, which are located beyond the borders of populated areas and are in areas of occurrence of minerals, for the placement beyond the borders of populated areas in areas of occurrence of minerals of underground structures within the limits of the mining allotment, as well as cases in which issuance of such conclusions, permits is not required; cases in which during construction and reconstruction of capital construction facilities no approval of the federal executive authority in the field of fisheries is required (with the exception of cases in which the construction and reconstruction of a capital construction facility has a negative impact on aquatic biological resources and their habitat), a territorial body of the federal executive authority in the field of environmental protection.

The Government of the Russian Federation has the right to adopt decisions establishing specifics of the procedure for determining the presence or absence of objects possessing the attributes of an archaeological heritage site on territories, subject to the impact of prospecting, excavation, construction, amelioration, economic works, forest use and other works, prior to the establishment of criteria for determining the territories, in relation to which the bodies for protection of cultural heritage objects have grounds to assume the presence of archaeological heritage objects or objects possessing signs of an archaeological heritage object on these territories.

In addition, the list of priority infrastructure modernization and expansion projects includes: trunk gas pipelines, oil pipelines, oil product pipelines, and trunk infrastructure facilities, the construction and reconstruction of which are carried out in accordance with the comprehensive plan for the modernization and expansion of trunk infrastructure approved by the Government of the Russian Federation; social infrastructure facilities, construction and reconstruction of which are carried out with the involvement of the budgets of the budget system of the Russian Federation, funds of legal entities created by the Russian Federation, the subjects of the Russian Federation, legal entities, the share of the Russian Federation, the subjects of the Russian Federation in the authorized (share) capital of which is over 50 percent, in order to reduce the deficit of such facilities in the territory of the RF subject, a municipal entity; objects of the industrial infrastructure, construction, reconstruction of which is carried out for the purpose of creation, introduction and development of import-substituting, resource-saving, environmentally safe technologies, production of products having no Russian equivalents, production of innovative, energy-efficient building materials.

It also establishes certain peculiarities of town planning, cadastral activities, state cadastral registration and (or) state registration of rights to the created linear object.

In particular, the maximum amount of obligations under which organizations and individual entrepreneurs who are not members of SROs may participate in construction contracts has been increased from 3 to 10 million rubles.

The term of cadastral works in respect of land plots for subsidiary farming, gardening, horticulture, construction of garages for own needs or residential housing and real estate located on such land plots is limited to three working days. Five working days are allocated for the cadastral registration and state registration of rights to the above objects if the application is submitted through the MFC.

The right of a regional operator to pay in advance more than 30 % of the cost of the relevant type of services or works on capital repair of the common property in an apartment building is provided for (cases and procedure to be established by the Government of the Russian Federation).

The authority of the Government of the Russian Federation to determine in 2022 the specifics of issuance of certain documents and approvals is fixed.

This Federal Law enters into force from the date of its official publication.

Federal Law of June 11, 2022 No. 163-FZ "On Amending Article 25 of the Federal Law "On Privatization of State and Municipal Property" [5]

Russia will improve the efficiency of state property management.

Amendments are made to the Law on the Privatization of State Property aimed at optimizing the processes for managing subsidiary organizations of holding structures in various sectors of the economy.

In particular, provision has been made for the possibility to make, as a contribution by the RF to the charter capital of a JSC wholly owned by the state, 100 % of shares of another JSC.

Moreover, it is prohibited to privatize 100 % of shares of the main JSC, which fully owns a subsidiary JSC. It will be possible only in case of termination of participation of the main JSC in the subsidiary JSC or if the main JSC ceases to be its sole shareholder.

Federal Law No. 165-FZ of June 11, 2022 "On Amendments to the Housing Code of the Russian Federation" [6]

Since September 1, 2022 in Russia the procedure for selecting the managing organization for an apartment building has changed.

The Housing Code of the Russian Federation was amended to streamline the selection of the managing organization in an apartment building. In particular, the competence of the general meeting of owners of premises in an apartment building includes taking a decision on the choice of the managing organization. Before adoption of amendments to choose the managing organization in an apartment building required a majority of votes of the total number of votes of premises owners participating in this meeting in an apartment building. The introduced amendments increased andspecified the quorum of decision making which was more than fifty percent of votes of the total number of votes of premises owners in an apartment house.

In addition, the amendments stipulate that federal laws, laws of constituent entities of the Russian Federation and normative legal acts of local governments may stipulate that citizens shall be compensated for expenses on payment for residential premises and utilities by transferring funds to the entity to which payment for residential premises and utilities is made, i.e. directly to the managing organization, homeowners' associations, housing, housing construction and other consumer cooperatives.

