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05.23.19 Экологическая безопасность строительства и городского хозяйства
05.23.22 Градостроительство, планировка сельских населенных пунктов

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Уважаемые читатели!

Совокупный потенциал предприятия инвестиционно-строительного комплекса представляет собой меру его способностей, которые формируются в результате взаимодействия основных производственных фондов, трудовых ресурсов, оборотных и нематериальных активов с учетом маркетинговой деятельности.

Развитие любой способности предприятия совершается по спирали: реализация возможностей, которые представляют способность данного уровня, отражает новые возможности для развития способностей более высокого уровня, т.е. переходит на более высокую ступень.

Совокупный потенциал строительного предприятия определяется потенциалоемкостью, которая представляет собой оценку его возможностей по выпуску объема готовой строительной продукции (вида услуг) требуемого качества за определенный период времени, т.е. является интегральной оценкой результативности производственно-строительной системы (далее — ПСС).

Результативность системы определяется набором показателей-индикаторов, которые образуют результаты инвестиционно-строительной деятельности предприятия. Иначе говоря, потребители платят за готовую строительную продукцию (товары и услуги), получают ее, используют ее, реагируют на нее, и мы можем и должны следить за результатами производства в качестве измерителя результативности системы.

Система индикаторов результативности: конкурентоспособность, экономичность, качество продукции (услуг), прибыльность, производительность, рентабельность продаж, инновации, учитывающие энтропию рыночного спроса и предложения.

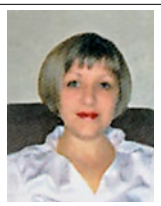
Совокупный потенциал ПСС характеризует максимально возможную потенциалоемкость, реализуемую предприятием на получении конечной готовой строительной продукции.

В основе ее расчетов находится, с одной стороны, информация о проекте (характеристики готовой строительной продукции и нормативные требования к процессам ее реализации), отражающаяся в контрактной форме документации, а с другой — характеристики трудовых ресурсов ПСС, обеспечивающих реализацию инвестиционного проекта.

По результатам анализа контрольной выборки учеными НИУ МГСУ (154 строительных предприятий, 2021 г.) было определено, что более 70 % строительных предприятий имеют величину эффективности по использованию совокупного потенциала ниже среднего уровня (на единицу производственно-финансовых ресурсов). Это еще раз подтверждает имеющиеся значительные резервы повышения потенциалоемкости строительных предприятий.

Главный редактор, **Пётр Грабовый**

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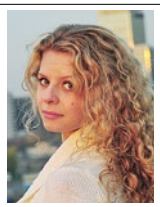
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Хрусталев Б.Б., Антипов В.А., Луняков М.А.
В связи с низким уровнем конкуренции ухудшается качество проводимых работ, компании редко прибегают к разработке долгосрочной стратегии развития собственного предприятия, что напрямую сказывается на их подготовке к всевозможным внутренним и внешним изменениям.

Грабовый П.Г., Жихарев Д.Ф.
Величина чистой прибыли сама по себе не является достаточным основанием, чтобы судить о высокой потенциалоемкости предприятия индустриального домостроения или эффективности использования производственно-технического потенциала, включая трудовые ресурсы.

Силка Д.Н., Бурлуцкий Н.А.
Эксперты отмечают, что за последние три года была расторгнута четверть госконтрактов на сумму более 4 трлн рублей, что привело к увеличению числа проблемных строительных проектов по всей стране. Современные административные меры по ускорению внедрения ТИМ для повышения эффективности строительства явно не позволят устранить хронические проблемы.

Пантелеева М.С.
Состояние жилого фонда в стране сегодня таково, что без массового проведения капитальных ремонтов с использованием энергоэффективных материалов и инновационных технологий количество аварий в жилых зданиях будет только увеличиваться.

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АКЦЕНТЫ НОМЕРА

России нужна новая система формирования тарифов, которая смогла бы учесть все особенности отрасли ЖКХ и возможности финансирования с учетом ее монопольной структуры.

Акристиний В.А.
Современные тенденции развития городских агломераций определяют условия, в которых необходимо принимать оптимальные решения по выбору способов реконструкции городской застройки. Актуальным механизмом является внедрение инструментов «зеленой» архитектуры для повышения критериев эффективности реконструкции городских пространств.

Дмитриев А.Н., Мустафин И.Г.
Реализация мероприятия по автоматизации системы управления позволит согласовать цели и задачи, стоящие перед компанией с целями и задачами, стоящими перед отдельными подразделениями и топ-менеджерами, четко понять функции, ответственность и требования к сотрудникам для построения эффективной системы управления компанией, сформировать целевую бизнес-модель компании для внедрения корпоративной информационной системы.

Волков Р.В.
Необходима системная программная модернизация инфраструктуры государственных вузов с разработкой и внедрением механизмов эффективного управления имущественным комплексом государственных вузов.

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05.23.00 Construction and architecture
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05.23.19 Environmental safety of construction and municipal economy
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Khrustalev B.B., Antipov V.A., Lunyakov M.A.
Due to the low level of competition, the quality of work is being deteriorated. The companies rarely try to use a long-term strategy for the development of their own enterprise, which directly affects their approach to all kinds of internal and external changes.

Grabovy P.G., Zhikharev D.F.
The amount of net profit in itself is not a sufficient reason to judge the high potential intensity of an industrial house-building enterprise or the efficiency of using production and technical potential, including labor resources.

Silka D.N., Burlutsky N.A.
Experts note that over the past three years a quarter of state contracts worth more than 4 trillion rubles were terminated, which led to an increase in problematic construction projects across the country. Modern administrative measures to accelerate the implementation of IMT to increase the efficiency of construction clearly will not allow eliminating chronic problems.

Panteleeva M.S.
The state of the housing stock in the country today is such that without mass overhauls using energy efficient materials and innovative technologies, the number of accidents in residential buildings will only increase. Russia needs a new system of tariff formation, which would be able to take into account all the features of the housing and utilities sector and the possibility of financing, taking into account its monopolistic structure.

Akristiniy V.A.
Modern trends in the development of urban areas determine the conditions in which it is necessary to make optimal decisions on the choice of methods for the reconstruction of urban construction. An actual mechanism is the introduction of “green” architecture tools to increase the criteria for the effectiveness of urban space reconstruction.

UDC 330.322.54

Khrustalev B.B.
Antipov V.A.
Lunyakov M.A.

Principal development features of the investment and construction complex in the Russian Federation

The article discusses the efficiency of construction enterprises in the Russian Federation. The main development trends of the Russian investment and construction complex were identified using the data made available by the Russian Federal State Statistics Service ("Rosstat") and the Unified Resource for Developers. The authors analyzed the total area of constructed facilities, the number of constructed facilities, the total area of constructed facilities whose commissioning was delayed, the average area of real estate facilities constructed in Russia, the average price per square meter. The methods of research include the theoretical analysis and empirical studies, namely, statistical data analysis, data description and pooling. Data resources, used to analyze this problem, include sources about the activities of the construction sector, research articles, monographs, electronic resources, and sources of legal information. The methods, used to draft this article, include description, comparison, and classification.
The effective operation of enterprises on the construction market requires the establishment of a set of legislative, legal and economic standards to ensure the effective resolution of the problem of unfinished construction and transition to innovative and technology-focused developments.
Keywords: *investment and construction complex, analysis of operation and development of the investment and construction complex of the Russian Federation, development strategy of the construction industry, efficiency of the country's construction industry*



Khrustalev Boris Borisovich,
Doctor of Economics, Professor, Head of the Department of the Economics, Organization and Production Management; Penza State University of Architecture and Construction; 28 German Titov St., Penza, 440028, Russian Federation; ID RISC: 468261, Scopus: 56682739600, ResearcherID: AAR-2319-2021, ORCID: 0000-0002-9172-3487; hrustalev_bb@mail.ru



Antipov Vladislav Anatol'evich,
Graduate student of the Department of Economics, Organization and Production Management; Penza State University of Architecture and Construction; 28 German Titov St., Penza, 440028, Russian Federation; ID RISC: 1118212; antipov_vladislav@list.ru



Lunyakov Mikhail Aleksandrovich,
Doctor of Economic Sciences, Professor, Professor of the Department of Organization of Construction and Real Estate Management; Moscow State University of Civil Engineering (National Research University) (MGSU); 26 Yaroslavskoe Shosse, Moscow, 129337, Russian Federation; ID RISC: 371455, ResearcherID: ABG-9701-2021, ORCID: 0000-0001-7093-3779; 1398934@mail.ru

PROBLEM STATEMENT AND STUDY

The construction sector of the Russian Federation plays a crucial role in the development of the economic, social, and cultural potential of the country and each individual region. In this regard, the development of the construction industry is particularly important for solving regional and federal economic tasks. The construction sector is vital for the reproduction of fixed assets held by state-owned and private enterprises. It is also a key to the strategic tasks of Russia's long-term social and economic development programmes [1].

Well-balanced state control and management practices, applied to the construction sector, enable enterprises to adapt to rapidly changing external and internal factors. Notably, effectively operating construction enterprises influence the development of each region, the economic growth of regional industries engaged in the material production, which, in turn, affects the growth of the country-wide business and investment activity in terms of living standards [2]. Therefore, we believe that the advancement level of the construction industry determines the development level of the whole country and explains the importance of effective management of the construction industry and support provided to its business entities. A closer look at the recent statistics on the Russian enterprises is needed to accurately analyze the construction industry in the Russian Federation [3].

