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Уважаемые читатели!

Целью управления недвижимостью является поддержание ее состояния в соответствии с проектными решениями и по возможности усовершенствование ее технических, экологических функций и стандартов. Затраты на управление в значительной степени определяются уже на момент нового строительства. Тогда выбирается тип каркаса здания, технические коммуникации, интерьеры, отделка и дизайн. С возросшей ответственностью застройщика долгосрочные вопросы экологической безопасности стали еще более важными. И тот, кто строит недвижимость, владеет или управляет ею, несет ответственность за экологические последствия построенного объекта.

Многие владельцы недвижимости разрабатывают долгосрочные планы обслуживания или региональные программы, основанные на анализе технологических потребностей и экономических возможностей. Управление недвижимостью может состоять из трех элементов: административного, экономического и практического.

Административное управление занимается вопросами найма, инспектирования, планирования персонала, эксплуатации и обслуживания, закупок и т.д. Экономическое управление имеет дело со сбором средств, управлением ими, арендной платой, платежами, составлением смет, ведением бухгалтерского учета и финансовой отчетности. В практическое управление входит обслуживание зданий и коммуникаций, текущий контроль, оперативное управление, уборка и др.

Организация процесса управления влияет на результат и работу по охране окружающей среды. Поэтому управляющие компании и владельцы недвижимости стали вводить сертификацию качества управления в отношении окружающей среды. Это означает, что предприятие принимает экологическую политику и определяет цели и задачи в области охраны окружающей среды с учетом выделения достаточного количества ресурсов для их достижения в течение установленного времени.

Этим и прочим проблемам экологической устойчивости посвящен настоящий номер журнала.

С уважением, главный редактор, **Пётр Грабовый**

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Kankhva V.S., Uvarova S.S., Belyaeva S.V.

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Kulakov K.Yu., Iziumov M.D.

One of the parameters which can be used to quantify the economic efficiency of corporate development projects is the total cost of ownership of real estate.

Krylova A.M.

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Bolotin S.A., Dadar A.H., Malsagov A.R.

The practical utility of the proposed method lies in the fact that the calculation of pessimistic durations of works is made dependent on the discount rate, which by its basic purpose is used to assess the economic efficiency of investment projects, and therefore is always a relevant parameter for any construction project under development.

Gvozdev E.V.

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Sternik S.G.
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Trends in the housing market and housing construction in Russian regions in 2022

This paper provides a qualitative and quantitative analysis of current development trends, along with a price analysis of the housing market and the housing construction market against the background of serious geopolitical changes in the socio-economic situation in Russia in 2022. In the course of the research, the author used the methodology of discrete spatial-parametric modelling of the real estate market. In addition to the study of market price indices, the article reviews the pace and structure of housing commissioning in the regions of the Russian Federation, assesses the specifics of the current situation in the housing construction sector, examines the impact of state support measures for the industry and identifies factors that have the most significant impact on the prospects for the development of the industry in 2023. Based on the author's research, the key features of the domestic residential real estate and housing construction markets in 2022 are stated. The relevance of this study is determined by the significant demand for the scientific method of analyzing existing risks and the impact of the uncertainty factor for the industry development forecast alongside with the assessment of the possibilities and scope of the state support measures.
Keywords: *housing market, price indices, housing construction market, mortgage lending, state support measures, preferential mortgage programmes*



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INTRODUCTION

Last year, the Russian real estate market was fully impacted by the shocks to the domestic economy and went through several stages.

The first months were characterized by continued price growth with a shortage of supply. The mechanism of state mortgage support stimulated demand, ensuring the prevalence of mortgage lending transactions in the total volume of transactions in Russian cities.

In early spring, a change in the socio-economic situation due to escalating geopolitical tensions caused panic in the housing market and resulted in a significant drop in transaction volume. The Central Bank's sharp increase in the key interest rate to 20 % led to a collapse in mortgage lending by banks. The rapid buying up of the "cheap" supply was done more by withdrawing cash from people's bank accounts.

After a certain stabilization of the key interest rate level in September 2022, it was back to its pre-crisis level. Demand for mortgages, following the decline in the key interest rate, was recovering at a slower pace and did not reach the level of winter 2022. Households began to incline towards a savings model of consumer behavior, refraining from investing in the purchase of real estate or financial assets. Investment transactions, which had been an important catalyst for the primary residential property market in 2020–2021, fell.

With a decrease in GDP by 2.1 % and real disposable incomes of the population by 1 %, the volume of housing construction increased. The industry started facing the problem of selling built housing. At the same time, the supply volume in the secondary market increased, resulting in satisfied demand in this segment by the autumn in most cities. The growth of bid prices slowed down, and in some places stopped, but prices crash happened. In general, in 2022 the housing market demonstrated volume of sales decrease by about a third and even the traditional demand increase on the New Year's eve was very downsized, indicating the onset of a stagnation.

THE MARKET PRICE INDICES

Preceding the analysis of the price situation, we point out that the dynamics of prices for housing real estate can be valuated both by the official reports of Rosstat and by the data of real estate agencies.

To begin with, let us look at the Rosstat data. As stated on the departmental portal [1], Rosstat experts calculate price indices in the primary and secondary housing markets based on the registered prices for newly built apartments and for existing privately owned housing stock if it is the subject of market transactions. Monitoring is performed on a selective range of companies performing real estate transactions in territorial centers and separate cities of the constituent subjects of the Russian Federation. The quantitative and qualitative characteristics of the apartments are considered for prices record. Average prices in Russia are based on the average prices prevailing in the regions. Cumulative data on the total area of apartments sold in one year with breakdown by the primary and secondary housing markets are used as weights.

Let us consider the Rosstat data for the past year in more detail, starting with the quarterly price dynamics for the country as a whole (Table 1).

Table 1. Housing market price indices in 2022 (at the quarter end, % against the previous quarter, all types of apartments)

Period	Secondary market	Primary market
I quarter	106.5	108.0
II quarter	102.0	106.5
III quarter	101.4	104.3
IV quarter	101.6	100.9

Source: housing market price indices by the constituent subjects of the Russian Federation in 2022, primary market data[1]; secondary market data[2].

Prices grew at the highest rate in the first quarter of 2022, when the market experienced the impact of a shock resulting from the drastic change in the economic and political situation. In the future, there was a quarterly slowdown in the growth rates of both market segments.

For most of the year, the primary market outpaced the secondary one in terms of price growth, most noticeably in the second quarter. A small exception was the final IV quarter, when growth in the primary market was less than 1 %, which did not dramatically affect the yearly results (Table 2).

The price increase in the primary segment turned out to be about 1.8 times more than in the secondary. Such a picture was observed for all categories of apartments, to the most extent — for standard apartments, while for elite housing the rates of price growth were comparable. For the secondary market, the main pattern was an increase in the rate of price growth with an increase in the quality of housing, whereas in the primary market there were moderate discrepancies in housing categories with premium quality apartments leading.

A detailed analysis of the dynamics in the territorial context at the level of the constituent subjects of the Russian Federation confirms the prevailing outperformance of the secondary market by the primary one in terms of price growth (Table 3).

In the primary housing market, the group of leading regions in terms of price growth (over 30 %) included the Leningrad, Chelyabinsk and Omsk regions, as well as Bashkortostan. Outsiders by

Table 2. Housing market price indices and average housing prices in 2022 by category (at the IV quarter end)[3]

Apartment category	Secondary market		Primary market	
	Percent against IV quarter 2021	Thousan. rubles/ sq. m total area	Percent against IV quarter 2021	Thousand rubles/sq. m total area
All types of apartments	111.8	94.4	121.0	122.3
Low quality	107.4	72.3	–	–
Average quality (standard)	110.4	86.8	120.0	122.9
Premium quality	113.3	102.9	122.1	112.4
Elite apartments	118.3	162.8	119.4	262.7

Table 3. Housing market price indices in 2022 broken down by region (at the end of the fourth quarter in % against the fourth quarter of 2021, for all types of apartments)

Federal district/region	Secondary market	Primary market
Russia	111.8	121.0
Central Federal District	111.1	120.8
Moscow	107.1	115.9
Moscow region	117.4	119.6
Voronezh region	127.6	125.8
Northwestern Federal District	103.4	120.9
St. Petersburg	95.7	120.6
Leningrad region	106.9	157.8
Southern Federal District	111.5	114.1
Krasnodar region	106.2	107.7
Volgograd region	114.6	126.2
Rostov region	116.1	129.9
North Caucasion	107.0	116.6
Dagestan	112.7	125.8
Stavropol region	121.1	116.2
Volga Federal District	118.0	127.6
Bashkortostan	115.9	134.3
Tatarstan	120.0	128.0
Perm region	111.4	124.8
Nizhny Novgorod region	114.3	129.6
Samara region	110.1	126.6
Ural Federal District	112.7	118.7
Sverdlovsk region	113.4	119.8
Tuymen region*	105.8	114.2
Chelyabinsk region	138.6	131.5
Sibirian Federal District	118.0	124.0
Krasnoyarsk region	113.5	115.7
Novosibirsk region	113.2	121.2
Omsk region	123.2	131.5
Far East Federal District	106.3	114.7
Primorsky region	106.5	113.2
Khabarovsk region	102.1	107.1

* — autonomous area included.

Source: housing market price indices broken down by the constituent subjects of the Russian Federation in 2022, primary market data[1]; secondary market data[2].

1 Price indices in the primary housing market by subjects of the Russian Federation in 2022. URL: torage/mediabank/ind_perv_4kv-2022.xlsx

2 Price indices in the secondary housing market by subjects of the Russian Federation in 2022. URL: torage/mediabank/ind_vtor_4kv-2022.xlsx

3 Socio-economic situation of Russia. 2022; 132. URL: https://gks.ru/bgd/regl/b22_01/Main.htm

this indicator (under 15 %) were the Tyumen Region, Primorsky, Krasnodar and Khabarovsk region. In St. Petersburg, Moscow and Moscow region, the price growth dynamics also turned out to be lower than the average for the country.

In the secondary segment, the group of leading regions in terms of price growth (over 20 %) included Chelyabinsk, Voronezh and Omsk regions, Stavropol region, Tatarstan. At the opposite pole were Moscow, Leningrad and Tyumen regions, Primorsky, Krasnodar and Khabarovsk region, as well as St. Petersburg, where prices fell by 4.3 %.

The price growth in the primary market in most regions exceeded that of the secondary market. It is noteworthy that the Leningrad Region, Dagestan, Bashkortostan, Perm region, Nizhny Novgorod, Samara, Tyumen Region (including autonomous areas), Primorsky region stand out in terms of price growth in the primary market outpaced the same value in the secondary market by more than twofold. In the Leningrad region, the gap is sevenfold. As an exception to the general trend of the primary market price growth rates leadership, the Stavropol Territory, Voronezh, and Chelyabinsk regions should be noted.

Now, to describe the price level in absolute terms, let us consider the data of professional market analysts from several well-known companies united by the Russian Guild of Realtors (RGR) (Table 4).

Table 4. Multi-apartment housing market prices broken down by the cities of Russia at the end of 2022[4]

Federal district/city	Secondary market	Primary market	Markets price gap, %
	Thousand rubles/sq. m	Thousand rubles/sq. m	
Central Federal District			
Moscow	266.6*	305.3	14.5 in favour of new buildings
Zhukovsky (MR)	130.0	120.0	8.3 in favour of secondary market
Voronezh**	100.0**	90.0**	11.1 in favour of secondary market
Ryazan	80.0	94.0	17.5 in favour of new buildings
Tambov	80.0	80.0	Approximate equality
Kostroma	72.0	81.0	12.5 in favour of new buildings
Northwestern Federal District			
St. Petersburg	172.0	214.0	24.4 in favour of new buildings
Kaliningrad	95.0	106.0	11.6 in favour of new buildings
Southern Federal District			
Novorossiysk	107.0	115.0	7.5 in favour of new buildings
Yalta (Crimea)	100.0	150.0	50.0 in favour of new buildings
Krasnodar	87.0	110.0	26.4 in favour of new buildings
Volgograd	80.0	80.0	Approximate equality
Volga Federal District			
Samara	140.0	120.0	16.7 in favour of secondary market
Nizhnyi Novgorod	103.0	130.0	26.2 in favour of new buildings
Perm	84.4	105.5	25.0 in favour of new buildings
Tolyatti (Samara region)	65.0	80.0	23.1 in favour of new buildings
Ural Federal District			
Tyumen***	110.0***	120.0***	9.1 in favour of new buildings
Ekaterinburg	102.0	120.0	17.6 in favour of new buildings
Chelyabinsk	75.0	90.0	20.0 in favour of new buildings
Magnitogorsk	55.3	60.5	9.1 in favour of new buildings
Chebarcul	46.0	56.0	21.7 in favour of new buildings

4 Analytical statement. Preliminary 2022 residential real estate market performance according to the experts from the Russian Guild of Realtors (RGR). 2022; 5, 11-13, 15. URL: https://cms.rgr.ru/files/images/8bcb13fe84fe11ed8547b4b52f561288.pdf (other companies and experts mentioned above, authors' calculations).

End of the Table 4

Federal district/city	Secondary market	Primary market	Markets price gap, %
	Thousand rubles/sq. m	Thousand rubles/sq. m	
Sibirian Federal District			
Novosibirsk	100.0	110.0	10.0 in favour of new buildings
Krasnoyarsk	95.0	109.0	14.7 in favour of new buildings
Tomsk	85.0	98.0	15.3 in favour of new buildings
Abakan	80.0	90.0	12.5 in favour of new buildings
Far East Federal District			
Yuzhno-Sakhalinsk	160.0	170.0	6.25 in favour of new buildings
Khabarovsk****	112.3	130.9	16.6 in favour of new buildings

* — according to the Committee on Statistics and Analytics of the Guild of Realtors of Moscow (GRM), the average bid price on the secondary market on 30.12.22 amounted to 264.8 thousand rubles;

** — according to the Analytical Consulting Group "InvestOcenka", the weighted average bid price of housing (apartments) in the city at the end of December amounted to 82.3 thousand rubles/sq. m in the secondary market and 89.9 thousand rubles/sq. m in the primary one;

*** — according to the certified real estate analyst-consultant A.A. Ryaposova in December, the average bid price was 106.1 thousand rubles/sq. m in the secondary market and 108.1 thousand rubles/sq. m in the primary one;

**** — according to LLC "Center of Property Rights" at the end of December.

According to the absolute price level in both markets, Moscow was followed by St. Petersburg and Yuzhno-Sakhalinsk, and outside the top three, in the price range from 100 thousand to 150 thousand rubles per sq. m there were notable differences. In the secondary segment, it was followed by Samara, the cities of the Moscow region, Tyumen, Novorossiysk, Nizhny Novgorod, Ekaterinburg. In the primary segment — Yalta, Nizhny Novgorod, Zhukovsky (Moscow region), Samara, Tyumen, Ekaterinburg, Novorossiysk, Krasnodar, Novosibirsk, Krasnoyarsk, Perm.

In the most cities, prices for new buildings were 10 to 20 % higher than those of the secondary market.

CONSTRUCTION AND COMMISSIONING OF NEW HOUSING

According to preliminary Rosstat data, 2022 witnessed a record 102.7 million sq. m of housing being commissioned in Russia, which became the highest absolute indicator in the entire period of statistical monitoring in Russia (Table 5).

A positive trend of commissioning was demonstrated by most of territories, including almost all regions, with a total volume of housing commissioning exceeding 1 million sq. m (Table 6), if we consider the dynamics of housing construction against the regional background.

As follows from Table 6, the increase in housing commissioning of more than 20 % took place in Chechnya, Moscow and Vladimir regions, Perm and Krasnodar region, Udmurtia. In the Tyumen, Leningrad and Novosibirsk regions, Primorsky and Stavropol region, this indicator ranged from 11 to 20 %, i.e., it exceeded or approximately corresponded to the average country's figures. Another

Table 5. Housing commissioning in the Russian regions in 1999–2022[5, 6, 7, 8]

Year	Million sq. m of total area	Growth rates, %	
		Against the previous year	Against 2000 year
1999	32.0	104.2	105.6
2009	59.9	93.4	197.7
2019	82.0/81.0*	108.3/107.0*	270.6/267.3*
2020	82.2/77.1*	100.2/95.2*	271.3/254.5*
2021	92.6	112.7	305.6
2022	102.7	111.0	338.9

* — excluding the commissioning of garden cottages, the number of which is provided according to the Rosstat initial data (2019 — 1.0 million sq. m, 2020 — 5.1 million sq. m, no data available for 2021–2022).

12 regions gained a positive momentum of housing commissioning, and only three of them, including Moscow, showed a reduction.

Against the previous year, there were noticeable changes within the traditional group of leading regions, due to reduced housing construction in Moscow and its real stagnation in St. Petersburg. The Moscow region has asserted its leadership in terms of the absolute volume of commissioning, and Moscow, due to a 13 % drop, closed the top three, having let the Krasnodar region go ahead. The top five leading regions also included the Leningrad Region and St. Petersburg, and for the first time the northern capital lagged the neighboring region[9].

General commissioning data combine both multi-apartment housing (MAH) built by professional developers, and the results of

5 Russian Statistical Yearbook. 2010: Statistical Collection. Moscow, Rosstat Publ., 2010; 477. URL: torage/mediabank/Ejegodnik_2021.pdf

6 Socio-economic situation of Russia. 2022; 43, 56–57, 58–59, 66, 94-95, 142-143, 283-286. URL: https://gks.ru/bgd/regl/b22_01/Main.htm

7 Russian Statistical Yearbook. 2021: Statistical Collection. Moscow, Rosstat, 2021; 418-419. URL: https://rosstat.gov.ru/storage/mediabank/Ejegodnik_2021.pdf

8 Socio-economic situation of Russia. 2022; 43, 56–57, 58–59, 66, 94-95, 142-143, 283-286. URL: https://gks.ru/bgd/regl/b22_01/Main.htm

9 Besides, more than 3 million sq. m yearly was commissioned in the Tyumen region (including autonomous areas), Tatarstan and Bashkortostan.

Table 6. Housing commissioning in the Russian regions in 2022 (in the order of the commissioning pace)[8]

Region	Hosing commissioning pace, % by 2021
Chechnya*	196.8
Moscow region*	153.9
Perm region*	150.9
Vladimir region	142.8
Udmurtia	139.8
Krasnodar region*	120.8
Tyumen region (with autonomous areas) *	119.3
Primorsky region	117.9
Leningrad region*	117.2
Novosibirsk region	111.9
Stabropol region*	110.9
Chelyabinsk region*	108.3
Nizhny Novgorod region *	107.0
Bashkortostan*	105.4
Samara region*	104.4
Irkutsk region	104.0
Krasnoyarsk region	103.8
Kaliningrad region	103.7
Voronezh region	103.1
Tatarstan*	102.7
Sverdlovsk region*	101.9
Rostov region*	100.7
St. Petersburg	100.3
Dagestan	97.5
Moscow	87.1
Saratov region	85.6

* — regions where commissioning of private housing exceeded 1 million sq. m.

individual housing construction (IHC), i.e. built by individuals independently on their land plots.

For the second year in a row, the percentage of individual housing built by the population at their own expenses or with the borrowed funds exceeded half of the total commissioning (55.7 %). Accordingly, the share of multi-apartment housing, which has been steadily declining since 2016, amounted to 44.3 % (Table 7).

According to Rosstat, the area of residential housing facilities commissioned in Russia by the end of 2022 amounted to

Table 7. The breakdown of commissioned residential buildings in the Russian Federation in 2010–2022[6]

Year	Total, million sq. m	Multi-apartment housing construction		Individual housing construction at the expense of owner's cash / borrowed funds	
		million sq. m	Share in total commissioning, %	million sq. m	Share in total commissioning, %
2010	58.4	32.9	56.3	25.5	43.7
2015	85.3	50.1	58.7	35.2	41.3
2020	82.2	42.4	51.6	39.8	48.4
2021	92.6	43.5	47.0	49.1	53.0

57.2 million sq. m, which is 16.5 % increase against the previous year. The five leading regions in terms of the absolute value of housing commissioning included the Moscow region (about 9.5 million sq. m), the Krasnodar region (about 4.5 million sq. m), the Leningrad Region (about 2.6 million sq. m), Tatarstan (2.2 million sq. m) and Bashkortostan (1.9 million sq. m).

A comprehensive study of all regions with a total volume of housing commissioning exceeding 1 million sq. m is a very motley picture. IHC accounted for over 90 % of the commissioning volumes in Chechnya, over 70 % — in Tatarstan, from 60 to 70 % — in Moscow, Irkutsk, Leningrad, Nizhny Novgorod, Samara and Vladimir regions, Udmurtia, Bashkortostan, Stavropol and Perm region, from 50 to 60 % — in Krasnodar region, Chelyabinsk, Saratov and Rostov regions, Dagestan.

Moscow and St. Petersburg were expected to be at the other pole, where the contribution of IHC was 11.7 and 7.5 %, respectively[10]. The Primorsky region, Voronezh, Kaliningrad and Sverdlovsk regions held an intermediate position, with IHC accounting for 40–50 % of the commissioning volumes, as well as the Krasnoyarsk region, Tyumen Region (with autonomous area) and Novosibirsk Region, where the contribution of the IHC amounted to 37–39 %.

The volume of MAH commissioned by developers in 2022 increased by 4.6 % compared to 2021, surpassing the pre-pandemic levels of 2018–2019, but still falling short of the indices of the previous four years. More than half (57 %) of the housing construction volume (excluding that built by the population)[11] was accounted for by 10 regions (each with a construction volume of at least 1 million sq. m), and the share of the top five regions (Moscow and Moscow region, St. Petersburg, Krasnodar region, and Tyumen region with autonomous areas) amounted to about 42 % of the total volume of multi-apartment housing construction[8].

10 For comparison: in another city of federal significance, Sevastopol, the share of housing commissioned by the population amounted to 76.3 % with a total volume of about 0.56 million sq. m.

11 In the official Rosstat reports such an indicator is not available, but it can be calculated as the difference between the total volume of housing commissioning and housing commissioning by the population at the expense of own and borrowed funds.

ANALYSIS OF THE CURRENT SITUATION IN THE CONSTRUCTION INDUSTRY

According to a survey conducted by the ERZ.RF portal[12] in collaboration with the School of Developers[13], GMK[14] и RRG[15], the key trend of the past year identified by developers was the beginning of developers expanding beyond local markets. The top five trends also included the emergence of developers of multi-apartment buildings in the segment of IHC, an increase in the share of online sales, a growing importance of developer's reputation, and a reduction in the size of apartments [2].

According to experts from the Russian Guild of Realtors (RGR), there has been an active review of residential projects in terms of their quality class. The volume of projects in the "standard" class has increased, including the subclass of small-sized housing, while the share of small-format housing has increased in higher quality class projects[4].

Speaking about the mechanism of financing the housing industry, it can be noted that the transition to a new system using project financing tools has been completed overall. As of the beginning of 2023, almost 89 % of the constructed multi-apartment housing was built using escrow accounts, compared to 51.5 and 76.8 % at the end of 2020 and 2021, respectively. This is confirmed by a stable increase in the volume of loans provided using corresponding tools. The amount of approved credit lines increased by 84 % to 12.1 trillion rubles. A negative factor is the lag in filling escrow accounts (an increase of one-third to 4.1 trillion rubles at the beginning of 2023) from the dynamics of bank lending to developers[16].

The following indices characterize the real construction activity in the housing sector and the industry's prospects.

Against a favorable background, the fading quarterly dynamics of housing construction volumes is a negative factor by the end of 2022. If in the first and second quarters they exceeded the amount for the same period in 2021 by almost 65 and 25 % respectively, then in the fourth quarter there was already a decrease of more than 21 %.

According to the Unified Information System of Housing Construction (UISHC), the total area of housing under construction, considering all financing mechanisms, amounted to 100.8 million sq. m as of December 22, 2022. The majority of this is accounted for by housing being built in accordance with Law No. 214-FZ and exceeds the value of this indicator from the previous year by more than one fifth[4].

As of the beginning of 2023, 98.7 million square meters of multi-apartment housing were under construction, the volume of which, accounting for about 92 % of the value at the beginning of 2020, increased by 2.4 % over the year. At the same time, the volume of unsold housing is growing: by the beginning of 2023, it exceeded two-thirds of the total volume of housing under construction throughout the country. This is the highest indicator in recent years, exceeding the minimum at the end of 2020 by 41.5 %. The growth in unsold housing in new buildings over the year exceeded 16 %, compared to 21.6 % in 2021. Another more than 27 million sq. m of housing under construction are accounted for by projects whose sales have not yet opened (no equity participation agreements (EPAs) signed)[17].

According to the research conducted by VCIOM "Administrative Barriers in Construction: Survey of Moscow Developers" [3], the most important factors limiting the growth of current construction volumes were identified:

- high cost of materials, structures, and products (84 %);
- difficulties in obtaining permits and approvals (78 %);
- constant changes i.rules and legislation (71 %);
- shortage of skilled workers (62 %);
- crisis phenomena due to the pandemic (58 %);
- increase in production costs (51 %).

Due to the shortage of approximately 1/4 of the necessary workers in the industry, the production of several key construction products has decreased by the end of the year.

The excavators, glass, and elevators became the leaders of the fall. Production of ceramic tiles, ceramic sanitary ware, silicate wall blocks, roll roofing, waterproofing, and other materials decreased by up to 15 %. However, production of cement, bricks, and concrete increased. Despite the ambiguous situation with production, prices for construction materials increased for the vast majority of items[8]. The decrease in production coupled with rising prices has a negative impact on the profitability of development for various classes of housing.

Sanction restrictions also seriously affect the development of the construction industry. According to a survey by Sberbank [4] among bank clients, up to 70 % of respondents believe that changes in logistics supply chains for imported materials and equipment can increase the implementation time of current projects by up to six months and raise their cost. At the same time, it is noted that the greatest risks are associated not so much with construction materials for typical housing, but with more high-tech equipment and solutions (for example, BIM technology, elevator equipment, spare parts for certain types of equipment, electrical equipment, electrical panels, ventilation systems) demanded in the elite housing sector, where the share of such costs can exceed 50 % of the cost. Since import substitution of the most technologically complex solutions can be a fairly lengthy process requiring not only additional investments but also competencies that take a long time to form, it is expected that this factor will have a negative impact on construction timelines and costs, primarily in the elite segment.

Another trend of the last year was the departure of some foreign players from the multi-apartment housing construction market, which in the future may be offset by a more active expansion of development companies from China.

MORTGAGE LENDING DYNAMICS AND STATE SUPPORT MEASURES

To overcome the difficulties that arose, the state implemented programmers to support the construction industry. The main role in this was played by the extension of various preferential mortgage

12 The main trends in development in 2022. With the participation of GMK, Developer's School and RRG. URL: https://profi.erzrf.ru/poll/trands-2022-development/

13 A specialized center of competence and educational platform for developers and building contractors in Russia and the CIS.

14 The consulting agency GMK is among the top 100 largest consulting groups and companies in Russia, and holds the first place in the marketing and PR segment (according to RAEX rating).

15 The company RRG is a major professional player in the commercial real estate market since 2005.

16 Review of multi-apartment housing construction in the Russian Federation. 2022. DOM.RF. March 2023; 2-5, 6. URL: https://дом.рф/upload/iblock/8a2/hboqccub5re4hmoac9c9s3206flp5pq1.pdf (authors' calculations).

17 Mortgage lending market Overview in 2022. DOM.RF. February 2023; 3-5. URL: https://дом.рф/upload/iblock/1bb/7 l6iiiu5p6 t82cjbu2hywdk85aid7q0k.pdf (authors' calculations).

programmers, which make up an increasing share of financing when purchasing housing. Events related to sanction shocks and the geopolitical situation served as a catalyst for the growth of the share of preferential mortgages in the financing structure and, as a result, the role of government support in developing the housing market financing system.

The past year began with an active growth of the mortgage portfolio. So, according to DOM.Russia[17] in the first quarter of 2022, a total of 393 thousand mortgage loans were issued for a total amount of 1.325 trillion rubles against 418 thousand loans for 1.164 trillion rubles in the first quarter of 2021, which meant an increase in the amount of issuance by almost 14 %.

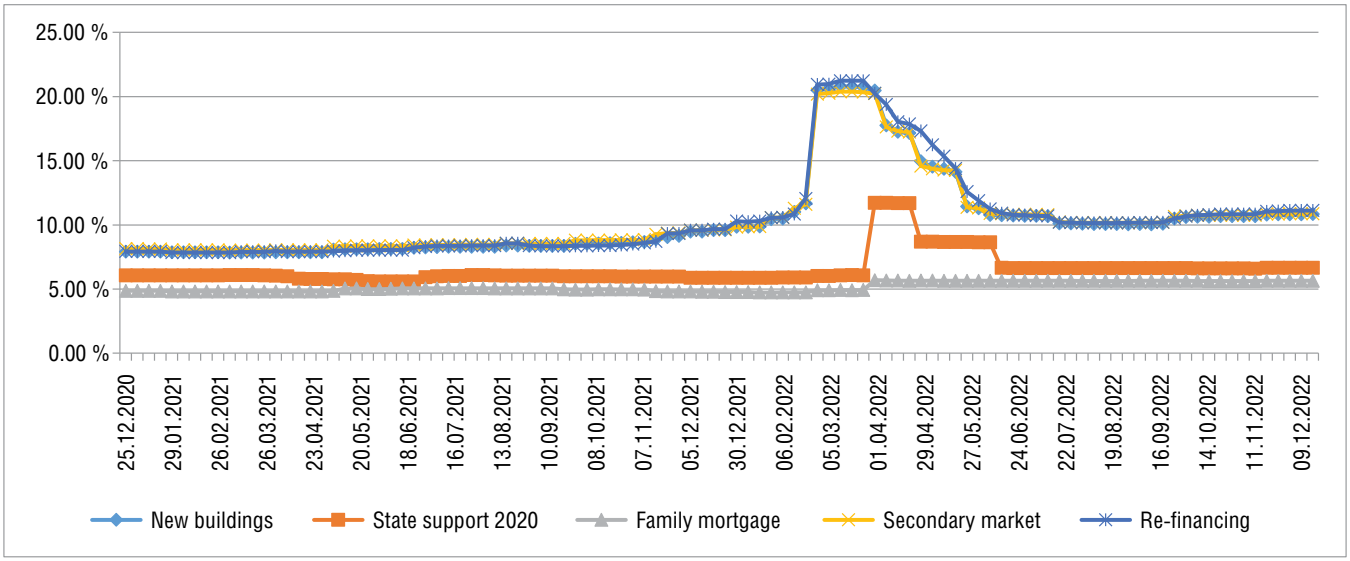
However, in the second quarter, active growth was replaced by a sharp decline due to overall uncertainty and a sharp rise in the key rate, which naturally led to a sharp increase in the weighted average rates for various categories of mortgage loans (Fig.).

Gradual normalization of the key rate and extension of preferential financing programmes allowed for stabilization, and by the end of the third quarter of 2022, the amount of preferential financing almost equaled that of the same period in 2021, reaching 1.317 trillion rubles, although the number of loans decreased by almost 25 %.

Overall, after record levels in 2021, there was an obvious decline in mortgage lending. According to reports from DOM.RF and the Central Bank of Russia, mortgage lending in 2022 decreased by more than 30 % in terms of the number of loans and more than 15 % in terms of volume (Table 8).

In fact, the IHC was thrown 2–3 years back, since the number of loans issued turned out to be comparable to the pre-pandemic 2019 (1,312 thousand units), and their volume was only 8 % higher than in 2020 (4.45 trillion rubles). However, the cardinal difference from 2019 is that then the role of preferential programmes was hardly noticeable (3–4 % in terms of the number of issues and their volume), in 2020 they have already had a significant impact on the housing market, but not to the same extent as two years later.

The main shift in the IHC structure was the increase in the share of primary market loans secured by equity participation agreements (EPAs). In terms of amount, this category of loans approached new loans on the secondary market (about 44 %). However, despite a decrease in its share in the total amount of loans issued by almost 7 percentage points, this category maintained a position close to the previous one in terms of the share in their number (55 %). In terms of absolute values, new lending on the secondary market lagged behind the 2021 figures, i.e., it



Dynamics of the weighted average rate for the main types of mortgage loans of the top 20 largest banks in 2020–2022[18]

Table 8. Mortgage lending 2021–2022 (Rural mortgage excluded)[17]

Loan category	Loans				Total amount			
	Thousand items		%		Billion rubles		%	
	2021	2022	2021	2022	2021	2022	2021	2021
Mortgage loans, total	1,909	1,327	100	100	5,700	4,813	100	100
Secondary market (new loans)	1,075	730	56.3	55.0	2,904	2,126	50.95	44.2
Primary market (secured by equity participation agreement (EPA))	476	410	24.9	30.9	1,881	2,063	33.0	42.85
Secondary market (refinancing)	211	28	11.1	2.1	506	85	8.9	1.75
IHC and built houses*	147	160	7.7	12.05	408	539	7.15	11.2

* — top-30 banks'data.

18 Dynamics of supply rates of the top 20 mortgage banks. URL: https://www.xn--d1aqf.xn--p1ai/analytics/mortgage/

Table 9. Dynamics and breakdown of sales in new buildings in 2020–2022 (by the number of EPA registered for residential premises)[16]

Transaction type	2020		2021		2022	
	Thousand items	%	Thousand items	%	Thousand items	%
Total EPA	609	100.0	676	100.0	544	100.0
Mortgage transactions, total	484	79.5	476	70.4	410	75.4
preferential mortgage programme	355	58.3	383	56.65	360	66.2
market mortgage programme	129	21.2	93	13.75	50	9.2
Without mortgage	125	20.5	200	29.6	134	24.6

declined more deeply than residential real estate as a whole, especially in terms of amount.

The record holder in this regard was refinancing on the secondary market, the scale of which decreased by 7.5 times in terms of quantity and almost 6 times in terms of amount to a symbolic 2.1 and 1.8 % respectively, and their place was taken by loans for individual housing construction and ready-made houses. They became the only category that demonstrated growth in both the number of loans and their amount by the end of 2022. The share of loans for individual housing construction and ready-made houses reached 11–12 % compared to just over 7 % in 2021.