The current Federal Law came into effect on September 1, 2022.

Federal Law No. 185-FZ of June 28, 2022 "On Amendments to Certain Legislative Acts of the Russian Federation" [7]

The electronic registration of the agreement on the assignment of rights of claim under the DDE has been introduced, real estate transactions have acquired protection.

The Federal Law is aimed at improving the procedure for state registration of the transfer, termination, restriction of the right to an object of real estate and (or) encumbrance of the corresponding object of real estate if an entry is made in the Unified State Register of Real Estate (hereinafter — UGRN) on the impossibility of state registration of the right without personal participation of the owner of the object of real estate or his legal representative. The law amends Federal Law No. 218-FZ of July 13, 2015 "On State Registration of Real Estate" [8] (hereinafter — Federal Law No. 218-FZ) and the Fundamentals of Legislation of the Russian Federation on Notaries [9]. The Federal Law provides for the grounds for returning without consideration the application and documents submitted for the state cadastral registration and state registration of rights in terms of state registration of the agreement on assignment of the right of claim under an agreement on participation in shared construction.

The Federal Law establishes the possibility to submit an application for the state registration of rights in the Unified State Register without personal participation of the right holder by a person authorized by the owner (his legal representative) in a notarial power of attorney issued by him. Federal Law supplements the provisions of Federal Law No. 218-FZ on making an entry in the USRN on the possibility of registration of the transfer, termination of ownership of real estate owned by a person and the documents attached thereto in the form of electronic documents and (or) electronic images of the documents, signed by the reinforced qualified signature, the provision of the possibility of state registration of the right on the basis of the application for the state registration of the transition, termination of ownership of the real estate on the basis of the documents in the form of electronic documents or their electronic images, signed by reinforced qualified electronic signature, which were submitted by a notary, provided that the transaction was carried out with the personal participation of the right holder (his legal representative), as well as extends the application of the above provisions to the cases of filing an application for state registration of the contract of cession of the claims of the share construction participant under the contract of participation in shared construction.

Federal Law postpones the entry into force of Federal Law No. 430-FZ of December 21, 2021 "On Amendments to Part One of the Civil Code of the Russian Federation" [10], which established the signs of immovable things, rights to buildings, constructions, construction in progress, premises and parking lots, defined the ownership of buildings, constructions, construction in progress, premises and parking lots — from March 1, 2023 to September 1, 2022, and also postpones the entry into force of Federal Law dated December 30, 2021. Implementation of the amendments introduced by the Federal Law will allow to reduce the risk of fraudulent actions in the sphere of property relations and simplify the procedure of state registration of rights for the interested persons.

Federal Law No. 318-FZ of July 14, 2022 "On Amendments to the Civil Procedure Code of the Russian Federation" [12]

The mechanism of payment for forensic examinations has been improved.

The law amends articles 85, 95 and 98 of the Code of Civil Procedure of the Russian Federation [13] (hereinafter — CPC RF) concerning the procedure for payment of fees to experts, specialists and interpreters involved in the process.

According to the proposed amendments in case of failure by the parties to comply with the obligation to make a preliminary payment to the depositary account of the court of the amounts payable to the experts, if later they have not paid for the expertise or have not paid it in full, sums of money payable for the expertise, as well as compensation of the actual costs of the expert, forensic expert institution incurred in connection with the expertise, shall be recovered from one or both parties and distributed between them as set forth by the CPC.

The proposed norms are in line with the approaches already existing in the procedural legislation. A similar approach to the procedure for the recovery of monetary amounts for forensic examination is provided for in article 110 of the Arbitration Procedural Code of the Russian Federation [14].

The bill also provides for amendments clarifying the procedure for determining the remuneration for forensic examination by an expert of a state forensic expert institution — by agreement with the parties and by agreement with the head of the state forensic institution.

The proposed amendments are aimed at unifying the norms governing proceedings in courts of general jurisdiction and arbitration courts, as well as at introducing certainty in the regulation of the payment procedure for forensic examinations appointed as part of civil proceedings at the initiative of the parties.

Federal Law No. 217-FZ of 28.06.2022 "On Amendments to the Housing Code of the Russian Federation"[15]

The legislator has established the limitation for carrying out the extraordinary general meeting of owners of rooms in an apartment house on the questions which have been included in the agenda of the general meeting carried out earlier and on which decisions have been made by this general meeting. Such general meeting can be called after the term established by a part 1 of article 46 of the Housing code of the Russian Federation (further — the Housing code) of placing in the state information system of housing and communal services (further — system) or the regional information system provided that the minutes and decisions of such earlier general meeting are placed in system in an automated mode. The federal law imposes on the owner or other person at the initiative of which the general meeting of owners of premises in an apartment house is convoked, the obligation on placement in the system or in regional information system of the message on carrying out general meeting of owners of premises in an apartment house, and also decisions and minutes of general meeting of owners of premises in an apartment house under condition of providing placement in the system in an automated mode of the specified documents.