RESULTS

The construction complex of the Russian Federation has large, medium-sized, and small business entities. However, large enterprises are responsible for more than 90 % of construction work and services. The majority of these enterprises are privately owned. Over the last few years, the Russian market has had more than four thousand legal entities associated with the construction industry. As of January 2022, 3,742 companies were engaged in construction activities. 19 % of the total area of constructed facilities was built by the top ten companies. Table presents statistics on the construction industry over the last five years.

According to Rosstat and the Unified Resource for Developers, 2018 was the best year for the Russian construction industry, if we address the time period under study. The maximum total area of facilities under construction reached 136,596,558 sq. m. The number of houses under construction in the Russian Federation was maximal in 2018; it reached 16,198 units. However, relative to 2021, the area of construction facilities, whose commissioning was postponed, reached 35,920,016 sq. m in 2018. This trend is explained by a decrease in the total area of facilities under construction in 2021. Hence, the ratio of postponed commissioning to the total area of facilities under construction went down from 26.3 % in 2018 to 23.4 % in 2021[1]. Fig. 1 shows the pattern of change.

The analysis of changes in the total area of facilities under construction has proven the irregular pace of changes. The amount of construction work went up until 2018, when it reached its maximal value of 136,596 thousand sq. m. In 2018–2019,

1 Construction. Federal State Statistics Service. URL: https://rosstat.gov.ru/folder/14458 (date of appeal: 21.01.2022).

Russian construction industry

Indicator	Year				
	2017	2018	2019	2020	2021
The total area of constructed facilities, sq. m	115,817,529	136,596,558	130,870,821	110,149,961	104,911,219
Facilities under construction, units	14,463	16,198	14,543	10,885	10,067
The area of construction facilities, whose commissioning is postponed, sq. m	25,735,869	35,920,016	34,107,914	30,391,545	24,572,775
The average area of facilities under construction, sq. m	49.3	49.3	49.7	50.1	49.7
The average price per square meter, RR	64,672	68,589	76,605	91,233	123,939
The number of home mortgage loans, loans	813,342	1,174,604	1,007,995	1,310,651	1,558,473

the total area went down by 5,725 thousand sq. m. In 2019–2020, the total area of facilities under construction went down by 20,661 thousand sq. m, which is a maximum reduction over the studied period. In 2021, the area of facilities under construction reached its minimum of 104,911 thousand sq. m[2].

The leaders in terms of facilities under construction were such developers as PIK Group, Samolyot Group, LSR Group and Setl Group Holding Company. In the aggregate, these companies build more than 10 % of the total area of construction facilities in the Russian Federation with a focus on the Moscow and Leningrad regions.

Moreover, almost each of the top fifteen developers, responsible for over 20 % of the total construction work, is headquartered in Moscow and St. Petersburg. Only two companies are based in other regions; they are the SouthStroyInvest Group of Companies (the Stavropol Territory) and SK SouthStroyImperial (the Krasnodar Territory). Many of the TOP100 Russian construction companies are based in Moscow and St. Petersburg, and the situation does not look favourable for other Russian regions, because each has 1 or 2 positions on the TOP100 list. Such a state of affairs prevents any direct competition between Russian construction companies and affects the total area of construction facilities, whose commissioning is postponed. Fig. 2 shows the breakdown of delayed commissioning [4].

2 Single resource of developers. LLC "Institute for the Development of the Construction Industry". URL: https://erzrf.ru/issledovaniya (accessed: 17.01.2022).

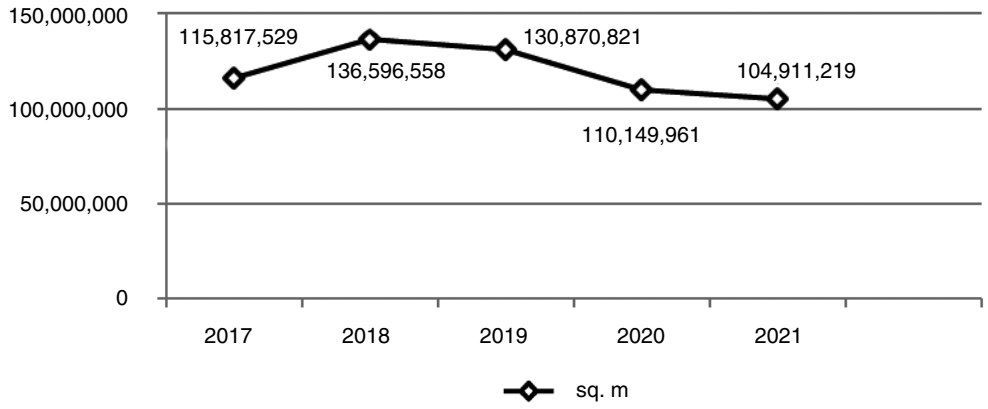


Fig. 1. A change in the total area of facilities under construction, 2017–2021

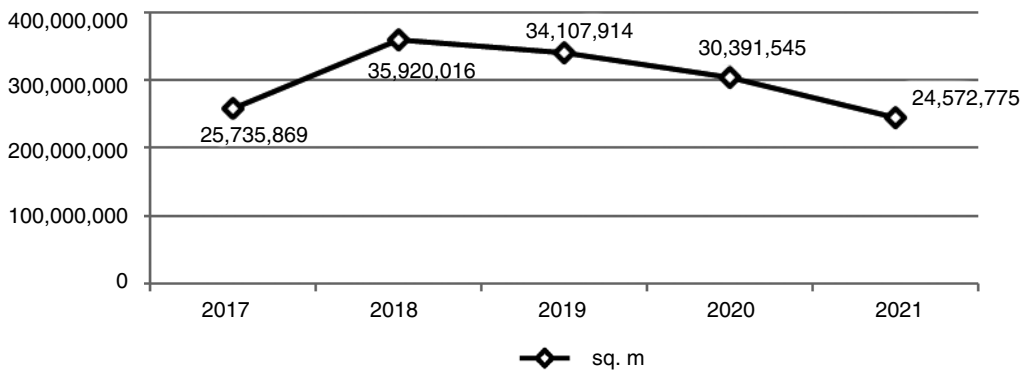


Fig. 2. Delayed commissioning of facilities under construction in 2017–2021

Low competition causes a decline in the quality of work. Companies rarely draft any long-term development strategies, and their unavailability affects their preparedness for internal and external changes [5].

This is exactly what happened in the Republic of Bashkortostan and the Krasnoyarsk Territory in 2021, whose major developers failed to meet the deadlines and delayed the commissioning of more than 80 % of the total construction volume. Indeed, in Bashkortostan, GK FSK Archstroyinvestitsii delayed the commissioning of more than 379,763 of 473,870 sq. m. Hence, the commissioning of 80.1 % of the total facilities under construction was delayed. In the Krasnoyarsk Territory, Monolitholding Group of Companies and KKFZhS delayed the commissioning of 530,879 of 552,493 sq. m; therefore, the commissioning of 96 % of facilities under construction was delayed [6].

In Russia, 2017 was the best year for the construction industry when the lowest percent of delayed commissioning was recorded: it reached 22.2 % or 25,735 thousand sq. m. The largest percent of delayed commissioning was in 2018, when it reached 26.3 %, or 35,920 thousand sq. m. An increase was triggered by the larger total area of facilities under construction. The next three years (2019–2021) are characterized by a gradual decrease in delayed commissioning to 24,572 thousand sq. m. However, this trend does not mean any construction industry improvement, since the decrease occurred against the background of the annual reduction in the total area of facilities under construction, and the average percent of delayed commissioning was 23.1 %.

The analysis of the number of facilities under construction has proven that this situation was triggered by the construction market crisis, which affected the majority of the Russian companies (Fig. 3).

First of all, a decrease in the number of facilities under construction was caused by a decrease in the total area of constructed facilities. Indeed, this number was maximal in 2018, it was 16,198 of facilities under construction. In the next three years, this number went down by 6,131 facilities and dropped down to 10,067 facilities under construction in 2021. Hence, the construction market has grave problems that decelerate the construction of new facilities. The economic and construction crisis affects long-term strategies, implemented by the developers that minimize their risks and reduce the number of facilities under construction [7].

A reduction in the number of facilities under construction has barely affected the average area of apartments under construction. Indeed, in 2017 the average area was 49.3 sq. m, while in 2021 this value was up by 0.4 sq. m and reached 49.7 sq. m. However, this trend has not affected the average price for one square meter. During the period under discussion, it nearly doubled due to the economic and construction crisis, the shortage of building materials, the adoption of the 175-FZ law, etc. A change is shown in Fig. 4.