Overall, mortgage debt increased by 2 trillion rubles over the year, and as of the beginning of 2023, its size exceeded 14 trillion rubles (including acquired credit organization rights, excluding securitization). At the same time, mortgages accounted for 86 % of the growth in all retail loans, and their share exceeded half of the total debt of individuals for the first time. The share of overdue debt in the mortgage portfolio on banks' balance sheets at the beginning of 2023 decreased to 0.4 % compared to 0.5 % a year earlier.

The level of mortgage interest rates over the past year has fluctuated under the influence of macroeconomic dynamics and the degree of prevalence of preferential programmes. Due to them and a mortgage with a subsidy from the developer, the weighted average rates in the primary market fell to 4.3 % per annum against 5.9 % in 2021, while in the secondary market, on the contrary, increased by 1 percentage point to 9.3 %. As a result, the weighted average mortgage rate in 2022 (7.2 %) was still lower than in 2021 (7.5 %)[17].

The increase in the gap between the interest rates on the primary and secondary markets by 2 times to 5.0 percentage points has made the primary segment more attractive and shifted demand towards new buildings. If in 2021, 1/4 of all mortgage loans issued were for residential properties registered under EPAs, then in 2022, it will be almost 31 %. The total number of signed EPAs has decreased by 19.5 %, but the significance of mortgages in the sales structure of new buildings has increased (Table 9).

More than 3/4 of all concluded EPAs in 2022 were for such transactions (70.4 % in 2021 and 79.5 % in 2020). Their absolute number decreased by almost 14 % compared to 2021, including a decrease of more than 46 % under market conditions. The share of market mortgages was minimal (9.2 %), decreasing by one and a half times compared to 2021 and more than twice compared to 2020. The decreasing number of market mortgage transactions year-on-year accounted for less than 40 % of the level recorded at that time. The share of EPAs without mortgages (24.6 %) was lower than in 2021 (29.6 %), but higher than in 2020 (20.5 %).

However, the issuance of mortgages under preferential programmes decreased by only 6 %, approximately to the level of 2020. As a result, the share of preferential mortgages was the highest in 3 years (2/3). The total volume of mortgages with state support remained high: about 485 thousand loans for a total amount of more than 2.2 trillion rubles (Table 10).

The share of preferential mortgages reached its highest levels: more than 36 % of the total number of issued mortgages and more than 46 % in terms of volume. Among others, the programme for issuing loans for new buildings at rates ranging from 7–12 % dominated (57.3 % of all preferential lending). The Family Mortgage programme accounted for 35.5 %, while the Far East Mortgage programme was rather complementary (about 5 %). Overall, the volume of preferential lending increased by almost 41 %: the largest growth was demonstrated by the Family Mortgage programme (by 72 %), while the preferential mortgage programme showed the smallest growth (by 21 %).

In contrast to the volume of lending, the total number of loans decreased slightly due to a reduction in issuance by more than 16 % under the preferential mortgage programme, against the background

Table 10. Preferential mortgage lending 2021–2022 (excludind rural mortgages)[17]

Loan category and programme	Loans				Total amount			
	Thousand items		%		Billion rubles		%	
	2021	2022	2021	2022	2021	2022	2021	2021
Mortgage loans, total	1,909	1,327	100	100	5,700	4,813	100	100
Preferential mortgage new buildings	340	285	17.8	21.5	1,054	1,276	18.5	26.5
Family mortgage	134	169	7.0	12.7	460	792	8.1	16.5
Far East mortgage	17	24.4	0.9	1.8	70.0	110.0	1.2	2.3
IT mortgage	–	6.0	–	0.5	–	52.0	–	1.1
Preferential loans (total for 4 programmes)	491	484.4	25.7/24*	36.5	1,584.0	2,230	27.8/27*	46.3

* — according to the DOM.RF 2023 review, excluding the supplementary agreements to existing loans under the family mortgage.

of a 26 % increase in Family mortgages and 43.5 % — under the Far East Mortgage programme.

The significant increase in the issuance of family mortgages can be attributed to the expansion of the programme in mid-2021 to families with one child born after 2018, while maintaining a stable interest rate throughout the year. As for other government-supported programmes, it is worth noting the increase in the subsidized loan amount for preferential mortgages up to 12 million rubles in the capital regions and up to 6 million rubles in other regions when the programme is extended to self-construction of private houses (by household method). The Far East Mortgage programme was extended to teachers and doctors, as well a.rural settlements with an extension until the end of 2030.

By Resolution of the Government of the Russian Federation dated December 28, 2022, No. 2485, the preferential mortgage was extended until July 1, 2024, at a rate of up to 8 %, and the same programme with a similar time horizon for family mortgages was extended to families with two children under 18 years old.

The Rural mortgage programme with a preferential loan rate of 3 % has been extended indefinitely. It applies to all settlements with a population of no more than 30,000 people, except for urban districts and municipalities in Moscow, St. Petersburg, and the Moscow region. During the programme's operation since 2020, more than 97,000 loans were issued for a total amount of 187.1 billion rubles, which is comparable to the total volume of issuance under the Far East Mortgage programme for 2021–2022.

An important innovation in the package of preferential programmes introduced last year was the mortgage for IT specialists introduced by Resolution of the Government of the Russian Federation dated April 30, 2022, No. 805. This programme, valid until the end of 2024, is designed to mitigate the consequences of their outflow from the country and contribute to solving the industry's personnel problems.

The programme has not yet become a significant segment in terms of the total mortgage portfolio, but it is promising for further growth, especially after the easing of requirements in the new version of the Government Resolution dated January 23, 2023, No. 72, which approved the expansion of the age range of potential borrowers up to 50 years old and the list of organizations where IT specialists work against the backdrop of a decrease in the salary threshold for potential borrowers.

2023 OUTLOOK

In the current economic situation, the spectrum of risks for construction and sale of housing has significantly expanded, which can be classified as follows:

- sanction-related risks (reduced transparency, which in turn makes it difficult for third-party and conditionally independent evaluation and expertise of business, for example, during IPO and placement of bonds of major developers);
- technological risks (related to critical technologies/products in case the company is heavily dependent on their continuous supply, for example, the need to replace OTIS elevators with domestically produced ones);
- risks of Russian jurisdiction (arising from the very fact of doing business in a “toxic” country for the Western world, making it likely to be deprived of access to settlement services, insurance, etc. regardless of sanctions);
- security risks (hacker attacks, data leaks, associated with additional regulatory burden, for example, Rosreestr ban on obtaining extracts with the indication of the owner by third parties, including realtors and banks);
- market risks (reduction in demand for rental and purchase of housing as a result of the departure of some foreign businesses from Russia).

The presence of the above risks and the influence of the uncertainty factor actually reduce the forecasting of industry prospects to assessing the opportunities and scale of support measures from the state [5–8].

In the absence of new geopolitical shocks in 2023, it is expected that the industry will be supported sufficiently to provide adequate housing supply. The expansion of developers beyond their “own” regions will become widespread. After the regulatory implementation of building information modeling and construction monitoring technologies in the development process, a leap in digitalization is possible. Therefore, it is not excluded that another record for annual housing supply will be set due to extensive development in new regions and increasing contribution of individual housing.

At the same time, from the side of solvent demand, stagnation is more likely to be expected even with maintaining mortgage lending at last year's level and a high share of preferential programmes. The most significant countercyclical support to the market will be the extension of preferential mortgages and, especially, the expansion of family mortgages by extending it to families with two children under 18 years old. Thus, a sharp recovery in demand for apartments is not expected, which will lead to a decrease in sales rates at stagnant prices with subsequent reduction in the average price level of the market in all segments of multi-apartment housing, including elite.

In addition, the overall trend in the housing construction industry will be the formation of various economic models and financial mechanisms of public-private partnerships (PPP) at all levels of public authority in implementing comprehensive territorial development programmes.

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Тенденции развития жилищного рынка и жилищного строительства в регионах России в 2022 году

В работе проведены качественный и количественный анализ актуальных тенденций развития наряду с ценовым анализом жилищного рынка и рынка жилищного строительства на фоне серьезных геополитических изменений социально-экономической ситуации в России в 2022 г. В ходе исследования автор использовал методологию дискретного пространственно-параметрического моделирования рынка недвижимости. Помимо исследования ценовых показателей рынка в статье рассмотрены динамика и структура ввода жилья в регионах РФ, дана оценка специфики текущей ситуации в секторе жилищного строительства, изучено влияние мер государственной поддержки отрасли и выявлены факторы, оказывающие наибольшее влияние на перспективы развития отрасли в 2023 г. На основании проведенных авторских исследований сформулированы основные особенности отечественных рынков жилой недвижимости и жилищного строительства в 2022 г. Актуальность данной работы предопределяется значительной востребованностью научного метода анализа существующих рисков и влияния фактора неопределенности для прогнозирования перспектив развития отрасли и оценки возможностей и масштабов мер поддержки со стороны государства.

Ключевые слова: *жилищный рынок, индекс цен, рынок жилищного строительства, ипотечное кредитование, меры государственной поддержки, льготные программы ипотеки*

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Contract structures for environmentally sustainable development of enterprises in the investment and construction sector

Striving to create a business environment that forms socially responsible business functioning is especially important in the spheres of activity related to satisfaction of basic needs in housing, work, medicine, recreation, etc. Investment and construction activities carried out by various contractors are characterized by a high level of economic, social and environmental risks. Their neutralization in the format of practical implementation of ESG principles for the implementation of real estate creation and management projects is primarily related to the initial phases of the project and taking into account socio-environmental requirements in contracts for the performance of works, supplies, financing, equity participation, provision of services, etc. Contracts that take into account the requirements of sustainable development in practice form a family of "sustainable contracts". They are distinguished by the unity of economic, social and environmental requirements. The latter reflect the norms of national regulation and are aimed at creating a legal environment of corporate responsibility of the construction business for sustainable development. Based on international practice, the authors proposed the structure of the Concept of a "sustainable contract" in construction. It covered both the system of sustainable development standards and the need to develop and harmonize the Code of Sustainable Corporate Governance in Construction. The organization of activities in this direction is seen in the interconnected joint aspiration of sectoral and territorial governing bodies, corporate and public organizations, scientific and educational institutions to standardize investment and construction activities, develop standard "sustainable contracts", use out-of-court dispute resolution methods in terms of fulfilling obligations to implement ESG principles, as well as the adoption of sectorial code of corporate construction management.
Keywords: *sustainable development, sustainable development standards, investment and construction business, corporate governance code, organizational activity tracks, coordination center*



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INTRODUCTION

The semantic colonization of the future is fundamentally based on mandatory compliance with environmental requirements of sustainable development. The concept of sustainable development is creating not only new international relations, but also new business models, prompting a rethink of the goals and objectives of development institutions. The declared ESG principles are reshaping many types of activities, including the design, construction and operation of real estate. The international practice of using reduced credit rates or subsidizing them, methods of guaranteed sales and promotion of products of environmentally oriented manufacturers are currently being actively analyzed and developed by enterprises of the investment and construction sector. In this regard, there are many tasks at the sectoral level of regulation, both in terms of the norms recommended by the Ministry of Construction of the Russian Federation, and in the contractual format of interaction between members of public associations (NOSTROI, NOTIM, etc.). At the same time, the analysis of practice shows that the participation of economic entities of the industry pool remains beyond the active discussion of the implementation of the principles of sustainable development in the investment and construction sector. This requires a detailed analysis and search for mechanisms for implementing ESG principles for investment and construction activities.

MATERIALS AND METHODS

The evolution of the idea of sustainable development, declared and researched initially by business at the beginning of the XVIII century[1], was fully developed in the late 80's and early 90's of the last century. The report "Our Common Future", prepared by the UN World Commission on Environment and Development, fixed certain limitations in the exploitation of natural resources, affirming the need to support the ability of the biosphere to cope with the consequences of human activity. Already in 2005, the sustainable development agenda was formulated until 2030. The transformation plan included 17 goals and 169 tasks[2, 3]. In the field of specific economic activity, the basic principles of sustainable development are modified into the principles of sustainable innovative and environmentally safe activities[4]. Back in 2004, UN Secretary-General Kofi Annan formulated the ESG

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3 Who Cares Wins: connecting financial markets to a changing world. URL: https://www.unepfi.org/fileadmin/events/2004/stocks/who_cares_wins_global_compact_2004.pdf

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Main types of regulatory documents and initiatives in the world and in the Russian Federation

Supranational regulation	National regulation
1. UN Sustainable Development Goals until 2030 2. G20 Corporate Governance Principles 3. OECD Guidelines (for multinational enterprises) 4. Directive 2014/95/EU on non-financial reporting 5. Roadmap for the development of a set of standards, etc. 6. Voluntary disclosure initiatives	1. National codes of sustainable development management 2. National Corporate Governance Codes 3. Orders of the Government of the Russian Federation dated 14.07.2021 (defined the goals and main directions of sustainable development, including green, in the Russian Federation)[5] 4. Decree of the Government of the Russian Federation No. 1587 of 21.09.2021 "On approval of criteria for sustainable development projects"[6] 5. IRIIS and CLEVER Assessment Systems

Developed by the authors on the basis of

principles of business in his report "Caring Wins". He addressed them mainly to large companies, calling for voluntary compliance with environmental requirements (E), social responsibility (S), corporate governance (G), that is, compliance with ESG principles of sustainable development. Industry ESG standards were rapidly formed on their basis. Table shows the main types of regulatory documents and initiatives in the world and in the Russian Federation.

As noted in[7], there are already more than 400 different indexes that disclose the requirements of the ESG principles[8]. At the same time, their composition varies, forming the basis of *decentralized information control*. The latter can significantly affect both stock and bond quotes, as well as the investment attractiveness of a particular company, region and country as a whole.

Responsible business conduct is increasingly becoming the norm even in the absence of unified approaches and unifor. rules. We are certainly talking about large companies with more than 500 employees. They are of the greatest interest to society. Currently, large companies include environmental indicators, social indicators and employment dynamics indicators in the annual report in accordance with the EU Directive 2014/95/EU. The framework approach to the report is set out in the White Paper[9].

Analyzing the actively emerging approaches to modelling the environmentally sustainable development of territories, we note that they are inextricably linked with the development of the concept of a "sustainable contract". The latter mediates relations between government and business, as well as business entities among themselves. The problem is structured in the following main aspects:

1) adjustment of the pre-contractual stages of agreeing on the terms of interaction of the parties;

2) formation and evaluation of value-added chains;

3) conditions for disclosure of non-financial information;

4) the study of the increasing risks of activity in the context of the emergence of new environmental requirements;

5) methods of out-of-court dispute resolution and search for consensus on the ESG agenda.

The presented aspects are updated in practice, based on the need for risk management to ensure sustainable development, taking into account environmental requirements. Thus, one of the most common trends of our time has become the commitment of companies to minimize their carbon footprint. Despite the difficulties of implementing the hydrocarbon agenda, switching to renewable energy sources, reducing greenhouse gas emissions are increasingly becoming publicly verifiable commitments. The global practice of extending ESG-principles compliance assessments to all participants in supply chains, and in the investment and construction sector to contractors and subcontractors, implies the company's desire to expand the range of business entities whose activities should be examined for compliance with the requirements of sustainable development. At the same time, the control of the reliability of ESG reporting is not only strengthened, but also practices of influencing the investment, financial, and transactional policies of companies, as well as their communication formats, are being formed. An analysis of international practice shows that the ESG principles apply to investment contracts, loan agreements, joint venture agreements, mergers and acquisitions [1, 2]. The use of ESG conditions/clauses in contracts is essentially becoming an actual method of managing the risks of sustainable development. Therefore, it requires the development of the concept of a "sustainable contract".

RESULTS

It is obvious that the concept of a "sustainable contract" should reflect the essence of the concept of sustainable development and fix its goals and norms in the concluded contracts, step by step and consistently forming the legal environment for the functioning of a socially responsible business. Synthesizing the most common views in international practice on the essence of a "sustainable contract"[10], its concept implements the principle of trinity in the evaluation of business activities.These are compliance with social criteria, compliance with environmental requirements and economic efficiency of activities (Fig.).

The practical implementation of the principle of the trinity of economic, social and environmental projection of investment and construction activities involves:

1) development of judicial and non–judicial practice of resolving economic disputes in the direction of providing judges, arbitrators, mediators, consultants and experts with the possibility of accurate qualification of the contract in the context of compliance with ESG principles;

5 Decree of the Government of the Russian Federation dated 07/14/2021 No. 1912-r "On approval of the goals and main directions of sustainable (including green) development of the Russian Federation". URL: https://cloud.consultant.ru/cloud/cgi/online.cgi?req=doc&base=LAW &n=390943#4U1ZtZTvJhflgkLA

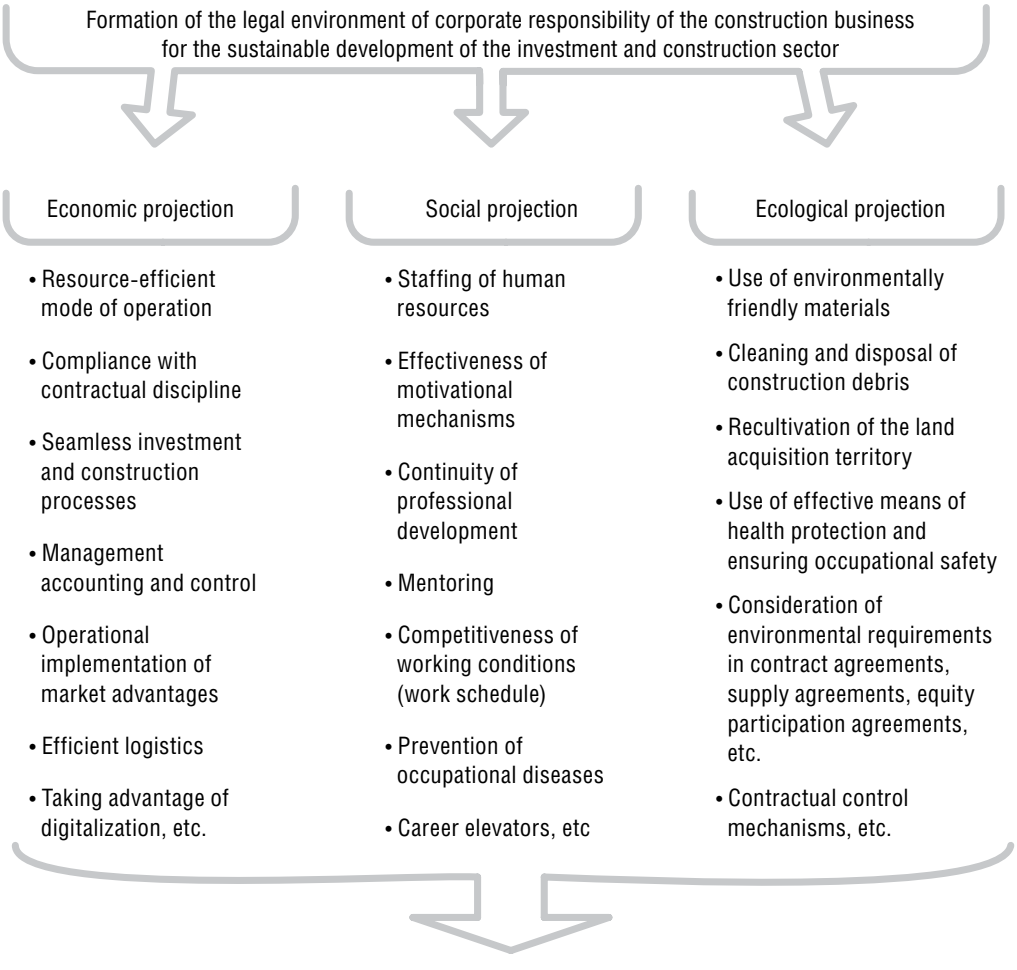
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The concept of a "sustainable contract" in construction

2) formation of standards of social and environmental responsibility of the construction business at all stages of its functioning, taking into account the subject binding to the activities of construction contractors (designers, contractors, suppliers, creditors, shareholders, etc.);

3) development of standard contracts in order to ensure mutual compliance of economic, social and environmental consequences of investment and construction activities [3].

The implementation of these directions will require, from the point of view of the authors, the unification of disparate norms and indicators of sustainable development. This means that a "sustainable contract" becomes a kind of tool for evaluating the effectiveness and compliance of investment and construction activities with ESG principles.

Summarizing international experience of the unification of contractual conditions in terms of compliance with the requirements of sustainable development, we note the version of the standard "sustainable contracts" developed by the American Bar Association (MCC 2.0) in 2021. The most important thing for domestic practice is the use of a *contract control*mechanism equally applicable to suppliers/contractors and buyers/users of products or services. Compliance with responsible procurement practices "and due diligence in the field of compliance with the rights of consumers of works and services". This approach in practice implements the principles of responsible contracts[11], contributing to the integration of risk management methods. Their application is associated with the specification of contractual conditions associated with risk neutralization, disclosure of information and the use of a system of special sustainability clauses.

The formation of standard/model "sustainable contracts" will require the organization of systematic analytical work in the field of implementation of corporate, tax, environmental, administrative, labor standards.rules and traditions of business turnover. For the investment and construction sector, reference to ESG principles should occur already at the project initiation stage. The examination of the pre-project,

11 Principles of responsible contracts: integration of risk management related to human rights into the format of negotiations for the purpose of concluding contracts between the state and investors: guidelines for negotiators. URL: https://www.ohchr.org/Documents/Publications/Principles_ResponsibleContracts_HR_PUB_15_1_RU.pdf

project stages should be of the utmost importance. Prevention and prevention of violations in terms of environmental pollution, energy efficiency, etc. it is advisable to carry out already at the stage of preparation of initial permits for construction. The rights and responsibilities of construction participants to comply with ESG principles should be fixed in contracts, taking into account the following requirements:

1) symmetry of rights and responsibilities, ensuring the potential possibility of fulfilling the liability regime;

2) integrity, providing for obligations to follow the provisions taken under the terms of the "sustainable contract";

3) consistency, which involves synchronizing the efforts of counterparties to comply with the principles of sustainable development in the context of the above three main projections.

The declaration of requirements is a necessary but insufficient condition for investment and construction activities carried out in accordance with the concept of sustainable development. We need the will of the authorities and the efforts of the industry management center in terms of *search, development and implementation*:

1) methods of coordination of activities, methods of supervision and control at all stages of implementation of investment and construction projects;

2) standard "sustainable contracts" regulating the entire range of investment and construction processes;

3) forms of liability for breach of obligations;

4) the new functionality of the regulator, taking into account the non-legal nature of industry standards;

5) methods of out-of-court dispute resolution, etc.

These actions are possible subject to the involvement of public organizations (NOSTROI, NOTIM, etc.) that are able to organize the online collection of information and systematization of proposals of the business environment. Separately, we note that all organizational work should be based on digital technologies of the distributed registry and blockchain. They will accelerate the processes of contract control, provide an entrance examination of compliance and reduce the risks of unfair performance of contractual obligations. Moreover, the realization of the advantages of digital tools creates conditions for the introduction of promising smart contract tools.

CONCLUSION AND DISCUSSION

The most important conclusion arising from the analysis of emerging contract models that serve the transformation of the relationships of participants in investment and construction activities in the direction of taking into account the requirements of sustainable development is the understanding of the need to switch to new standards of construction and real estate management. "Sustainable contracts" containing socio-environmental conditions and reservations are essentially only the first step towards the implementation of ESG principles in the industry. Obviously, it is not yet mandatory for counterparties. It is also clear that the process of ensuring the implementation of the triune principle of sustainable development requires the attention of not only the industry center, but also public organizations. The adequacy of the formed standards of investment and construction activity depends on their initiatives and consistent actions. In addition, regional authorities are becoming centers for the development of guidelines and models of "sustainable contracts". This activity is particularly active in the areas of sanitary-resort treatment and recreation. Environmental standards of the investment and construction business in such areas are subject to significant correction and tightening [4, 5]. Thus, it is advisable to form three basic tracks to ensure a business environment with corporate responsibility of the construction business for sustainable development in territorial and sectoral formats. The first track will be the initiatives of the industry regulator — the RF Ministry of Construction. According to the authors, its tasks should include:

1) implementation of the sectoral concept of sustainable development of the investment and construction sector;

2) systematization of approaches to the creation of standards for the sustainable development of the construction business;

3) formation of the structure of the construction corporate governance code.

The second track unites the efforts of public organizations and associations initiating public hearings and discussion of methodological approaches to the selection of sustainable development indicators in the context of the implementation of the triune principle of comprehensive assessment of the completeness of the conditions and clauses of "sustainable contracts".

The third track concerns taking into account the territorial features of the investment and construction business. It is also necessary due to the specifics of communication and climatic conditions for the creation of construction products and real estate management.

The tasks and measures of the basic tracks should be mutually consistent in content and linked in time. For these purposes, it is proposed to create a Coordinating Council of representatives of science, industry, enterprises, territories and public associations, subordinating its activities to the regime of joint responsibility for compliance with the schedule of joint events.

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Контрактные конструкции экологически устойчивого развития предприятий инвестиционно-строительной сферы

Стремление к созданию бизнес-среды, формирующей социально ответственное функционирование бизнеса, особенно важно в сферах деятельности, связанных с удовлетворением базовых потребностей в жилье, работе, медицине, отдыхе и др. Инвестиционно-строительная деятельность, осуществляемая различными контрагентами, характеризуется высоким уровнем экономических, социальных и экологических рисков. Их нейтрализация в формате практической реализации ESG-принципов осуществления проектов создания и управления недвижимостью связана, в первую очередь, со стартовыми фазами проекта и учетом социаль-

но-экологических требований в контрактах на выполнение работ, поставок, финансирование, долевое участие, оказание услуг и др. Контракты, учитывающие требования устойчивого развития, на практике формируют семейство «устойчивых контрактов». Их отличает единство экономических, социальных и экологических требований. Последние отражают нормы национального регулирования и направлены на формирование правовой среды корпоративной ответственности строительного бизнеса за устойчивое развитие. Базируясь на международной практике, авторы предложили структуру Концепции «устойчивого контракта» в строительстве. Она охватила и систему стандартов устойчивого развития, и необходимость разработки и согласования Кодекса устойчивого корпоративного управления строительством. Организация деятельности в этом направлении видится во взаимосвязанном совместном устремлении отраслевых и территориальных органов управления, корпоративных и общественных организаций, научных и образовательных учреждений к стандартизации инвестиционно-строительной деятельности, разработке типовых «устойчивых контрактов», использованию внесудебных методов разрешения споров в части выполнения обязательств по реализации ESG-принципов, а также принятию отраслевого кодекса корпоративного управления строительством.

Ключевые слова: *устойчивое развитие, стандарты устойчивого развития, инвестиционно-строительный бизнес, кодекс корпоративного управления, организационные треки деятельности, координационный центр*

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Integral assessment of resource and innovation potential of industrial housebuilding enterprises: mechanism of formation taking into account risks and uncertainty

The article highlights the significance of the resource and innovation potential of industrial housebuilding enterprises in the context of the rapidly changing global economic environment. The author emphasizes the need to develop a mechanism for a comprehensive assessment of this potential in order to provide a comprehensive understanding of the strengths and weaknesses of the enterprise and to identify areas for improvement. The proposed mechanism for assessing resource and innovation potential takes into account both internal and external factors affecting the enterprise. The authors suggest that this approach can lead to a more accurate and reliable evaluation of the enterprise's potential, as it considers both the resources available to the enterprise and the external factors that may impact its performance.
The article also points out the importance of risk management in the enterprise capacity assessment process. The proposed mechanism takes into account risks and uncertainties associated with the activities and development of an enterprise, allowing decision-makers to identify potential risks and develop appropriate strategies to manage them. The study concludes that the proposed mechanism can be used as a tool for decision-making related to the development of industrial housebuilding enterprises. The authors suggest that the results of the study can be of interest to specialists in the field of innovation management, risk management, and industrial housebuilding, as well as to business owners and government agencies involved in the development of this sector.
Keywords: *industrial housing construction enterprises, risk and uncertainty, investment, resource potential, economic reliability*



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In an unstable geopolitical situation in the country and a rapidly changing economic environment, construction industry enterprises need to have a well-developed resource and innovation potential in order to operate effectively and be competitive in the market [1]. However, assessing such potential is not always an easy task, especially considering the risks and uncertainties associated with enterprise activities.

A systematic and comprehensive analysis of the production and construction process of an enterprise is associated with its comprehensive evaluation of organizational and economic stability. Therefore, before starting the analysis, it is advisable to group the production factors and identify the reserves that can be used. Factors are a combination of elements and causes that affect the change in the controlled indicator taken as a criterion. The factors are classified depending on the purpose and objectives of the analysis [2]. If the analysis is carried out to identify the reserves that intensify the production process, then factors are divided into three groups: extensive, intensive, and integral.

The grouping of factors will change when setting other analysis tasks. After selecting factors, assessing their significance and classifying them into groups and levels, it is possible to move on to the analysis of specific production tasks.

A comprehensive assessment of production intensity is reduced to comparing indicators of production-technical and financial resources.

In the most general form, the complex analysis of the production process for construction industry enterprises includes the following main stages:

- assessment of production intensity;
- analysis of production and product sales;
- analysis of product (object) technological feasibility;
- analysis of fixed asset utilization;
- development and analysis of operational, tactical, and strategic tasks.

The risk assessment of the strategy of industrial housing construction enterprises of the territorial investment and construction complex engaged in the implementation of housing construction programs involves a thorough study of the sociological, scientific and technical, marketing, and technological situations in the real estate market (Fig. 1).

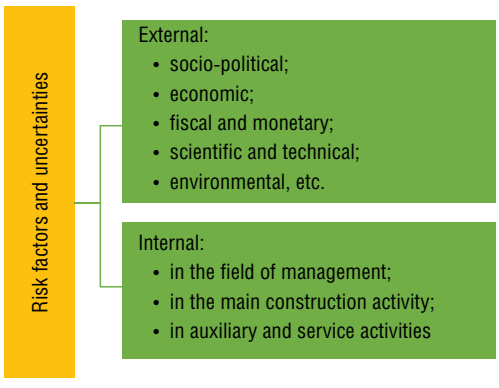


Fig. 1. General scheme for classifying risk factors for industrial housing construction enterprises

At the present time, the forecasting of risk and income is one of the key concepts in the economic activities of industrial housing construction enterprises [3]. Based on the existing classifier, possible risks and uncertainties in the economic activities of industrial housing construction enterprises can be divided into the following categories:

1) national;
2) sectoral;
3) territorial-regional;
4) project-specific;
5) local.

Country risks for industrial construction companies are unmanageable, while industry risks are difficult to manage. Territorial-regional risks include changes in municipal and regional construction and legal regulations, tax requirements, changes in consumer preferences, etc. [4].

To date, it is practically impossible to completely eliminate the negative impact of risk on the economic activities of construction companies. Let's consider risks that can be managed and reduce their negative impact on the further economic activities of construction companies:

- investment risks associated with the construction phase of the project's life cycle, i.e., the probability of loss of assets of an economic entity due to inefficient choice of investment and construction project, as well as an increase in the cost of the project at individual stages and phases of its life cycle, the nature and quality of management of the technical and technological components of the project (for example, risks of ensuring qualified labor resources, equipment, building materials, design errors, accessibility (remoteness) of the construction site, changes in quality, non-compliance with project documentation, contract risks);
- business risks associated with the implementation and partial operation of the investment and construction project (performance and management risks).

At any stage of the life cycle of a real estate object, there is an element of risk that can affect its profitability. However, in some cases, risk can become a stimulus for obtaining high profits: the higher the level of risk, the greater the potential reward for successful investment [5].

To successfully implement new projects for industrial housing construction as a developer, a thorough analysis of the current situation is necessary. According to research, there are various types of local risks associated with the functioning of industrial housing construction, such as financial risk, inflation risk, physical property violation risk, liquidation risk, and reputational risk.

1. Financial risk. With any type of investment, there is a risk that the invested financial resources may turn out to be unreliable, partially or completely. In addition, there may be situations where the enterprise has to use its capital to cover unforeseen expenses caused by changes in market conditions. When selling real estate, there is also a risk of losses and losses associated with underestimating risks. All of these factors can have a negative impact on the organizational and economic sustainability of industrial housing construction. There is also a risk associated with the loss of potential income that could have been generated if the capital was invested in another project. Additionally, there is a possibility of losing some or all of the investment capital.
2. Inflation risk. Economic inflation can negatively affect the return on invested funds, as even if there is a profit, it may be lower than the invested capital due to inflation.
3. Physical property risk. There is always a risk of physical damage and, consequently, of deterioration in the quality of the property as a result of natural and climatic phenomena, as well as of various natural disasters. Although insurance may partially compensate for the costs of restoring the property, physical destruction can significantly affect the further implementation of the project.
4. Liquidity risk. Due to the fact that real estate is not a highly liquid investment, such as equity capital or bonds, the company may take longer to own a property than originally planned.
5. Image risk. Various methods of marketing analysis are now used in practice for indicators of the organizational and economic sustainability and economic reliability of construction companies (financial position, experience, list of services etc.). In Fig. 2, the risk distribution is presented for the stages of implementation of an investment and construction project, taking into account the mechanism of risk management and uncertainty.

Research of the market segment for this type of real estate is crucial for achieving success in project implementation (the more research is conducted before construction begins, the more chances of identifying potential risks):

- random events associated with the acquisition of land;
- diversification of activities of industrial house-building companies;
- transfer of financial risk to the future consumer. Rental payments should compensate for the increase in current expenses and rent payments, which in turn will protect the company from inflation;
- limitation of financial responsibility. Reduction of costs associated with paying interest on loans during project implementation, as well as attracting partners who will share the responsibility of the investment and construction company;
- distribution of legal responsibility among partners [6].

The Fig. 3 illustrates types of risk and positive outcomes of effective solutions.

The economic reliability of the production and construction system of a construction company varies significantly and depends on many of its components, such as the material-technical, organizational-technological, and financial state [7]. Therefore, the overall integral coefficient of the economic reliability of the production and construction system, E_j^d can be expressed as a combination of its technical-technological and financial states.