Also the Federal law from a norm of part 2 of article 199 of the Housing code of the Russian Federation [16] excludes such basis for consideration by the licensing commission of the question of appeal to court with the statement for cancellation of the license, as absence within six months in the register of licenses of the subject of the Russian Federation of data on the apartment houses which management activity is carried out by the licensee.

Federal Law No. 276-FZ of July 14, 2022 "On Amendments to the Federal Law "Technical Regulations on Fire Safety Requirements" [17]

Technical regulations on fire safety requirements are clarified.

Amendments are made to technical regulations on fire safety requirements which are aimed at increasing the protection of citizens and property from fires.

The law expands the list of conditions for the compliance of objects of protection with fire safety requirements and eliminates obsolete, redundant and duplicative requirements. A limited list of regulatory documents on fire safety is established.

Fire safety declarations can now be submitted in the form of an electronic document signed by the UKEP. Updated declarations shall be submitted in the event of a change in the class of functional fire hazard of the protection object or its overhaul, reconstruction or technical re-equipment.

In socially significant facilities, fire signals must be automatically duplicated to the panel of the fire protection unit using a system of notification of fire.

Requirements for fire safety and fire extinguishing equipment are established by the technical regulations of the EAEU (TR EAEU 043/2017).

The law enters into force 10 days after the date of publication.

Federal Law dated July 14, 2022 No. 350-FZ "On Amendments to the Town Planning Code of the Russian Federation and Certain Legislative Acts of the Russian Federation" [18]

Amendments to the Town Planning Code of the Russian Federation were adopted.

Applicable norms in Moscow and St. Petersburg, extended to Sevastopol. In cases established by the legislation of the regions, it will be possible to adjust the general plans with respect to a part of the settlement.

Draft regional town planning standards will be published at least 15 working days before their approval (previously — not less than 2 months).

Compliance of project documentation with the established requirements can be assessed in the form of expert support by the authority or organization authorized to carry out expert review of documentation prior to the submission of documentation for examination.

It is established that the functional and technological, structural, engineering and technical and other solutions contained in the standard design documentation can be recognized as a standard design solution. Such decisions will be entered in the register of conclusions of the expert examination of design documentation.

The Government will be able to determine the cases in which expert reviews of project documentation are not carried out.

As part of the comprehensive development of the territory, facilities will be demolished on the basis of the decision on such development without a separate decision on demolition.

From September 1, 2022 regions will be able to se.rules for approval of architectural and urban planning image of capital construction projects for the period until March 1, 2023.

The amendments will come into force from the date of publication.

Decree of the Government of the Russian Federation of March 26, 2022 No. 479 "On establishment of peculiarities of application of forfeits (fines, penalties), other financial sanctions, and other measures of liability for non-fulfillment or improper fulfillment of obligations under agreements on participation in share participation construction, established by the legislation on share participation construction, and on peculiarities of the inclusion in the unified register of problematic objects of apartment houses and (or) other objects of real estate, in respect of which the developer has violated for more than 6 months the terms of completion of construction (creation) of an apartment building and (or) other real estate and (or) the obligation to transfer the object of share construction to a participant of share construction under a registered contract of participation in share construction" [19]

The Government has exempted from liquidated damages and penalties under a contract of shared participation in construction (hereinafter — the "CDP") for the developer until the end of the year.

Until the end of 2022 the following shall not be charged against the developer: forfeits for violation of payment terms under the CDU and for violation of the terms of the object transfer; losses in excess of the forfeit for violation of the CDU; interest for the use of funds upon termination of the contract; forfeits (fines, penalties) under the Law on Protection of Consumer Rights.

On the claims submitted for execution shall be deferred until the end of 2022. Claims from the writ of execution, presented for execution from the date of entry into force of the resolution, during the deferment period shall not be executed by the banks servicing the developers' accounts.

Until the end of 2022 no notices of the developer's breach of the deadlines for completion of construction and transfer of facilities shall be sent. The authorized regional authority will not be entitled to apply to the court of arbitration for suspension of the developer's business till December 31, 2022. Also temporarily will not be included in the register of problem objects in case of delay in construction. Resolution aims to reduce the burden during the sanctions regime of unfriendly countries on the developer.

The Resolution comes into force on the day of its publication.