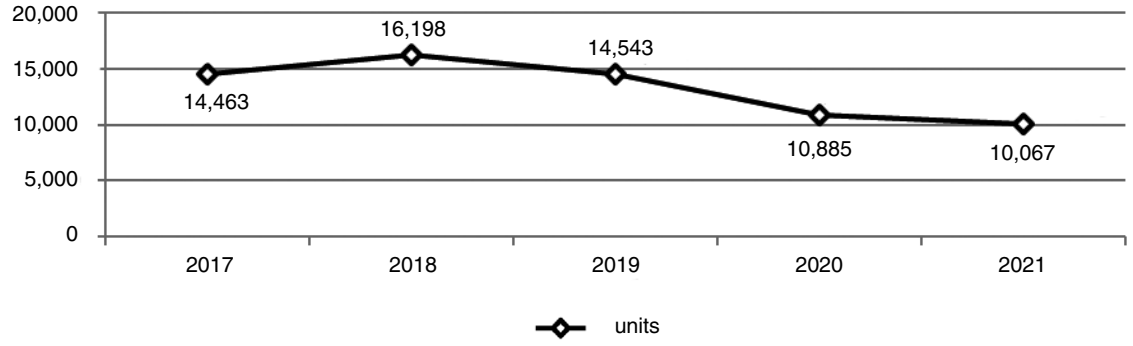


Fig. 3. A change in the number of facilities under construction in 2017–2021

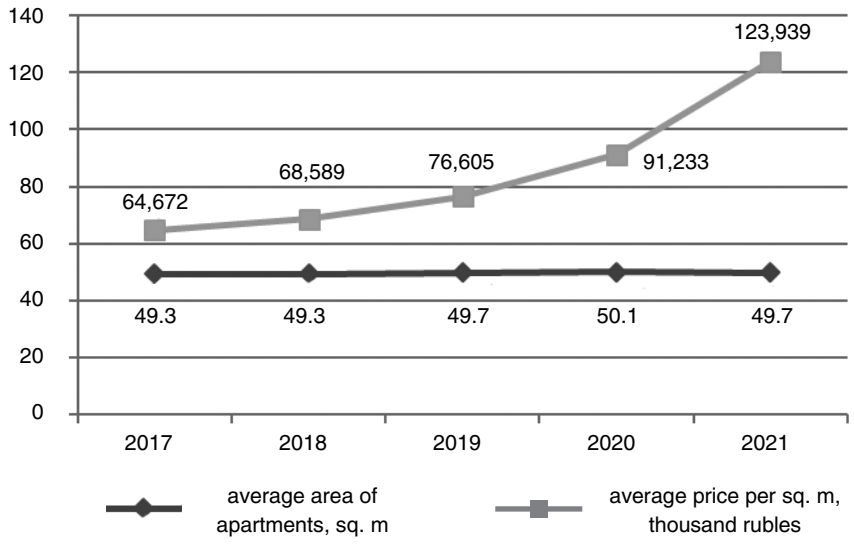


Fig. 4. Changes in the average area of apartments and the average price per square meter in 2017–2021

Changes in the average area of apartments had imperfect periodicity. It was minimal in 2017–2018, when it reached 49.3 sq. m. The average area of apartments was maximal in 2020, when it reached 50.1 sq. m. The average area of a residential unit was 50.3 sq. m. This means a relatively high demand for one-room, two-room apartments and studio apartments in the Russian Federation.

The average price per square meter kept growing. In 2017, it was 64 RR. The growth rate was maximal in 2020–2021, when it reached 32,706 RR. During the entire period, the average price went up by 59,267 RR and reached 123,939 RR per square meter in 2021. The average apartment price went up from 3,188,329 RR in 2018 to 6,159,768 RR in 2021.

An increase in the cost of construction projects, in particular, residential real estate construction undertakings, affected the number of mortgage housing loans. Fig. 5 shows the loan issuance pattern.

Changes in the number of home mortgage loans had imperfect periodicity. In 2017–2018, the number went up by 361,262 and reached 1,174,604. Later it went down to 166,609 in 2019. Until 2021, the number of home mortgage loans had an upward trend in Russia. In 2021, this number reached its absolute maximum of 1,558,473 loans. During the analyzed period it went up by 52.19 %.

A 2020–2021 upward trend is explained by a set of actions taken to support the construction industry, which suffers from the crisis. The President of the Russian Federation relaxed the monetary policy of the Bank of Russia, and government programmes were implemented in the construction industry to stimulate the issuance of mortgage loans. The average mortgage rate was 6.5 % [8–10].

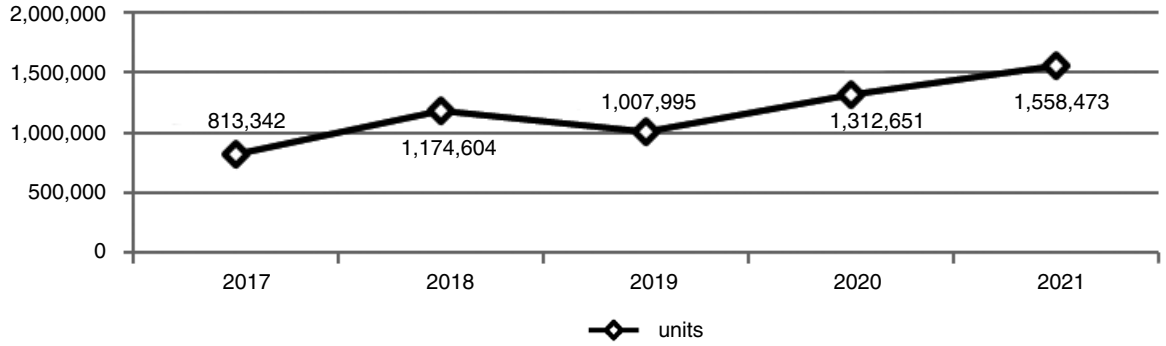


Fig. 5. A change in the number of home mortgage loans in 2017–2021

CONCLUSION

Indeed, according to the data made available by the Federal State Statistics Service of the Russian Federation, the Unified Resource for Developers and the analysis made by the authors, the construction market of the Russian Federation suffers from grave problems. The market values went down from 2017 to 2021. They include the total area of constructed facilities, the number of facilities under construction and the postponed commissioning. At the same time, there is a trend towards an increase in the cost of one square meter of facilities under construction. These factors mean that the Russian construction market faces serious problems, such as the 175-FZ law, the economic crisis, the unfinished programme on the RF construction industry development through 2030. All these factors have a negative effect on the country's construction industry. However, many small, medium-sized and even large developers are not ready to face these changes, neither do they put enough effort into long-term corporate development strategies [11–13].

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Основные особенности развития инвестиционно-строительного комплекса Российской Федерации

В статье рассматриваются вопросы эффективности работы строительных предприятий на территории Российской Федерации. Согласно данным Росстата и «Единому ресурсу застройщиков» выявлены основные тенденции инвестиционно-строительного комплекса Российской Федерации. В частности, дана оценка таким показателям, как совокупная площадь строящихся единиц, количество возводимых объектов, перенос срока ввода в эксплуатацию кв. м (с прошлых периодов), средняя площадь строящихся объектов недвижимости в России, средняя цена за 1 кв. м. Методами исследования являются теоретический анализ и эмпирическое исследование, в частности анализ статистических данных, а также описание и группировка данных. Информационной базой для анализа данной проблемы стали литературные источники по вопросам деятельности строительного комплекса, научные статьи, монографии, электронные ресурсы, источники правового характера. Методологической основной при выполнении статьи послужили такие научные методы, как описание, сравнение, классификация.

Для эффективной работы предприятий на строительном рынке необходимо создание системы комплекса законодательных, правовых и экономических нормативов по обеспечению эффективности решения проблемы незавершенного строительства, перехода к инновационным и технологическим новшествам.

Ключевые слова: *инвестиционно-строительный комплекс, анализ функционирования и развития инвестиционно-строительного комплекса Российской Федерации, стратегия развития строительной сферы, эффективность строительной отрасли страны*

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Об авторах: **Хрусталев Борис Борисович** — доктор экономических наук, профессор, заведующий кафедрой экономики, организации и управления производством; **Пензенский государственный университет архитектуры и строительства (ПГУАС)**; 440028, г. Пенза, ул. Германа Титова, д. 28; РИНЦ ID: 468261, Scopus: 56682739600, ResearcherID: AAR-2319-2021, ORCID: 0000-0002-9172-3487; Hrutalev_bb@mail.ru;

Антипов Владислав Анатольевич — аспирант кафедры экономики, организации и управления производством; **Пензенский государственный университет архитектуры и строительства (ПГУАС)**; 440028, г. Пенза, ул. Германа Титова, д. 28; РИНЦ ID: 1118212; antipov_vladislav@list.ru;

Луняков Михаил Александрович — доктор экономических наук, профессор, профессор кафедры организации строительства и управления недвижимостью; **Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ)**; 129337, г. Москва, Ярославское шоссе, д. 26; РИНЦ ID: 371455, ResearcherID: ABG-9701-2021, ORCID: 0000-0001-7093-3779; 1398934@mail.ru.

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Grabovyy P.G.
Zhikharev D.F.

The productivity of an industrial housing construction enterprise as the main indicator of the potential intensity growth of the production and construction system

The heterogeneity of products and consumed resources can make it impossible to measure the productivity of construction enterprises and the construction industry as a whole. Man-hours cannot be added to cubic meters used as a measure of placed concrete mix or to rubles used as a measure of durable equipment, kilowatt-hours, etc. to obtain the total value of resources. Kazan DSK PJSC or Samolet construction group cannot use the method of continuous concreting to add two square meters of exterior panels to two square meters of constructed frames of residential and commercial real estate to find the final product. Since gains and losses, related to productivity, are distributed by a housing construction company between consumers through price systems, it seems appropriate to use money as the measure of this system to analyze this distribution. The ruble serves as a convenient common denominator in Russia. However, the ruble is a variable value, especially in the current economic environment. These fluctuations must be minimized when the ruble, a monetary unit, is used as an aggregation tool. One of the main features of the proposed approach is the availability of an appropriate corrective (revaluation) mechanism. This method allows:

- measuring the impact of productivity changes on profits;
- learning how acceptable and reasonable productivity changes are in relation to the integral indicator of potential intensity of an enterprise;
- identifying the impact of productivity on the competitive position in terms of the location of residential and commercial real estate.

The article assesses the main criteria of potential intensity (performance) and their impact on profitability and productivity.