If the efficiency of the production-construction system, E_s is expressed as a function of its output potential capacity, P_{en}^i

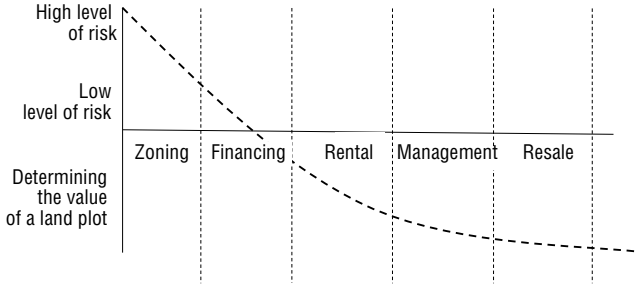


Fig. 2. Distribution of risk by stages of implementation of an investment and construction project

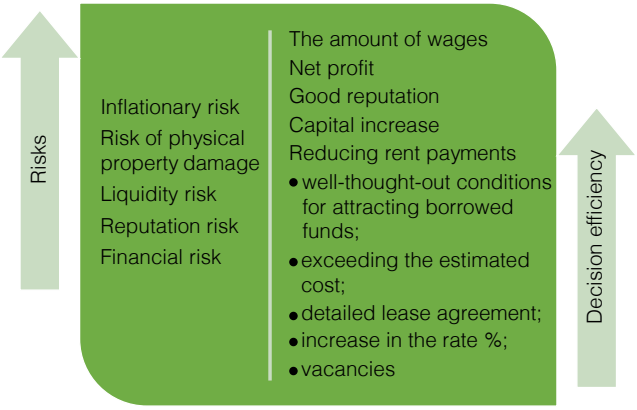


Fig. 3. Types of risk and results of effective decisions

(resource-innovation potential), and the integral coefficient of performance results, $K_r = \int(R_i)$, then [7]:

$$E_j^s = P_{en}^i \int(R_i). \quad (1)$$

As the degree of risk increases, enterprises experience losses of their resources utilized (Fig. 4).

In accordance with the analysis of the feasibility of costs at risk during the implementation of an investment and construction project, the overall financial condition can be divided into 4 areas — a normal state (E^A), an unstable state (E^C), a critical state (E^T), a crisis state (E^H), which in turn, they can also vary depending on the degree of risk management [8].

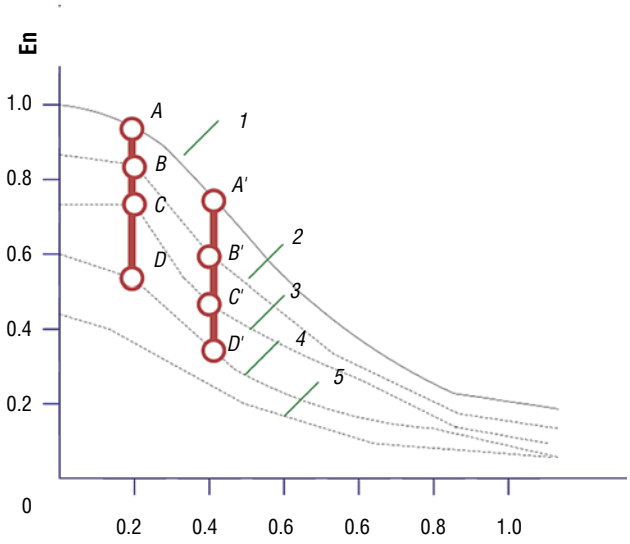


Fig. 4. The law of distribution of the level of economic reliability (E_j^s) of the production and construction system of industrial housing construction enterprises: 1 — integral coefficient of calculated effectiveness K_r; 2–5 too, determined by risk; AB, AC, AD, A'B', A'C', A'D' — risks under the influence of factors of uncertainty and randomness

From the graph presented in Fig. 4, it can be seen that risks can fundamentally alter the financial state of the industrial-construction system. Their influence can both decrease the technical and economic indicators by 40–75 % (as shown by curves *1* and *2*), and cause catastrophic damage [9]. Managing risk is further

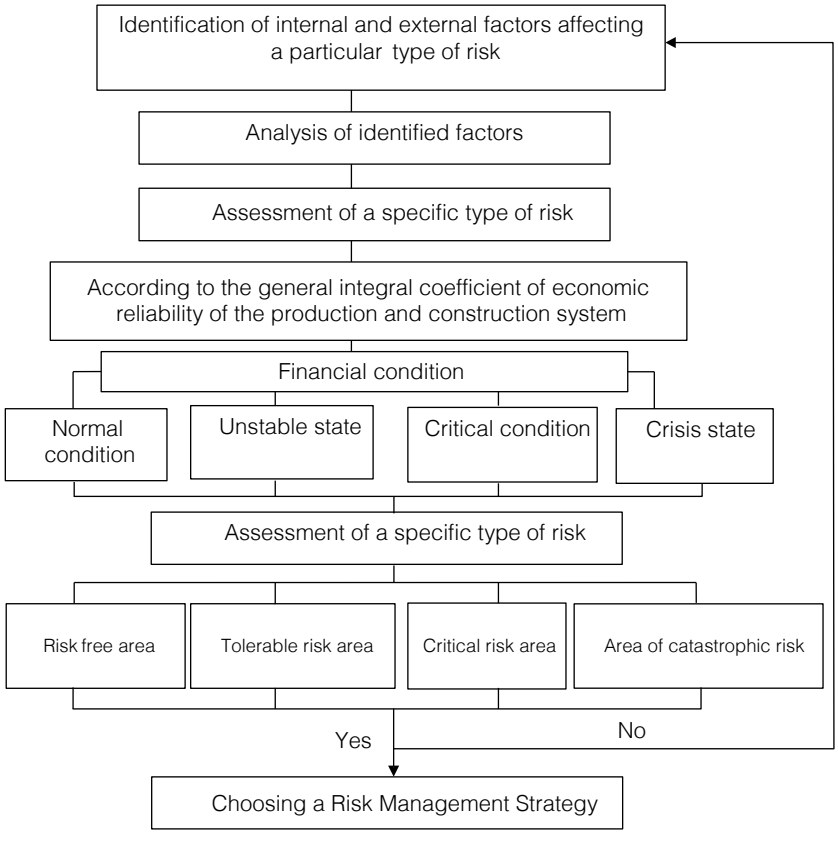


Fig. 5. Flowchart of risk analysis and methods for regulating the financial state of industrial housing construction enterprise

complicated by the fact that it is shaped by external factors of uncertainty and internal factors of randomness.

Fig. 5 shows a flowchart of risk analysis and methods for regulating the financial state of the company [4]. The main objectives of risk analysis should include determining the level of risk, i.e. the area of its operation on an assessment scale; establishing the magnitude of risk; comparing the magnitude of risk with the level of economic reliability of the industrial-construction system and regulating its value with the areas of financial state of the enterprises of industrial housing construction [10].

The concept of determining the impact of risk on the losses and benefits of the production and construction system is expressed in establishing the ratio of the probability of loss of profit and its increase, taking into account the results of the economic activity of industrial housing construction enterprises [11].

This ratio of obtaining possible results with risky actions is shown on the graphical model of the "butterfly of probabilities" (Fig. 6).

One wing of the "butterfly" OABCDB" — the area of probability of profit, which increases with increasing risk. The other wing — *OA"B"CD"* — characterizes the area of possible losses in case of an increase in the degree of risk. Therefore, by taking risks, enterprises will have the same chance of both gaining and losing [12]. Thus, in order to make an optimal decision, it is necessary to justify and choose options with minimal risks, but with the possibility of obtaining maximum income (Table).

Degree of provision of industrial housing construction enterprises with necessary resources, rational use of internal reserves largely determines the required (planned) level of economic reliability E_i^d of the functioning of the production-construction system in areas of acceptable risk and its financial condition [13].

Resource and innovation potential is one of the most important parameters that industrial housing construction enterprises use to implement plans to produce and reduce the cost of finished construction products, increase profits and increase labor productivity [14].

The need to increase labor, material and technical resources for the production can be compensated both through an extensive method of development and through the intensification of production (rational use of available resources, reduction in the number of workers, introduction of innovative technologies, etc.).

The essence of assessing the resource and innovation potential, which consists of various groups of indicators (logistical, financial,

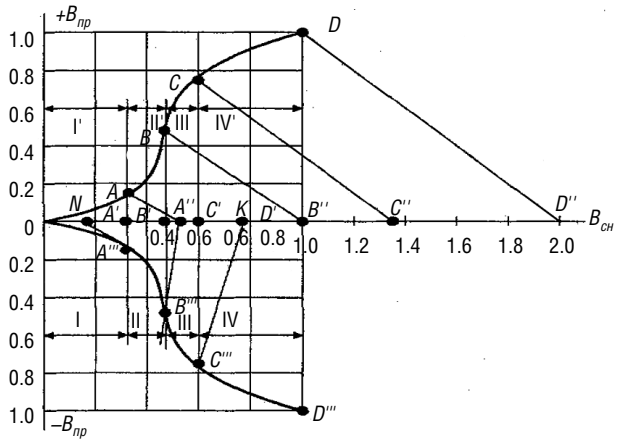


Fig. 6. Evaluation scale of the indicator (price) of risk depending on the probability of its manifestation ("butterfly of probabilities" of risk results)

Determination of the economic reliability of the operation of an industrial housing construction enterprise (on the example of LLC Kazan House-Building Plant)

Planning and controlling system	Economic reliability				Note
	Recommended Risk Thresholds				
	Risk free area (1)	Tolerable risk area (2)	Critical risk area (3)	Catastrophic risk area (4)	
(O) Operational planning and management	> 0.75	0.5–0.75	> 0.75	0.5–0.75	> 0.75
(T) Tactical planning and control	< 1 > 0.75	1.00–0.75	< 1 > 0.75	1.00–0.75	< 1 > 0.75
(S) Strategic planning and management	> 0.75	0.75–0.5	> 0.75	0.75–0.5	> 0.75

economic and organizational), is to develop an integral indicator of economic reliability, taking into account acceptable risk areas [15].

Each assessment indicator, quantitative and qualitative levels, form the possibility of using the management, planning and controlling system in conjunction with the dynamics of existing trends in managing the organizational and economic sustainability of industrial housing construction enterprises [16].

In conclusion, it is important to note that in order to effectively build the potential of industrial housing construction enterprises, it is necessary to take into account all possible risks and uncertainties, conduct a thorough analysis of the market and resources, and identify potential opportunities for innovation. An integral assessment of the resource and innovation potential allows you to get a comprehensive idea of the capabilities of an industrial housing construction enterprise, its competitiveness and risks, and also contributes to making informed decisions on further business development. The need to take into account risks and uncertainty emphasizes the importance of continuous monitoring and analysis of the activities of enterprises, which is a necessary condition for ensuring their sustainable functioning.

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Интегральная оценка ресурсно-инновационного потенциала предприятий индустриального домостроения: механизм формирования с учетом рисков и неопределенности

В статье освещена значимость ресурсного и инновационного потенциала предприятий индустриального домостроения в контексте быстро меняющейся глобальной экономической среды. Автор подчеркивает необходимость разработки механизма для комплексной оценки этого потенциала с целью обеспечения всестороннего понимания сильных и слабых сторон предприятия и выявления областей для улучшения. Предлагаемый механизм оценки ресурсного и инновационного потенциала учитывает как внутренние, так и внешние факторы, влияющие на предприятие. Автор предполагает, что такой подход может привести к более точной и надежной оценке потенциала предприятия, поскольку он учитывает как ресурсы, доступные предприятию, так и внешние факторы, которые могут повлиять на его производительность.

Также в статье отмечается важность управления рисками в процессе оценки потенциала предприятий. Предлагаемый механизм учитывает риски и неопределенности, связанные с деятельностью и развитием предприятия, что позволяет принимающим решения идентифицировать потенциальные риски и разрабатывать соответствующие стратегии для их управления. Исследование приводит к выводу, что предлагаемый механизм может быть использован как инструмент для принятия решений, связанных с развитием предприятий индустриального домостроения. Автор предполагает, что результаты исследования могут быть интересны специалистам в области управления инновациями, управления рисками и индустриального домостроения, а также владельцам бизнеса и государственным органам, занимающимся развитием данного сектора.

Ключевые слова: *предприятия индустриального домостроения, риск и неопределенность, инвестиции, ресурсный потенциал, экономическая надежность*

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Л.И. Павлова. Москва. Успенский собор. Рисунок, тушь перо

UDC 338.5

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Rapid assessment of the current price level of basic building materials and analysis of their dynamics

Successful implementation of investment and construction projects, including in housing construction, should take into account the results of monitoring prices for building materials with the possibility of forecasting in the short term. Obviously, modern conditions require better cost planning from construction organizations.
The evaluated studies confirm the lack of information in the field of analyzing the dynamics of prices for basic building materials in order to define the relationship of various factors affecting the ability to predict and establish trends in costs change in the short and medium term.
To eliminate subjectivity in the research, the authors provided an express analysis at various levels of generalization of statistical information on the cost indicators of building materials and considered a conjunctural analysis of the cost according to contractors.
The study revealed that according to the manufacturers the shortage of building materials is not expected, but in conditions of work in the regime of sanctions pressure, the costs not only for construction materials, but also for the repair and maintenance of equipment can significantly increase. In addition, the problems may occur concerning the supply of technological equipment and disruption of logistics links.
The authors made a rapid assessment of the current price level of the main price-forming building materials, as well as analysis and forecasting of their dynamics. The objectivity of the conclusions is due to the representativeness of information on the dynamics of price indicators, achieved through rapid analysis at various levels of generalization of statistical information, starting from Rosstat data and ending with the level of market analysis according to contractor construction organizations. The results of the study will allow us to determine the trends in the price dynamics of the cost of building materials and, accordingly, construction products.
Keywords: *building materials, price, analysis, dynamics, forecast*



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The implementation of investment and construction projects, as well as the growth of housing construction in order to provide affordable and comfortable housing for citizens of the country, in modern conditions of geopolitical changes is directly dependent on the availability of housing and the level of prices for building materials. It should be noted that various studies interpret modern trends in the price dynamics of building materials in different ways [1–5]. Accordingly, there is a need for an express analysis of price dynamics in order to establish certain trends, cause-and-effect relationships, as well as the possibility of a certain forecast of trends in the short term. In order to ensure the objectivity of analytical conclusions and representativeness of data on the dynamics of price indicators, we consider it necessary to perform an express analysis at various levels of generalization of statistical information on the price indicators of building materials, as well as to consider the level of market analysis of the cost of building materials according to contracting organizations.

Monitoring of the price level for building materials is carried out at various levels: at the level of Rosstat, Pricing regional centers or Construction department of regions, enterprises when conducting market analysis. In order to predict the cost, we consider it expedient to make a rapid assessment of the level and dynamics of prices for the studied building materials according to the data of the relevant above-mentioned services[1, 2,3,4].

Monthly monitoring reports of Rosstat are carried out in the context of average prices for basic materials purchased by construction organizations. It should be noted that there is no data on prices for a number of building materials for a number of periods, as a result of which such materials are excluded from the sample.

In this study, representative materials contained in the Rosstat database are selected for analysis www.fedstat.ru “Average prices for basic materials, parts and structures purchased by construction organizations”, which are price-forming for housing construction projects[5].

The analysis of the dynamics of prices for basic building materials in the Russian Federation as a whole is shown in Fig. 1.

Since the beginning of the year, the cost of building materials in the country, according to Rosstat estimates, has increased by an average of 6.7 %, in annual terms prices have increased by 4.5 %. In August, a number of materials fell in price. As can be seen from these figures, the price increase in March 2022, which occurred for

1 Investment portal of the Moscow region. URL: https://invest.mosreg.ru/about_mo/regional_economics
2 Interfax. URL: https://realty.interfax.ru
3 Monitoring of prices of rolled metal and building materials. URL: https://mc.ru/stats/stats
4 RBC. URL: https://chr.rbc.ru
5 EMISS — state statistics. URL: https://www.fedstat.ru

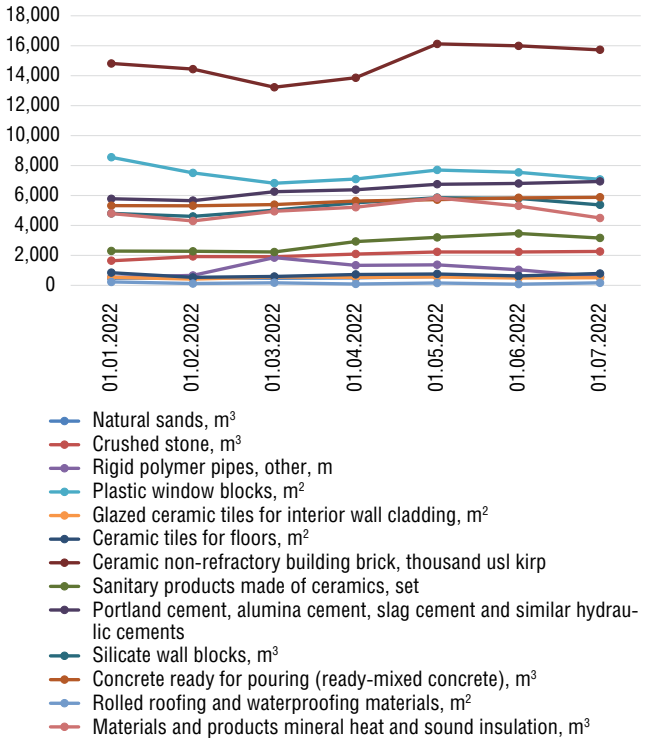


Fig. 1. Dynamics of prices for non-metallic building materials in the Russian Federation, RUB

geopolitical reasons, was later replaced by price stabilization with a slight jump due to the influence of the seasonal factor[6].

A significant increase in prices is observed for exported goods[7, 8]. This is a large part of the finishing materials. Electrics and all materials related to engineering systems are becoming more expensive. We believe that these trends will continue.

It should be noted that such fluctuations do not significantly affect the cost of construction.

Monitoring of the main factors of pricing in construction, including monitoring of prices for: building materials, products, structures and equipment in the Moscow region is carried out by State Unitary Enterprise of the City of Moscow "Department of Economic Research, Informatization and Coordination of project work" (GAU "NIAC"), which is subordinate to the Moscow City Committee on Pricing Policy in Construction and state expertise of projects.

Monthly monitoring reports are carried out in the context of average selling prices for representative materials.

The dynamics of the price level of building materials in the Moscow region according to the GAU "NIAC" is shown in Fig. 2[7].

Based on the analysis of the data of GAU "NIAC", there is a relative stabilization of price growth after the price jump due to the influence of both geopolitical factors in March 2022 and increased demand in the market along with high uncertainty, logistics component, rising cost of raw materials, the need for repair and maintenance of foreign equipment and its components. "Reaching

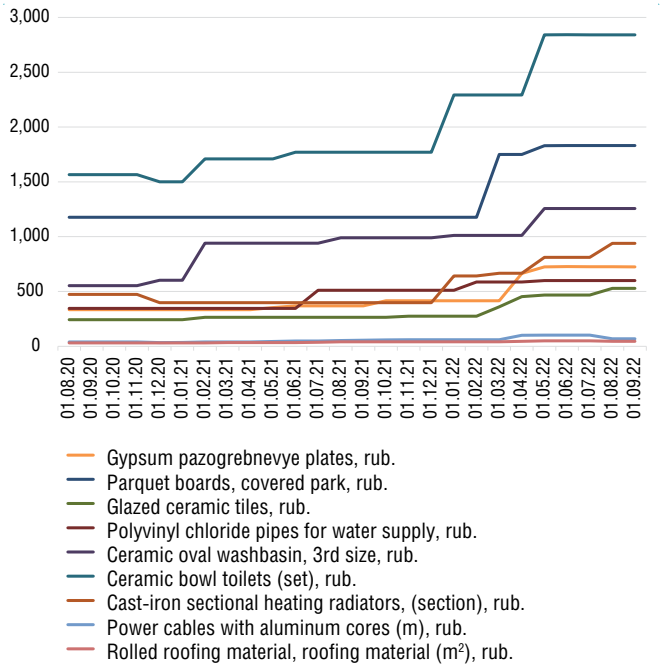


Fig. 2. Dynamics of the price level of building materials in the Moscow region according to the data of GAU "NIAC"

a plateau" and a slight decrease in the price after the jump in March 2022 is observed for a number of materials[7].

However, the increase in prices for construction materials in almost all positions during the year compared to the data for January should be noted. A slight decline in prices in June caused by the strengthening of the ruble, we believe, was temporary due to further emerging risk-forming events and factors of geopolitical genesis. The increasing sanctions pressure contributes to the further reduction of raw materials, components and equipment elements necessary for the production of building materials in Russia.

The correlation analysis of the dynamics of the cost of building materials carried out by us according to the data of the GAU "NIAC" (Table) showed a direct relationship between the price level of reinforcement and steel prices; the dependence of the price of concrete on the price level of its components (sand, crushed stone, cement) along with the practical absence of correlation with the dynamics of the dollar[7, 8, 9].

The lack of correlation of the price level for the studied building materials with the dynamics of the dollar is explained by the domestic production of these materials from local raw materials. The need for technological renewal of foreign-made equipment characterizes precisely the existing level of interrelation of factor features.

Further, a conjunctural analysis of market prices for a number of building materials was carried out. To conduct a market analysis, data on the cost of fittings for several types for 2 weeks of May 2022 from several suppliers in the Moscow region were selected, for some types for 2 weeks of October 2021 and 2 weeks of November 202 average values[10].

6 Price monitoring . URL: https://www.mcena.ru

7 NIAC. URL: https://niac.mos.ru

8 Market news. URL: https://cmpro.ru/rus/news/novosti-rinka

9 The state and prospects of development of the industry of production of building materials and related industries, Investment portal of the Moscow region. URL: https://investmoscow.ru/media/

10 Soyuzcement: The cost of the basic building material lags behind the prices of other goods and services. URL: oyuztsement:-stoimost_-bazovogo-stroimateriala-otstaet-ot-tsen-na-drugie-tovari-i-uslugi.html

Results of correlation analysis of price dynamics according to the data of GAU "NIAC"

	Concrete mixes	Crushed stone	Cement	Enriched sand	Reinforcement workpieces	USD exchange rate	Alloy steel
Concrete mixes	1.00	–	–	–	–	–	–
Crushed stone	0.92	1.00	–	–	–	–	–
Cement	0.86	0.84	1.00	–	–	–	–
Enriched sand	0.71	0.85	0.60	1.00	–	–	–
Reinforcement workpieces	0.55	0.61	0.51	0.70	1.00	–	–
USD exchange rate	0.34	0.31	0.40	0.30	0.29	1.00	
Alloy steel	0.43	0.51	0.47	0.59	0.94	0.21	1.00

Based on the data analysis, the following assessment and conclusions can be made.

Average prices by types of fittings were determined based on the results of market analysis of data on the cost of fittings in the Moscow region. The results of the analysis of the price dynamics of valve suppliers and calculated average prices are shown in the diagram below (Fig. 3).

According to the diagram, it can be concluded that the average cost of fittings in the Moscow region D 10 A500 in the summer of 2022 amounted to 61,200 rubles per ton, fittings D 12 A500 amounted to 56,200 rubles per ton, fittings D 16 A500 amounted to 55,867 rubles per ton, fittings D 20 A500 amounted to 55,700 rubles per ton. The minimum price of fittings in this period was observed at LLC "ASK" (3.5–4 % lower than the average price of the market analysis). The standard deviation of the market analysis sample data for a certain date is on average 1,500 rubles per ton.

According to the calculations, it can be concluded that the average cost of fittings in the Moscow region for the summer of 2022. D 10 A500 was 61,200 ± 1,915 rubles per ton, fittings D 12 A500 was 56,200 ± 1,473 rubles per ton, fittings D 16 A500 was 55,867 ± 1,644 rubles per ton, fittings D 20 A500 was 55,700 ± 1,473 rubles per ton.

The dynamics of average prices for fittings, calculated and constructed by us according to the data provided by the customer, for the period from October 2021 to May 2022, is shown in the diagram below (Fig. 4).

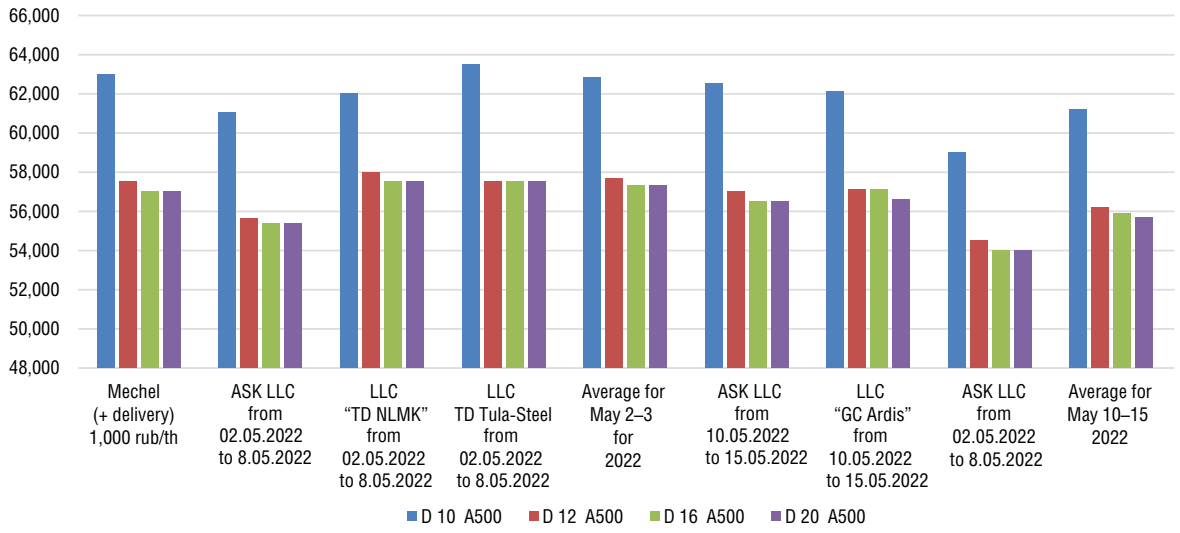


Fig. 3. Results of the analysis of the dynamics of supplier prices and calculated average prices for fittings in the Moscow region

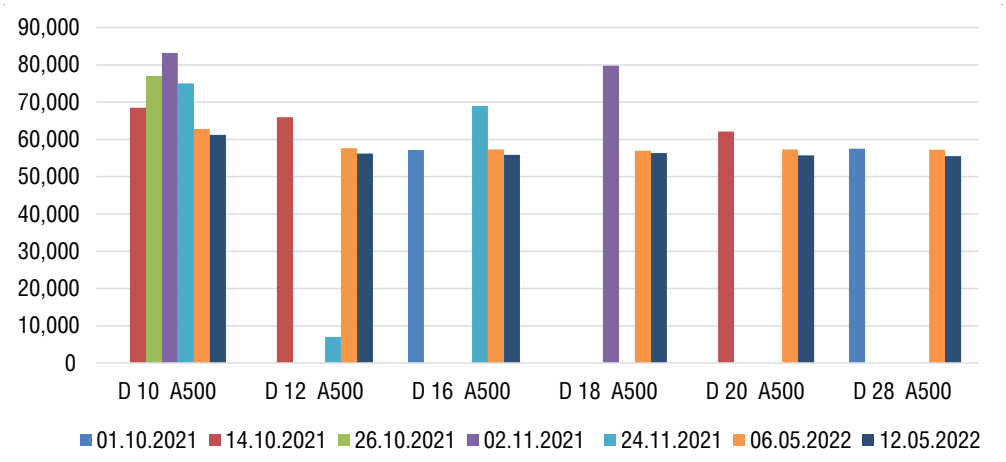


Fig. 4. Dynamics of average prices for rebar according to market analysis

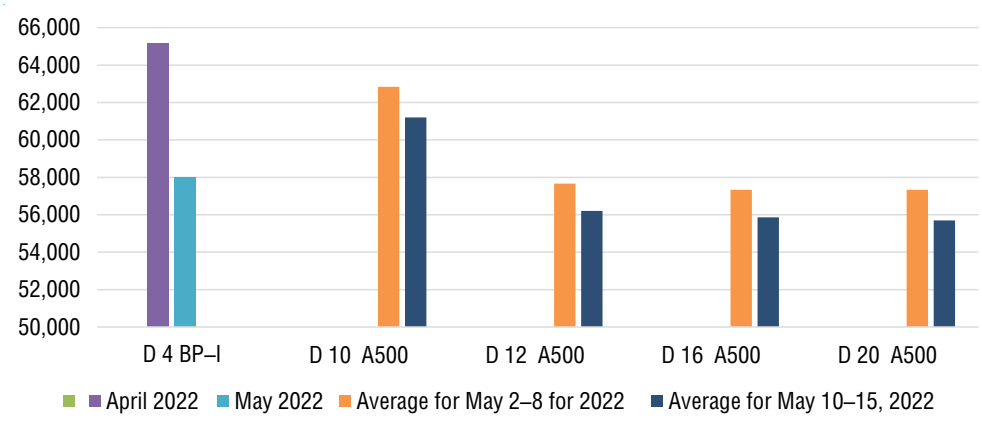


Fig. 5. Dynamics of average prices for rebar in the Moscow region in comparison with average prices according to GAU "NIAC"

Based on the analysis data, it can be concluded that prices for fittings are currently declining compared to the increase at the end of 2021, which is explained by the effectiveness of the antitrust policy. The measures taken by the Government of the Russian Federation limiting the growth of metal prices in the domestic market show their effectiveness. The price decrease is also caused by foreign trade restrictions, including a decrease in export volumes.

The corresponding dynamics of the average prices for fittings in comparison with the average prices according to the data of GAU "NIAC" is shown in the diagram (Fig. 5).

Based on the data of the figure, it can be concluded that the price indicators of fittings in the Moscow region are comparable according to market analysis with the results of regional monitoring of the GAU "NIAC"[7]. Therefore, since it is not possible to build a series of dynamics with subsequent trend formation due to the extremely small volume of price indicators of market analysis, the presence of a high level of correlation of price indicators with price indicators of official regional statistics allows us to conclude that the homogeneity of these samples and the expediency of using indicators of official regional statistics of prices for fittings to build a number of dynamics and forecast trend.

The dynamics of prices for concrete B 25 in the Moscow region is shown in the graph below (Fig. 6).

The increase in the price of concrete B25 for 2021 was 18 %, for 2022 (January–September) 16 %.

The dynamics of prices for concrete mixtures in 25 according to the market analysis of the contractor construction organization is shown in the diagram below (Fig. 7).

The increase in the price of concrete B25 in January 2022 to the initial price on the date of conclusion of the contract (February 2021) was 39 %.

The correlation analysis of the dynamics presented by the contractors with the data of the GAU "NIAC" showed the presence of a high level of correlation (the value of the pair correlation coefficient is 0.79), which indicates the homogeneity of the samples and the identity of the trends in price dynamics.

The results of the analysis indicate the uniformity of samples of prices for building materials according to Rosstat, GAU "NIAC" and market analysis data. Due to the volume of the sample data set, the data of Rosstat and (or) GAU "NIAC" can be considered a general data set. Accordingly, the construction of a trend line and price forecasting by methods of economic and statistical modeling is possible and reliable. The results of forecasting the price of commercial concrete are shown in Fig. 8.

In the course of the study, it was revealed that there is no shortage of the studied building materials on the part of manufacturers, however, due to the influence of the sanctions regime, not only the costs of repair and maintenance of equipment of manufacturing plants of building materials increase, but also problems with

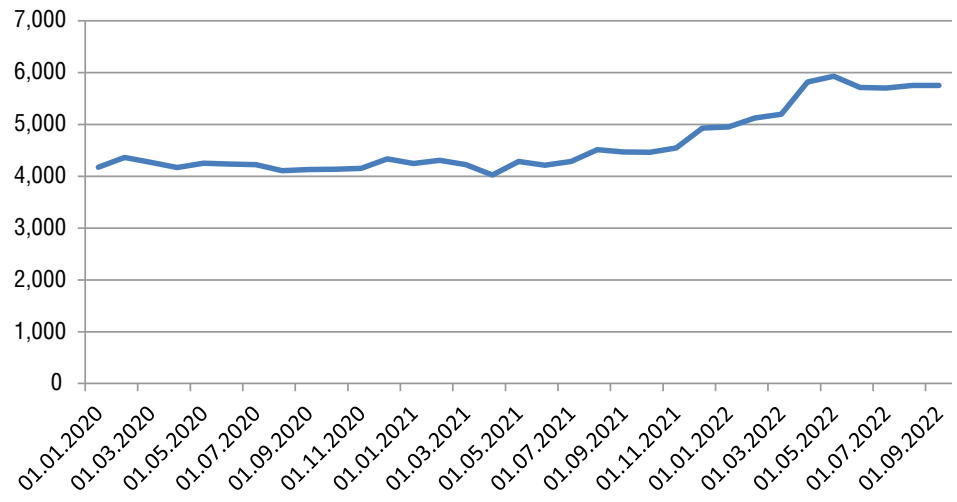


Fig. 6. Dynamics of prices for concrete B25 in the Moscow region, rub

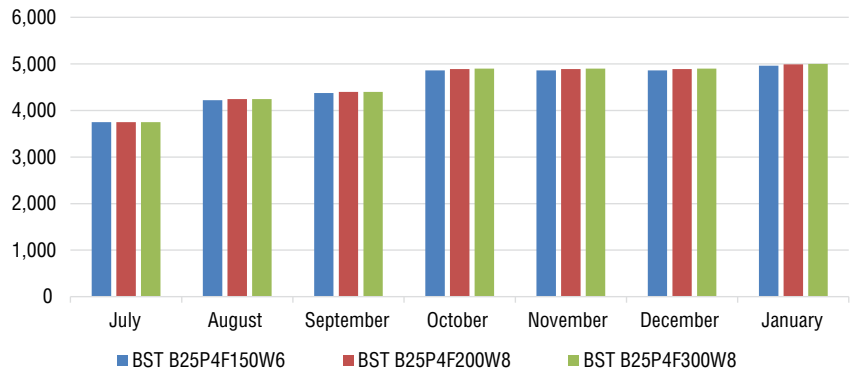


Fig. 7. Dynamics of prices for concrete mixtures B25 in the Moscow region.rub.