Decree of the Government of the Russian Federation No. 575 dated April 2, 2022 "On the specifics of preparing, approving, approving, extending the validity of documentation on the planning of the territory, town-planning plans of land plots, issuing permits for the construction of capital construction facilities, permits for commissioning" [20]

The government has reduced the administrative burden on developers.

The terms of valid construction permits, which expire before August 1, 2022, are automatically extended by one year. Also, the validity of all city planning plans for land plots (GPZU) has been extended by one year.

The need to formalize the decision of the authority on the preparation of a territory planning project was abolished. The term of approval of such a project was reduced from 15 to 10 working days.

To obtain a building permit and commissioning of the object it is no longer necessary to provide building control authorities with GPZU and several other documents.

The Decree enters into force on the date of its publication.

Decree of the Government of the Russian Federation of 4 April 2022 No. 579 "On the establishment of peculiarities of making changes in the design documentation and (or) the results of engineering surveys that received a positive conclusion of the state expertise, including in connection with the replacement of construction resources with analogues, peculiarities and cases of state expertise of design documentation" [21]

The procedure for conducting a State expert examination of design documentation is simplified.

The government has established a special procedure for making changes to project documentation in 2022.

In particular, if the builder has replaced the building materials specified in the project with analogues not inferior in quality, the re-examination will be carried out free of charge within a shortened time frame.

If the replacement of construction materials on analogues did not increase the cost of construction by more than 30 % and more than 100 million rubles, re-examination of the project will not be conducted.

For the objects of priority importance the check of observance of environmental requirements and requirements in the sphere of preservation of objects of cultural heritage will be provided in the framework of state expertise of project documentation.

This will apply to the construction of transport and municipal infrastructure facilities, construction projects in the Arctic zone, and structures constructed as part of national projects.

Decree of the Government of the Russian Federation of November 16, 2022 No. 2076 "On Amendments to the rules for the provision of public services to owners and users of premises in apartment buildings and residential buildings" [22].

If you do not use the service — the payment for the removal and disposal of solid municipal waste can be recalculated.

From March 1, 2023 it will be possible to recalculate the fee for household waste removal for all residents of apartment buildings who temporarily (more than 5 full calendar days in a row) do not use this service for some reason (for example, due to departure on vacation).

The Government of the Russian Federation has fixed the procedure. An application and supporting documents will be required for recalculation.

The resolution will take effect on March 1, 2023, and will be in force until December 31, 2027.

Resolution of the Government of the Russian Federation of April 6, 2022 No. 603 "On the cases and procedure for issuing permits for the construction of capital construction projects, which are not linear objects, on two or more land plots, permits for commissioning such projects, as well as issuing necessary for these purposes town planning plans of land plots" [23]

The cases and procedure for issuing permits for the erection of capital construction facilities, which are not linear, on two or more plots of land were determined.

For 2022 a number of peculiarities of urban planning activities were established. Thus, the Government of the Russian Federation determines the cases and procedure for issuance of permits for erection of capital construction facilities which are not linear, on two or more land plots, commissioning permits, as well as urban planning plans of land plots required for these purposes.

Such cases and procedure are established. Construction permits are issued in cases where land plots are simultaneously adjacent, belong to the same person by right of ownership, and (or) permanent (perpetual) use, and (or) lifetime inheritable possession, and (or) gratuitous use, have the same type of permitted use, which allows the placement of capital construction.

Permits for commissioning shall be issued in accordance with the procedure if construction permits were obtained in a similar manner.

Permits for construction are valid until the expiry of the period for which they were issued.

Resolution of the Government of the Russian Federation of May 5, 2022 No. 813 "On Amendments to Some Acts of the Government of the Russian Federation" [24]

Regional capital repair operators are entitled to increase advance payment to contractors.

If the draft agreement on capital repair of an apartment building stipulates the condition on treasury support of settlements with regard to payment of advance payment or the condition on banking support of the contract, the customer may provide for payment of advance payment up to 50 % of the cost of works. Up to 80 % — if the contract also provides for the purchase of materials and equipment.

As for the price of the contract, there is a possibility to increase it by agreement of the parties by not more than 30 %.

A number of other indulgences to change the essential terms of the contract are provided for. Part of the amendments are related to the introduction of an independent guarantee.

The decree enters into force from the date of its official publication.

Decree of the RF Government No. 861 of May 13, 2022 "On Approval of the Exemplary Form of Agreement on Accrual by a Participant of Shared Construction of a Share in the Common Property of Owners of Individual Residential Buildings in Low-Rise Residential Complex" [25].

Low-rise development: a standard form of an agreement on the emergence of a share in the ownership right to the common property of a residential complex by a participant in shared construction was approved.