Keywords: *potential intensity, productivity, profitability measures, total income, total expenses, cost, return on assets*



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



Zhikharev Dmitry Fedorovich,
Candidate of the Department of Organization of Construction and Real Estate Management; Moscow State University of Civil Engineering (National Research University) (MGSU); 26 Yaroslavskoe shosse, Moscow, 129337, Russian Federation; Zkikharev.77@mail.ru

GENERAL PROBLEM STATEMENT

In the production and construction system of an industrial housing construction enterprise (hereinafter — DSK), labour productivity growth (PI) can be boosted if:

- cost prices go down, while the amount of finished construction products (hereinafter, FCP) goes up (Fig. 1, *a*);
- the volume of finished construction products grows faster than the cost prices;
- the volume of finished products do not change for a long time, and their cost goes down (for example, as a result of regional innovation programmes (Fig. 1, *b*));
- the volume of finished construction products grows at a constant cost;
- the volume of finished construction products decreases slightly, while the cost price grows at a slow pace.

It is known that innovations and investments are the main drivers of reproduction of capital and labour productivity growth at DSK enterprises [1, 2]. Capex as an investment in the development of the production and engineering potential of an industrial housing construction enterprise can be allocated by reducing the cost of production during the construction of new and reconstruction of existing production facilities [3].

As is known, for industrial housing construction enterprises, the main form of production is a combination, which means a technological combination of interrelated heterogeneous productions and their technical and economic unity with construction [4].

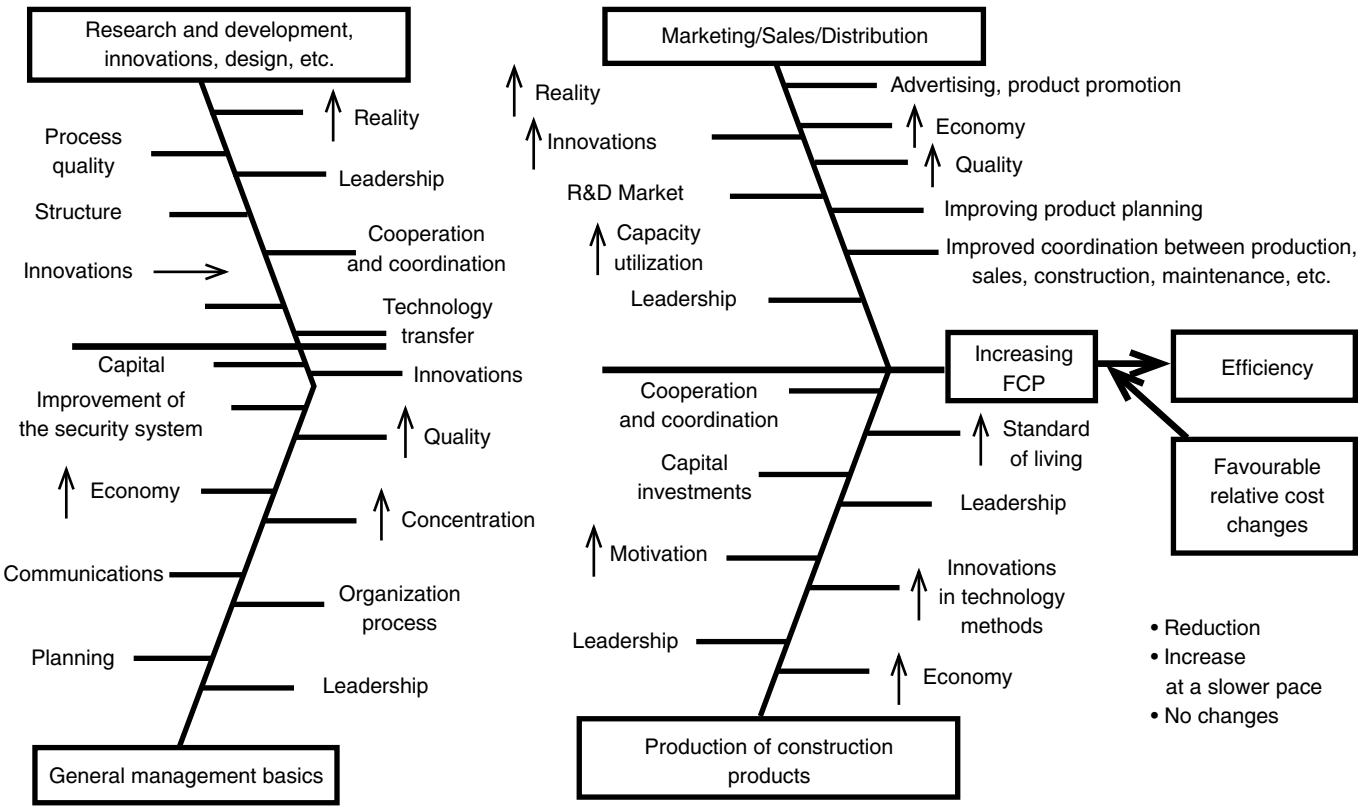
For the effective use of capex, it is important to have options for a rational combination of production, technical potential, technological potentials (means of production, such as tools, working conditions, labour items and labor resources) with the financial and economic potential (financial resources and intangible assets), which represent the total potential of the production and construction system (Fig. 2) [5].

In general, the total production and technical potential is determined by the integral criterion of effectiveness (potential intensity), which includes a set of indicators [6]: resource concentration — *RC*, efficiency — *E*, product quality — *Q*, productivity — *PI*, the level of activity of labor resources — *W*, innovations — *I*, profitability — *P* (Fig. 2).

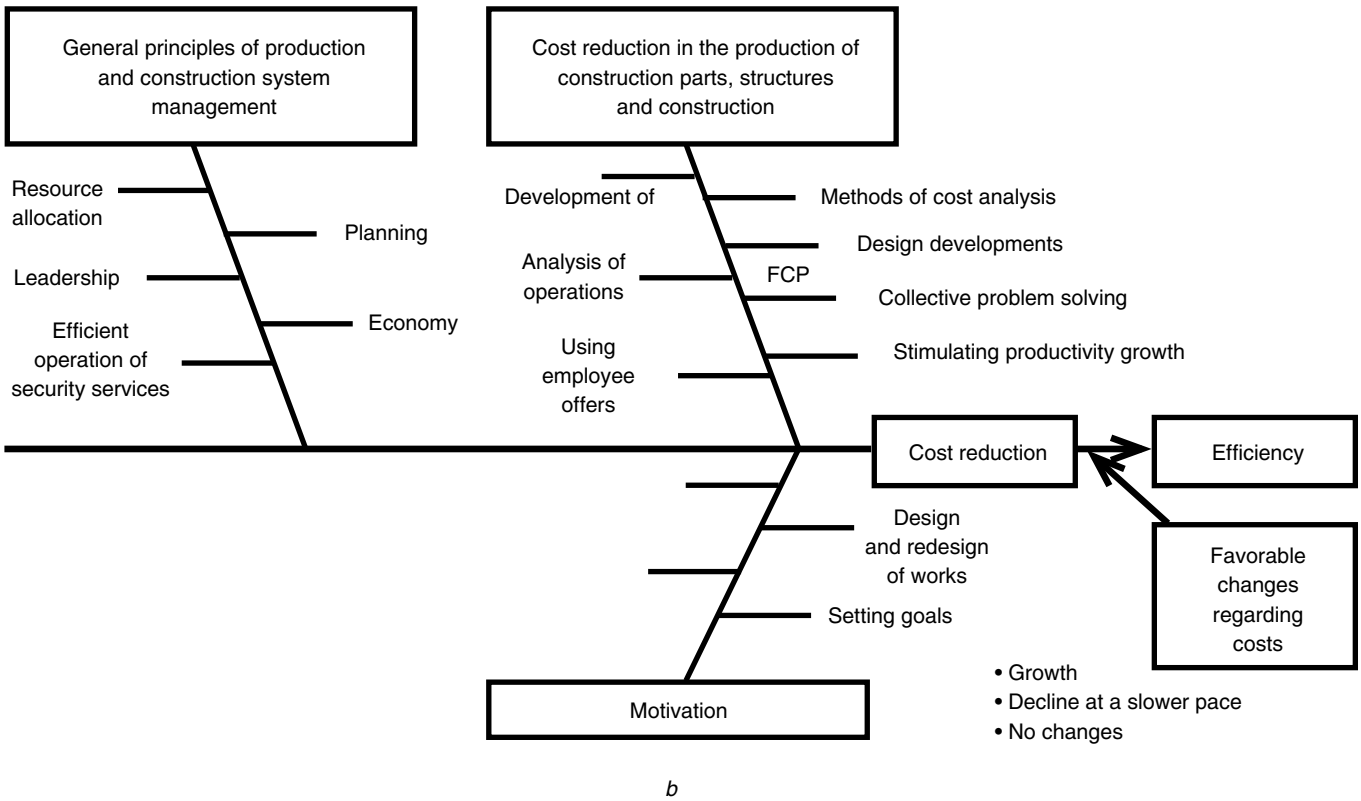
$$V(t) = U^{N}_{i,j,k} = [\{RC\},\{E\},\{Q\},\{PI\},\{W\},\{I\},\{P\},R,C]V(t) \rightarrow \max, \quad (1)$$

where *R* is the aggregate risk level of an investment project (programme); *C* is the indicator of sufficiency of the total resources.

The potential intensity of the production and construction system of an industrial housing construction enterprise is understood as the effectiveness of



a



b

Fig. 1. Options a) and b) are to increase the labour productivity (PI) of industrial housing construction enterprises: a — by increasing the volume of FCP; b — by reducing the cost

productivity of its activities, when the ratio between what the system produces and the available resources of the "proper" type spent on the production of finished construction products allows for its high performance in the long term from the perspective of income and expenses of the system.