Fig. 8. Forecast of prices for concrete B35 in the Moscow region, rub

the supply of technological equipment and logistics appear; accordingly, the following cost dynamics is available and expected:

- relatively stable moderate positive dynamics of prices for concrete mixtures in all the studied regions is determined by the dynamics of prices of the main components of the concrete mixture;
- the dynamics of rebar prices after the jump at the end of 2021 is decreasing due to the measures taken by antimonopoly regulation; according to the forecast results, the dynamics of rebar prices are expected to stabilize with a subsequent slight increase (excluding the influence of geopolitical factors);
- correlation analysis of the dynamics of the cost of building materials showed a direct relationship between the price level of reinforcement and steel prices; the dependence of the price of concrete on the price level of its components (sand, crushed stone, cement), along with the practical absence of correlation with the dynamics of the dollar;
- prices for building materials (rebar and concrete) are not expected to decrease in 2022;
- the growth and subsequent stabilization of concrete prices is expected, which is explained by the multiplicative influence of both the increasing price dynamics of the components of the concrete mixture, the seasonal increase in demand for concrete mixtures and their components, and the increase in the cost of maintenance of technical equipment of production facilities.

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Экспресс-оценка текущего уровня цен на основные строительные материалы и анализ их динамики

Успешная реализация инвестиционно-строительных проектов, в том числе в жилищном строительстве, должна учитывать результаты мониторинга цен на строительные материалы с возможностью прогнозирования в краткосрочном периоде. Необходимость планирования строительными организациями своих затрат обретает особую актуальность в современных условиях.

Проанализированные исследования подтверждают нехватку

информации в области проведения анализа динамики цен на основные строительные материалы в целях установления взаимосвязи различных факторов, влияющих на возможность прогнозирования и установления трендов изменения стоимости в краткосрочной и среднесрочной перспективе.

Для устранения субъективности при проведении исследования авторами был проведен экспресс-анализ на различных уровнях обобщения статистической информации о ценовых показателях строительных материалов и рассмотрен конъюнктурный анализ стоимости по данным подрядных организаций.

В ходе исследования выявлено, что дефицит строительных материалов по данным заводов-изготовителей не ожидается, но в условиях работы в режиме санкционного давления могут существенно возрасти затраты не только на строительные материалы, но и на ремонт и техническое обслуживание оборудования. Кроме того, возможно появление проблем, связанных с поставками технологического оборудования и нарушением логистических связей. Авторами произведена экспресс-оценка текущего уровня цен основных ценообразующих строительных материалов, а также анализ и прогнозирование их динамики. Объективность выводов обусловлена репрезентативностью информации о динамике ценовых показателей, достигаемой за счет проведения экспресс-анализа на различных уровнях обобщения статистической информации, начиная от данных Росстата и заканчивая уровнем конъюнктурного анализа по данным подрядных строительных организаций. Результаты исследования позволят определить тенденции ценовой динамики стоимости строительных материалов и, соответственно, строительной продукции.

Ключевые слова: *строительные материалы, цена, анализ, динамика, прогноз*

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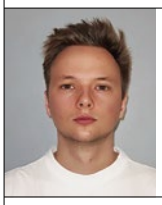
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Distinctive features of corporate development projects management compared to commercial development projects

Based on the main essence of development project management, i.e. managing efficiency of such projects, the authors have analyzed the existing approaches to defining the concept of efficiency. As a result of the analysis it was concluded that the existing approaches to the definition of the concept of efficiency are not fully applicable in the context of corporate development project management. Therefore, based on the existing approaches and taking into account the specifics of activities, the concept of efficiency was formed in relation to corporate development projects. In addition, taking into account peculiarities of business processes of corporations and development activities within them, the organizational structure of interaction between participants of corporate development projects was clarified. Taking into consideration connection of corporate development projects with corporate strategy, managerial decision-making algorithm was developed in the process of controlling activities. Given the focus of corporate development projects exclusively on corporate strategy objectives, it was found that the standard indicators used in commercial development projects are not fully applicable to corporate development project performance evaluation. This fact creates a need to develop new methods to assess the effectiveness of such projects. One of the parameters which can be used to quantify the economic efficiency of corporate development projects is the total cost of ownership of real estate. This study outlines the general principles for determining this parameter for corporate development projects. Given the complex function of real estate objects in a corporation's portfolio, a social return on investment parameter is proposed to assess the positive effect of projects.
Keywords: *project management, corporate real estate development, development efficiency*



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The classic project management methodology, as set out in the project management standards, is based on the triple bottom line theory formed by Martin Barnes back in 1969 [1]: the quality of a product depends on three project indicators — cost, time spent and labour intensity. When managing corporate development projects as a whole, the same indicators should be used, but they will take a special form.

Earlier in the study [2], the author outlined the main differences between corporate development and commercial development projects:

- the aim of project implementation depends on the objectives shaped by the corporate strategy;
- strictly defined functionality and the end user of the property, which is one of the business units of corporations;
- financing of the project, in most cases, will come from the corporation's own resources.

These characteristics create the need to develop new and optimize existing management methods for corporate development projects, which is what this paper does.

Obviously, in any development project, a certain quality parameter of the completed project has to be met. In corporate development projects, this parameter can often be quantified. Thus, when implementing a development project, the corporation has a certain goal — it is necessary to obtain a well-defined amount of resources to solve the business task at hand. It is worth noting that due to the difference in the goals of commercial and corporate development projects, the conditions of goal achievement are also different, i.e. the result of the corporate development project is achieved by combining the intellectual and human resources of the corporation and the real estate object through high-quality project management. Therefore, this process ensures a new quality of real estate that meets the original requirements and covers certain needs of the corporation.

A key aspect of the project management process is to maximize the level of efficiency. Depending on the definition of efficiency, the way in which it is defined will vary accordingly. The concept of efficiency can be interpreted in several ways:

1. Efficiency is the ability to achieve objectives [3]. In this approach, effectiveness is defined solely in terms of the result of the activity, i.e. the extent to which the final goal is achieved. The difficulty in applying this approach is that the objectives are often formulated rather implicitly. It is also worth noting that not all formulated objectives can be evaluated, and with a large number of objectives it is difficult to accumulate evaluation.

2. Efficiency is the ratio of the useful output to the resources spent to achieve it. More generally, it is the ratio of what was input to what was output, which allows us to avoid being linked to the concepts of "resources" and "outputs" [4]. Using this approach, it is only possible to quantify the results.

3. According to the concept of system resources, efficiency refers to the ability of an organization to provide the necessary amount of resources to carry out its activities without interruption [5]. The advantage of this approach is the ability to formalize the need for resources and to calculate resource availability.

4. The approach that defines effectiveness as the degree of satisfaction with the effects of a project or activity is called the multi-stakeholder concept [6, 7]. The essence of this approach is that the interests of all project stakeholders and the degree of their satisfaction should be taken into account when assessing the effectiveness of a project, as they often do not coincide. Conflicting indicators are subject to mandatory balancing in order to achieve optimal results and maximum effect for all participants in the process. This approach is the basis of the international standard ISO 26000 and its domestic analogue IC CSR08260008000, in which the effectiveness of socially responsible organizations is assessed as the sum of different types of efficiency: business, environmental and social [8].

5. In the benchmarking approach, performance is defined as achieving compliance with various corporate, industry or global standards of practice in a given area. This approach is most useful if the performance is clearly regulated by global, industry or organizational standards, or if there are examples with performance benchmarks.

Based on the above mentioned approaches and taking into account the specifics of corporate development processes and outcomes, the author has formed the following definition of efficiency in the context of corporate development project management.

The efficiency of a corporate real estate development project is the ability to achieve the objectives set out in the corporate strategy through project implementation, thereby providing the corporation with the maximum amount of necessary final resources while using the minimum amount of resources and simultaneously meeting all corporate standards and consumer requirements for product quality. Thus, the task of managing a corporate development project comes down to managing the effectiveness of the implementation of a particular project.

Development project performance management is a set of management processes — planning, organization of execution, control and analysis — that allows the developer, in this case the corporation, to strategically define the mission, to promptly assess and manage project activities to achieve the goals set while making the best use of available resources.

Since the effectiveness of the project will depend on the effectiveness of each individual participant of this project, it is necessary to define the composition of the participants of the corporate development project, as well as the order of their interaction. Methodologically, the process of interaction between the participants of the corporate development project and their functional responsibilities can be reflected by means of a flow chart (Fig. 1).

Development project management is about managing the performance of this project, which, as noted earlier, includes the following processes: planning of activities, organization of production processes, project implementation control and analysis of the current state. Due to the fact that corporate development projects have a peculiarity in the form of focus on solving a business problem conditioned by the corporation's strategy, the management processes outlined above have their own peculiarities.

More often than not, activity planning consists of sequencing the business processes of a project in such a way that it is possible to realize the project within a predetermined corporate strategy timeframe. This complicates the planning process itself, knowingly putting the developer within certain limits. It is also worth noting that large corporations either have a large share of public capital, or may be fully owned by the state, which in turn requires all procurement procedures in accordance with applicable law[1, 2]. These aspects need to be taken into account in scheduling and network planning and reflected in Level 3 and Level 4 schedules. In addition to the specifics of the facility itself, the planning process must also take into account the peculiarities of internal business processes.

A number of features can be distinguished in the scheme of interaction between the participants in a corporate development project in relation to a similar scheme in commercial development projects.

First of all, it should be noted that the project is fully financed by a corporation, whereas commercial development projects often involve third-party investment in the form of loaned cash or investment capital. The involvement of external funds is also possible in the case of particularly large projects where several corporations will be beneficiaries at the same time, including international projects.

Secondly, an important aspect to be considered in the implementation of a project is the existence of clearly defined consumer requirements for the end result. This fact, on the one hand, simplifies the implementation of the project and relieves the developer of the need to conduct market research in order to formulate the product concept. On the other hand, the existence of such strict requirements for the finished property deprives the developer of a certain flexibility in decision-making during the project implementation process.

Of course, monitoring and controlling the progress of any development project, including corporate projects, is an integral part of project management. In its essence, it is the controlling function that aims to ensure the necessary efficiency of the project. Being the basis of system management, the function of so-called situational controlling ensures effective management of real estate development through the implementation of management measures by adjusting the predetermined relationship between resources and objectives [9].

A special feature of corporate development projects is the higher and clearer quality requirements for the property, which in some cases creates the need for the developer to be involved in management decisions not only at the level of interaction with the technical customer, but also at lower management levels.

The management decision-making process itself is carried out by analyzing current conditions, comparing actual parameters with planned ones and then influencing the system of resources involved in project implementation. This process is implemented through forward and backward communication between the system elements of the project itself [10].

There are several types of controlling in common practice, the first of which is embedded control. Embedded control is a set of procedures that result in fixed points or milestones in a project, without which further implementation is simply not possible. In practice, these activities are implemented through the development of strategic project roadmaps that reflect key project milestones. Namely, site selection, concept readiness, project documentation readiness, obtaining initial permitting documentation, achieving full construction readiness of the facility, obtaining commissioning permit, etc.

For operational management of the project, ongoing monitoring of project implementation is carried out. This type of control aims at detecting current deviations in the cost and time parameters of all processes carried out during the design and construction of the project. It

1 On Procurement of Goods, Works and Services by Certain Types of Legal Entities : Federal Law of July 18, 2011 No. 223-FZ.

2 On the Contract System in the Sphere of Procurement of Goods, Works and Services for State and Municipal Needs : Federal Law of April 5, 2013 No. 44-FZ.

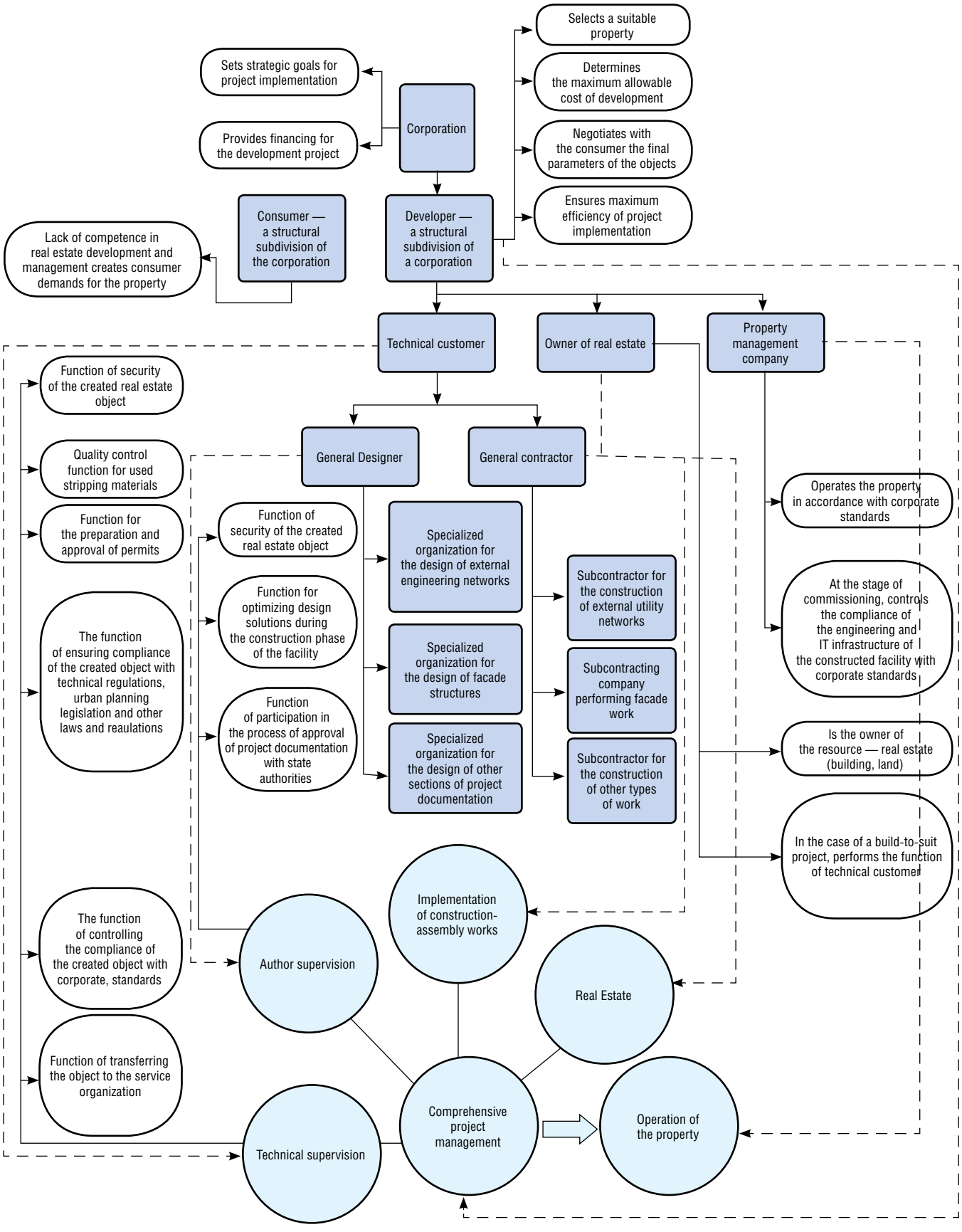


Fig. 1. Organizational scheme of interaction between the participants of a corporate development project. Source: compiled by the author

is carried out by means of multi-level scheduling as well as by controlling the current cost of design, construction and other works.

Post-inspection methods are used to ensure the required quality and compliance with the parameters of the constructed object. In the course of this type of control, the construction work actually carried out is checked, as well as the execution documentation.

An important aspect in the process of controlling the implementation of development projects is the identification of risks that have a direct impact on corporate strategy. Based on this criterion, two types of risks arising in the corporate development process can be distinguished. Risks that have a direct impact on the achievement of corporate goals and risks that do not have an impact on the achievement of strategic goals, but affect project performance.

Introducing these types of controls into the corporate development project management system allows us to propose an algorithm for making and adjusting management decisions (Fig. 2).

Integration of these types of controls ensures the necessary efficiency in corporate development projects at all stages of implementation.

Continuous work on the analysis of the results of controlling measures, combined with the algorithm of making and adjusting decisions, allows the controlling system not only to improve itself in the process of work, but also to identify systemic problems in the implementation of development projects. Based on the analysis of the identified systemic problems, adjustments are developed both in the strategic planning system and in the controlling system. In particular, the planning system is filled with new parameters, the absence of which directly affected the detailing and quality of the controlling system. The management system is adjusted to take into account the identified critical points that reduce the speed and quality of management decisions.

In commercial development projects, efficiency is known to be assessed most often by using the following parameters [11]:

- net discounted cash flow (NPV);
- profitability index (PI);

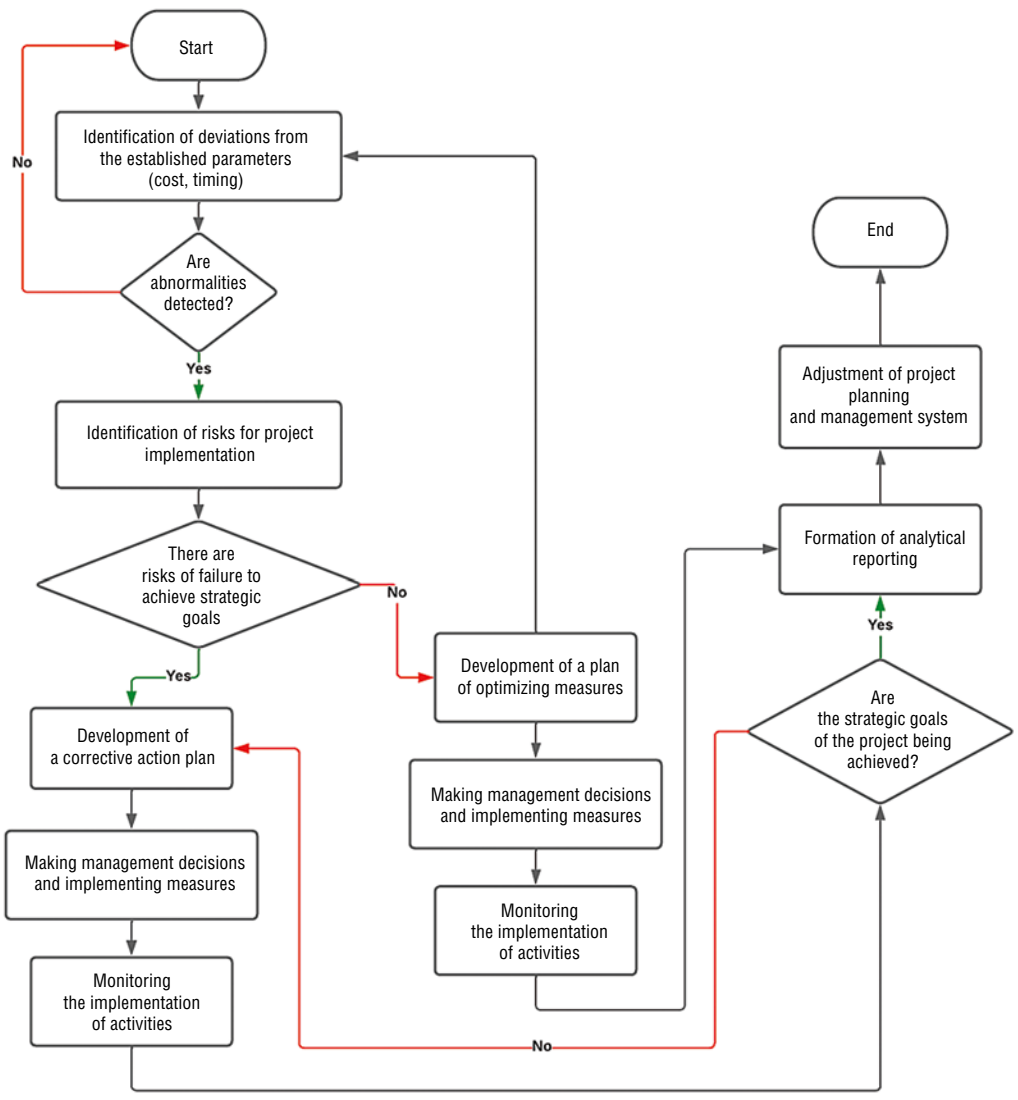


Fig. 2. Algorithm of making and adjusting management decisions during the implementation of corporate development projects. Source: compiled by the author

• internal rate of return (IRR);

• payback period (PP).

For corporate development projects, it is often not possible to define the above parameters because the project does not always have a direct economic impact. Therefore, from an economic point of view, in order to be most efficient, the least costly project should be sought. To estimate this characteristic. It is necessary to determine the total cost of ownership of the property (TCO — total cost of ownership), which in general terms defined by the formula (1):

$$TCO = \sum_{i=0}^{n} \frac{CAPEX_i + OPEX_i + TAX_i}{(1+r)^i}, \quad (1)$$

where $CAPEX_i$ — the capital cost of the *i*-th period to maintain the facility in the corporation's property portfolio;

$OPEX_i$ — the *i*-th period operating cost of maintaining the facility in the corporation's property portfolio;

TAX_i — tax payments due during the *i*-th period;

r — the discount rate.

Given the complex function of real estate properties in a corporation's portfolio, when assessing the effectiveness of development projects, not only the economic component must be taken into account. An important aspect in such projects is the social and image component of the project itself. In order to evaluate these components of the project, a social return on investment indicator (SROI — Social Return on Investment) must be determined. The main task of SROI is to compare the positive social effects (in monetary terms) received from the implementation of the project with the corresponding costs of all stakeholders [12]. Thus, in general terms, SROI is defined by formula (2):

$$SROI = \frac{SR}{I}, \quad (2)$$

where *SR* — is the amount of monetized social return resulting from the project;

I — is the amount of investment.

In practice, when calculating the value of social return, the value of social effects obtained from the implementation of the project is determined by comparing the state of the system before the project and after the project [13]. Such effects may include quite different results, for example: impact on the corporate brand, creation of a more comfortable environment for employees, reduction of harmful emissions, etc. The results themselves depend on the type of project, the participants and the business task being solved, and are therefore determined individually for each project.

CONCLUSIONS

1. The development division, as part of a vertically integrated corporation, has to operate under all-round constraints, which requires a special approach to the organization of management processes. When planning a project, it is most important to sequence business processes in such a way that the set goal is achieved within a strictly defined corporate strategy deadline. For the very fact that the goal is achieved, it is crucial to build a system of monitoring and controlling production processes that takes into account the distinctive features of corporate development.

2. The composition of participants in corporate and commercial development projects has some differences, which affects the way they interact and their functional responsibilities. For this reason, the author has developed an organizational structure describing the order of interaction between the participants and the boundaries of their functional responsibilities.

3. The analysis of existing approaches to defining the concept of project efficiency has shown that the existing ideas about this concept cannot fully reflect its essence in the process of corporate development project management. Thus, the author proposed a definition of the concept of efficiency that takes into account all factors and features of corporate development. To quantify the efficiency of projects, the author proposes to use indicators of the total cost of ownership of the property, as well as the social return on investment.

4. Given a large number of constraints for the developer in the process of project implementation, the management decision-making process is of particular importance. To optimize this process, the author has proposed an algorithm for making and adjusting management decisions that takes into account the specifics of corporate development, as well as the possible risks that arise during project implementation.

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Отличительные особенности управления корпоративными девелоперскими проектами в сравнении с проектами коммерческого девелопмента

Исходя из главной сути управления девелоперскими проектами — управления эффективностью таких проектов, авторами были проанализированы существующие подходы к определению понятия эффективности. В результате анализа было сделано заключение, что существующие подходы к определению понятия эффективности в полной мере не применимы в контексте управления корпоративными девелоперскими проектами. В связи с этим на основании существующих подходов и с учетом специфики деятельности было сформировано понятие эффективности применительно к проектам корпоративного девелопмента. Также, учитывая особенности бизнес-процессов корпораций и девелоперской деятельности внутри них, была уточнена организационная структура взаимодействия участников корпоративных девелоперских проектов. Учитывая связь корпоративных девелоперских проектов с корпоративной стратегией, был разработан алгоритм принятия управленческих решений в процессе осуществления контроллинговых мероприятий. Учитывая направленность корпоративных девелоперских проектов на решение исключительно задач корпоративной стратегии, было установлено, что стандартные показатели, используемые в коммерческих девелоперских проектах, не вполне применимы для оценки эффективности проектов корпоративного девелопмента. Данный факт создает потребность в разработке новых методов оценки эффективности таких проектов. Одним из параметров, который может быть применяться для количественной оценки экономической эффективности проектов корпоративного девелопмента, является совокупная стоимость владения объектом недвижимости. В данном исследовании обозначены общие принципы для определения данного параметра для проектов корпоративного девелопмента. Учитывая сложную функцию объектов недвижимости в портфеле корпорации, для оценки положительного эффекта от реализации проектов предложен параметр социального возврата на инвестиции.

Ключевые слова: *управление проектами, девелопмент корпоративной недвижимости, эффективность девелопмента*

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Methodological peculiarities of housing and communal services prime cost planning

The topic of methodological peculiarities of planning the cost of housing and communal services is relevant in light of the need to increase the efficiency of managing housing and communal services by optimizing costs and reducing management expenses. The government tariff policy on organizations providing housing and communal services is one of the main directions of the Russian federation modern policy. The growth rate (changes) of regulated prices (tariffs) of natural monopolies and organizations in the housing and communal services sector is an initial internal factor in the forecast of socio-economic development of Russia; and the growth rate (changes) of prices specified in this forecast is a reference point for regulatory bodies when setting maximum tariffs for housing and communal services in the Russian regions and tariffs for organizations' services for consumers. Currently, there is an imbalance of economic interests of providers of housing and utilities services and consumers, which can be identified as one of the essential principles of organizing economic relations with regulated pricing within the government's tariff policy. With continuously increasing cost of resources, increasing demands from consumers, as well as the renovation of existing service implementation systems by resource supplying organizations, cost management and planning are an integral part of the activities of housing and communal services organizations. Proper planning of services prime cost allows not only to optimize the budgets of resource supplying organizations by reducing expenses but also increasing the quality and reliability of provided services, leading to an improvement in the standard of living and a decrease in the growth rate of tariffs for housing and communal services. Therefore, the study of the methodological peculiarities of housing and communal services prime cost planning can be useful for optimizing financial resources, improving service quality, and enhancing the overall management of the housing complex.

Keywords: *prime cost planning, housing and communal complex, economy, regulated tariffs, pricing methodology, expenses of resource supplying organizations, tariffs for housing and communal services*



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In the framework of the implementation of the Russian Federation Government Resolution of November No. 2053, November 14, 2022, the existing tariffs have been indexed, and new tariffs have been established from December 1, 2022 to July 1, 2024 (Table). The next indexing is planned from July 1, 2024 [1]. This was done in order to increase financial stability and support resource supplying companies, to ensure uninterrupted service and affordability of the tariff to consumers in 2023.

Currently, consumers of housing and communal services have access to information related to tariff regulation and the cost-effectiveness of services provided by regulated organizations. However, the transparency of tariffs regulation process for housing and communal services is not provided to a sufficient extent. The available information to consumers does not allow to make a conclusion regarding the feasibility and justification of the increase in tariffs for housing and communal services and the economic justification for the expenses of organizations providing these services in terms of their level of quality and reliability.

Extraordinary indexation of tariffs for services in the housing and communal sectors

Index	Growth index, %
Citizens' payment index by constituent entities of the Russian Federation	9.0
Maximum price (tariff) limits for electricity, water and heat supply	9.0
Wholesale prices for natural gas, tariffs for gas transportation services	8.5
The amount of payment for supply and demand services	6.0
Tariff for electricity transmission services via UNEG	11.5

At the same time, the evaluation of tariff increases from the perspective of consumers, including the population, is negative, which is quite natural in the absence of clarity and transparency regarding the goals set by the government, which must be achieved within the framework of the set rate of growth for tariffs for housing and communal services. This is complicated by the fact that key technical and economic indicators in regulated sectors such as the electric power complex, heat supply, water supply, and water disposal do not currently reflect positive dynamics [2].

The growth rates of regulated prices (tariffs) for housing and communal services are formed within the framework of indexing the rate of price growth based on forecasts of socio-economic development (Fig. 1).

Since 2017, tariffs have been approved with the aim of ensuring that their growth will be lower than the forecasted inflation rate ("inflation minus"), as can be clearly seen in Fig. 1. At the same time, the needs of regulated organizations in the necessary gross proceeds to cover their expenses are not specifically taken into account or analyzed [3]. The impact of tariff decisions on the financial sustainability of housing and communal services organizations under given constraints is also not taken into account, as the "inflation minus" principle is

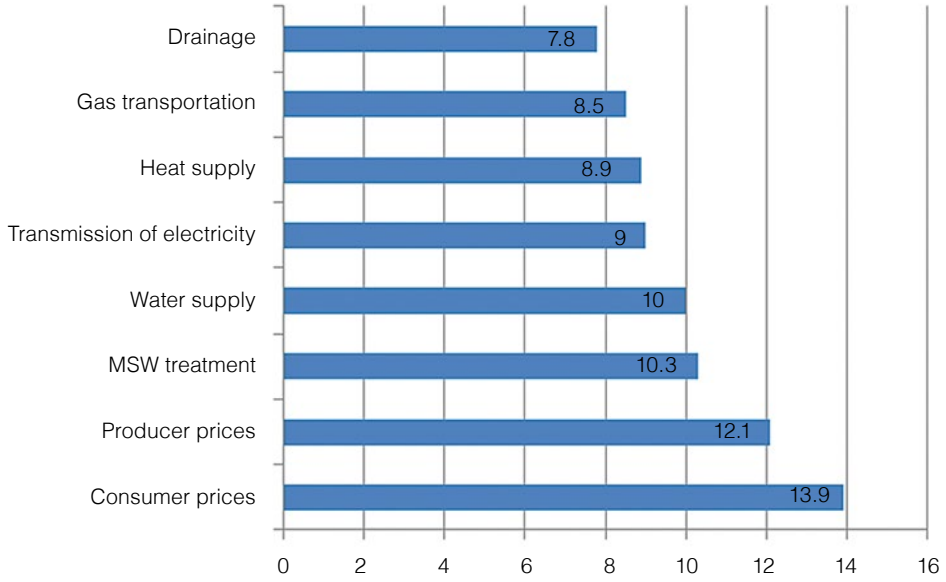


Fig. 1. Indices of price growth and regulated tariffs from December 1, 2022, %[1]

not always focused on the economically justified costs of providing housing and communal services.

However, cost planning has always been one of the main stages of forming economically justified prices (tariffs) for housing and communal services. This process is necessary both for housing and communal services enterprises and for other organizations providing housing and communal services to consumers.

The amount of planned cost is determined by the organizations in accordance with the methodology approved by the legislation of the Russian Federation [4–6]. Each of the cost items is formed on the basis of actual costs and their planned values dynamics analysis, assessment of the economic justification of expenses based on the relevant examination of tariffs. The influence of reducing the volume of services provided to consumers as a result of resource-saving measures and installation of metering devices is also taken into account when determining the level of specific costs for the organization. Besides, additional costs must be taken into account to ensure the required quality and safety of services provided in accordance with contractual obligations. At the same time, it is necessary to assess the need for investment to finance the planned activities for the organization's development.

Cost planning in the housing and communal sector is based on analysis, control, and optimization of expenses for resources and services necessary for the operation of serviced facilities, rather than on the price indexes set for them. Therefore, organizations that provide housing and communal services need to approach the process of planning the prime cost responsibly to be able to substantiate the economic justification of planned expenses to regulatory authorities when necessary.

The cost of housing and communal services is the total amount of resources required to provide these services, taking into account all costs associated with production and service implementation. The prime cost of services may vary between different organizations in the housing and communal sector, depending on the specific needs, resources, and the economic situation in a particular area [7, 8].

The cost includes numerous elements, such as labor costs, communal resources (electricity, water, gas) cost, equipment maintenance and repair cost, production costs for material and tool acquisition and use, rental costs, and other expenses associated with providing services. The prime cost of housing and communal services affects the price of the services provided by the organization as well as its profit. Proper and accurate determination of the prime cost of services helps the organization manage its resources, improve efficiency, and make rational managerial decisions, while taking into account its specific needs [9].

There are several methods for planning the prime cost of services [10–12]. Let us consider some of them:

1. Target Costing method: this method involves determining the cost of a product or service based on the amount that a customer may be willing to pay for it, taking into account its performance and quality. If the cost exceeds this amount, the company's task is to reduce costs and maximize the optimization of production processes to achieve the desired price position.

2. ABC method (Activity-Based Classification) is a method that allows for a more detailed and comprehensive analysis of services prime cost. It involves dividing all of the company's costs into several categories based on the purpose for increasing efficiency, as well as the impact on the price and cost reduction of the product or service.

3. The Standard Costing method is based on using a normative volume of a position and calculates the cost of production by fixing costs per batch and per unit produced. This method of prime cost planning is simpler and more traditional.

4. The “Backward pricing” method is based on the formation of wages into costs for better determination of the production cost, taking into account the costs of raw materials, materials, and production itself.