The common property of the owners of individual residential buildings in a low-rise residential complex includes capital construction facilities located within its boundaries, other property and land plots if they are used exclusively for meeting the needs of the owners of the buildings. Such property includes, in particular, boiler houses, water towers, heating points, driveways, bicycle paths, crosswalks, sidewalks, landscaping elements, children's and sports grounds, recreation areas, parking lots, solid municipal waste collection areas. The creation of such objects is allowed, if the participants of the shared construction have the right of common share ownership to them or in case of gratuitous transfer of such objects by the developer into state or municipal ownership.

An agreement on the emergence of a share in the right of common share ownership of the common property shall be an integral part of the VDU [26]. The Government has established an approximate form of such an agreement. It shall contain: a list of objects to

be included in the common property; the procedure for determining the share in the right of common share ownership of such objects; information on tax and other obligations of the owners of the objects included in the common property.

The Decree shall come into force from the date of its official publication.

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Новеллы российского законодательства в сфере строительства, экономики и управления недвижимостью за второй–четвертый кварталы 2022 года

В представленном аналитико-правовом анализе отражены изменения российского законодательства в сфере строительства, экономики, управления недвижимостью, управления жилищно-коммунальным комплексом, рассматриваемые в первом номере настоящего журнала [1]. В статье отражены нормативное правовое регулирование общественных отношений по вопросам, связанным с индивидуальной жилой застройкой; регулирование отношений в рамках долевого участия в строительстве; особенности применения неустойки (штрафа, пени), иных финансовых санкций, а также других мер ответственности за неисполнение или ненадлежащее исполнение обязательств по договорам участия в долевом строительстве, установленным законодательством о долевом строительстве; требования к документации застройщика многоквартирных жилых комплексов, проведения собраний собственников многоквартирного дома по выбору управляющих организаций, определения статуса общего имущества собственников многоквартирного дома, порядка учета и оплаты за предоставленные коммунальные услуги, взаимоотношений региональных операторов и подрядных организаций, осуществляющих капитальный ремонт в многоквартирном доме; вопросы статуса объектов незавершенного строительства, проведения строительных работ до получения разрешения на строительство, проведения государственной экспертизы проектной документации, вопросы создания единого реестра строительных организаций — участников саморегулируемых организаций; порядок выплаты вознаграждения экспертам, специалистам и переводчикам, принимающим участие в судебном процессе; создание и определение полномочий публично-правовой компании «Роскадастр», а также изменение технического регламента о пожарной безопасности и иные изменения в российском законодательстве.

Ключевые слова: *изменения, дополнения, законодательства, нормативно-правовые акты, строительство, экономика, градостроительство, многоквартирный дом, жилищно-коммунальное хозяйство (ЖКХ), малоэтажные жилищные комплексы (МЖК), договор долевого участия в строительстве, общее собрание собственников многоквартирного дома, го-*

сударственная экспертиза проектной документации, пожарная безопасность, разрешение на строительство, публично-правовая компания «Роскадастр»

Примечание. *При формировании обзора использовалась информация открытых источников: сайт ГД СФ РФ[1]; Интернет-портал правовой информации[2]; Интернет-портал «Российская газета»[3]; Справочная правовая система «КонсультантПлюс»[4]; Информационно-правовой портал «Гарант.ру»[5]; Информационный портал «РБК Недвижимость»[6].*

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Об авторе: **Ткаченко Владимир Борисович** — кандидат юридических наук, доцент кафедры организации строительства и управления недвижимостью, эксперт (адвокат) по вопросам имущественных споров, строительства, управления недвижимостью, вопросам жилищно-коммунального регулирования; **Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ)**; 129337, г. Москва, Ярославское шоссе, д. 26; РИНЦ ID: 451978, ORCID: 0000-0002-6425-7249; Tkachenkovb@mail.ru.

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6 РБК Недвижимость. URL: http://realty.rbc.ru

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Kurakova O.A.

Some aspects of project team building and selection of the leadership style taking into account personality types and development levels of team members

Kurakova Oksana Anatolevna,
Candidate of economic Sciences, Associate Professor of the Department of Organization of Construction and Real Estate Management; Moscow State University of Civil Engineering (National Research University) (MGSU); 26 Yaroslavskoe shosse, Moscow, 129337, Russian Federation; ID RISC: 549544; kurakovaoa@mgsu.ru

The implementation of the project approach in the course of managing investment and construction projects is accompanied by a relevant problem, that is, project team building, selection of the leadership style depending on the team members. Numerous approaches are applied to resolve this issue. This article aims to consider such an aspect of project team building as the types of personality of the team members. The article addresses the identification of behavioural motives governing the interpersonal communication of individuals in the course of work. The article considers the main characteristics of emotional drivers in the behaviour of an individual; volitional aspects of personality formation are provided. The classification of personality types is based on the Enneagram, which allows classifying personality types by their emotional-volitional and business structure to correctly conduct personnel policy in the course of the project team building. The article also discusses an algorithm for selecting a project team management style depending on the level of development of its participants. The main task of a manager, selecting an effective team management style, is to correctly assess potential capabilities and needs of employees, their involvement and responsibility for the results of their work. Appropriate motivation of team members leads to job satisfaction and ensures its effectiveness.