THE PROPOSED METHOD OF PERFORMANCE MANAGEMENT

Capital construction needs production and circulating assets to perform its activities [7]. The working capital of enterprises is in continuous motion. It is known that a change in the value of working capital is expressed in the following form:

$$M – P... FCP ...P' – M', \quad (2)$$

where *M* is a change in the monetary form (value), *P* is a product (service), *FCP* means finished construction products.

This is a classical pattern. Industry-specific engineering and economic features of industrial housing construction enterprises determine the features of the turnover of funds in capital construction due to the fact that construction is characterized by a relatively long duration of production and technological cycles, and this is its first feature [8]. Suffice it to say that the renovation of existing buildings may take several years. Prerequisites for reducing the duration of construction in progress are the management of the duration of production, technological and construction cycles. It can reduce the term of construction and eliminate the "spraying" of funds due to the simultaneous concentration of production, technical, technological, financial and economic potentials at the start-up facilities of the urban renewal programme.

Secondly, construction production is not stationary. Unlike industrial enterprises, where means of labour and labour force are geographically connected to a certain place, and the product of labour leaves the place of production, in construction it is not the product of labour (finished products and non-production fixed assets) that moves, but the means of labour and labour force. The need to move means of production from one construction site to another disrupts the continuity of the production process.

Thirdly, construction means unique work. This implies various functions of developers and contractors.

Fourth, not one, but several specialized construction organizations, including transport and logistics firms, are usually engaged in the industrial production of structures on the construction site. Due to the further specialization of contractors, the composition and structure of the working capital of individual corporate contractors may differ significantly from the average industry composition and structure of the working capital [9].

Stages of circulation of funds in construction differ depending on whether calculations are made for the stages of work or fully completed facilities.

A customer or a management company (depending on the chosen organizational form of management and the type of contract) wires money to pay for the equipment and certain types of materials transferred to the contractor. The contractor transforms the monetary form of value into the commodity one [10].

Next, the production maintenance process takes place. Inventory (products, materials, structures) and equipment arrive at the construction site, where their value is transferred to the newly created product as a result of the application of labour to them. The volume of construction and installation work is accounted for on the contractor's balance sheet as work in progress, while the equipment commissioned for installation continues to be accounted for on the developer's balance sheet.

For a contractor, the completion and delivery of a stage of work means the completion of the circulation of funds, although for the whole construction project it is nothing more than continued circulation of working capital in the process of production.

If we proceed from the fact that unfinished construction accounted for on the developer's balance sheet is not a current asset (which is not a fixed asset yet), but as it is moved to the contractor's balance sheet, it acquires the function of working capital, but the economic nature of unfinished construction listed by developers remains unclear.

A fundamental solution to the problem of unity of working capital is especially important, since in the future settlements between developers and contractors will be made only for fully operational facilities and enterprises according to formula 3.

$$M – P ... FCP ...P' – M' – M – Ce... FCP ... P' – M', \quad (3)$$

where *Ce* is the cost of equipment purchased and installed by the developer.

In contrast to the pattern of circulation of funds in the calculations made for the stages of work, the scope of work, performed by developers, has no unfinished construction.

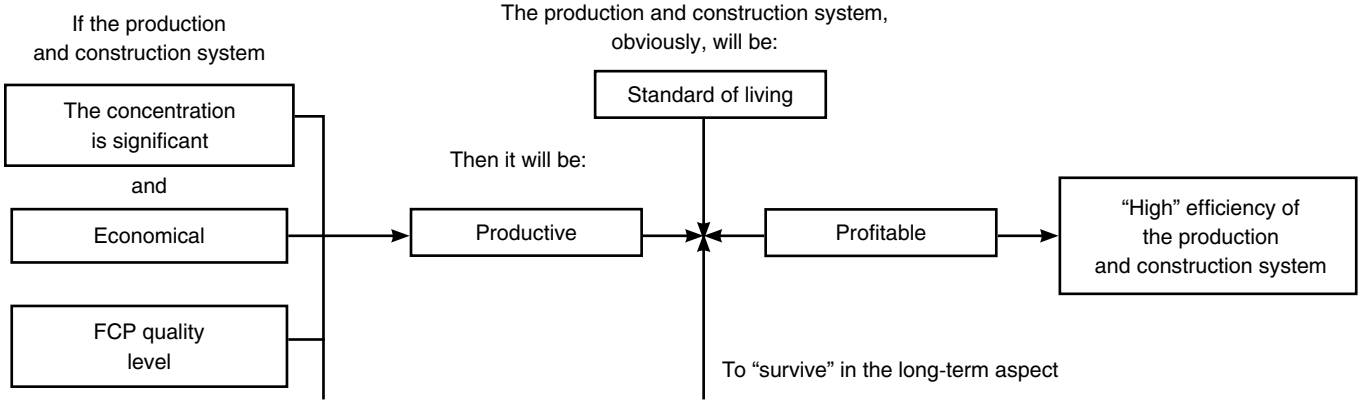


Fig. 2. Hypothetical cause-and-effect relationships between the meters (criteria) of effectiveness of the potential intensity of the production and construction system

Constructed structures and various products are listed as part of the production stock of contractors: reinforced concrete, concrete, metal, wood, as well as electrical and sanitary units, blanks, etc. Basic building materials, structures and products, such as cement and concrete mixtures, metal and metal products, timber, sanitary and electrical materials, roofing, etc. rank high among the production stock. The share of basic building materials accounts for more than 50 % of the production stock held by the contractor. Other auxiliary materials are necessary for the maintenance of construction operations (cleaning, lubricating, etc.); spare parts of machines and equipment, non-inventory containers are not treated as fixed assets (barrels, bags, etc.) needed for temporary buildings and household premises [11].

At the same time, the following four options can boost the aggregate potential of industrial housing construction enterprises and improve the labour productivity in the future (Fig. 4).

For each of the four options (see Fig. 3) actual t_f and standard t_n of the duration of production and construction processes are determined [12]. After identifying the optimal duration of the process, only those options that meet the conditions are accepted $t_{f.opt} \le t_n$.

EVALUATION OF POTENTIAL INTENSITY CRITERIA

The ratio between productivity, cost recovery and profitability is presented in formula (4).

$$\begin{array}{c}\Delta\text{ production volume} \times \Delta\text{ production price} = \Delta\text{ income} \\ \| \qquad\qquad \| \qquad\qquad \| \\ \dfrac{\Sigma\left[\left(Q_i^O\right)\text{period2} \times \left(p_i^O\right)\text{period2}\right] = CI\,\text{period2}}{\Sigma\left[\left(Q_i^O\right)\text{period1} \times \left(p_i^O\right)\text{period1}\right] = CI\,\text{period1}} \\ \dfrac{\Sigma\left[\left(Q_i^I\right)\text{period2} \times \left(p_i^I\right)\text{period2}\right] = CP\,\text{period2}}{\Sigma\left[\left(Q_i^I\right)\text{period1} \times \left(p_i^I\right)\text{period1}\right] = CP\,\text{period1}} \\ \| \qquad\qquad \| \qquad\qquad \| \\ \Delta\text{ amount of resources} \times \Delta\text{ price of resources} = \Delta\text{ cost} \\ \text{Column1} \times \text{Column2} = \text{Column3} \\ \text{“performance”} \times \text{“cost recovery”} = \text{“profitability”}\end{array} \quad (4)$$

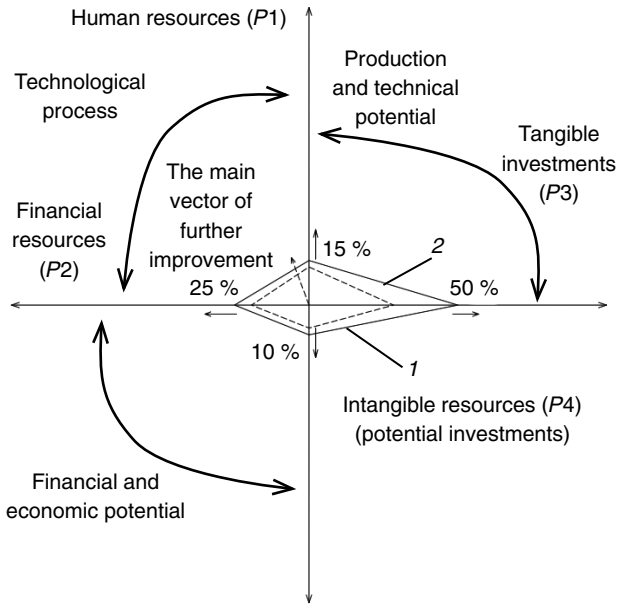


Fig. 3. The total potential of the production and construction system (the case of Kazan DSK PJSC): 1 — planned value; 2 — actual value