5. The “EV-VE” (Economic Value – Visitor Value) method from Indestron Group is based on the theory of the economic value estimation of a product or service and customer satisfaction level. Its

1 Forecast of the socio-economic development of the Russian Federation for 2023 and the planning period of 2024 and 2025. URL: https://www.economy.gov.ru/material/directions/makroec/prognozy_socialno_ekonomicheskogo_razvitiya/prognoz_socialno_ekonomicheskogo_razvitiya_rossiyskoy_federacii_na_2023_god_i_na_planovyy_period_2024_i_2025_godov.html

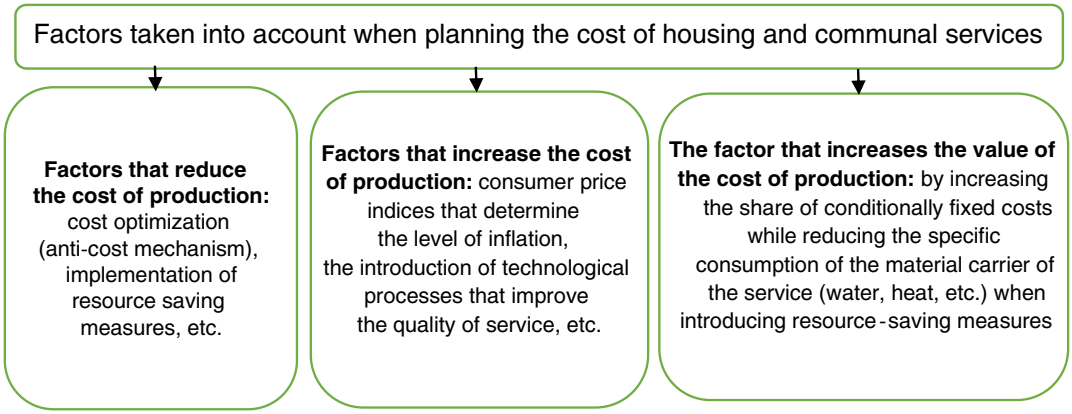


Fig. 2. Factors considered in the cost planning process

application is aimed at maximizing customer interests, meeting their needs, and adapting the cost of services based on customer data.

These cost of services planning methods are aimed at optimizing logistics and production processes to achieve the most efficient and profitable performance. The choice of a specific method depends on the company's characteristics, size, and goals.

In the process of services prime cost planning, companies take into account the following groups of factors (Fig. 2).

Planning the prime cost of housing and communal services is a complex process that involves many aspects [13, 14]. Let us consider the main methods and principles of prime cost planning:

1. Analysis and classification of services. The first step in prime cost planning is analyzing the services provided by the organization. This allows to determine the cost structure and its expense volumes.

2. Budget development. Planned expenses for resources and services necessary for the operation of housing and communal services are reflected in the budget. The budget focuses on controlling expenses, deadlines, and quality of work performed.

3. Work volume planning. The provided services must be planned according to the volume of work. This allows to determine the necessary staff and other resources to carry out the work.

4. Cost control. Cost control at each stage of the work allows to manage expenses and evaluate the effectiveness of the work.

5. Application of cost optimization methods. In addition to traditional cost planning methods, it is possible to use cost optimization methods, such as reducing losses and excess inventory, optimizing costs for energy resources and technological processes.

6. Quality control. To ensure the quality of the services provided, control is required, which may include testing and analyzing results.

Planning the prime cost of housing and communal services can face several risks and problems. Let us consider the most common ones:

1. Incorrect planning can lead to overpayment for services or insufficient profit, negatively affecting the organization's financial results.

2. Changes in market conditions can lead to increased costs for resources such as energy, labor, etc.

3. Inadequate resource utilization efficiency. Factors that reduce resource utilization efficiency may include low labor productivity, insufficient use of modern technology and equipment, and low staff qualifications.

4. Errors in assessing volume and cost of work can reduce the organization's profitability.

5. The organization's inability to forecast demand for services can lead to a decrease or increase in work volume, with a negative impact on financial performance.

6. Non-compliance with regulatory requirements and standards can result in fines and additional expenses to correct the identified violations.

Before planning the prime cost of housing and communal services, it is necessary to evaluate the productivity of each process stage and recognize possible risks and problems to make a rational decision and efficiently manage the organization's resources.

Developing a methodology to improve the planning of housing and communal services prime cost can be based on the analysis of best practices and successful experiences of organizations. Considering existing prime cost calculation methodologies [15] and all the experience, the following methodology to improve housing and communal services prime cost planning can be proposed:

Step 1. Analyze the current process of prime cost planning and identify problems and risks associated with all stages of the process.

Step 2. Determine goals and requirements, taking into account the specific activities of each individual organization.

Step 3. Choose the optimal prime cost planning method in accordance with goals and requirements. In some cases, it may be necessary to consider a combination of several methods.

Step 4. Upgrade the accounting information system.

Step 5. Implement a service quality control method and continuous staff training.

Step 6. Monitor plan execution and work on its complete implementation. If necessary, make adjustments.

Developing a methodology to improve service prime cost planning based on the experience of successful housing and communal services organizations can help to determine the best approaches to cost management, increase work efficiency, and improve the quality of services provided.

Assessing the effectiveness of the new prime cost planning approach can be done by analyzing the results after the implementation of the new methodology. To do this, several key indicators must be established that reflect the new cost planning approach. The possible indicators for assessing effectiveness are the following:

- reduced service costs (an important indicator of effectiveness would be a decrease in service costs after implementing the new approach to prime cost planning);

- increased profit, which could result from cost reductions, as well as increased sales volume or prices for services;
- improving the quality of services (the new approach to cost planning can help to improve service quality, which, in turn, increases customer satisfaction);
- reduced planning time (the new methodology can help to reduce planning time, allowing employees to focus on other tasks);
- developing a performance measurement system to evaluate planning quality through a comparative analysis of planned indicators and actual data obtained through the accounting system. Such a performance measurement system can be incorporated into the organization's management accounting and serve as a motivating factor for employees involved in the planning process.

In order to assess the effectiveness of the new approach to prime cost planning, conduction of data analysis before and after the introduction of the new methodology is necessary. Other factors that may influence the results, such as changes in market conditions or internal organizational processes, should also be taken into account. Feedback from consumers is also an important aspect that can help to evaluate the effectiveness of the new approach. In the end, conclusions can be drawn about the effectiveness of actions taken after implementing the new approach to prime cost planning.

Before developing a services prime cost plan, it is necessary to analyze the costs for each type of service, determine what resources will be required, and find ways to reduce costs. It is also advisable to determine the value for customers for each type of service. Modern prime cost planning methodologies such as “Target Costing” or “Activity Based Costing” help to increase the accuracy and effectiveness of budgeting.

To plan prime costs more accurately, it is necessary to have complete and precise information about all the organization's expenses. This can be achieved by systematizing data into a single database and regularly updating and verifying information. A unified information system will also allow for control of plan implementation. It is important to monitor the implementation of the prime cost plan throughout all the stages and, if necessary, adjust it according to new conditions.

It is also important to train staff in prime cost planning, modern cost management methodologies, and other technologies to increase efficiency and improve planning results.

Organizing feedback from customers is advisable to make management decisions on improving prime cost planning practices and service quality. Regular feedback is recommended for analysis and adjustment of service implementation strategy.

Applying these recommendations can help to increase the effectiveness of prime cost planning in housing and communal services organizations.

Prime cost planning for housing and communal services can face many challenges and difficulties. For example, to accurately determine the cost of services, precise data on internal expenses for electricity, gas, water, and other resources are needed, and it is also necessary to determine the level of losses, including technical losses. However, it can be difficult in the housing and communal sector to accurately determine how much resources were used, their quantitative consumption for residential properties, and to assess whether this consumption is fair and reasonable. To determine the prime cost of services, it is also necessary to accurately determine the amount of services provided. This can be challenging in the housing and communal sector since different properties require different amounts of services.

Determining the prime cost for housing and communal services can also be a problem. To establish the correct cost, many factors must be taken into account, while acceptable tariffs for consumers should be maintained (different income levels and other social indicators should also be considered).

To reduce expenses for the cost of services, housing and communal enterprises invest in modern equipment. However, the acquisition and maintenance of such equipment can become an additional burden on the company's budget. Accounting and cost control also present a serious problem for housing and communal enterprises. There are frequent cases of incorrect cost estimation and errors in calculations, which can lead to serious consequences and damage to the company's budget.

On the other hand, setting a high price for services does not guarantee their quality provision, which may lead to the loss of consumers and a decrease in company revenues. Considering the difficulties associated with services prime cost planning, housing and communal enterprises should be careful and no.rush to make decisions related to pricing and providing high-quality and reliable services.

Developing a methodology to improve prime cost planning can help the company to improve its production processes and achieve more accurate results in cost planning and control. Below there are some steps for developing a methodology to improve prime cost planning:

1. Evaluate the current prime cost planning methodology. Start by analyzing how prime cost planning is carried out in your company. Evaluate which data is currently being used in calculations, what methods are being used to account for costs, and how they are being controlled.

2. Determine goals for improving the prime cost planning methodology. Identify existing problems in the current methodology, establish the goals you want to achieve, and determine how improving the prime cost planning can increase business efficiency and reduce costs.

3. Develop a new prime cost planning methodology. The new methodology should consider all factors that influence the prime cost of services. The new methodology should determine how all expenses will be considered, which data will be used, and what processes and methods will be used to control expenses.

4. Implement the new methodology. Organize training for employees who will work with the new methodology. Ensure complete integration of the new methodology into all processes related to prime cost planning.

5. Evaluate the results and adjust the methodology as needed. Evaluate the effectiveness of the new methodology after implementation. Pay attention to any problems that may arise and make necessary adjustments to the methodology to achieve the best results.

The goal of developing a new methodology is to create more accurate and efficient prime cost planning, which will lead to a reduction in service costs and an increase in the quality of services provided.

Research has shown that a new approach to planning the prime cost of housing and communal services can significantly increase business efficiency and, if necessary, justify the level of economically sound expenses included in the calculation of tariffs for the services to the regulatory authorities, who are now guided in approving tariffs for housing and communal services not by the cost of these services, but by inflation rates set and regulated by the state.

The effectiveness of the new approach can be evaluated by comparing the results of using the new methodology with the results of using the old methodology. This can result in a higher accuracy of service prime cost calculations, allowing housing and communal enterprises to estimate costs and plan budgets better, while maintaining or increasing the quality and reliability of services provided.

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Методологические особенности планирования себестоимости услуг предприятий жилищно-коммунального хозяйства

Тема методологических особенностей планирования себестоимости услуг жилищно-коммунального хозяйства актуальна в свете необходимости повышения эффективности управления услугами жилищно-коммунального хозяйства за счет оптимизации расходов на их оказание и уменьшения затрат на управление. Тарифная политика со стороны государства в отношении организаций, предоставляющих услуги ЖКХ, является одной из основных направлений современной политики Правительства Российской Федерации. Темпы роста (изменения) регулируемых цен (тарифов) естественных монополий и организаций в сфере ЖКХ являются исходными внутренними факторами в Прогнозе социально-экономического развития России; а темпы роста (изменения) цен, указанные в нем, — это ориентир для принятия решений регулирующими органами об установлении предельных тарифов на услуги ЖКХ в субъектах РФ и тарифов на услуги организаций для потребителей. В настоящее время наблюдается дисбаланс экономических интересов поставщиков услуг ЖКХ и потребителей, который можно обозначить как один из важных принципов организации экономических отношений с регулируемым ценообразованием в рамках проводимой государством тарифной политики. В условиях постоянного увеличения стоимости ресурсов, возрастающих требований со стороны потребителей, а также обновления действующих систем реализации услуг ресурсно-снабжающими организациями, управление и планирование себестоимости являются неотъемлемой частью деятельности организаций жилищно-коммунального хозяйства. При правильном планировании себестоимости услуг возможно не только оптимизировать бюджеты ресурсно-снабжающих организаций, сокращая расходы, но и повысить качество и надежность предоставляемых услуг, что в свою очередь приведет к повышению уровня и качества жизни населения и сокращению темпов роста тарифов на услуги ЖКХ. Следовательно, изучение методологических особенностей планирования себестоимости услуг жилищно-коммунального хозяйства может быть полезно для оптимизации финансовых ресурсов, повышения качества услуг и улучшения управления жилищным комплексом в целом.

Ключевые слова: *планирование себестоимости, жилищно-коммунальный комплекс, экономика, регулируемые тарифы, методология ценообразования, расходы ресурсно-снабжающих организаций, тарифы на жилищно-коммунальные услуги*

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Creating probabilistic construction schedules in Microsoft Project

The *PERT* method allows generating and analyzing probabilistic construction schedules. In project management software this method takes the form of an information toolkit. However, to use this method to its full extent, it requires information on pessimistic durations of work. A number of methodological approaches based on theoretical provisions of mathematical statistics and expert evaluation methods could potentially be tapped to obtain this information. Under these approaches, a matter of principle is that the conclusions made are based on knowledge and data obtained in the past. However, the data required for *PERT* analysis may either not exist altogether, or not be representative, or fail to reflect the specifics of a project planned. Therefore, to get out of such situations, we have developed a methodology for discounting work time/durations, which allows the formation of pessimistic work schedules. The practical utility of the proposed method lies in the fact that the calculation of pessimistic durations of works is made dependent on the discount rate, which by its basic purpose is used to assess the economic efficiency of investment projects, and therefore is always a relevant parameter for any construction project under development.

Keywords: *project management, probabilistic scheduling of construction works, assessment of project's economic efficiency, flow construction methods, PERT analysis of construction projects*

INTRODUCTION

The *PERT* method is widely used in project management as it allows generating and analyzing probabilistic construction schedules. The schedules generated using this method are classified by groups that include optimistic, most probable, and pessimistic schedules. All these schedules of works are based on the respective probability durations, which are defined as optimistic — t_1, most probable — t_2 and pessimistic — t_3. It is assumed that all three characteristics, defined as parameters of random durations of works, are set by the user. In order to reduce all three schedules to a single work schedule, the beta distribution is used, according to which the mathematical expectation t is calculated using the following formula:

$$t = \frac{w_1 t_1 + w_2 t_2 + w_3 t_3}{6},\ w_1 + w_2 + w_3 = 6, \qquad (1)$$

where w_1, w_2 and w_3 are weighting factors, the sum of which in Microsoft Project (MP) [1] is considered to be 6, and by default, the numerical values of these weights are set as follows: $w_1 = 1$, $w_2 = 4$ and $w_3 = 1$.

When using the given method of probabilistic scheduling, it should be noted that the interpretation of the given durations of works should take into account the specific circumstances of the project delivery. For example, an optimistic duration can be interpreted as a planned time, which can also be inherently represented as a deterministic duration. In this case, both network and flow-based methods of work scheduling can be used to form optimistic schedules [2, 3].

The most probable duration is generally interpreted as the maximum value of the probability density distribution for a unimodal random variable. However, if the unimodal distribution is symmetric relative to the mathematical expectation, the corresponding mode is calculated as the arithmetic mean of the two extreme estimates. For example, if the total random duration/time is determined by a multitude of random works, then, because the central limit theorem applies to this case, its graph is defined by a normal distribution, which just happens to possess the property of symmetry [4]. In all other cases, to determine a mode of a random variable, respective representative statistics is required, on the basis of which one can use the regression analysis to restore the probability density function of the random duration. But then a contradiction arises in accepting the *PERT* method and the use of the beta distribution therein, as a factor of reliable management [5]. In the organizational design of construction works, however, the most typical situation is precisely the lack of representative statistics and therefore the determination of the most probable duration should proceed from a priori preset extremes.

Pessimistic durations of works are precisely those necessary and sufficient parameters of random works used in the *PERT* method. However, it should be noted that existing methodologies for generating pessimistic work schedules do not fully reflect all the practical situations that arise in construction scheduling. There are various methodologies defining the characteristics of random work durations, but each of them has its own merits and drawbacks, yet almost all of them are based on the past experience and background taken into consideration.

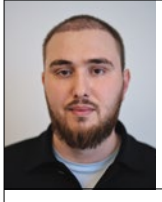
The methodology based on the application of mathematical statistics methods can be used whenever the statistics reflect a representative sample, as this requirement directly affects the error of the result [6]. It should also be noted that a special domain, called nonparametric statistics, has been dedicated for the statistical analysis of small



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samples [7]. A certain difficulty arises every time it is necessary to estimate the delay of complex works, with only part of these works being fully completed. A cost metric is used to reduce all volumes of the work to a single indicator. However, the labor involved, which mainly causes a delay, is not proportionate to the corresponding cost of the works. In the theory of measurement, this problem is referred to as data non-homogeneity and it is quite clearly revealed in the monograph [8]. In its applied aspect, the monograph [9], in order to hold to the homogeneity of results reflecting construction delays, presents statistics separating contracts with fixed and floating costs of construction projects. And this is only one characteristic determining the adequacy of the statistics transfer to future construction. Therefore, if reliable statistics are scarce or inadequate, given the future conditions, the applicability of mathematical statistics methodology is highly questionable.

The methodology of expert judgement or evaluation is another means of predicting the untimely performance of works. A significant disadvantage of its application is that it represents a fundamentally subjective way of measurement [8]. And so it is used only in extreme cases — for example, when planning the construction of unique facilities [10]. Another disadvantage of using this methodology is forming an adequate team of experts. There is no universal methodology governing this process in principle, although various methods for assessing the concordance of opinions surely exist. One example is Spearman's rank correlation available for judgments presented in a ranking scale [11].

In some cases, an analogy can be used between the spatial diminution of an observed physical object and the temporal uncertainty of the random duration of a work attributed to the future, as outlined in [12]. However, while data on the radius of curvature and height of observation above the surface are used in determining the spatial diminution of an object, data on the temporal planning horizon are pretty much artificial in terms of their origin [13].

The presented brief analysis indicates the limitations of the *PERT* methodology. Therefore, the practical purpose of our research is to develop such a methodology for generating probabilistic construction schedules that would ensure, to the maximum extent possible, a viable tool for finding pessimistic work durations, with instrumental implementation of the proposed method to be oriented towards the application of up-to-date project management software. As such, we chose *Microsoft Project*, since it allows visualizing pessimistic schedules of works through the *PERT* module.

METHODS

Consider an arbitrary work whose duration could be preset using the following limits: the minimum value of a and the maximum value of b and these characteristics can be treated as optimistic and pessimistic durations. Let us denote the moment of a pessimistic start of the work by the letter p and assume that this duration is determined by respective connections with the previous works. The $b = a$ case determines the traditional calculation of deterministic schedules described in numerous academic works [2, 3], and the alternative option, where $b > a$, determines the formation of a probabilistic work schedule.

In the methodology we suggest, to calculate pessimistic work durations, we will use the discount rate, denoted by the letter E. This rate is set as the main parameter included in the calculation of various criteria for assessing the economic efficiency of investment projects [14]. The discount rate used is part of the calculation of the discount multiplier, which, purely formally, shows the relative decrease in the value of money over time:

$$k_d = (1+E)^{-t}, \quad (2)$$

where t is the moment of time, when the relative depreciation in the value of money becomes apparent.

In [15], the ratio of discounted duration to a simple payback period used as the maximum pessimistic job performance index was suggested to determine the pessimistic durations of the works. This approach became known as the discounted duration method. However, under this approach additional information on the payback or income-generating period would be required to calculate pessimistic work schedules. If such information is not available, it is possible to simulate the income-generating part of the cash flow, based on calculating the minimum value of the virtual sale as defined in [16]. Yet, with this approach, we encounter with degeneracy in the characteristics of both payback periods, because under a one-shot sale of a built asset, both values of the payback periods will be determined by the planned duration of construction works. This negative circumstance can surely be eliminated by replacing the instantaneous virtual sale by an equivalent annuity, though in this case many additional conditions are added to the set problem, which artificially complicates the calculation methodology. Therefore, we'll further present an improvement of the discounted duration method outlined above.

Analyzing the change in the discount factor over time, we come to the conclusion that any income generated or payment made at the beginning of the project will be higher than the income or payment assigned to the end of the project. As a result, assuming that the duration of the work is unchangeable, it appears that if it is done at the beginning of the project, the unit cost of doing the work will be higher than if it is done at the end of the project. The given example shows that the deterministic schedule does not take into account the reduction in costs associated with money value depreciation over time. If we assume that the unit cost of doing the work shall not change over time, the duration of the work must increase and this increase should be inversely proportionate to the discount factor.

Note the following circumstance. It is assumed that the decrease in the value of money over time is only used as an estimation characteristic. Extrapolating this assumption to the subject of interest to us, related to the increase in the work duration over time, the latter can also be interpreted as a valuation characteristic determining a pessimistic increase in the duration of the work(s) in question.

Taking this provision as a foundation, in order to quantify the pessimistic duration, we'd need to consider any work consisting of small elements. Then each small element of the optimistic duration divided by a discount factor would determine its corresponding pessimistic duration. It follows from this assumption that the pessimistic duration can be calculated using the following formula:

$$b = \int_p^{p+a} (1+E)^t \, dt = \frac{(1+E)^p \cdot \left[(1+E)^a - 1\right]}{\mathrm{Ln}(1+E)}. \quad (3)$$

As can be seen from formula (3), the calculation of the pessimistic job duration depends on the following values: the discount rate used as a constant parameter, the work start date associated with the calculation of the schedule preceding this work, and the deterministic duration of the job being calculated. The algorithm for calculating a pessimistic schedule is reduced to the following steps.

Step 1. The deterministic schedule is generated according to the given calculation method using optimistic durations of works.

Step 2. The zero point in time for the beginning of pessimistic and optimistic schedules is found.

Step 3. For all activities that start at the zero point in time, the pessimistic durations and corresponding pessimistic endings of the works are calculated.

Step 4. The pessimistic beginnings of subsequent activities or works are also determined, as prescribed by the critical path method.

Step 5. Pessimistic durations and terminations are calculated for the activities with pessimistic beginnings.

Step 6. If the list of activities/works is not exhausted, return to step 4 would be required; otherwise the calculation of the pessimistic schedule is thought to be completed.

Note the following specifics of the above algorithm. At step 5, the pessimistic durations are calculated; however, the pessimistic duration determined through other alternative methods can be used to implement the algorithm instead of the duration calculated via formula (3). Also, this algorithm allows the use of any time constraints presented in project management software. Therefore, the above sequence of actions can be considered universal enough for the purpose of forming any variants of pessimistic scheduling.

RESULTS AND DISCUSSION

Table 1 shows an example of calculating a pessimistic work schedule, whose optimistic (deterministic) version is calculated using the critical path method for early event dates. In the schedules presented, the discount rate is 30 % per annum, all event dates and durations are shown in months, whereas the relevant input data are practically equivalent to those included in the residential construction duration standards[1].

If both calculated work schedules are entered into *Project Expert (PE)* and, at the same time, the economic environment of this 4-building development project is simulated therein, the calculation may result in obtaining all of the cost-effectiveness evaluation criteria for the given project in case of its deterministic and pessimistic delivery [17]. This is a very useful feature whenever the *PE* software is used, given that its basic functionality, related to sensitivity analysis, does not include the calculation of performance indicators for pessimistic schedules of works.

The methodology presented above can also be applied to the calculation of construction flows, carried out according to different principles outlined in [3]. Table 2, assuming the same input or source data, shows the results of calculating a pessimistic schedule of works corresponding to the flow organization of construction works, relying on the method of continuous use of resources (CUR).

The peculiarity of the algorithm applied to this method of construction organization is that the calculated deployment periods are used to form such timing of events, at which continuous performance of the same type of works on all buildings is observed. Further, the algorithm is fully adequate to the previous example, but its application to form a pessimistic schedule does not result in maintaining the continuous use of resources. This, in our opinion, is not the main point, since the main priority in forming a pessimistic schedule of works is the calculation of pessimistic deadlines, which

Table 1. Optimistic and pessimistic schedules calculated using the CPM

Stages of work		Preparation			Ground zero			Above-ground portion			Interior works		
Number of buildings		Start	Duration	Finish	Start	Duration	Finish	Start	Duration	Finish	Start	Duration	Finish
1	Plan	0	1	1	1	3	4	4	4	8	8	3	11
	Pessimistic	0	1.01	1.01	1.01	3.17	4.18	4.18	4.58	8.76	8.76	3.76	12.52
2	Plan	1	2	3	4	2	6	8	4	12	12	2	14
	Pessimistic	1.01	2.09	3.1	4.18	2.24	6.42	8.76	5.06	13.82	13.82	2.77	16.59
3	Plan	3	2	5	6	3	9	12	6	18	18	4	22
	Pessimistic	3.1	2.19	5.29	6.42	3.57	9.99	13.82	8.67	22.5	22.5	6.84	29.34
4	Plan	5	1	6	9	2	11	18	5	23	23	3	26
	Pessimistic	5.29	1.13	6.42	9.99	2.54	12.53	22.5	8.64	31.14	31.14	6.13	37.27

Table 2. Optimistic and pessimistic schedules calculated using the CUR method

Stages of work		Preparation			Ground zero			Above-ground portion			Interior works		
Number of buildings		Start	Duration	Finish	Start	Duration	Finish	Start	Duration	Finish	Start	Duration	Finish
1	Plan	0	1	1	1	3	4	4	4	8	14	3	17
	Pessimistic	0	1.01	1.01	4	3.38	7.38	8	4.98	12.98	17	4.5	21.5
2	Plan	1	2	3	4	2	6	8	4	12	17	2	19
	Pessimistic	1.01	2.09	3.1	7.38	2.4	9.79	12.98	5.55	18.53	21.5	3.27	24.77
3	Plan	3	2	5	6	3	9	12	6	18	19	4	23
	Pessimistic	3.1	2.19	5.29	9.79	3.84	13.63	18.53	9.62	28.15	28.15	7.74	35.88
4	Plan	5	1	6	9	2	11	18	5	23	23	3	26
	Pessimistic	5.29	1.13	6.42	13.63	2.75	16.38	28.15	9.78	37.93	37.93	7.11	45.03

1 SNiP 1.04.03–85*. Duration of construction and margin in building industrial facilities and structures.

Table 3. Optimistic and pessimistic schedules calculated using the CFE method

Stages of work		Preparation			Ground zero			Above-ground portion			Interior works		
Number of buildings		Start	Duration	Finish	Start	Duration	Finish	Start	Duration	Finish	Start	Duration	Finish
1	Plan	0	1	1	1	3	4	4	4	8	8	3	11
	Pessimistic	0	1.01	1.01	1.01	3.17	4.18	4.18	4.58	8.76	8.76	3.76	12.52
2	Plan	4	2	6	6	2	8	8	4	12	12	2	14
	Pessimistic	4	2.23	6.23	6.23	2.34	8.57	8.76	5.06	13.82	13.82	2.77	16.59
3	Plan	7	2	9	9	3	12	12	6	18	18	4	22
	Pessimistic	7	2.38	9.38	9.38	3.81	13.19	13.82	8.67	22.5	22.5	6.84	29.34
4	Plan	15	1	16	16	2	18	18	5	23	23	3	26
	Pessimistic	15	1.4	16.4	16.4	2.93	19.33	22.5	8.64	31.14	31.14	6.13	37.27

determine the pessimistic cash flow, being the basis for calculating the performance criteria.

Similarly, pessimistic schedules of works are formed according to a flow-based method related to the principle of continuity of works on each building (see Table 3), which was given the name of the Continuous All-Front Endeavour (CFE) method.

Now let us analyze the applicability of the results of calculating pessimistic durations in the *PERT* module of Microsoft Project, for which we should consider the specifics of setting the probable work duration. As was noted above, this duration is relevant only for unimodal distribution density functions. But if we consider symmetric distribution functions, we can calculate the average duration for different distribution types using variations of weight coefficients. For example, taking $w_1 = 3$, $w_2 = 0$ and $w_3 = 3$ and using formula (1), we can calculate the average time of any symmetric distribution and it is not necessary to preset its most probable value. As for asymmetric distributions, their relevance can be justified by determining the asymmetry coefficient, though its calculation will require additional statistical data which, as has already been noted, are extremely limited. Therefore, in our view, the *PERT* analysis can be limited to the setting of only two parameters, one being the planned duration and the other the pessimistic duration.

CONCLUSION

The presented article has given the methodology, its justification and practical examples related to the formation of pessimistic schedules of works, depending on the discount rate, which by its main purpose is used to assess the economic efficiency of investment projects.

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Формирования вероятностных расписаний строительных работ в программе Microsoft Project

Метод *PERT* позволяет формировать и анализировать вероятностные расписания строительных работ. В программах управления проектами данный метод представлен в форме информационного инструментария. Однако для полноценного использования этого метода требуется информация по пессимистическим продолжительностям работ. Для ее получения может быть использован ряд методологических подходов, основанных на теоретических положениях математической статистики и методах экспертной оценки. При таких подходах принципиальным моментом является то, что получаемые выводы базируются на знаниях и данных, полученных в прошлом. Однако нужные для *PERT*-анализа данные могут либо вообще отсутствовать, либо быть нерепрезентативными, либо не отражать конкретную специфику планируемого проекта. Поэтому для выхода из подобного

рода ситуаций авторами разработана методика дисконтирования продолжительностей работ, позволяющая формировать пессимистические расписания работ. Практическая полезность предлагаемой методики заключается в том, что расчет пессимистических продолжительностей работ поставлен в зависимость от дисконтной ставки, которая по своему основному назначению используется для оценки экономической эффективности инвестиционных проектов, а поэтому всегда является актуальным параметром для любого разрабатываемого строительного проекта.

Ключевые слова: *управление проектами, планирование вероятностных расписаний строительных работ, оценка экономической эффективности проекта, методы поточного строительства, PERT-анализ строительных проектов*

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Setting a problem on the rational allocation of a resource, intended to ensure integrated enterprise security

This article introduces the resources of an enterprise as a rich internal potential, which is aimed at the sustainable functioning of the production process. For the first time, in the form of a problem, a new consolidated methodologically described direction is presented, the solution of problems in which is focused on the resource provision of subsystems included in the complex security of an enterprise. Approaches using existing methods in the integrated security of enterprises are analyzed, peculiarities of their application are considered. Justification for choice of the Lagrange multiplier method is presented, with the use of which statement of a problem for the rational distribution of the resource intended to ensure the sustainable functioning and development of departmental (industry) subsystems included in the integrated security of the enterprise is formed. The article presents a statement of the problem of the rational allocation of resources (material, economic, time, labor, information, the rational use of which allows the integrated security system to move to a higher level of development. The solution of particular problems that are part of the content of the methodologically described problem will make it possible to develop a methodology for the synthesizing of integrated security that can adapt to various conditions of enterprise functioning (routines of daily activities, as well as threats and emergencies of a natural and man-made nature), which has important economic value for Russia.

Keywords: *problem statement, rational distribution, particular tasks, integrated security system, interdisciplinary approach*



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INTRODUCTION

A rather long period, covering the beginning of the 19th century and up to the present, is marked by a constant increase in interest in technosphere safety, the solution of tasks in which requires constant improvement and development. Recently, the focus of fundamental, systemic and applied research in the field of analysis and management of technospheric safety, taking into account the accumulated experience of setting and solving this problem, has acquired a new importance in connection with the transition from 2018 to a fundamentally new level of solving issues of scientific analysis , regulation, regulation and ensuring of technosphere safety and protection against emergencies in accordance with the Decrees of the President of the Russian Federation on the basis of state policy in these areas for the period up to 2030 and beyond [1, 2].

The analysis of the statistics of accidents, fires, damage to health or the death of personnel working at the enterprise allows us to conclude that the solution of tasks related to improving the safety of the functioning of industrial safety (IndS), fire safety (FS), labour protection (LP) at enterprises is of exceptional importance for the state and society, their solution is one of the priority areas for ensuring the national security of Russia [3]. The introduction of a new approach to safety management at an enterprise requires the development of an appropriate scientific and methodological apparatus (methods, techniques) that allows you to manage this state [4]. It is obvious that stabilization of the situation in departmental (sectoral) subsystems (IndS, FS, LP) at industrial enterprises of Russia will be able to occur when, in general, for the integrated security (hereinafter — IS) of these enterprises, a course is chosen according to its purposeful and comprehensive development [5]. The development of the security of any enterprise is a change in the old approach to its management formed over the years and the introduction of such a new approach that would be based on the results of introducing innovations, advanced knowledge in science, application of new technologies [6]. The key idea in solving the problem of ensuring the qualitative level of safety at the enterprises of the Russian petroleum industry is directly related to the development of an integrated intersectoral approach based not only on scientific and technical achievements and methodological approaches in the field of reliability, safety, survivability functioning of physical objects [4, 7, 8], but also in building adequate tools for organizational and technical work for the transition of IS system of industrial enterprises to a new qualitative level of development [9]. Previous studies indicate the fact that the problems of providing IS system for oil and gas sector (OGS) in Russia are complex and multifaceted, their solution requires consideration of the interaction between industry subsystems (IndS, FS, LP), which have the properties of adaptation to counteract accidents and fires [3, 5, 10]. The circumstances presented above are characterized by a high degree of relevance, have a direct relation to the management of IS at industrial enterprises, require a detailed in-depth study of the mechanism of functioning of industry subsystems (IndS, FS, LP), included in the content of IS of enterprises OGS in Russia.

METHODS

In this study, the method of analyzing and criterion of Hegel were used. Any developing management system strives to achieve a compromise, based on rationality, between stability and development in the course of its operation. Everything that develops is contradictory, and "contradiction is the criterion of truth, the absence of contradiction is the criterion of delusion" (Hegel).

The increase in the number and technical complexity of hazardous production facilities at the enterprises of the OGS requires the use of various types of resource means (material, economic, time, labor, information, etc.) designed to ensure the stable functioning of the IS [11, 12]. In turn, stability and development (based on rationality), used in the field of IS, are two extreme points of interrelation, as they reflect the dialectical unity of opposites, namely:

- stability denies development, at the same time it acts as a foundation, without which it is impossible;
- development destroys stability, as it requires the introduction of a new scientific and methodological apparatus used in the form of procedural knowledge for subsystems (IndS, FS, LP), which makes it possible to ensure the adaptation of subsystems to counteract accidents and fires for their more stable functioning [13–15].

More and more attention paid to the issues of rational use of various types of resource funds intended to ensure the stable functioning of the IS of oil and gas companies of Russia, knowledge of the characteristics relevant to the rational use of resources can support the search for the right tools to bring Russian industrial enterprises to a new qualitative state.