Keywords: *motive, communication, will, personnel policy, personality types, leadership style, personality type*

A project team is a group of specialists who jointly work on common goals and tasks, such as the implementation of an investment and construction project. The project team is headed by the project manager. Each member of the team performs his or her function. Each team member is motivated to work on the project together with the others and achieve results. A notable example of teamwork is the fairy tale about the turnip tree.

The organization of processes in a team depends on the management style, skill level, personality types of its team members, etc.

One of the project manager's tasks when making a team is to build a relationship with its members, find the “keys” to the subordinates' minds to influence them to achieve the project team goals.

To properly influence people, it is necessary to understand, first of all, what goals motivate a person and how you can competently manage people by managing these goals.

D. Carnegie believed that the only way to manage a person and get him to do something was to offer him what he wanted [1].

Studies have shown that almost all normal adults have the same needs: health and safety, food, sleep, money and other material goods, sexual satisfaction, confidence in their future, the well-being of their children, and a sense of their worth [2].

What is characteristic is that almost all desires are satisfactory, all except one. Freud called it “the desire to be great”, and Dewey called it “the desire to be significant”. William James said: “The deepest property of human nature is the passionate desire of men to be appreciated”. Many psychologists believe that it is this feeling that determines the development of an individual personality [3].

Being faced with the problem of misunderstanding the behaviour of the people around us, one has to understand that at its core lies, above all, a different goal-setting. When building relationships with the people around us, we should remember that each of us pursues certain goals, which he is more or less clearly aware of [1].

Achieving a goal is associated with overcoming difficulties and obstacles. They are of two kinds: external and internal.

External obstacles are objective obstacles that do not depend on a person. Internal ones depend on the person himself, and, first of all, it is the unwillingness to do what is to be done.

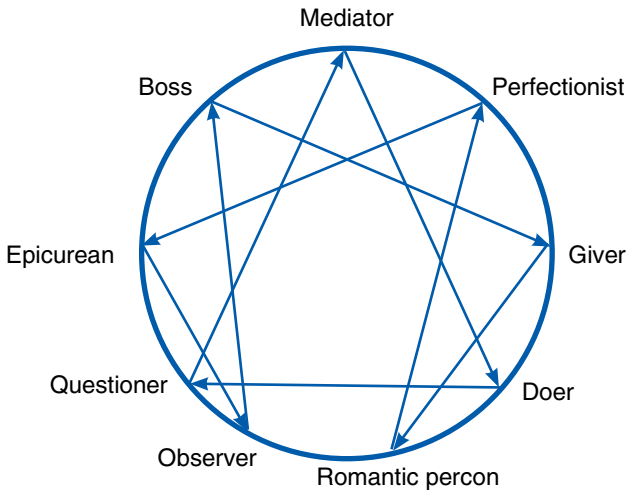
A person's ability to overcome obstacles and difficulties on the way to the goal, the ability to control his or her behaviour, to subordinate activity to certain tasks, is expressed in his or her will. According to psychologists, this ability determines the position and nature of human behaviour in the work process and teamwork [3].

Will (from Latin “voluntas”) is a mental process of conscious control over one's thoughts, feelings, desires, behaviour, activities, communication, expressed in the ability to overcome external and internal difficulties, to make decisions and stick to a certain course in purposeful actions. Will is one of the most important conditions of labour activity [3].

Consequently, we can make an assumption that volitional regulation is the highest level of regulation of human actions, needed to overcome external and internal difficulties, obstacles to achieve the goal.

As volitional qualities are mental properties, reflecting features of volitional regulation of a person and formed in the course of gaining life experience, then, being relatively stable properties (characteristics) of a person, they nevertheless can change and develop during life [3].

When building a project team, it is certainly important to pay attention to work experience and



Enneagram of personality types

skills, but it is also important to understand who works in your team and what kind of people are missing in it to successfully achieve project goals.

In an effort to classify and define the personality types we encounter in the work process, let's turn to the Enneagram below (the figure).