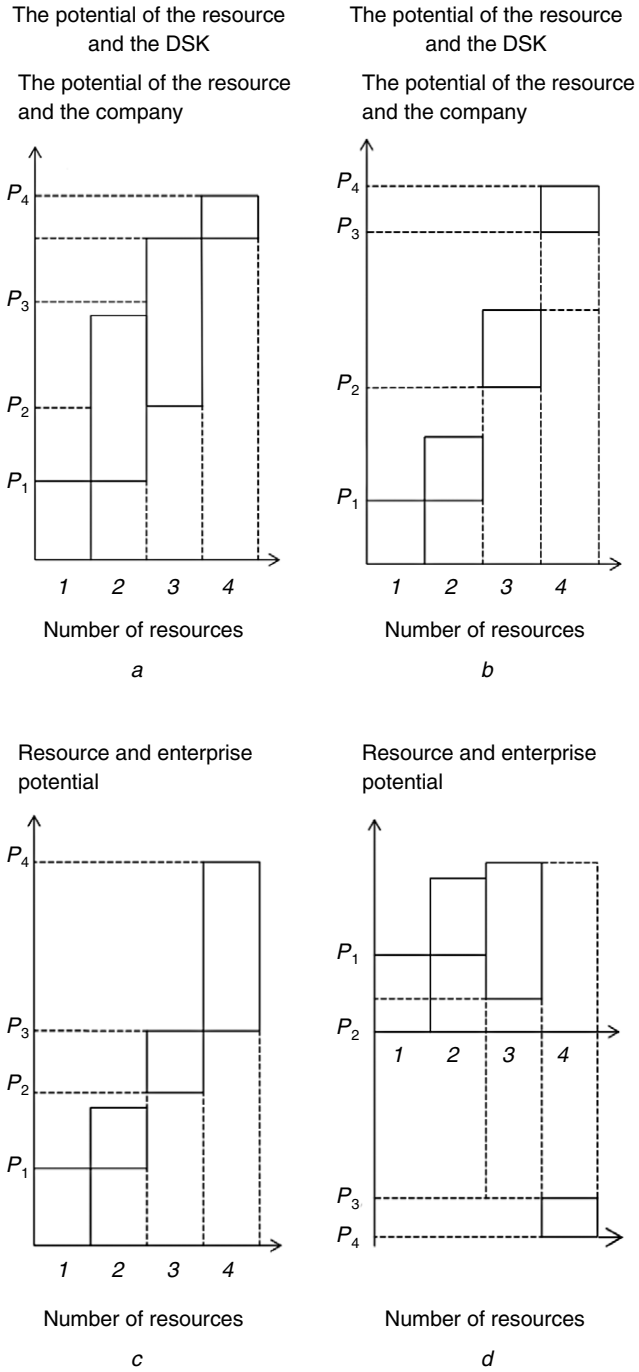


Fig. 4. Alternative options of formation of the aggregate potential of an industrial housing construction enterprise

Currently, it is evident that the behaviour of a manager of an industrial housing construction enterprise depends more on his ideas than “reality”. Nowadays managers believe that their freedom of action is largely limited by uncontrolled factors. Potentially, this circumstance can have an impact on the prospects for measuring productivity [13].

When using formula (4), they try to develop and deepen the traditional profit analysis (Column *3*). They realize that the ability to assess the causes of profit changes is an important element of the control system. At the same time, the ratio between the actual

and standard duration of the production and construction process determines the potential of the labour productivity growth *PI*:

$$PI = \left(1 - \frac{Q - \Sigma D_i}{Q} \times \frac{T_n}{T_f}\right) \times 100\ \%\ , \qquad (5)$$

where Q — construction cost; D_i — total damages; T_n — standard duration; T_f — actual duration.

Indicators of capital return R and labour productivity PI are interrelated as follows:

$$R = \frac{V}{F} = \frac{V/u}{F/u} = \frac{PI}{K}, \qquad (6)$$

where V is the the volume of the construction works; u is the average number of employees/workers engaged in construction and installation; F is the cost of fixed assets used in the performance of

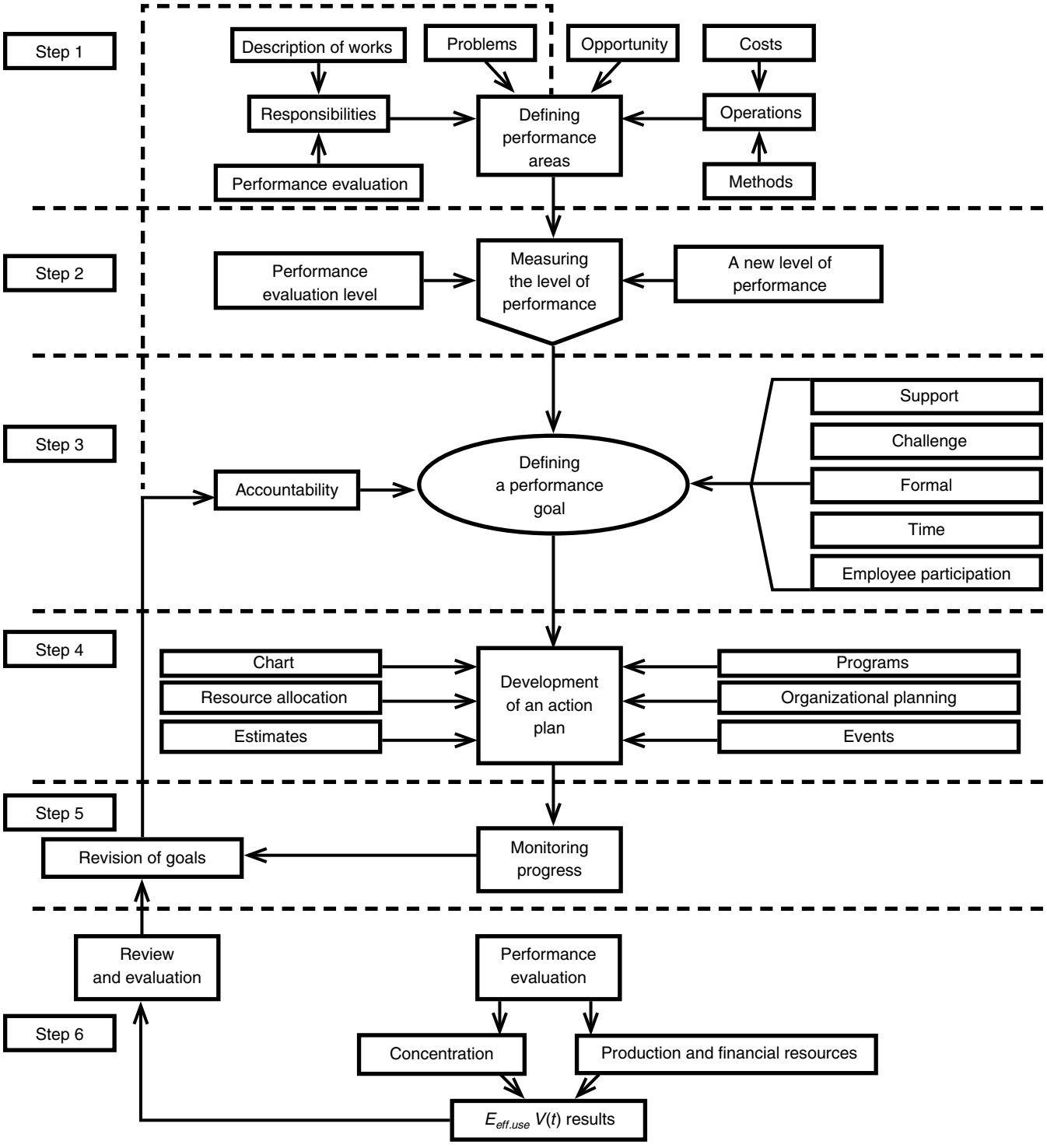


Fig. 5. The process of managing the performance of the DSK

construction work; *K* is the capital intensity of the labour of one employee/worker employed at the DSK enterprise (including main production and construction) [14].

The net profit amount in itself is not a sufficient reason to assess the potential intensity of an industrial housing construction enterprise or the efficiency of using its production and technical potential, including labour resources (workforce).

Net profit can only confirm that a satisfactory balance between income and costs has been achieved. Let's go back to formula (4).

Formula (4) shows the main ratio of productivity, a change in the volume of production to a change in costs. Each organizational system has its own performance index for each resource. Column *2* shows the cost recovery index, i.e. a change in product prices relative to a change in resource prices. Column *3* shows the profitability index. Given that all other factors are constant, namely the prices of products and resources, an increase in the productivity index will entail an increase in profits [15]. Similarly, with constant volumes and a long-term cost recovery index (product prices are rising faster than prices of cost elements), profits will be positive, at least, in the short term.

The effectiveness of the integral indicator of potential intensity should be diagnosed using the minimum number of most informative, non-duplicating relative indicators of production and construction activities.

As an option, it is proposed to use a resource approach based on determining the value of the DSK enterprise productivity per unit of production and financial resources (balance sheet currency) with the definition of the areas of efficiency of the use of potential intensity *V*(*t*) as the critical value, optimal (normal) value, rational value.

$$E_{eff.use}V(t) = \frac{Pf}{resources}. \quad (7)$$

FINAL PART

A rational value can only be achieved in the case of high potential intensity (efficiency) of the production and construction system due to the proper organization of labour and motivation of administrative and managerial personnel (labour resources P_1) related to the structure of fixed assets P_3, current and intangible assets (P_2 and P_1), which implies the potential efficiency of their use with minimal resources and time.

Fig. 5 shows the process of managing the productivity of an industrial housing construction enterprise and achieving the maximum value of *V*(*t*).

The specific weight of the influence of a group of indicators on the integral indicator *V*(*t*) is distributed as follows (according to the analysis of the activities of 22 DSK):

- business activity indicators (productivity, return on funds) — 37 %;
- financial stability indicators — 42 %;
- solvency indicators — 8 %;
- profitability indicators — 13 %.