The article will not present the whole complex of tasks solved at the enterprise related to the distribution of the resource in monetary or material terms, but only part of it related to the potential of the working personnel performing labor duties to ensure departmental (sectoral) subsystems included in IS of the enterprise, where with the help of the indicated potential it will be possible to:

- analyze the statistics of hazard occurence in industry areas (Rostekhnadzor, the Ministry of Emergency Situations of Russia, the Ministry of Labor, etc.), to build a structural diagram of the factor relations between sources of occurrence and receivers of hazards, to determine the parameters of the susceptibility of these areas to the impact of hazards, their initiation of secondary influencing factors;
- to assess the reserve of reliable functioning of departmental areas included in the IS of the enterprise, which will allow the formation of a resource for sending to those points in the first place, which have the highest risk indicators.

The structural content of the system study on the distribution of the resource intended for the IS of the enterprise is presented (see Fig. 1).

The consistent description of the block elements included in the content of the blocks (Fig. 1) will allow the development of methodology as a science that studies the pattern of emergence and development of methods for cognition of IS. Methodology as a particular system of knowledge that arises at the methodological stages of cognition is the study of methods and theories that arise at the corresponding stages of cognition [16]. Some of the most important points of application to the methodology of the IS of an enterprise as a science include the formulation of a scientific problem will be presented in this research.

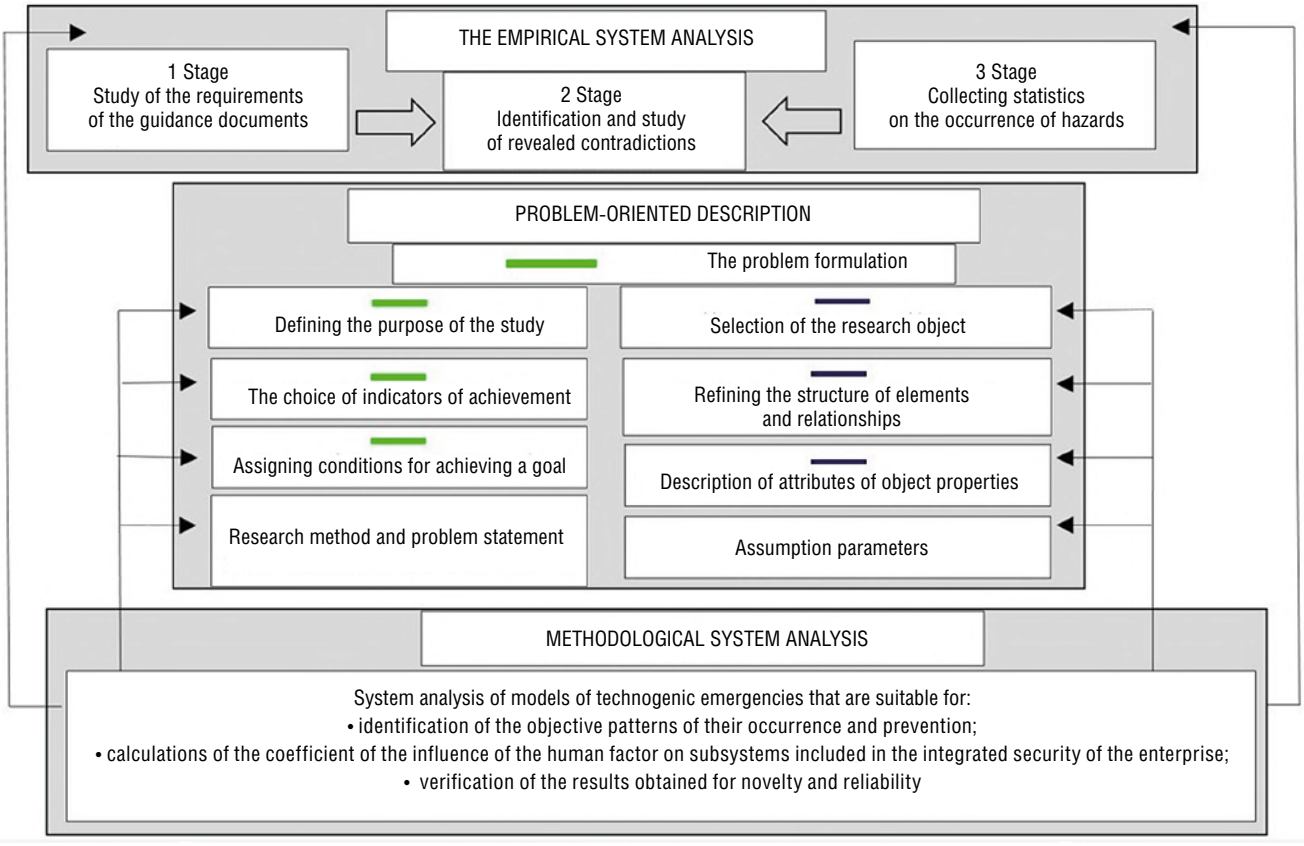


Fig. 1. The structural content of the system study on the distribution of the resource intended for the IS of the enterprise

RESULTS

Statement of the problem of the rational distribution of resources to ensure the IS system at the enterprises of the OGS of Russia in the conditions of development demonstrated below. Task is to reduce accidents and fires at Russian oil and gas companies, a common limited resource is allocated equal to the general indicator S, which combines all resource private volumes S_n in the form of targeted resource investments in departmental (industry) subsystems (IndS, FS, LP), included in the IS enterprises:

$$S = \sum_{n=1}^{N} S_n. \quad (1)$$

A problem to be solved: how to allocate the common resource S, allocated by the enterprise for the stable functioning of the IS system, in such a way among the elements of departmental (industry) subsystems (IndS, FS, LP) in order to obtain the greatest effect in the development of a stable system of IS functioning at the oil and gas company of Russia in conditions of restrictions on its total volume of resource provision:

$$\sum_{n=1}^{N} S_n < S. \quad (2)$$

In order to obtain the best indicator of the development of a stable functioning IS system of OGS of Russia (P), it was necessary to redistribute the order of resource allocation so that it would be targeted to eliminate violations of precisely those activities in the ranking list that have a high index of impact on the occurrence of events (accidents and fires) with maximum damage.

There is a mathematical problem of finding the largest value of the function:

$$P = F(S_1, S_2, \ldots, S_N), \quad (3)$$

subject to the following restrictions:

- for the total amount of resource provision, represented by variables in the form:

$$S_1 + S_2 + \ldots + S_N = S; \quad (4)$$

- for allocated private volumes of resource support intended for departmental (industry) subsystems (IndS, FS, LP) in the form:

$$S_1 > 0,\ S_2 > 0,\ \ldots,\ S_N > 0. \quad (5)$$

Values in the form of indicators of partial volumes $S_1, S_2, \ldots, S_N$, subject to the restrictions represented by expressions (4), (5), are considered as uniformly overhanging from the central point $M(S_1, S_2, \ldots, S_N)$ weights (loads) related to indicators private volumes $S_1, S_2, \ldots, S_N$ adjacent to the lateral surface of the cylinder (Fig. 2).

The maximum value of the function represented by expression (3) is on the surface of downwardly sloping lines supporting weights at the top of the cylinder (point M_k), where all coordinates except one are equal to zero, and the zero coordinate $S_k = S$. At this point of the top of the cylinder (point M_k) the equality:

$$dP = E_k \Delta S, \quad (6)$$

where E_k — the significance of the contribution to the k industry (IndS, FS, LP), the value of which is directly proportional to the distance (from the lowest point of the weight (load) to the point M_k,

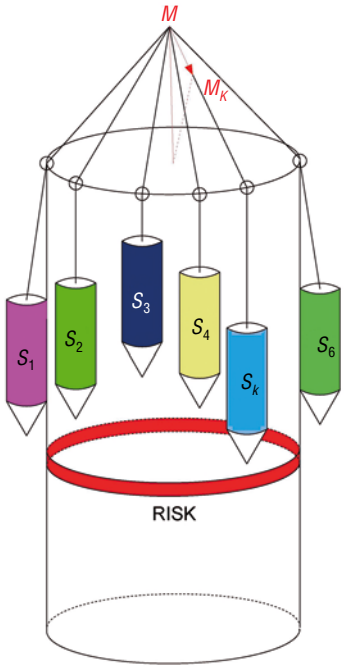


Fig. 2. The Steady State Weighting Factor of subsystems of IS of oil and gas companies of Russia

located at the top of the cylinder (see Fig. 2). Thus, the greatest value of the function represented by expression (3) has the stress vector in the direction of the line downwards, the weight (load) of which is as close as possible to the risk line.

For the efficient use of the enterprise resource intended to provide the IS system, the application of the Lagrange multiplier method is justified [17–21]:

$$L(S_1, S_2, \ldots, S_N, \Lambda) = F(S_1, S_2, \ldots, S_N, \Lambda) + \Lambda\left(S - \sum_{n=1}^{N} S_n\right), \quad (7)$$

where Λ — Lagrange multiplier.

The extremum condition for expression (8) was written as:

$$\begin{cases} \dfrac{\partial L}{\partial S_n} = \dfrac{\partial F}{\partial S_n}((S_1, S_2, \ldots, S_N) - \Lambda) = E_n - \Lambda = 0 \ (n = 1, 2, \ldots, N) \\ \dfrac{\partial L}{\partial S_n} = S - \sum_{n=1}^{N} S_n. \end{cases} \quad (8)$$

With an increase in the resource contribution — S by dS for industry subsystems (IndS, FS, LP), when the extreme point from the point $M(S_1, S_2, \ldots, S_N)$ moves to the point $M_k(S_1 + dS_1, S_2 + dS_2, \ldots, S_N + dS_N)$ (Fig. 6), the mathematical expression is:

$$dS = \sum_{n=1}^{N} E_n, \quad (9)$$

where E_n — the efficiency of the resource's contribution to the subsystems (IndS, FS, LP). Hence, the development of a stable IS system functioning at an oil and gas company of Russia can be represented as:

$$dS = \sum_{n=1}^{N} E_n dS_n = \Lambda \sum_{n=1}^{N} dS_n = \Lambda dS. \quad (10)$$

It follows from the ratio presented by formula (10): $dP = \Lambda dS$, which confirms the meaning of using Lagrange multipliers (Λ),

which is considered as the efficiency of the resource's contribution to the development of a stable functioning IS system at Russian oil and gas companies.

This leads to the conclusion that if we consider the development indicator for a stable functioning IS system of an OGS of Russia as one of the most important safety indicators, then based on the use of the Lagrange multiplier method, factor indicators (weights) that affect the occurrence of joint events (accidents and fires) can be determined:

$$P = F\left(\lambda_1(S_1),\ \lambda_2(S_2),\ \ldots,\ \lambda_N(S_N)\right) = F(S_1,\ S_2,\ \ldots,\ S_N), \qquad (11)$$

which can be used to derive all the causal factors affecting the state of the IS system functioning at the enterprises of the OGS of Russia can be obtained.

CONCLUSIONS

The author of the article, in order to solve the tasks, included in the content of the presented problem, guided by a methodology that includes in its content both previously known methods and newly proposed ones [4], tried to achieve results in obtaining new scientific knowledge, based on the presentation justification of the chosen methods to obtain new results, which included in the content of the developed scientific and methodological apparatus, which is understood as part of the theory in the form of an arsenal of procedural knowledge, the main elements of which are the methods and techniques used to solve scientific and practical problems [16].

The sequence of solutions to the problem presented above consists in solving particular scientific problems:

- particular scientific task No. 1, related to the development of models for assessing the state of the existing stable-functioning IS system at the enterprises of the OGS of Russia;
- particular scientific task No. 2, related to the development of a methodology for assessing the state of the IS system at the enterprises of the OGS of Russia.

Information about the content of setting and solving particular scientific problems is presented with the help of an arsenal of tools included in the content of the scientific and methodological apparatus used to obtain new scientific results (Fig. 3).

Previous studies indicate that the problems of ensuring the IS of oil and gas companies of Russia are complex and multifaceted, the results of modern research used in the practical activities of enterprises indicate the need to develop a full arsenal of tools that can counteract accidents and fires at oil and gas companies of Russia.

The article presents a theoretical justification and develops a problem statement for the rational distribution of the resource, to ensure the IS system at the enterprises of the OGS of Russia. To achieve the goal, it is necessary to use an arsenal of tools (models, methods, techniques, etc.) included in the content of the scientific and methodological apparatus, the adequacy of the use of which was confirmed when solving particular problems.

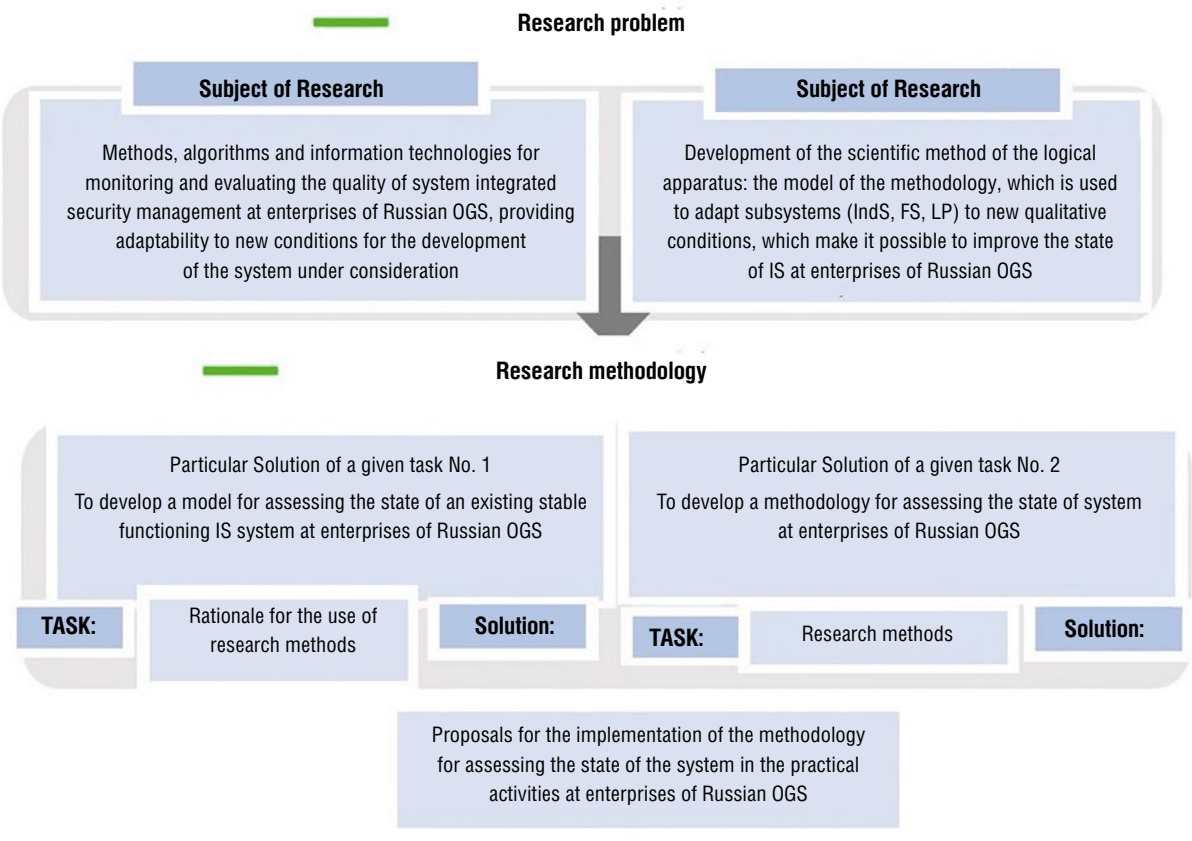


Fig. 3. The model of solving particular scientific problems

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Постановка проблемы по рациональному распределению ресурса, предназначенного для обеспечения комплексной безопасности предприятий

Ресурсы предприятия — это его богатый внутренний потенциал, который нацелен на устойчивое функционирование производственного процесса. Впервые в виде проблемы представлено новое укрупненное методологически описанное направление, решение задач в котором сосредоточено на ресурсном обеспечении подсистем, входящих в комплексную безопасность предприятия. Проанализированы подходы с использованием существующих методов в комплексной безопасности предприятий, рассмотрены особенности их применения. Представлено обоснование по выбору метода множителей Лагранжа, с применением которого сформирована постановка проблемы по рациональному распределению ресурса, предназначенного для обеспечения устойчивого функционирования и развития ведомственных (отраслевых) подсистем, входящих в комплексную безопасность предприятия. В статье представлена постановка проблемы по рациональному распределению ресурсных средств (материальных, экономических, временных, трудовых, информационных и т. д.), рациональное использование которых позволяет системе КБ перемещаться на вышестоящий уровень развития. Решение частных задач, входящих в содержание методологически описанной проблемы, даст возможность разработать методологию синтеза комплексной безопасности, способной адаптироваться к различным условиям функционирования предприятия (режимы повседневной деятельности, а также угрозы и возникновения чрезвычайных ситуаций природного и техногенного характера), что имеет важное хозяйственное для России значение.

Ключевые слова: *постановка проблемы, рациональное распределение, частные задачи, интегрированная система безопасности, междисциплинарный подход*

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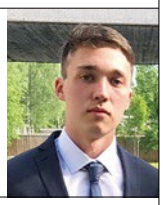
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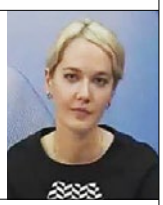
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Mechanisms for the application of information modelling technologies at individual stages of the life cycle of development projects

This article describes the benefits of using information modelling technologies, in particular, in the implementation of unique real estate objects. Automation of the stages of project implementation, especially in the implementation of unique objects, is one of the most important tasks, the purpose of which is not only to unload the ICP (Investment and Construction Project) participants, but also to eliminate errors at all stages of the project. The possibilities of using cloud systems, an information model of an object, etc., are considered, thereby obtaining an effective tool for improving the quality of the organization of construction production in the implementation of an investment and construction project. This article gives a review of the features of the application of information modelling technologies at individual stages of the life cycle, which reflect the main advantages and the effect achieved in the implementation of development projects, and also the optimal mechanism for the application of information modelling technologies is developed. A strategy is proposed for improving digitalization processes in the implementation of investment projects at its individual stages with the possibility of creating an information model of a building that will organize the functions of an information resource of an object and a digital platform for the interaction of all project participants. Thus, it becomes possible to obtain direct effects from the participants' control in the project implementation and from the procedures accompanying the project implementation. At the same time, the information model should function as part of a single digital environment to analyze and systematize the information received about the object. The opportunities of using the information modelling technologies as a digital platform for the effective implementation of development projects are considered.
Keywords: *IMT, 3D building model, information modeling*



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INTRODUCTION

At the present time there is a rapid development of digitalization of the construction industry in Russia. The realization that without information modelling technologies (hereinafter referred to as IMT) and artificial intelligence (hereinafter referred to as AI) the development of the industry is impossible has become fundamental in the development of IMT in Russia. It is thanks to IMT and AI that it became possible to implement complex projects with higher quality values. The use of IMT in the construction industry is one of the effective ways not only to bring the construction industry to a new level, but also to make the construction process more efficient [1].

The need for the construction of unique buildings is determined by social, technical, environmental needs, economic feasibility, as well as new trends towards creating a modern look for the city with the primary preservation of the surrounding landscape. It is characterized by the creation of space-planning solutions using multi-level spatial elements (underground spaces, passages, atriums), a combination of various functional areas, the use of environmentally friendly materials, and the introduction of innovative engineering solutions.

MATERIALS AND METHOD

An analysis of the specifics of the IMT application at individual stages of the life cycle made it possible to identify the achieved effect and the main costs, as well as to form the optimal mechanism for the IMT application in the implementation of development projects.

Concept and FEED (Front-End Engineering Design). This stage includes a set of economic and engineering surveys that establish the economic feasibility of locating and operating a construction site in the considered development area.

As a result of this stage, the following results can be obtained:

1. Provision of construction industry with local building materials, water, electricity.

2. Production capacities use of local construction companies and contractors.

3. The current local transport infrastructure use and its further development.

IMT at this stage is used not only in the form of an information model of an object, but also for the purpose of timely exchange of initial permits to allow to conduct electronic document management, conclude contracts, track the phasing of the project at this stage, etc.

Effects and costs at this stage: simulation modelling (case study of the project). Calculation of alternative costs of ICP.

Engineering. At the stage of engineering a construction object, engineering solutions, parts and sections of project documentation are considered, analyzed and agreed upon in various state authorities, depending on the type and nature of the work performed, the inhabited area or region where construction is underway.

At the final stage of the construction object engineering, in accordance with the current regulatory documents, an examination of engineering solutions (technical documentation) is carried out. During the implementation of the project, the project is

checked for compliance with the engineering assignment, the quality and correctness of the decisions made, the level of the modern construction base, the progressiveness of the design and architectural solutions of the facility, methods of organizing and mechanizing construction processes.

As a result, project documentation should reflect solutions that are oriented towards manufacturability and provide mandatory conditions and opportunities for subsequent periods of the life cycle of a construction object, including:

1. Ensuring standard values of construction loads (for the period of construction) and operational loads (for the period of operation) on structural systems or individual elements of the designed construction object.

2. The possibility of ensuring the efficient and safe operation of the designed building or structure and requirements, including the maintenance of structural elements of the building, networks of its engineering and technical support systems.

3. Ensuring the convenience of conducting inspections and surveys of the technical condition of the structural system, carrying out scheduled repairs during the operation of a building or structure.

Effects and costs at this stage: reduction of engineering time due to the use of backlogs from the model built at the previous stage. The quality, accuracy of the project increases, its susceptibility to changes increases. The time is reduced and the accuracy of constructive, estimated costs and other calculations is increased. The complexity of the initial design stage, which lays the foundation of the model, increases due to the need to simultaneously start modelling all sections of the project and the need to create new elements in the library of modelling elements. There is a restructuring of the costs according to the development contract of construction documents in favor of the engineering stage. The corresponding restructuring of the contract amount with specification for each of the projects becomes relevant.

Construction. The construction phase is key to ensuring the performance and performance established during construction surveys and engineering periods.

These characteristics and indexes determine the reliability and safety level of the subsequent operation of a building or structure. The scope of application of information modelling technologies at this stage is formed on the basis of a technological order that involves the implementation of simple and complex processes of construction and installation work. Their structure, volume and composition are determined by the adopted structural system of the building, the parameters of structural elements, as well as the uniqueness and technical complexity of the construction of a building object.

Effects and costs at this stage: cost reduction ≥ 10 %, along with an increase in the quality of the building project and the implementation of construction and installation works.

Exploitation. The stage of operation of a building object under construction (new construction, reconstruction, enhancement) is the main and target stage of its life cycle. Maintenance of the constructed construction object is carried out after obtaining permission to put the object into operation. The task of the management company is to assess the technical condition and maintain the aesthetic, structural characteristics, as well as reliability and safety indexes at the established level, during the established service life of the building.

The assessment of the technical condition is carried out, including using the information model, by periodically checking the conformity of the characteristics of structural systems and load-bearing structural elements.

Planned maintenance and preventive measures ensure the preservation of the performance of structural systems and/or individual structural elements (especially load-bearing elements) and compensate for the detrimental effect of influencing factors that occurred in previous periods of the life cycle of a construction object (survey, engineering, construction).

Dismantling. The transition to this stage is possible when negative impact factors appear in a dramatic number (for indexes of functional efficiency and the level of operational safety) of defects and damage to the structural system or individual load-bearing structural elements of the construction object.

The organizational and technological order of the demolition of the construction site is carried out in accordance with the characteristics of the technical condition of the structural system, the location in the surrounding urban development and the requirements of regulatory legal acts.

Effects and costs at this stage: improving the quality of the object at the stage of commissioning and at the stage of operation. Reduction of costs for the facility operation, for the cyclic change of the facility (overhaul works, reconstruction, etc.).

The improvement of digitalization in construction should be not only the information model of the construction object, which is an object shared information resource, the main function of which is to ensure the possibility of teamwork on the project of all participants in the investment and construction project at certain stages of the object's life cycle, but also a large digital platform, uniting all participants in the ICP implementation, who have access to the information model of the building and related documentation.

The presented mechanism will be effective not only in terms of "transparency" in the implementation of the project, but also in terms of control of all participants in the ICP.

The implementation of the main function of the information model is possible only if the model is part of a single digital environment capable of ensuring the continuous receipt, processing, accounting and analysis of information from various sources throughout the entire life cycle of the object.

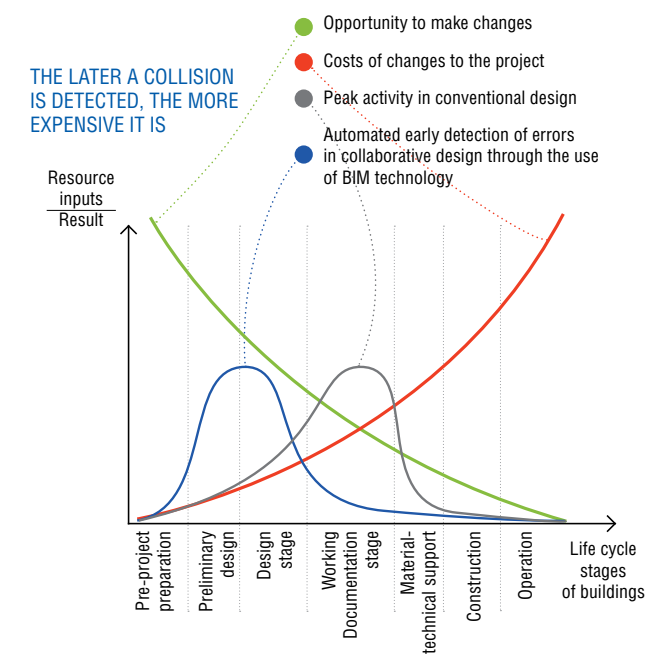


Fig. 1. Resource consumption changes

The creation of a unified digital environment is also gaining strategic importance in view of the need to reduce interaction during the implementation of construction investment projects (see Fig. 1).

Creating a single digital environment can be done in several ways:

1. Internal solution. Various schemes are used using network folders or some kind of software that ensures work within the company itself.

2. Specialized software is used. The scheme generally looks like this: the company's server has software, each user's PC has a frontend. Only the owner of the system can take full advantage of the system.

3. Cloud solution. The most promising way to organize a common platform. The main feature is that full functioning is provided.

RESULTS

The engineering of unique, high-rise and long-span buildings and structures requires mandatory and full-scale scientific and technical support. The tasks of scientific and technical support (hereinafter — STS) in the design and construction of unique, long-span and high-rise buildings and structures are to ensure the safety of people, the construction site and the reliability of the structures being built. Also, the tasks of the STS are:

1. Solution development to eliminate violations identified during the monitoring of engineering solutions.

2. Science-based and optimal solutions development, participation in the identification of design and engineering solutions.

3. Building and structure state forecast, taking into account possible types of impacts.

Conducting STS includes the following scope of work:

1. Evaluation of the results of engineering and geological surveys.

2. Participation in the development of the concept of the engineered object.

3. Engineering documentation analyses to improve design and space-planning solutions.

In this regard, the use of IMT, in particular, in the implementation of development projects of unique objects, is extremely necessary in order to eliminate errors.

Let's consider the use of a digital platform and other IMT opportunities in order to implement unique ICP.

Thanks to a digital platform, it becomes possible to monitor the status and change of the project in real time. To do this, there is the "General Information" tab, which displays general information on the project, a widget with the current status of the project, and a matrix of strategic risks. When you click on the "Editing log" link, a generated report on editing the card by users opens, the date and time of the change, the author, the changed field, the old and new value. This is extremely important in order to implement the project better (Fig. 2) [2–5].

Let us consider one of the possibilities of the digital platform — "Detailed Schedule", which is a Gantt Chart, it reflects all the elements of the PC of the construction site (Fig. 3).

To ensure the integrity control of the calculations, the system stores a schedule that includes all the work (including summary tasks) of the project and its subordinate construction objects in the "Full Project Schedule". It is important to pay attention to the fact that when data from domestic digital platforms is generated, it is possible to generate graphs with a Gantt chart without using foreign software. The schedule can be both formed on a digital platform, and full-fledged work of specialists can be carried out in it.

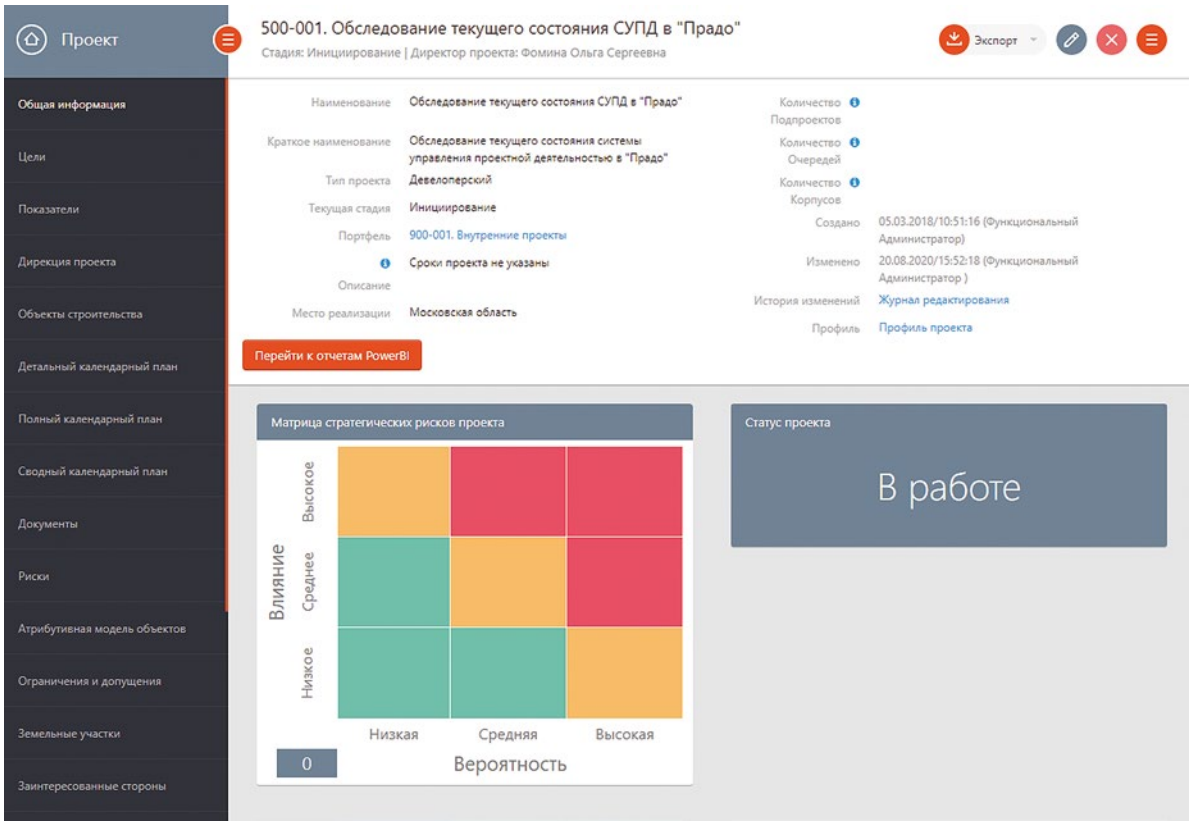


Fig. 2. Card of the construction site. Project general data

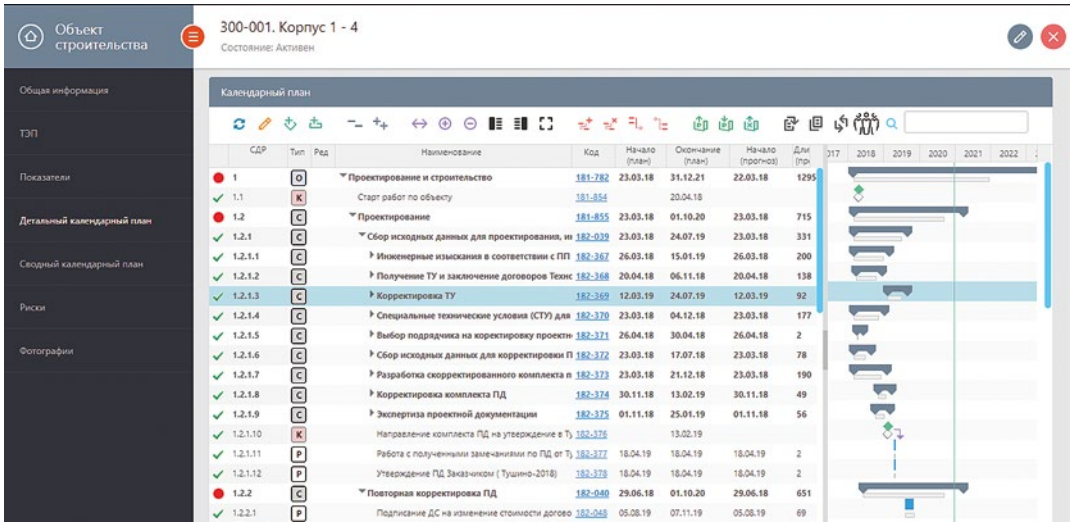


Fig. 3. The construction site card

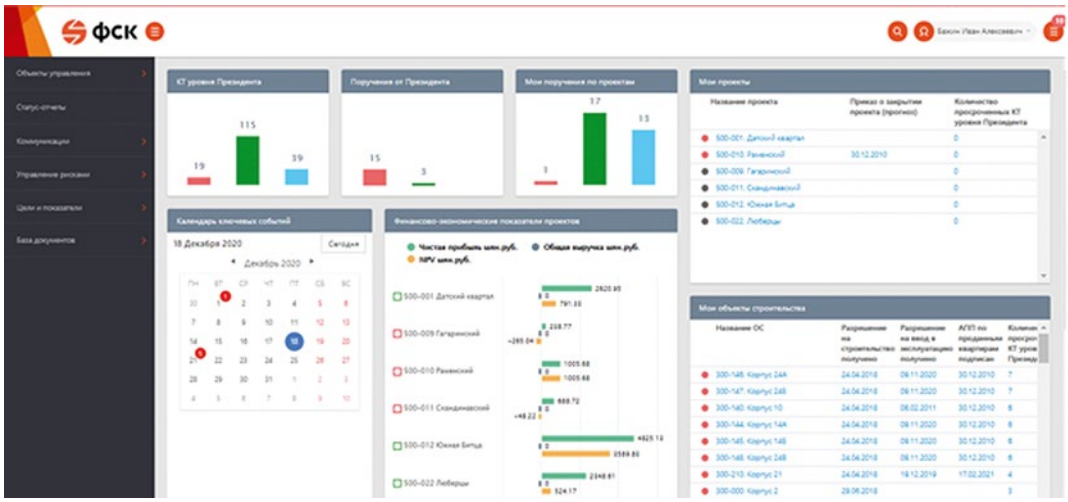


Fig. 4. Project director's panel

Let us consider the possibilities of digital platforms for project management. The Project director's panel displays analytical sections of information on project data (Fig. 4).