The Enneagram (from the Greek ennea, nine, and gramma, the outline) is a psychological model that describes the 9 underlying motives that drive us. Each of the 9 motives generates a very specific character with inherent thinking strategies, emotional and volitional reactions, as well as life attitudes [4–6].

The Enneagram model is a synthesis of ancient spiritual sources and modern psychoanalytic psychology. For a long time this knowledge remained unavailable and was passed down as part of the oral tradition. The Enneagram was first discovered to the Western world by the famous philosopher and mystic G.I. Gurdjieff. It is believed that he became acquainted with this knowledge in Central Asia [4–9].

The Enneagram of Personality, as we study it today, was developed in the 1970s by Bolivian Oscar Ichazo [4–6].

Starting from the 1970s of the 20th century, knowledge of the Enneagram began to spread rapidly, first in America and then around the world. This classification was adopted by the CIA, where it was used to evaluate the behaviour of foreign leaders.

The general rule of the Enneagram: When you are in a peaceful state of mind, you combine the features of the types that are indicated by the vectors coming from you; when you are distressed, you get the features of those people from whom the arrows point at you [4–9].

Let's consider the characteristics of personality types presented on the Enneagram [4–9].

1. The perfectionist strives for perfection, he is conscientious, diligent, a rational and strict critical thinker.
2. The giver is exalted, eager to be in the limelight, at times pushy, eager to impose his will on others.
3. The doer has a competitive spirit with high work efficiency, concerned about his image.
4. The romantic person has creative personality, prone to melancholy, drawn to the unattainable.
5. The observer is emotionally withdrawn, aloof from people, holding back feelings, turned inward, intelligent.
6. The questioner is eaten up by doubts, faithful, fearful, always fearful of signs of trouble to come.
7. The epicurean is sensual, cheerful, falling into childishness, unwilling to take responsibility.
8. The boss is a dictator, a fighter, a protector, taking responsibility, adoring a good fight.
9. The mediator is patient, constant, able to comfort, but sometimes running away from reality and finding oblivion in alcohol, gluttony, or television (spectacle).

The Enneagram describes nine personality types arranged on a circle at equal distances from each other. It symbolizes the equal contribution of each personality type to the creation of a holistic world. The types are connected not only by the circle, but also by the so-called "connections", a complex internal figure inscribed in the circle.

Unlike other typologies, the Enneagram is a dynamic model. Not only does it describe static personality traits, but it also reflects very precisely what happens to a person when he or she is stressed or comfortable. When we are in a familiar, calm environment, with people close enough to us, we behave differently than when we find ourselves in an unfamiliar tense or stressful situation. The Enneagram model describes these changes by means of connections.

Many authors of the Enneagram find it particularly valuable because it allows us to determine a person's current level of functioning, zone of closest development and destabilizing factors.

Using the knowledge of a team's personality types allows for the competent selection of the leadership style of that team as well. The most interesting model of leadership style for use in project team management is the Hersey-Blanchard situational leadership model, which appeared in 1960 and was called the "Hersey-Blanchard Lifecycle Theory".

As a criterion for selecting a style, it proposes the life cycle "maturity" of subordinates. The maturity of personnel is determined by their desire to achieve the set goal, the ability to be responsible for their own and collective actions, education and experience in solving problems of the appropriate type. In their theory, the authors distinguish four levels of maturity: low, moderately low, moderately high, and high. Depending on the maturity of the managed team, the manager should apply appropriate management styles [10–14].

The situational leadership model suggests four basic leadership styles.

S1. Directing

The directing leadership style is associated with authoritarian leadership.

When applying this style, the leader will make all decisions without consulting his subordinates. He will inform the team of his decision and expect the team to follow his instructions. The opinion of the team is not considered, the leader decides for himself who, what, how, why and where.

S2. Coaching

In a coaching style of management, the leader still defines functions and tasks. However, unlike the directing one, he is more receptive to the participation and opinions of his subordinates. Such leaders "sell" their ideas and plans to subordinates.

This management style is closely related to the democratic leadership style. Sports coaches are often associated with this style of leadership. They put players in positions and then train and coach the team to achieve the best results.

S3. Supporting

A supporting leader will be involved in creating ideas and making decisions, but most decisions will be made by the team.

This type of leadership may seem "quiet" because the leader is positioned as an equal member of the team, not a leader.

S4. Delegating

This style of leadership is based on non-interference and is similar to the liberal management style, where the group makes almost all decisions itself.

This type of leadership tends to be more focused on shaping the picture of the future than on day-to-day management. The leader works on strategy and vision, but the decision of how to achieve it is left to the subordinates.

According to the situational model of leadership, the choice of one of the four styles depends on the level of professionalism of your subordinates and their level of motivation.