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Производительность предприятия индустриального домостроения как главный индикатор роста потенциалоемкости производственно-строительной системы

Измерению производительности на предприятиях стройиндустрии и в строительной отрасли в целом может помешать разнообразие производимой продукции и используемых ресурсов. Человеко-часы нельзя складывать с м^3 выложенной бетонной смеси, рублями капитального оборудования, киловатт-часами и т.п. для получения суммарных ресурсов. ПАО «Казанский ДСК» или строительная группа «Самолет» не вправе складывать м^2 наружных панелей, м^2 построенных каркасных площадей объектов жилой и коммерческой недвижимости методом непрерывного бетонирования и т.п., чтобы получить итоговую продукцию. Так как выигрыш и потери, связанные с производительностью, распределяются через системы цен между потреби-

телями предприятием домостроения, то для анализа такого распределения представляется уместным использовать мерило этой системы — деньги; в России удобным общим знаменателем служит рубль. Однако рубль — величина переменная, особенно в нынешних экономических условиях. При использовании денежной единицы рубля в качестве инструмента агрегирования эти колебания необходимо минимизировать. Одна из главных особенностей предлагаемого подхода состоит в наличии соответствующего корректирующего (ревальвирующего) механизма. Этот метод позволяет:

• измерять степень влияния изменений производительности на прибыль;

• определять, насколько приемлемы и разумны изменения производительности в отношении интегрального показателя потенциалоемкости предприятия;

• установить влияние уровня производительности предприятия на его конкурентные позиции на территориальном уровне жилищной и коммерческой недвижимости.

В статье дается оценка основным критериям потенциалоемкости (результативность) и их влияние на прибыльность и производительность [1].

Ключевые слова: *потенциалоемкость, производительность, меры прибыльности, совокупные доходы, совокупные расходы, себестоимость, фондоотдача*

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

Жихарев Дмитрий Федорович — соискатель кафедры организации строительства и управления недвижимостью; **Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ)**; 129337, г. Москва, Ярославское шоссе, д. 26; Zkikharev.77@mail.ru.

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Lukmanova I.G.
Sudakova A.A.

Basis of the tourism clustering in the Russian regions (using the example of the Ivanovo region)

The article addresses the problem of the tourism industry development and the application of the clustering approach. The authors propose tourism clustering around the current landmark attractions in the regions. In the context of insufficient investment resources it is necessary to select the most effective landmarks for tourism clustering. To this end, the authors propose to take into account the factor space of influence and evaluate the effectiveness of operation of newly established clusters using the integral indicator of the anticipated effect. The main objective of this article is to study the business development prospects of domestic tourism and potential tourism clustering in different regions of the country using the example of the Ivanovo region. The authors have developed an algorithm of tourism clustering actions and identified the main groups of factors of influence on clustering validity. In the present-day world subject to globalization, the tourism industry, which generates an impressive share of income for the budgets of many countries, is becoming increasingly important. The problem of domestic tourism development in Russia is relevant in the context of the socio-economic development of Russian regions. Due to the unemployment and regional budget deficit, potential reserves of economic growth and a reasonable approach to the development of the tourism industry must be identified, taking into account the current characteristics and preferences of the population. The proposed approaches and methods are planned to be used in the Ivanovo region selected for tourism clustering.

Keywords: *tourism cluster, factor space of influence, integral indicator of clustering, domestic tourism development, able-bodied population employment rate*



Lukmanova Inessa Galeevna,
Professor of the Department of Economics and Management in Construction; Moscow State University of Civil Engineering (National Research University) (MGSU); 26 Yaroslavskoe shosse, Moscow, 129337, Russian Federation; ID RISC: 655039, Scopus: 57190412717, ResearcherID: B-4128-2016, ORCID: 0000-0002-2835-8181; lukmanova@mgsu.ru



Sudakova Anna Alexandrovna,
Lecturer of the Department of Economics and Management in Construction; Moscow State University of Civil Engineering (National Research University) (MGSU); 26 Yaroslavskoe shosse, Moscow, 129337, Russian Federation; ID RISC: 1101710, Scopus: 57221745186, ORCID: 0000-0002-2274-636X; sudakovaaa@mgsu.ru

Currently, the Russian Federation pays great attention to the public policy in the field of domestic and inbound tourism, that has economic and social effects[1].

Tourism is now seen as a source of financial income for budgets at all levels, a means of increasing employment and quality of life, a way to maintain the health of citizens, the basis for the development of socio-cultural environment, the nurture of patriotic feelings among young people, a powerful educational tool and a vehicle for the formation of a moral platform for civil society [1].

The level of tourism development is of great importance for the state as a whole, as well as for individual subjects of the Russian Federation and municipalities, what explains the relevance of the topic[1].

Key areas of tourism development in the Russian Federation are reflected in the strategy for tourism development in the Russian Federation for the period up to 2035 (approved by the Government of the Russian Federation on September 20, 2019, No. 2129-r), as well as in the national project "Tourism and the hospitality industry" adopted in 2021[1].

The strategic goal and objectives of the Strategy are aimed at implementing the scenario of intensive development of the Ivanovo region. Its main strategic goal until 2024 is to improve the quality of life for the region's population so that it reaches the average level in the Central Federal District, and to set the stage for the development of human capital based on the unlocking of its industrial, scientific, cultural and tourist potential[2].

The above documents draw particular attention to the development of tourism infrastructure, also using the cluster approach.

Currently, the tourism cluster can be seen as an element of a complex system, which allows the interests of business partners and competing groups at the regional and inter-regional level to achieve synergies [2].

The clustering strategy is considered as a strategy of the modernization scenario of social economic development of the region, based on the stimulation and support of innovation processes towards the formation and development of regional cluster systems in the tourism sector [3].

To apply the proposed clustering algorithm (Fig. 1), it is necessary to determine the factor space of influence, which identifies the need, opportunities and efficiency of clustering and the operation of the tourist cluster in a given region of the country [4].

Let's consider the main groups of factors that determine the opportunities, potential and feasibility of clustering and the operation of the tourist cluster in a particular region [5]:

- infrastructure factors;
- the availability of landmarks, attractions, nature reserves, recreation areas, etc.;
- the availability of human resources;
- the interest of professionals, service personnel;
- the interest of regional and local authorities in improving the economic and social climate in the region;

1 On the Strategy for the development of tourism in the Russian Federation for the period up to 2035 : Decree of the Government of the Russian Federation of September 20, 2019, No. 2129-r.

2 Summary of the Ivanovo region socio-economic development strategy up to 2024.

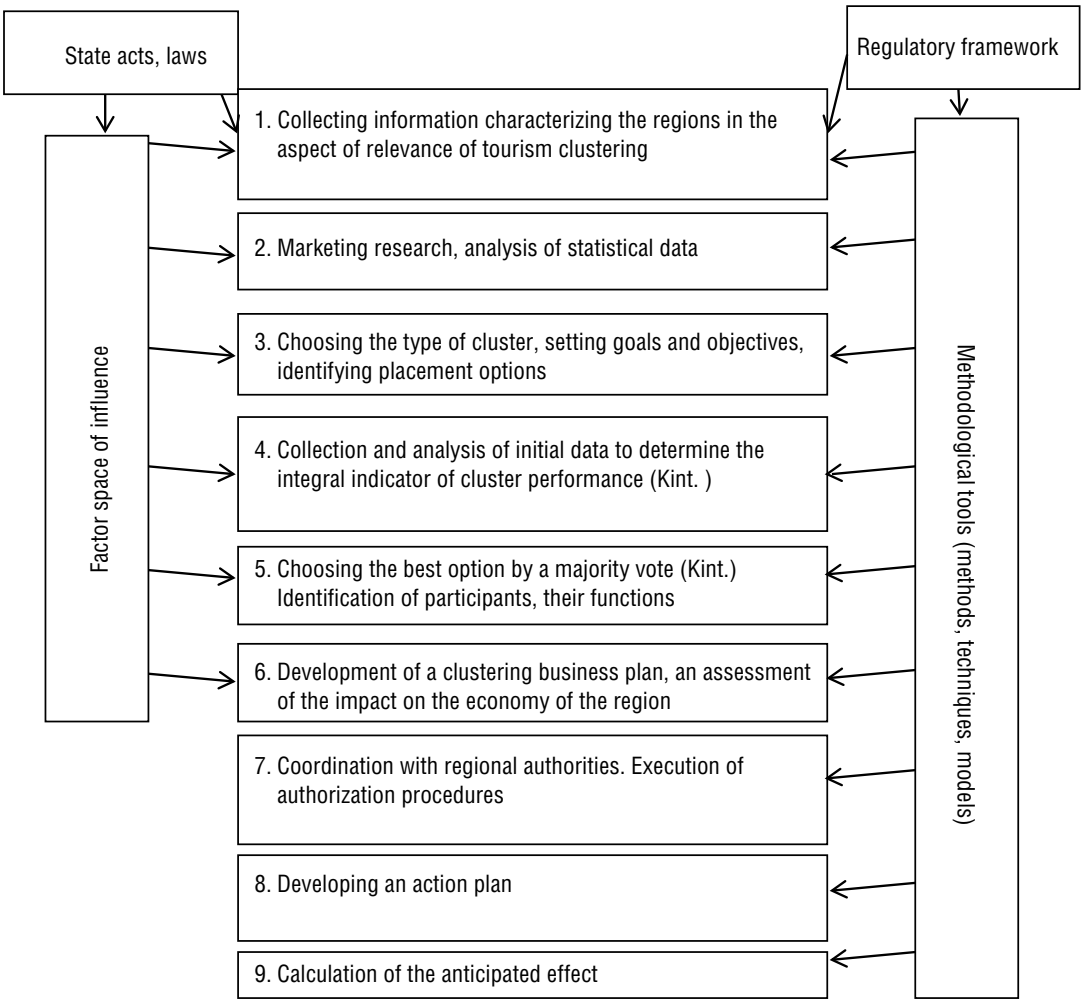


Fig. 1. Algorithm of creating a tourist cluster

- financial factors or availability of funding sources;
- the possibility of applying various organizational and managerial forms, including PPP.