Analytical sections are displayed as widgets — graphic blocks of information. The Project director's panel displays information on projects to which the user has access based on project roles [6, 7].

Some of the important features in the unique project implementation, in particular, are the stages on which attention is closely focused (Fig. 5, 6).

At these stages, due to the fulfillment of the tasks of the STS, changes may be made to the project, which entails postponement and unforeseen costs. These risks, of course, must be taken into account when planning the stages of implementation of the ICP.

All changes, after agreeing with certain authorities, must be made to the schedule used in the digital platform so that all project participants have up-to-date information. This is important in site planning, tendering processes, etc.

Considering the need for constant up-to-date information and documentation, it is important to use a shared data environment (Fig. 7).

This digital platform allows not only all ICP participants to work in one information field, but also to perform tasks such as:

1. Documentation approval.

2. Carrying out the transfer of documentation and other materials from the technical customer to all counterparties.

3. Work performance documentation release.

It is necessary to pay special attention to this list and work in the general data environment, since the implementation of unique objects implies not only the implementation of high-quality documentation and quick verification, but also the circulation of other materials between all counterparties in the engineering process and construction and installation works, in order not to overrun the schedule. This is most important when passing the state expertise, both initially and repeatedly, as well as when obtaining technical specifications.

The possibilities of using IMT make it possible to control engineering decisions at any stage of construction and installation work. This can be done using the information model of the building, which is carried out at the design stage and finalized at the engineering stage of the working documentation (Fig. 8).

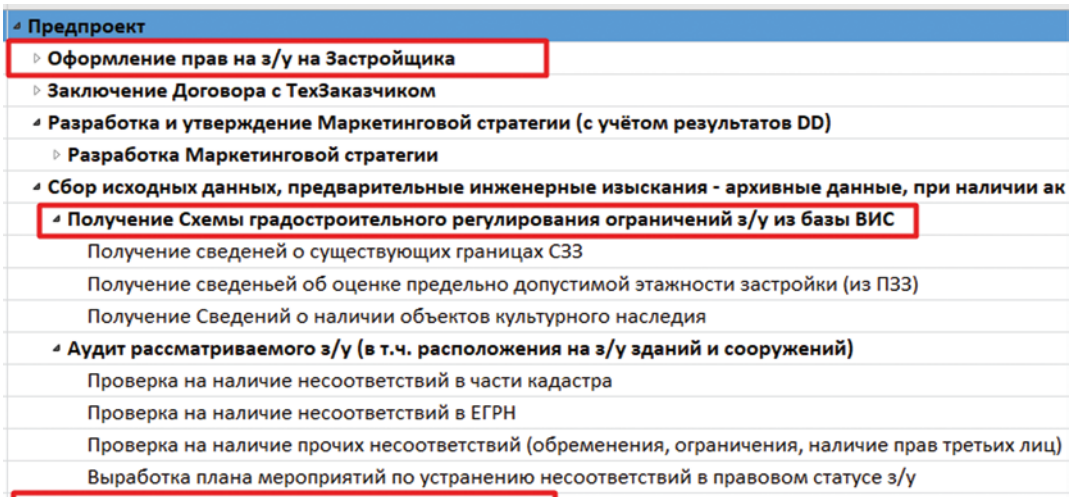


Fig. 5. Identification of especially important sub-stages at the pre-project stage

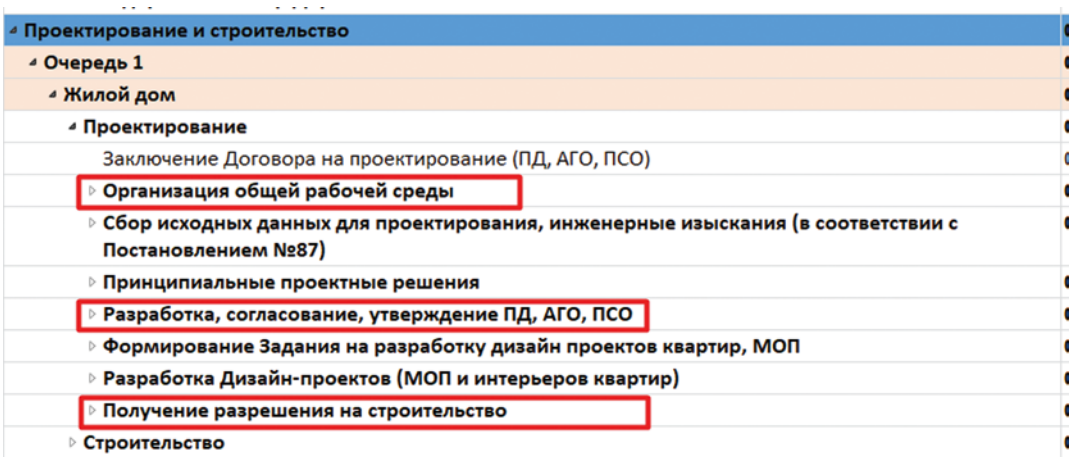


Fig. 6. Identification of particularly important sub-stages at the engineering stage

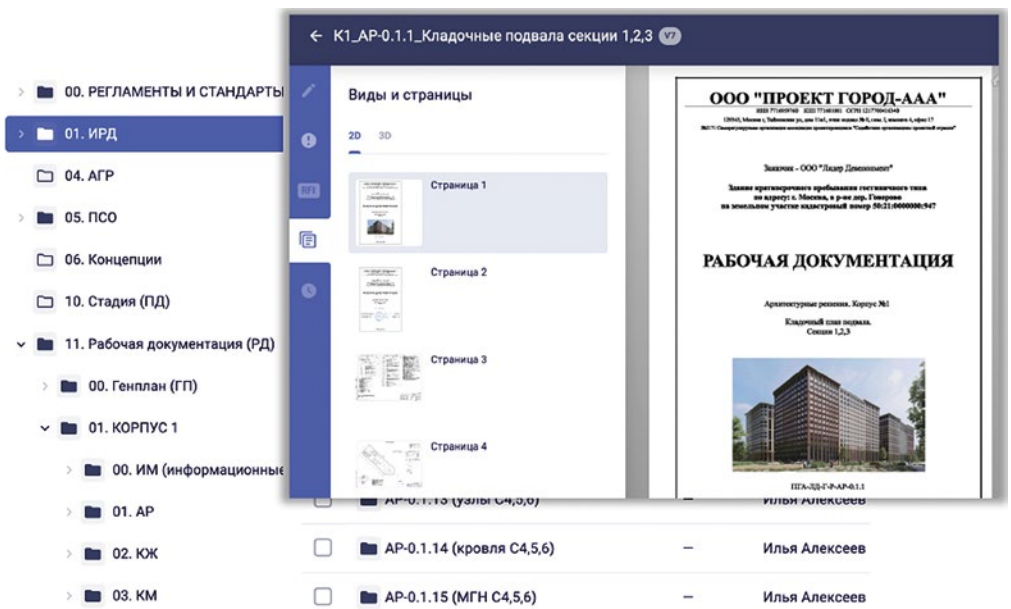


Fig. 7. Application of the shared data environment

In addition to control, it becomes possible to check volumes and specifications, which speeds up not only the check on behalf of the technical customer or management, but also the engineering check by the contractor — the main specialist. Also, there is an opportunity to generate reports in order to identify and prevent schedule overrun [8–10].

The capabilities of the digital platform allow not only task and documentation exchange between counterparties, but also the following:

1. Bill of quantities formation based on the information model of the building.

2. Signing contracts and additional agreements with contractors.

3. Load brand-list materials and equipment in order to form, among other things, cost calculations and other materials for purchases (Fig. 9).

Digital platforms also allow the execution and acceptance of construction and installation works, namely:

1. The scope of work formation and coordination.

2. Possibility to activate and conduct COA-2 via the platform, skipping all the steps according to the scheme, which is used everywhere.

3. In the absence of agreement on behalf of the customer of COA-2, assignments are submitted, thereby, simultaneously exercising control over construction and installation work.

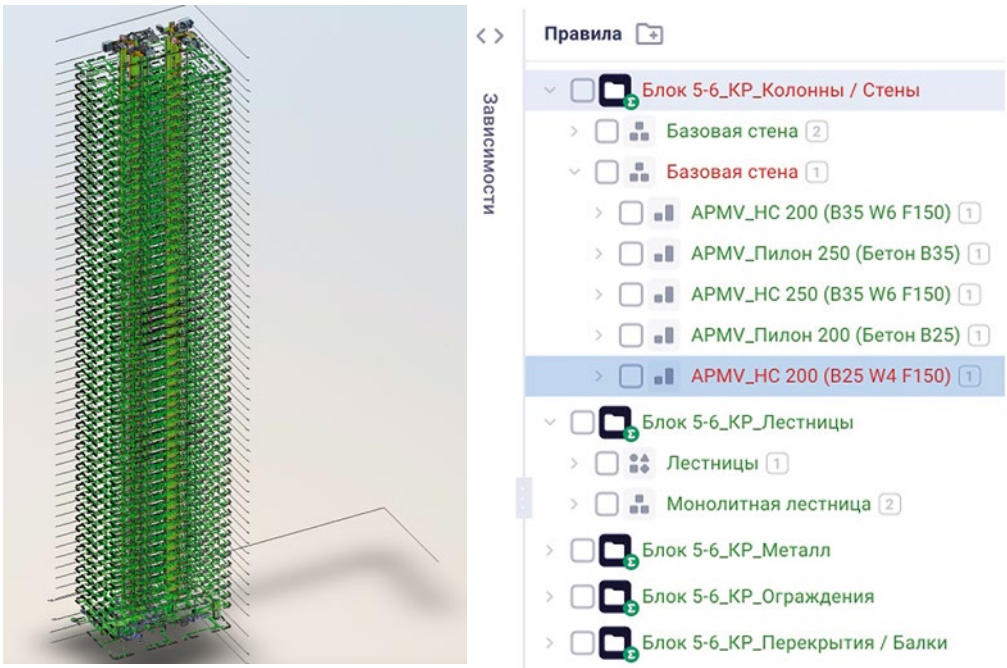


Fig. 8. Control of engineering decisions

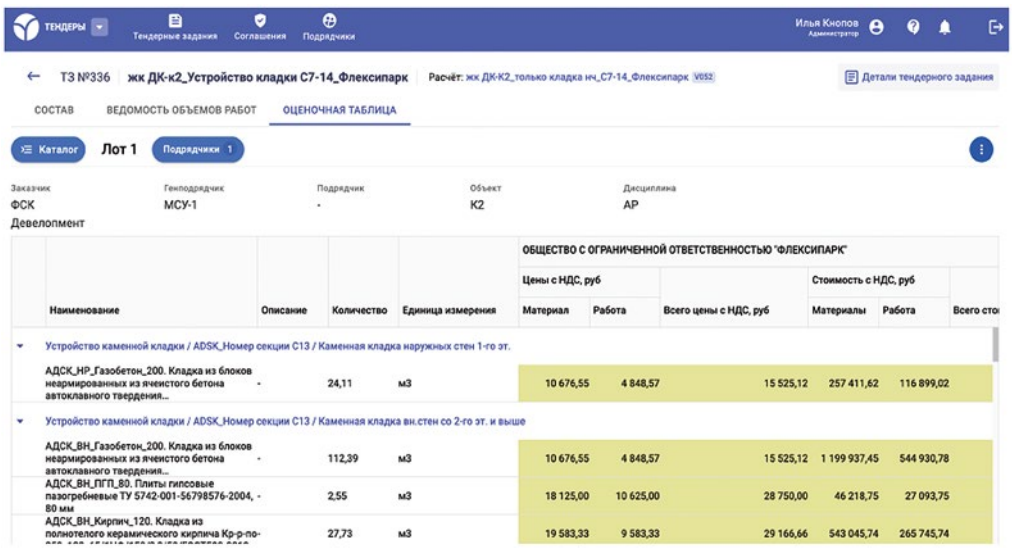


Fig. 9. Purchase catalog formation

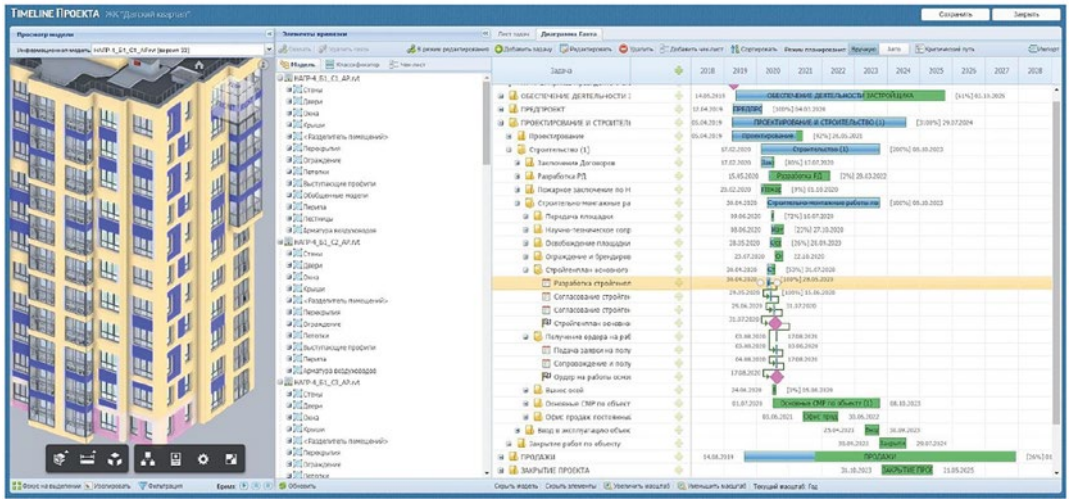


Fig. 10. Acceptance of construction and installation works, verification of volumes

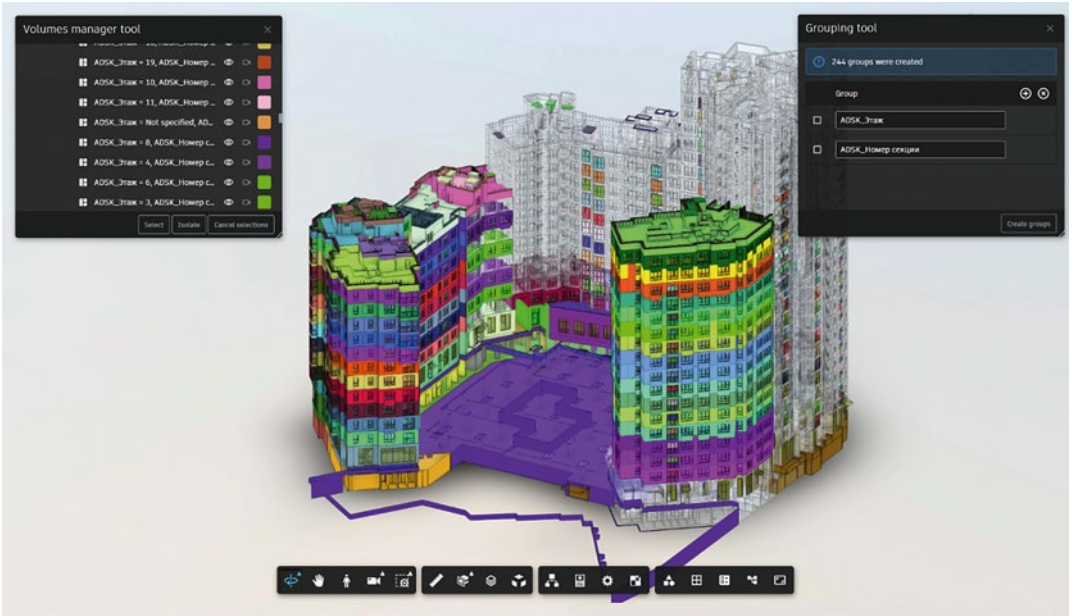


Fig. 11. Performing the acceptance of construction and installation works, checking the volumes

4. As-built documentation formation for verification by the general contractor/technical customer (Fig. 10) [11, 12].

Throughout the investment and construction project, control of resources and tasks is carried out using the Timeline module, where a work schedule is formed based on the elements of the information model and previous calculations. Also, an important task solved by this module is the data integration taken from different systems and control over the implementation of investment and construction projects, including deadlines.

Through BIM360 Field integration, data on the actual work execution is entered into the module, which allows to display the current progress of work and adjust plans. These data are entered through checklists. This module contributes to the control of the schedule not only at the construction and installation stage. There is an opportunity to make changes and plan work for some time in advance, which is important at the pre-project stage [13].

For example, the FSK group of companies, with the help of its partner, BIMSoft, is developing a tool that specializes in working with a 3D view. This tool is called G-Viewer. It is designed to work with the information model directly in the cloud. The tool allows to make any selection of elements, whether it is a selection of elements in the 3D view itself or a selection through a special tool, then it is possible to select elements by sections or floors, or by any other parameter value. Further, these selections can be saved and used in work with other modules [14, 15].

This reduces the dependence on the work of engineering organizations and on the accuracy and correctness of their data input into the elements of the information model (Fig. 11).

This tool is especially useful in the implementation of unique and long-span objects, due to the emerging opportunity to verify and control the accuracy of engineering solutions [14, 15].

DISCUSSION

The low interest of the main participants in the construction market is based on the following facts:

1. Lack of all-inclusive solutions.
2. Lack of understanding of the applied effect of digitalization in construction — a real acceleration of construction and cost reduction.
3. Difficulty in implementation due to different production processes for each company.
4. Low level of computer literacy among industry employees.
5. Lack of proven and full-fledged analogues of key IT products for construction (for example, MS Project, Primavera).
6. Lack of qualified specialists in the field of IT, in particular in the field of computer vision, big data.
7. Lack of available data for the algorithms and platforms development for piloting new solutions.
8. Long payback cycle of in-house development.

CONCLUSIONS

At the present time there is a trend towards the construction industry digitalization in Russia. The reason for this was the understanding of the key participants in the implementation of development projects that without the introduction and use of digitalization, and in particular, IMT, at all stages of the life cycle it is impossible not only to implement projects more effectively, but also to become more competitive in the global market. The use of BIM technologies in construction and design is one of the effective ways both to bring the construction industry to a new level, and to make the construction process better and more efficient.

Problems are identified and their solutions are proposed during coordination and documentation processing:

1. Control of the movement of the developed documentation.
2. Improving the quality of the developed documentation by simplifying and automating verification.
3. Loss free communication between project participants.
4. Online availability of the entire history of the transfer/approval and discussion of documentation.

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Механизмы применения технологий информационного моделирования на отдельных стадиях жизненного цикла девелоперских проектов

Данная статья описывает преимущества применения технологий информационного моделирования, в частности, при реализации уникальных объектов недвижимости. Автоматизация этапов реализации проекта, в особенности при реализации уникальных объектов, — одна из важнейших задач, целью которой является не только разгрузка участников ИСП, но и исключение ошибок на всех этапах проекта. Рассмотрены возможности применения облачных систем, информационной модели объекта и др., тем самым получая эффективный инструмент повышения качества организации строительного производства при реализации инвестиционно-строительного проекта. В статье рассмотрены особенности применения технологий информационного моделирования на отдельных стадиях жизненного цикла, которые отражают основные преимущества и достигаемый эффект при реализации девелоперских проектов, а также сформирован оптимальный механизм применения технологий информационного моделирования. Предлагается стратегия совершенствования процессов цифровизации при реализации инвестиционных проектов на отдельных его стадиях с возможностью создания информационной модели здания, которая будет систематизировать функции информационного ресурса объекта и цифровой площадки для взаимодействия всех участников проекта. Таким образом предоставляется возможность получения прямых эффектов от контроля участников реализации проекта и процедур, сопутствующих реализации проекта. При этом информационная модель должна функционировать как часть единой цифровой среды для анализа и систематизации получаемой информации об объекте. Рассмотрен потенциал применения возможностей технологий информационного моделирования в виде цифровой платформы в целях эффективной реализации девелоперских проектов.

Ключевые слова: *ТИМ-технологии, 3D-модель здания, информационное моделирование*

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The main principles of construction and restoration work in emergencies

The article deals with the implementation of construction and restoration work in emergency situations after military actions, the main principles of restoring the urban environment, as well as problems and risks associated with conducting restoration work. Construction and restoration work is an important tool for minimizing the negative consequences of accidents, natural disasters, military actions and ensuring the safety and environmental security of the population. The paper considers questions about organizational and managerial activities when carrying out construction and restoration work in emergencies, principles used during construction, planning, organization, and conducting restoration work. The main principles of urban environment restoration are considered, which include: the creation of a harmonious community is achieved through the establishment of tolerance, a comfortable and competitive environment for social development; cultural and religious diversity is expressed in the formation of multiculturalism in restored cities; this can be achieved through ensuring accessibility of urban infrastructure and public services; balanced urban planning, attracting investments; preserving cultural heritage; complying with environmental norms; promoting sustainable land use; improving living conditions, fostering social integration, and creating opportunities for education and culture; including educational; cultural, and sporting events. Development of transport networks, risk and safety management in the urban environment, respect for human rights, development of long-term strategies for rebuilding cities after military actions, improvement of housing conditions, establishment of cultural ties, and others. The stages of construction and reconstruction work are considered, which include damage assessment and planning work, clearance of sites of military actions, temporary restoration, restoration of infrastructure, and economic recovery.

Keywords: *the principles of construction and restoration work aimed at restoring urban infrastructure, restoration of buildings and structures, construction in emergencies, types of emergencies, construction principles, national strategies for urban development, urban legislation and regulatory requirements, urban planning and design, local economy and municipal finances, adaptation of city development programs to local conditions, stages of construction and reconstruction work*

Note. *The paper contains the information from open sources: the website of The State Duma of the Federal Assembly of the Russian Federation[1]; the official legal information website[2]; the "Rossiyskaya gazeta" website[3]; reference legal system "Consultant Plus"[4]; legal information website "Garant.ru"[5], information website "RBC Real Estate"[6].*



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During the evolution of human civilization, there have always been emergencies of a negative and destructive nature in the locations where people live. Natural disasters, technological accidents, terror acts, military actions — all of them make comfortable living for people more difficult. One of the most significant directions in light of current events is the reconstruction of cities that have been destroyed as a result of military actions [1]. The directions for carrying out construction and restoration work include not only the beautification of territories and the creation of conditions for comfortable living, but also the design of a concept of the restored territories development [2].

Construction and restoration work is a complex of activities aimed at restoring industrial, commercial, residential infrastructure. The aim of these measures is to restore vital installations as soon as possible to ensure the comfortable living of the population with minimal economic losses. However, carrying out work after emergencies is often associated with risks and difficulties, such as lack of resources, temporary residence restrictions, safety problems of people in sites of destruction, and the design of concepts of further large population centers (cities) development [3].

Construction and restoration work in the military zone is one of the most challenging tasks since it involves not only the process of restoring damaged objects, but also restoring of life and infrastructure as a whole [4]. Such work can be divided into several stages.

Firstly, damage assessment and work planning are conducted. This stage involves the inspection of damaged buildings, military action areas, and infrastructure to determine the damage and scope of work needed. Additionally, a work plan that takes into account all necessary measures to restore life and infrastructure is created [5].

Typically, the assessment of damage is based on a conventional indicator, where 10–20 % of the damage is considered insignificant and entails major restoration work. The conventional indicator is characterized by visual inspection and project

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

indications of the building, as well as analytical conclusions of specialists. If there is a disputed assessment, additional expert research is carried out by specialists.

Damage associated with 20–35 % can be considered as moderate, requiring specialists to evaluate the possibility of restoring the damaged building structures, taking into account their functionality, social and historical significance, as well as financial costs.

Damage associated with 35–50 % can be considered as severe and requires immediate evaluation by specialists. Restoration is considered only if the object has special historical value or significant social significance.

Damage associated with 50–70 % can be considered as complete, requiring the construction of a new object if the reconstruction of the destroyed object is necessary [2, 6].

Secondly, cleaning up military sites is necessary. This involves removing ammunition and other hazardous materials that may remain on the site, making it safe for restoration or demolition work to be carried out.

Thirdly, temporary restoration. It involves the objects that can be quickly restored to improve the quality of life for people and make it easier for them to live in these conditions.

Fourthly, restoration of infrastructure. This stage involves the complete restoration of real estate and infrastructure. This includes repairing roads, bridges, airports, hospitals, schools, industrial facilities, and other objects that were destroyed during the military actions.

Fifthly, economic recovery begins after the infrastructure has been restored. This transition stage includes supporting small businesses, restoring financial stability, providing loans and other measures that help to recover the economy.

The requirements for construction and restoration work in a war zone are very high as it is necessary to restore all aspects of life in the area and improve the lives of its inhabitants. However, with optimal planning and the use of effective technology, these works can be performed at the highest level [7, 8].

Apart from the stages, there are other important aspects to consider when carrying out construction and restoration work in a war zone.

The first aspect is safety. All work must be carried out with the increased focus on the safety, as unknown dangers may remain in the war zone. Workers must practice extreme caution and use all necessary protective equipment.

The second aspect is the provision of materials and equipment. Access to materials, equipment, and specialized machinery is necessary for carrying out the work. Materials are needed for construction, neutralization of explosives or hazardous waste.

The third aspect is the education of local residents. Local residents can participate in construction and restoration work, which can help them maintain the restored and created objects in proper technical condition based on their own experience. Their training can reduce the need for specialized labor and speed up the recovery process.

It is important to note that the process of restoration in a war zone is a long-term process that can take several years. Control and support must be maintained throughout the entire recovery period. The process of construction and restoration work in a war zone is very complex and requires a lot of time, resources, and labour. However, it is an important step in restoring life and public infrastructure. Proper planning of work, safety, access to materials and equipment, education of local residents, and support throughout the recovery process are key factors for success in this process.

Another important aspect when carrying out construction and restoration work in a war zone is social responsibility. Workers must understand that their work helps to restore normal life for people who have been affected by the conflict. Therefore, the main priority when carrying out work should be to improve people's quality of life and restore infrastructure. When designing the reconstruction, it is important to consider the needs of the local population and create a comfortable and safe environment for them to live in. A key factor is the sustainability of the results achieved, i.e. ensuring the long-term provision of restored objects.

Another major issue when working in a war zone is the disposal and neutralization of explosive objects, hazardous waste, etc. Special equipment and trained staff are necessary for safe and environmentally friendly disposal [9, 10].

In addition, an important aspect when carrying out construction and restoration work in a war zone is cooperation with local authorities, including government and local entities. This allows for the necessary support and resources to be obtained, and also takes into account local customs and culture, and the economy of the restored territories. At the same time, social and economic goals must be logistically aligned.

Another important aspect that should be considered during construction and restoration work in a war zone is access to communal resources (such as water, sewerage, gas, electricity, etc.). The catastrophic reduction and destruction of infrastructure during a war conflict can lead to a decrease in the standard of living for local residents and hinder effective restoration work.

Therefore, in order to ensure the necessary comfort level in life and work within the restoration and construction zone, it is necessary to create new energy and water infrastructure that will restore and facilitate the living conditions of the people. New technologies can be used for this purpose, such as safe and environmentally friendly methods of energy production, more efficient methods of water supply, etc.

The implementation of technological innovations that will speed up the restoration process is also an important aspect. Methods such as using 3D printers for building houses can significantly reduce the time and cost of restoration.

In addition to technological solutions, an important direction is to complete construction and restoration work with consideration for future development in the region. For example, when reconstructing housing, consideration should be given to the fact that residents in areas affected by military conflict may move, so it is necessary to build and restore houses that will be attractive, convenient and functional for the long term.

In addition, as previously mentioned, safety issues should not be forgotten when conducting construction and restoration work in a war zone. The presence of unexploded ordnance, mines and other dangerous items can pose a risk to workers and the population of the region. Therefore, before starting work, a special series of measures should be taken to clear the area of hazards and dispose of dangerous items.

Ensuring the safety of the local population and explaining the rules of behavior in areas of military conflict to them is also important, as well as organizing a system of life support: medical care, nutrition, etc.

The restoration of local markets and enterprises in order to provide local residents with work and income is also significant. For this purpose, it is necessary to assess the region's economic potential and support the creation of local enterprises, as well as the employment creation.

When carrying out construction and restoration work, it is necessary to take into account seasonal and climate conditions when developing restoration plans and strategies. This can significantly influence the success of the project and the level of living for the local population.

When conducting construction and restoration work in a war zone, it is important to take budget planning into account in order to ensure optimal use of resources and funds. The budget may be limited, so it is necessary to determine priorities and choose the most effective and sustainable methods for restoring life and infrastructure.

Cities have always been the main targets of military action — history is full of examples when cities were destructed during various wars. Despite this, cities are able to recover and become centers of life and culture.

When restoring destroyed cities after military action, the main task is to observe the principles of harmonious urban development. The main principles and objectives of urban development are reflected in the New Urban Agenda adopted on October 20, 2016 at the United Nations Conference on Housing and Sustainable Urban Development (Habitat III) held in Quito (hereinafter — the Program). It was also approved at the 68th plenary session of the United Nations General Assembly on December 23, 2016 [11].

It is possible to consider and take into account the main directions of urban development and the urban environment not only under positive conditions, but also under conditions of construction and restoration work carried out as a negative result of emergency situations and military actions [12]. Among the variety of urban development principles in conditions of restoration and construction work, the following directions should be taken into account [2].

In particular, the directions of continuous innovative development are expressed in the basis of urban development as a combination of improving living conditions and maximizing effective employment of the population. This direction implies the potential involvement of the population into intellectual activities, both within the urban environment and within the economic activity of the state.

The principle of harmonious community is implemented through the creation of a tolerant, comfortable, and competitive environment for social development. An important characteristic of this direction is the participation of the city population in municipal management, which reduces social and economic contradictions in the social environment.

The principle of cultural and religious diversity can be expressed in the formation of multiculturalism in restored cities, preserving established cultural and religious traditions while allowing for the formation of new cultures through the creation of new urban spaces.

The principle of allowing for development and economic conjugation of urban and agricultural directions, regulating the relationship between urban and rural territorial entities, creating unhindered connections on a mutually beneficial basis.

The principle of information transparency is based on creating an open society through accessible information exchange and communication between government and municipal bodies and residents. It is important to involve society in the process of restoring cities after armed conflicts. This can be expressed in connections with local residents, holding meetings of public councils, and participating in civil society initiatives aimed at supporting the restoration of cities.

The principle of ensuring accessibility of urban infrastructure and public services. Restoring cities is associated with meeting the needs of the population based on the accessibility of infrastructure and public services such as roads, water supply, electricity, healthcare, education, etc.

The principle of balanced urban planning assumes a balanced city planning taking into account social, economic, and environmental factors. This may include developing a master plan for the city, which sets zoning requirements, allocating land for various functions, creating recreation areas and green spaces [13].

The principle of attracting investments. Investing in urban infrastructure can accelerate the process of restoring cities and make them more attractive to new investors. Investments can be directed towards employment creation, developing small and medium-sized businesses, building housing, and other goals. Stimulation of the local economy can accelerate the restoration of cities. This may include providing grants and benefits for local entrepreneurs, reducing taxes or exempting from them, creating initiatives to attract investors, and other measures.

The principle of preserving cultural heritage assumes that restoring cities after armed conflicts should be done in a way that preserves and protects cultural heritage. This includes the restoration and renovation of historical monuments, the preservation of cultural practices and traditions, and support for local artists and cultural organizations.

The principle of environmental compliance. When restoring cities, it is necessary to take into account the impact on the environment and make efforts to reduce negative environmental consequences. This may include developing and implementing of programs to reduce pollution and increase the efficiency of natural resource utilization [14, 15].

The principle of sustainable land use. When restoring cities, it is important to consider sustainable land use. This involves using of buildings and engineering structures for other purposes, such as surface finishing that allows for sustainable water drainage, and other measures that help achieve sustainable land use.

The principle of the living environment improvement. Restoring cities after armed conflicts should also aim to improve the living environment of the population. This may include the development of public spaces, the creation of green areas and parks, the installation of sports and leisure equipment, and other measures that enhance the quality of life in the city.

The principle of social integration. Restoring of cities after armed conflicts should also support migrants, residents of marginalized communities, people with disabilities, individuals who have lost their loved ones during the conflict, and other measures that support social integration.

The principle of using technology involves using modern technologies that enhance the sustainability and attractiveness of cities. For example, the use of energy-efficient technologies, alternative energy sources, modern waste management systems, security systems, etc.

The principle of creating opportunities for education and culture, which involves creating opportunities for educational, cultural, and sports activities, is an important aspect of restoring the city. This includes the creation of media centers, cultural centers, access to educational programs, etc.

The principle of developing transportation networks. The direction involves the supply of the restored city with transport and public transport facilities, a pedestrian zone and bicycle paths, as well as preventive infrastructure solutions.

The principle of managing risks and safety in the urban environment involves the creation of measures to prevent natural disasters, engineering safety, physical security, crime prevention, etc. [16].

The principle of respecting human rights which involves the need to respect the rights of women, children, migrants, and other vulnerable groups during the restoration of the city. Restoration of cities can contribute to the protection of human rights, create equal opportunities and lead to improvements in the economic and social well-being of the population.

The principle of developing long-term strategies for cities restoration after armed conflicts. Long-term strategies are aimed at maintaining the achieved results and continuing to improve the quality of the urban environment, which involves updating the city's information base, creating crisis management systems, and accumulating experience in managing the process of restoring the urban environment.

The principle of improving living conditions, which includes improving the living conditions of the urban population, creating conditions for living in a safe and comfortable environment, as well as providing the city with various types of housing.