The model defines four levels of employee development.

D1: Rookie Enthusiast (can't do it, but wants to)

Level of professionalism: low.

Level of motivation: high.

Your subordinate has low competence but high commitment. He is inexperienced but enthusiastic. In this case, your subordinate may show a desire to work, but he will lack the specific skills needed to complete the task. For example, a university graduate. Figuratively speaking, this is a "rookie enthusiast".

D2: A frustrated student (can't and won't)

Level of professionalism: slightly higher than low.

Motivation level: low.

Your subordinate has been on the team for some time and now has some competence, but the enthusiasm has faded and with it the motivation. This can happen if the newcomer was abandoned at the beginning and no one dealt with him. For example, the expectations of the work were not met, the ideas did not meet the response from the leader, and he stopped believing in the company.

D3: Capable, but cautious performer (can, but won't)

Level of professionalism: high.

Level of motivation: changeable.

Your subordinate is highly competent but volatile in motivation. Your subordinate has the ability to perform better and achieve more, but for some reason he is unwilling to do so. Perhaps he lacks confidence. For example, the employee needs to be made to understand that he is trusted; the employee needs to realize that he is allowed to be independent.

D4: An independent professional (wants to and can)

Level of professionalism: high.

Motivation level: high.

Management styles in the Hersey and Blanchard model

Subordinates	Management styles
Can't – don't want to	Directives and supervision
Can't – but want to	Support and mentoring
Can – but don't want to	Engagement and support
Can – want to	Delegation

Your subordinate is highly competent and motivated. Your subordinate is confident in his abilities to complete the task and willingly accepts responsibility for completing it.

According to the situational model, a manager should change his management style depending on the type of subordinate (the table) [10–14].

Each level of development of an employee in relation to the task corresponds to a different management style.

P1–S1: motivated but unprofessional — need directives.

For an employee at the P1 level ("Incapable, but willing") we set the task clearly and give instructions. The employee needs supervision.

P2–C2: Not motivated and non-professional — needs coaching.

A P2-level employee ("Incapable and not willing") needs both directives and support from the leader, so a coaching style (C2) is optimal. You coach the employee, increasing his professionalism.

P3–C3: Professional, but not motivated and, thus in need of support.

A P3 employee is capable of solving the task, but not motivated. He has enough knowledge and skills; the only problem is motivation and self-confidence. Accordingly, the leader chooses a supportive style (C3) so that the employee realizes that he is allowed to be independent — his ideas find the response and are converted into work successes.

P4–C4: Motivated and Professional — Need Delegation.

A motivated, skilled and capable P4 ("Capable and Willing") employee can lead and apply developmental leadership styles to less experienced employees.

When selecting an effective team management style, the main task of the manager is to competently assess the potential capabilities and needs of employees, their involvement and responsibility for the results of their work. Proper motivation of team members entails job satisfaction and ensures its effectiveness.

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Некоторые аспекты формирования команды проекта и выбор стиля руководства с учетом типов личности и уровня развития ее участников

Актуальной проблемой при реализации проектного подхода в управлении инвестиционно-строительными проектами является формирование команды проекта, выбор стиля руководства в зависимости от состава ее участников. Существует множество подходов к решению этого вопроса. Данная статья нацелена на рассмотрение такого аспекта при формировании команды проекта, как тип личности ее участников. Статья посвящена выявлению поведенческих мотивов при построении межличностного общения индивидов в рабочем процессе. В статье рассмотрены основные характеристики побудительных мотивов в поведении индивида, приведены волевые аспекты формирования личности. В основу классификации типов личности положена Эннеаграмма, дающая возможность классифицировать типы личности по их эмоционально-волевому и деловому складу, позволяющая грамотно проводить кадровую политику при формировании команды проекта. Также в статье рассматривается алгоритм выбора стиля управления командой проекта в зависимости от уровня развития ее участников. Поскольку при выборе эффективного стиля управления командой основной задачей руководителя является грамотная оценка потенциальных возможностей и потребностей работников, их вовлеченности и ответственности за результаты труда. Правильная мотивация участников команды влечет за собой удовлетворенность работой и обеспечивает ее эффективность.

Ключевые слова: *мотив, общение, воля, кадровая политика, типы личности, стиль руководства, тип личности*

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Об авторе: **Куракова Оксана Анатольевна** — кандидат экономических наук, доцент кафедры организации строительства и управления недвижимостью; **Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ)**; 129337, г. Москва, Ярославское шоссе, д. 26; РИНЦ ID: 549544; kurakovaoa@mgsu.ru.

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ДЛЯ ЗАМЕТОК