The principle of establishing cultural connections, which will help to establish cultural connections with other cities, countries, and cultures. This will lead to cultural exchange, exchange of experience, implementation of technologies to create understanding between cultures, peoples, and countries.

The revival of cities after armed conflicts is an important and complex process that requires a variety of measures and actions. At the initial stage of restoration, it is important to determine the main vectors of restoration with respect to fundamental principles, develop a careful plan, and coordinate actions between all participants and stakeholders to ensure effective and sustainable restoration of the urban environment.

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Основные принципы строительно-восстановительных работ в чрезвычайных ситуациях

В статье рассматриваются вопросы осуществления строительно-восстановительных работ в чрезвычайных ситуациях, после военных действий, основные принципы восстановления городской среды, а также проблемы и риски, связанные с проведением восстановительных работ. Строительно-восстановительные работы являются важным инструментом для минимизации негативных последствий катастроф, природных стихийных явлений, военных действий и обеспечения безопасности и экологической безопасности населения. Рассматриваются вопросы организационно-управленческой деятельности при выполнении строительно-восстановительных работ, осуществляемых в чрезвычайных ситуациях, военном положении, принципы, используемые при осуществлении строительства, а также планирования, организации и проведения восстановительных работ. Рассматриваются основные принципы восстановления городской среды, к которым относятся: гармоничное сообщество, реализуемое посредством создания толерантной терпимости, комфортной и конкурентоспособной среды социального развития; культурно-религиозного многообразия, выраженного в формировании мультикультурности восстанавливаемых городов; обеспечения доступности городской инфраструктуры и общественных услуг; сбалансированного городского планирования; привлечения инвестиций; сохранения культурного наследия; соблюдения экологических норм; устойчивого использования земли; улучшения среды обитания; социальной интеграции; создания возможностей для образования и культуры, спортивных мероприятий; развития транспортных сетей; управления рисками и безопасностью в городской среде; соблюдения прав человека; разработки долгосрочных стратегий при восстановлении городов после военных действий; улучшения жилищных условий; установления культурных связей и др. Рассматриваются этапы строительно-восстановительных работ, к которым относятся: оценка ущерба и планирование работ; очистка мест военных действий, временное восстановление; восстановление инфраструктуры; восстановление экономики.

Ключевые слова: *принципы строительно-восстановительных работ, направленных на восстановление городской инфраструктуры, восстановление зданий и сооружений, строительство в чрезвычайных ситуациях, виды чрезвычайных ситуаций, принципы, используемые при строительстве, национальные стратегии развития городов, городское законодательство и нормативные требования, городское планирование и проектирование, местная экономика и муниципальные финансы, адаптация программы развития го-*

родов к местным условиям, этапы строительно-восстановительных работ

Примечание. *При формировании обзора использовалась информация из открытых источников: сайт ГД СФ РФ[1]; интернет-портал правовой информации[2]; интернет-портал «Российская газета»[3]; справочная правовая система «Консультант Плюс»[4]; информационно-правовой портал «Гарант.ру»[5]; информационный портал «РБК Недвижимость»[6].*

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Theoretical and practical features of data processing centers evaluation (DPCs)

In this Article the author considers the features observed in the course of valuation of special purpose real estate, i.e., the data processing centers (DPCs) and the data processing and storage centers (DPSCs) in accordance with experience accumulated by the international community and based on the recommendations contained in the International Valuation Standards as well as the RICS methodological guidelines (The Royal Institution of Chartered Surveyors (Great Britain)).

The present article is justified as currently Russia lacks a separate and uniform for all valuers or forensic experts standard or methodological recommendations in the sphere of valuation of the data processing centers and courseware is scarce. At the same time Russia, similar to other countries of the world, is witnessing a considerable growth of construction of the DPCs later involved in the stream of commerce as transacted, subject to mortgage or disputed properties.

The present article analyzes the modern approach internationally applied to value the DPCs, summarizes the author's personal professional experience in this sphere. At the same time the author determines and provides a deep insight into the specifics of the target group or real estate, identifies and classifies its key merits which exert effect on the properties' value. The author provides a deep insight into applying the valuation approaches and methods, together with practical recommendations as to how measure market value within the frameworks of the cost, market or income approaches. The author gives special focus to the key (income) approach, describes the details of the types of the services which are capable of forming income from DPC operating activities, examines the items of DPC operating costs and provides practical guidelines to be applied to measure the cap rate of this type of real estate.

Keywords: *real estate valuation, valuation approaches and methods, market value, commercial real estate, specialized assets, data storage and processing center (DSPC), DPC, or the data center, cloud services, ICT (information and communications technologies), forensic examination*



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INTRODUCTION

Currently Russia lacks a uniform for all valuers or legal experts standard or methodological recommendations pertaining to valuation of the data storage and processing centers (DPCs/DSPCs, data centers), while the academic literature is scarce.

Both in Russia and in all other countries of the world a considerable growth of construction of the above properties is observed which later are involved in the stream of commerce as transacted, subject to mortgage or disputed properties.

The unprecedented increase of global Internet traffic and data volumes during the COVID-19 pandemic and 2020 lockdown triggered a growth in the communications and technologies infrastructure (CTI) which resulted in the increased demand for the data centers as well as the cloud services.

In accordance with the Synergy Research Group, international agency, the volume of the global market of the data processing centers colocation in 2021 equaled 50,335.72 mln dollars. It is expected to grow up to 159,852.82 mln dollars by 2039, which means 13.7 % increase during the forecast period in average (2022 — 30) [1].

In the present Article the author has presented the results of the analysis of international experience [2] and methodological peculiarities of valuation of the data centers, generalized the practical experience accumulated in the course of valuation of DPC by Professional Group of Appraisal, as well as identified the key characteristics which have effect on value and also recommended how market value of DPC is to be valued.

DPC: CLASSIFICATION, CERTIFICATION AND TYPES OF OPERATING ACTIVITIES

The data (storage and) processing center (DPC/DSPC, the data center) is the complex technology and capital consuming infrastructural property intended for colocation of computer equipment (servers), storage, processing and transfer data systems for the corporate, commercial and government sponsored users of the services.

The DPC key functions include as follows:

- storage and analysis of different volumes of the data;
- ensuring security of hardware, stored, transmitted and received data;
- ensuring the maximum data availability for the users;
- failure free equipment operated in the uninterrupted mode;
- integration of distributed databases;
- ensuring conference communication, etc.

The above functions are mainly framed within those services demanded by the users, which may be delivered by DPC.

DPCs classification is based on determination of their reliability (security, fault tolerance, availability).

The reliability tiers are currently determined based on the criteria introduced by Uptime Institute[1].

There are 4 reliability tiers [3]:

1. TIER I is the lowest level with reliability of 99.71 %, to which installations in the office premises correspond. The weak protection scheme[2] N, basic safety, downtime up to 30 hours annually required for maintenance — all appropriate for the internal corporate services, but not for IT business. Here basic conditioning and additional power source are mandatory.

2. TIER II. In order to be certified for TIER II, the backup capacities are to be added in accordance with N + 1 scheme. This allows to decrease idle time to 22 hours a year and reach fault tolerance of 99.749 %. For this the data center must have:

- computer so-called raised floor with embedded in networks used for switching equipment on;
- improved conditioning system;
- additional power sources.

The above proves to be sufficient where failures are insignificant, however operation is to be suspended in case of technical maintenance.

3. TIER III. The key advantage of DPC certified TIER III is that in case of maintenance the servers are not to be switched off. Value is increased up to 99.982 %, and idle time is decreased to reach merely 1.6 hours a year. To this end:

- all system components are backup;
- one more independent power source is added;
- additional cooling system is installed.

TIER III is the level at which most major data centers are operated in Russia.

4. TIER IV is the higher level of reliability known today. At this level the best backup schemes which duplicate each component are used. In case of a failure in any network component it will be automatically switched to a parallel one which ensures uninterrupted operation of DPC. The maximum idle time is decreased to be the record of 0.8 hour a year.

Table 1 below reports the key differences in the level of fall-over protection.

Table 1. Key differences in the reliability level (fall-over protection)

Description	Tier I	Tier II	Tier III	Tier IV
Equipment protection	No	N + 1	N + 1	2(N + 1)
Possible maintenance without interruption	No	No	Yes	Yes
Annual idle time	28.8 h	22 h	1.6 h	26 min
Reliability level (fall-over protection rate), %	99.671	99.749	99.982	99.995

DPC characteristics and parameters which have effect on its value

Generally, pricing variables in the real estate market (both the land plots and the buildings and/or premises) are reported in different sources [4–6].

However, assuming that DPC is a specialized asset, its value is under effect caused by different variables determined by a specialized nature, destination, construction, configuration, composition, and other qualities of such unique asset:

1. certification level of protection (fall-over level) — Tier I, II, III, IV;
2. available technical switching on to the networks and commercial dedicated power supply, in MW;
3. number and characteristics of the racks or rack spaces (nominal capacity in terms of kW/rack, number of units);
4. calculated annual median PUE[3];
5. availability of IT equipment;
6. Total space and allocation of spaces for:
   - administrative area;
   - computer rooms;
   - technical, warerooms and utility rooms.

Selecting the DPC valuation approaches and methods

In accordance with Clause 2 of Federal Valuation Standard V [7], in the processes of valuation the valuer must give consideration to possibility of using all the valuation approaches, including for substantiation of the conclusions obtained when other approaches were used. In selecting valuation approaches and methods the valuer should consider the nature of the asset, valuation goals, type of value, availability of reliable source information, valuation assumptions and limitations. No one valuation approach and method is suitable in every possible valuation situation. The valuer may use one valuation approach and method when the valuer has a high degree of confidence in the accuracy and reliability of a single method given available information, assumptions and limitations of the valuation engagement.

The author describes possible use of each of the approaches to valuation of DPCs below.

Market approach

DPCs in the global market, as well as other real estate sectors, are considered as an investee, however, not the real estate properties but rather the DPCs owners, specifically, their stock and shares, operate in the market.

As to the number and volume of M&As in the DPCs market their record was observed in the year 2021. In accordance with Synergy Research, in 2021, 216 M&As with DPCs were registered to the total amount of over 49 bln dollars. This exceeds the 2020 result which was 34 bln dollars, which set a record for the year 2020, by 41 %.

In 2021 and 2022 the following major M&As deals were performed in the global DPCs market (transaction costs are reported

1 Uptime Institute is an independent entity headquartered in New York which certifies DPCs all over the world.

2 In the protection scheme the "N" symbol is used to mean a structural element. The basic level (N) corresponds to no protection. (N + 1) means that the basic element is added by a backup which is switched on where any problem is identified in the system thus allowing to avoid any failures however in such situation it will be necessary to suspend operation for the maintenance period. 2N means using of the parallel duplicate components. The protection scheme 2(N + 1) means that the 2N scheme is added by one more element which allows for simultaneously performed operations with two systems. In 2(N + 1) scheme both the basic and additional components. The protection scheme 3/2N provides for three parallel components to distribute the capacities which allows raising efficiency (infrequently-accessed).

3 PUE (Power Utilization Efficiency) indicates power efficiency of a data processing center and is calculated as the result of electric power consumed by the data center divided to electric power consumed by the equipment of DPC.

below based on the open publications with references to reports of Synergy Research) [8]:

- CoreSite (»10 bln dollars);
- QTS (»10 bln dollars);
- CyrusOne (15 bln dollars);
- Switch (11 bln dollars).

The above four companies are in top 15 colocation providers of the world[4], and they are rated from the third to the sixth places in the US market rating, being inferior in scales to only Equinix and Digital Realty Trust.

It is possible to calculate the price multiples used in the course of the deals (Table 2) considering as the price target the below merits and using the financial statements of the companies for the period preceding the deals.

Values of the multiples related to the deals with large DPCs correlate with the data reported by Damodaran on line for REIT (Real estate investment trusts) for the US market. In accordance with the portal, multiple EV/Sales equals 14.23.

Shares of the investors in DPCs as below are listed in exchanges:

- Equinix, Inc. (USA);
- Digital Realty Trust, Inc (USA).

The key multiples in accordance with the trades data for December 2022 [9, 10] are reported by Tables 3 and 4.

Thus, the market multiples for the US market range as follows:

- EV/EBITDA — 11.7–28.1;

Table 2. Deals' multiples for the deals attributed to large DPCs

Name of the indicator	CoreSite	QTS REIT	CyrusOne Inc (CONE)	Switch Inc (SWCH)
Enterprise Value (EV), In terms of US$, mln	10,000	10,000	15,000	11,000
Revenue, In terms of US$, mln	639	585	1,206	665
Book Value, In terms of US$, mln	2,167	4,335	7,452	3,301
EV/BV	4.61	2.31	2.01	3.33
EV/Revenue	15.66	17.08	12.44	16.53

Table 3. Market multiples for Equinix, Inc.

Indicator	2019	2020	2021	2022
Capitalization (MC), US$ mln	49,777	63,635	76,160	60,615
Enterprise Value (EV), US$ mln	59,723	74,490	88,365	60,615
P/E ratio	97.4	171	153	85.4
MC/Revenue	8.95	10.6	11.5	8.35
EV/Revenue	10.7	12.4	13.3	8.35
EV/EBITDA	22.2	26.1	28.1	22.8

Table 4. Market multiples for Digital Realty Trust, Inc.

Indicator	2019	2020	2021	2022
Capitalization (MC), US$ mln	24,992	39,086	50,193	28,830
Enterprise Value (EV), US$ mln	35,025	52,282	63,499	28,830
P/E ratio	51.0	140	29.8	88.7
MC/Revenue	7.79	10.0	11.3	6.14
EV/Revenue	10.9	13.4	14.3	6.14
EV/EBITDA	18.6	23.9	26.3	11.7

- EV/Revenue — 6.14–14.3;
- P/E ratio — 51–171.

The Russian DPCs market also reports large deals however, in most cases it is impossible to acquire detailed information about such deals performed.

For example, in accordance with information published by information and analytical portal Mergers and Acquisitions in Russia, IXcellerate (LLC EXELERATE), a leading Russian operator of the commercial data centers raised investments of about 190 mln dollars from both the active shareholders and new investors, including Mubadala Investment Company, SberInvest, and Russian Private Equity Fund. However, information about the cost of the company was not disclosed neither before the investment round nor after the exit therefrom.

The similar situation is observed with another large market operator — Selectel (LLC Network of Data-centers "SELECTEL"), which held two issues of bonds to the total of 3 bln rubles each, earnings yield to maturity is[5] 9.9 % [11]. Unfortunately, there is no information available about this company's cost, even expert's information.

In 2020 and 2021, PAO "Rostelecom" performed the largest deals of acquisition of the DPCs operators in the Russian market [12]:

- in January 2020 LLC "CENTER FOR DATA STORAGE", which is a subsidiary of PAO "Rostelecom", acquired the 100 percent share of LLC "DataLine" with the total of the deal of 17.5 bln rubles.

At the moment of the deal LLC "DataLine" had 4,811 server racks, and its proceeds for 2019 (the recent reporting period before the deal) were 5.6 bln rubles;

- in December 2020, the 44 percent stock of LLC "DATA PROCESSING CENTER" was sold to PAO "VTB", which acted in the capacity of a strategic partner. The above deal totaled 35 bln rubles, which means that at the end of 2020 the company was valued at RUB 79.5 bln rubles. At the moment of the deal the total capacity of the company's DPC network was 12.2 thousand racks.

Open information sources report the data about the acquisition deal completed by the company which owns DPC:

- PAO "MTS" acquired for 5.2 bln rubles, with account for net debt, the 100 percent share of LLC "GDC Energy Group", which is the owner of GreenBushDC, the data processing center located in Zelenograd данных GreenBushDC [13]. In accordance with the financial statements of LLC "GDC Energy Group", at the moment of sale the company's fixed assets were 3.4 bln rubles, which accounted for 94 % of all

4 Colocation means use of the data processing center technical resources by the client, colocation of the own telecommunications equipment, servers, data storage systems, etc.

5 At the application date.

company's assets. At the moment of sale, the number of the racks put into operation was 600 and there were plans to additionally equip two thirds of full capacity in 2021 [14].

Thus, currently the market offers scarce price information about the DPCs segment which could be used for the purposes of the market approach, meanwhile this approach may be used for reference, and the result may be presented in the form of the range of process.

Cost approach

As the target asset, the DPC is a property complex comprising the real estate and movable assets (specialized engineering systems, IT hardware), in the course of valuation of which and within the frameworks of the cost approach the summation method that calculates the value of the asset by the addition of the separate values of its component parts could be used.

Table 5 reports the data from open sources [15–18] concerning the analysis of the structure of DPC construction costs.

Lack of price information about DPCs construction in Russia in the market hampers the use of the cost approach for the purposes of valuation. Information available in the open sources [16, 19–21], may be presented only as a reference range (Table 6).

Many factors, including the level of DPC fall-over protection, have effect on construction costs. In accordance with the global market data, rise in construction costs of DPC for Tier IV compared with construction costs of DPC for Tier III reaches about 30 percent [22]. As to the Russian market such public data are unavailable.

Table 5. Structure of construction costs of DPC

Indicator	Indicator's merit (range), %		Mean value (calculated value), %
Construction of the building	10	20	15.0
Drop wire	20	25	22.5
Structured wiring system	0	5	2.5
Engineering systems of DPC	60	70	65.0
Additional costs	Pre-planning, design and commissioning of DPC may add 20 to 25 % to construction costs		

Table 6. Public market data about DPCs construction costs

Indicator	Indicator's value, In terms of US$ (range)		Mean value (calculated value)
DPC construction costs (for Tier II), per 1 sq. m of the total space	14,000	15,000	14,500
DPC construction costs (for Tier III), per 1 sq. m of the total space (including auxiliary rooms (for Tier III) per 1 sq. m of the computer room	30,000		30,000
Construction costs per 1 rack (for Tier III)	72,000	85,500	78,750
Construction costs per 1 MW (for Tier III)	7,000,000	8,000,000	7,500,000

Search of information about prices of equipment which is a component of DPC present additional difficulty for implementing the cost approach. Most producers of such equipment are from the countries which announced about the economic sanctions (e.g., France, Germany), which raises difficulties for acquiring and supply of such equipment to the territory of the Russian Federation. Where replacement cost is calculated, additional costs out of logistics and delivery terms, as well as adjustments for differences in technical characteristics when the analog equipment produced in other countries (e.g., Turkey, China) are to be accounted for.

Thus, currently the cost approach may be used for reference, the result may be presented as a cost range or otherwise used to examine the budget of the valued asset construction if it is submitted by the client to valuation.

Income approach

The income approach is applied in the valuation of real estate assets that generate or are capable of generating income flows. Here the valuers should follow the requirements of Clause 23, Federal Valuation Standard 7, and if the real estates which are leasable rents should be considered as income source and where real estate assets are intended for a certain type business, the valuation may be performed based on information about the operating activities of such business by way of selection out of its cost of its components which do not relate to the valued real estates.

DPC operating activities mean deriving of income based on the following commercial services, which may be classified into the standard and complex ones [23].

Standard shall be the services as follows:

- colocation of equipment, i.e., use by the client of the data processing center technical resources: colocation of own telecommunication equipment, servers, data storage facilities, and etc.;
- dedicated server, i.e., leasing the data center's servers out to the client;
- telehousing, i.e., colocation and switching on to the power and cooling systems of the telecommunication equipment and different components of the client's IT infrastructure in DPC;
- shared, i.e., lease by the client of the disc space of the DPC equipment.

Complex shall be understood as the services as follows:

- outsourcing of the information systems is a service which has it that the provider obtains part or the total IT infrastructure of the client in control or ownership;
- hosting of software maintenance and administration is a service which suggests centralized control of the replicated software assuming that the client has a remote or hands-off access to the software and the applications are hosted by the provider's information center;
- hosting of the infrastructure services is a service which provides standard parts of the IT infrastructure into the remote access for a definite term.

Clouds computing shall be considered as a service provided by the data centers. Actually, cloud technologies are a means of IT applications distribution between the physical servers and physical data processing centers.

Generally, three key services based on the cloud technologies are indicated as follows [24, 25]:

- infrastructure as a service (IaaS);
- platform as a service (PaaS);
- software as a service (SaaS).

The target of the widespread models of the cloud computing services (SaaS, PaaS и IaaS) is definite business models. The X (anything) as a service (XaaS) is that anything capable of being delivered by Internet may be sold. This includes as follows:

- backend as a Service (BaaS);
- storage as a Service (SaaS);
- communications as a Service (CaaS);
- network as a Service (NaaS);
- monitoring as a Service (MaaS) and etc.

Today open price information about the DPCs services is available in the market. Table 7 reports examples of the colocation services.

Table above proves that average prices of the colocation services in Moscow range from 126 thousand rubles to 200 thousand rubles per month (VAT included) per 1 rack space with load of 5 kW. Table 8 above mainly reports process for the DPCs which are certified for TIER-3; meanwhile if DPC is not certified, the rack place price is lower (refer to, e.g., to considerably lower value before 85 thousand rubles per month for asset No. 5).

Also, there are industrial researches, e.g., the research performed by iKS-Consulting agency or 3data company. In accordance with the data presented by the above companies, average prices of the colocation services in Moscow agglomeration (includes Moscow and the Moscow Region) and St. Petersburg (includes St. Petersburg and the Leningradskaya Oblast), performed in the 1st Quarter of 2023 ranged from 104.8 thousand rubles to 74.6 thousand rubles per rack (without VAT) [26].

The income approach makes it possible to apply different methods based on direct capitalization or future cash flows (income) discounting. Irrespective of the method to be selected by the valuer the following moments call for special attention where the income approach is applied to valuation of DPC.

1. *Underload.* In accordance with the market participants [27], the existing data services load reaches 80 to 85 % with the restricted number of free places in the highly fall-free segment (Tier III) and the load striving to be 100 percent.

2. *Operating expenses*. Totally expenses to maintain DPC significantly depend on the level of security and quality of the applied technological decisions, however, the expenses structure is capable of being valued. Operating expenses from DPC maintenance may be divided into five main groups [16]:

1) *Payment for electric power consumed (~ 30–35 %).* Electric power costs are the heaviest item in DPC expenses' structure. Where the above indicator is calculated it is necessary to account for not only the quantity of kWs consumed by the racks but also for the power consumption structure as well as the annual average level of power usage effectiveness, or PUE;
2) *Lease (~ 15–20 %).* This indicator mainly depends on the geographical location of DPC and is time-dependent;
3) *Payroll (~ 25–30 %).* Where the above indicator is calculated the open financial data about the DPC services provider may be used. Table 8 reports the respective example;
4) *Maintenance (~ 10–15 %).* Maintenance expenses are determined by the operated systems structure;
5) *Other costs (~ 10–15 %).* Other expenses may include taxes, depreciation, insurance of the data processing center, etc. Where taxes are computed tax benefits are to be accounted for if DPC is located in an Export Processing Zone, or EPZ. If, for example, the would-be built DPC will be located in the Dubna EPZ and enjoy benefits and preferences for the residents, the income tax rate payable to the regional budget in the first 8 years will be 0 percent, the next 6 years, 5 percent, and thereafter, 13.5 percent; income tax rate payable to the federal budget will be 2 percent, property tax holiday will be 10 years and land tax holiday will be 5 years.

Table 7. Examples of prices of the colocation services in Moscow

Description of the leased asset	Load, kW	Price, RUB/ month, (VAT included)	Information source
Lease of rack (47 Unit 600 × 1000 mm with 6 xPDU16A) In certified DPC TIER-3	5	110,000	https://datahouse.ru/price/
Lease of 1/2 rack (22 Unit 600 × 1000 mm with 3 xPDU16A) In certified DPC TIER-3	3	61,000	https://datahouse.ru/price/
Lease of 1/3 rack (15 Unit 600 × 1000 mm with 2 xPDU16A) in certified DPC TIER-3	2	44,000	https://datahouse.ru/price/
Lease of server rack in certified DPC TIER-3 42U, up to 5 kVA	5	150,000	https://www.reg.ru/colocation/stand_rental/
Lease of server rack in DPC of level TIER-3 42U, up to 5 kVA, not certified	5	85,000	https://www.reg.ru/colocation/stand_rental/
Collocation of equipment in the certified DPC certified in accordance with the standard of the Uptime Institute TIER III (Detailed Design, Constructed Facility)	5	126,000	https://greendc.ru/services/colocation/ rack-space-rental/
Closed server rack 47U in certified DPC TIER-3	5	129,000	https://itsoft.ru/data-center/rack/
Server cabinet 47RU, up to 5 kVA, Berzarina (Moscow) in certified DPC TIER-3	5	200,000	https://selectel.ru/services/colocation/server-rack/
Server cabinet 47RU, up to 5 kVA, Dubrovka (LO) in certified DPC TIER-3	5	190,000	https://selectel.ru/services/colocation/server-rack/
Lease of rack 42-48U in certified DPC TIER-3	5	115,000	https://netrack.ru/server-rack

Table 8. Payroll expenses. The data are reported as at the end of 2021

Name of the entity	Payroll expenses, thousand RUB	Proceeds, thousand RUB	Share in proceeds, %
LLC "SVYAZ VSD"	223,814	1,281,612	17.5
LLC "Excelerate"	508,340	2,689,030	18.90
LLC "NETWORK OF SELECTEL DATA CENTERS"	1,479,611	4,847,983	30.5
LLC "STEK TELECOM"	228,564	715,111	32.0
Average value			25

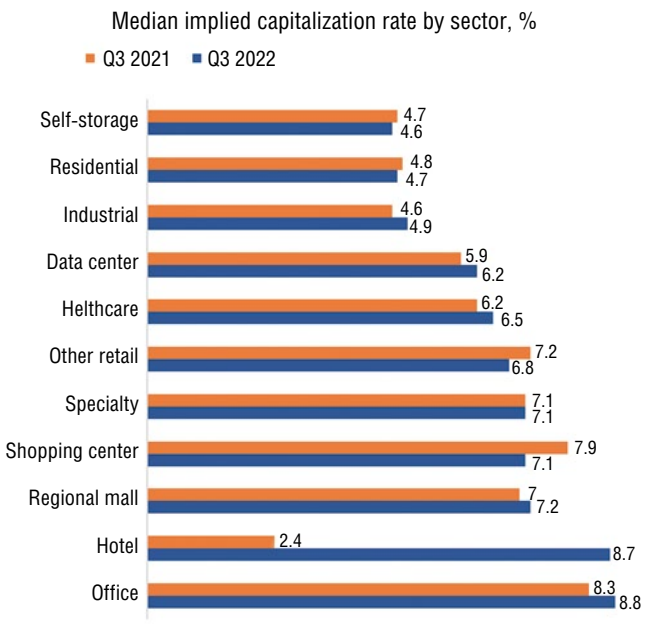
Cap rate and discount rate

In accordance with Clause 22, Federal Valuation Standard 5, cap rate and discount rate must indicate the risks as assessed by the market participants, of obtaining the expected cash flow as well as a specific transaction or user (in accordance with the type of determined value).

To derive the discount rate value weighted average cost of capital (WACC) model may be recommended while the capitalization rate may be derived with certain difficulties. There are difficulties in implementing the market extraction method as the market lacks the data about the deals (sale offers) of the comparable subjects and the build-up method may yield ever greater error in part of risks analysis and consideration.

Today Russia is witnessing recurring research works [28, 29] analyzing capitalization rates for the wide spread sectors of commercial real estate market: office, trade, warehouse; however, there are no such research works in DPCs.

Meanwhile, Western analytical research works, e.g., S&P Global Markets [30], consider the capitalization rates in many market sectors of the US commercial real estate (Fig.).



Cap rates observed in different sectors of the US real estate market [30]

The Figure shows [30], that average cap rate for DPC (data center) in the USA is 6.2 %. The data about the cap rate for DPCs in the USA as well as the data about the risk-free rate in the USA and Russia allows for computing cap rate for DPCs in the Russian market.

Final calculation

As the income approach yields the market value of the DPC operating business it will be required to leave aside the components of the resulting value which do not relate to the target real estate assets.

CONCLUSION

Valuation of the specialized assets requires from the valuer or expert rich experience, high qualification and knowledge of the market specifics. Valuation of the data centers is a labor consuming process as all valuation approaches are applied. The result obtained within the frameworks of the individual approaches may be presented not as a definite figure but also by a range of values. The key provisions of this paper may be useful and applied by the practicing valuers or forensic examiners.

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Теоретические и практические особенности оценки центров обработки данных (ЦОД)

В настоящей статье автор разбирает особенности оценки объектов недвижимости специального назначения: дата-центров или центров обработки (и хранения) данных (ЦОД/ЦХОД), опираясь на международный опыт, рекомендации международных стандартов оценки и методического руководства RICS (The Royal Institution of Chartered Surveyors/Королевское общество сертифицированных экспертов в области недвижимости (Великобритания)).

Актуальность статьи обусловлена тем, что в настоящий момент в России нет отдельного единого для всех оценщиков или судебных экспертов стандарта или методических рекомендаций по оценке центров обработки данных, а учебно-научной литературы крайне мало. При этом в России, как и в целом в мире, отмечается значительный рост строительства ЦОД, которые впоследствии вовлекаются в коммерческий оборот в качестве объектов сделки, залога или имущественного спора.

В статье проанализирован современный международный подход к оценке ЦОД, а также обобщен личный профессиональный практический опыт автора. Отдельно в статье дано определение и проанализированы особенности этой группы недвижимости, приведена классификация и выявлены основные характеристики, которые оказывают влияние на стоимость. Автором исследованы особенности применения подходов и методов оценки и даны практические рекомендации по определению рыночной стоимости в рамках затратного, сравнительного и доходного подходов. Особое внимание автор уделил основному (доходному) подходу, подробно описаны виды услуг, которые могут формировать доход от операционной деятельности ЦОД, постатейно рассмотрены расходы на эксплуатацию ЦОД, даны практические рекомендации по определению ставки капитализации.

Ключевые слова: *оценка недвижимости, подходы и методы оценки, рыночная стоимость, коммерческая недвижимость, специализированные активы, центр хранения и обработки данных (ЦХОД), центр обработки данных (ЦОД), дата-центр, облачные сервисы, инфраструктура коммуникаций и технологий, ИКТ, судебная экспертиза*

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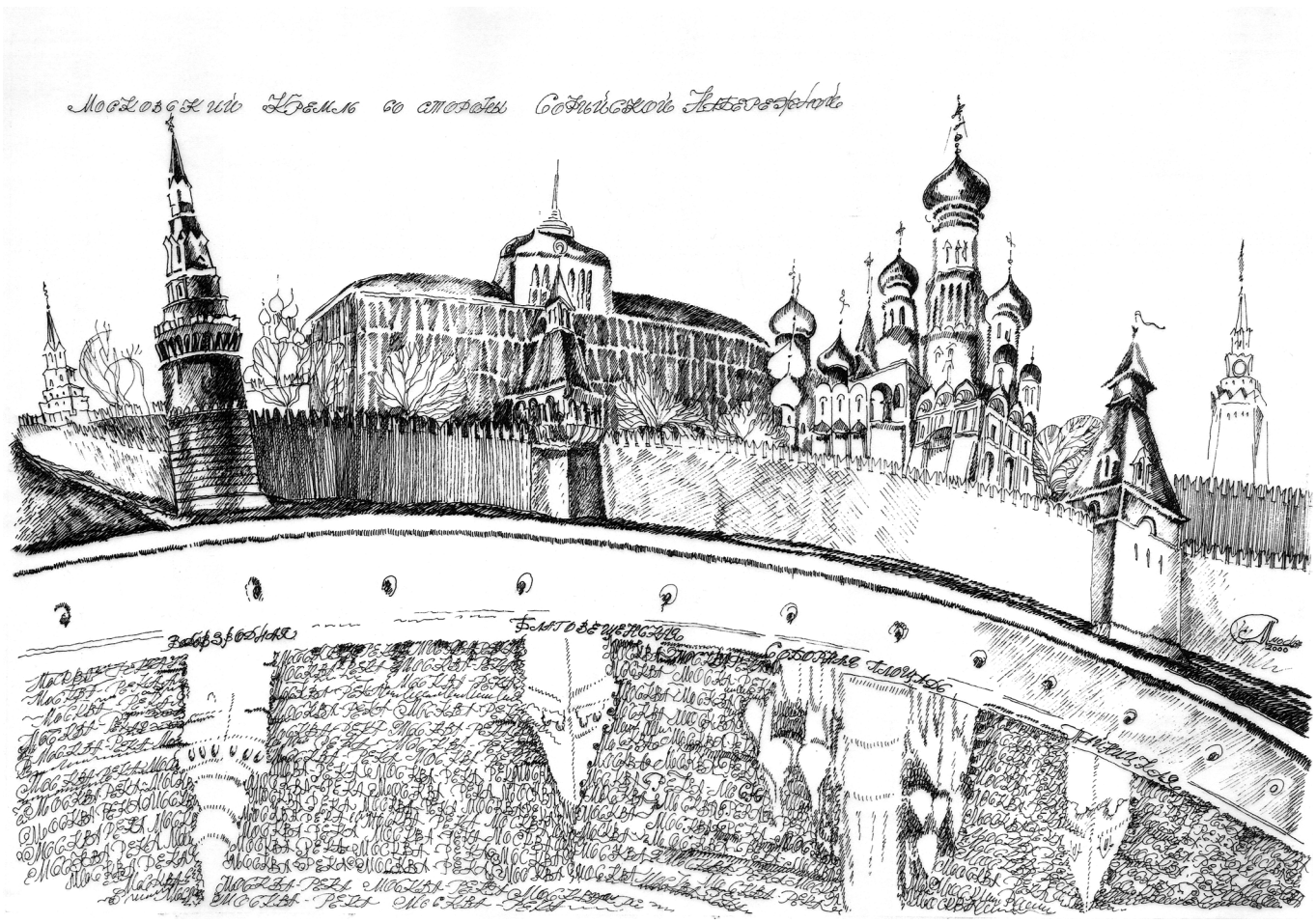
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Л.И. Павлова. Московский Кремль со стороны Софийской набережной. Рисунок, тушь перо



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