Unlocking the potential of the tourism industry in the Russian Federation is possible for the following reasons.

1. Investing in the development of tourist and backbone infrastructure.
2. Increase in tourist flows in the Russian Federation, including higher loading level of hotel infrastructure. This, in turn, is possible by reducing the influence of the seasonality factor in the tourism business.
3. Reducing bureaucratic barriers hindering the development of the industry, increasing its openness and transparency.

To develop and justify the tourism clustering procedure, we chose the Ivanovo region as a region with high potential and opportunities for the development of tourism. This includes the presence of ancient cities, towns, historical monuments, natural conditions and sufficient labour potential, in view of the closure of some production facilities[2].

Despite the fact that the tourist potential of the Ivanovo region is not considered to be the highest (the region is not on the list of the top 20 regions of Russia in terms of the tourist potential, according to the 2020 rating), it is more due to the underdeveloped tourist infrastructure and lack of appropriate information, rather than lack of places of attraction to explore.

It should be noted that the landmarks of the famous "Golden Ring" are also located in the Ivanovo region, among the most attractive places are the following ancient cities: Plyos, Kineshma, Yurievets, Vichuga, Rodniki, Ivanovo, Lukh, Puchezh, Shuya, Palekh, Holui, Yuzh, Gavrilov Posad.

The centre of the region is the city of Ivanovo, which is historically considered the textile capital of Russia. Ivanovo is a part of the "Golden Ring of Russia" and has a rather attractive geographical location in terms of the accessibility of tourist destinations. It should also be noted that the most important transport highways (water and railway) pass through the Ivanovo region. In addition, the travel infrastructure includes highways, road maintenance and civil aviation facilities (an airport).

The environmental situation is relatively good in the Ivanovo region. There are no large ecologically dangerous production facilities in the region, and vast forest areas (they occupy 48 % of the erritory of the region — 1,037,5 thousand hectares), evenly distributed throughout the region, compensate the negative impact, made on the nature by anthropogenic activity.

Natural recreational resources of the Ivanovo region are complemented by numerous cultural and historical monuments with truly

priceless historical and cultural heritage. The region takes one of the top positions in Russia in terms of the number of monuments, primarily architectural and archaeological ones. There are 1,618 monuments (1,770 facilities) in the region, of which 57.4 % are architectural monuments, 12.4 % are historical monuments, 26.3 % are archeological monuments, and 3.9 % are monumental art pieces [6].

The fact that the Ivanovo region has the second largest portion of the Volga River increases its competitiveness in the development of tourist and recreational clusters.

As of the year-end of 2019, the tourist flow in the region reached 824.6 thousand people, which is 3 % more than in 2018 (800.6 thousand people). The most visited cities of the region are Ivanovo, Kineshma, Palekh, Shuya and Plyos. This indicator was increased by the development of transport logistics: river navigation in Kineshma, a larger number of electric trains "Lastochka", reconstruction of roads and improvement of tourist attractive cities of the Ivanovo region (Ivanovo, Yurievets, Kineshma, Gavrilov Posad, Ples).

In the context of the tourism development in general, its forms and types, in particular, new tourist realities appear and spread, one of which is industrial tourism. In 2020, the Ivanovo region was added to the list of pilot regions of the Russian Federation selected for the development of industrial tourism. Proposals were drafted for 16 enterprises participating in the pilot project on behalf of the Ivanovo region[2].

Tours to the enterprises of the region for official delegations and production partners, as well as regular tourists, will attract additional travellers to the region and, consequently, serve to sustainably improve the socio-economic and tourist attractiveness of the region [7].

The development of tourism in the Ivanovo region complies with the objectives of socio-economic development of the region (a decree), which suffers from the following problems [8].

1. The lack of investment in the development of tourist infrastructure.
2. The absence of a system of comprehensive (organizational) support for the development of tourism from the executive bodies of government authorities of the Ivanovo region.
3. The lack of a system of information and advertising support needed to inform potential customers about the services.
4. Substantial physical deterioration of material resources.
5. Insufficiency of advanced tourist and entertainment industry facilities, display and entertainment facilities.

Obviously, the main problem is inadequate financial support.

In addition, in our opinion, there is no systematic approach to planning the development of tourism, based on a multi-factor analysis of the situation to quantify the complex tourist integral potential of a particular region, city, district, allowing to choose the most appropriate option with regard for the economic and social aspects. Also, this region enjoys little attention from the federal authorities and has neither federal, nor regional target programmes [9].

For the effective development of tourism in the Ivanovo region, even in the presence of a serious potential of historical, cultural, entertainment and other destinations, a systematic approach is needed, including, among other things, the formation of a sustainable and attractive tourist brand of the region [10].

As already mentioned, a serious obstacle to the development of tourism in the region is the lack of financial resources. This problem must be solved together with regional and local authorities using the anticipated economic and social effect. A real opportunity to promote the idea of creating a tourism cluster is to choose the right organizational and managerial form. It is proposed to establish a public-private partnership, which will raise public funds and private investments [11, 12].

Based on the strategic objectives the authors propose a mechanism and a model for a public-private partnership of a tourism cluster (Fig. 2).

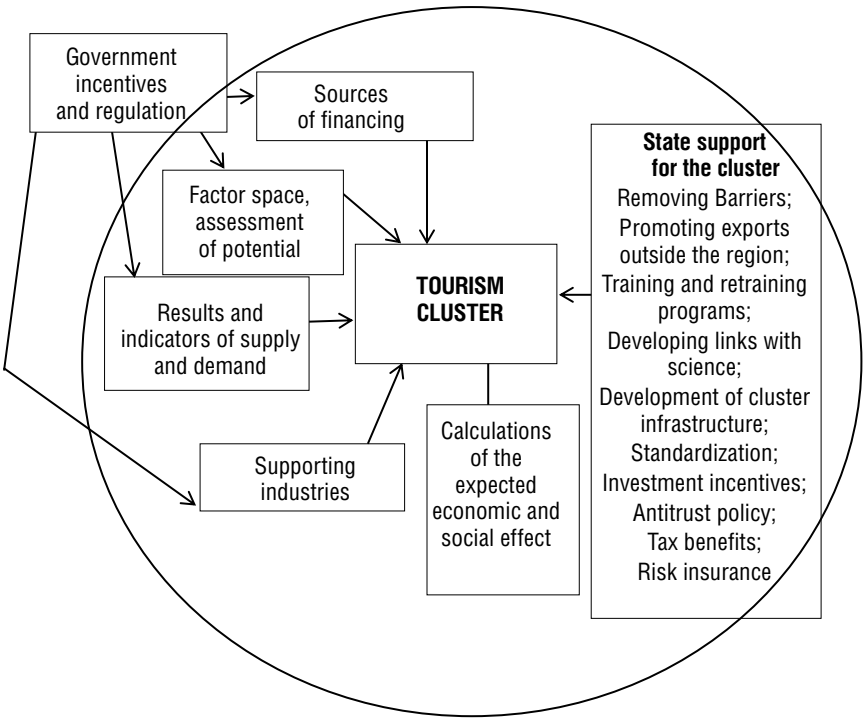


Fig. 2. The model of a public-private partnership within the framework of tourism clusters

Two target federal and regional programmes, including "Development of domestic and inbound tourism in the Russian Federation (2019–2025)" and the strategy for socio-economic development of the Ivanovo region until 2024, were studied to address this issue[3].

CONCLUSIONS

Development of tourism in the Ivanovo region will improve the socio-economic environment in the region, rise its economic efficiency, overcome its economic development delay and, most importantly, improve the living standards in the region.

This programme will undoubtedly give a powerful impetus to the tourism industry by using the potential of the cluster approach.

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3 On approval of the Concept of Federal Target Program "Development of domestic and inbound tourism in the Russian Federation (2019–2025 years)" : Decree of the Government of the Russian Federation from May 5, 2018 No. 872-r (ed. from July 11, 2019).

Обоснование создания туристических кластеров в регионах России (на примере Ивановской области)

В статье рассмотрена проблема развития туристической отрасли с использованием кластерного подхода. Предлагается создавать туристические кластеры на основе имеющихся в регионах интересных объектов притяжения туристов. В условиях дефицита инвестиционных ресурсов необходимо отобрать наиболее результативные варианты объектов, где планируется создание туристических кластеров. С этой целью авторы предлагают учитывать факторное пространство влияния и оценивать эффективность функционирования создаваемых кластеров с помощью интегрального показателя ожидаемого эффекта. Основной задачей данной статьи является изучение перспектив развития бизнеса в области внутреннего туризма и возможностей создания туристических кластеров в различных регионах страны на примере Ивановской области. Авторы разработали алгоритм действий по созданию туристического кластера, определили основные группы факторов влияния на обоснованность организации кластеров. В современном мире в условиях глобализации все большее значение приобретает туристическая отрасль, которая приносит в бюджеты многих стран внушительную долю дохода. Проблема развития внутреннего туризма в России является актуальной в аспектах социально-экономического развития регионов страны. В связи с наличием безработицы и дефицита региональных бюджетов необходимо изыскивать возможные резервы экономического роста и обоснованно подходить к вопросам создания туристической индустрии, учитывая нынешние особенности и предпочтения населения. Предложенные подходы и методы планируется использовать на примере Ивановской области в аспекте создания там туристического кластера.

Ключевые слова: *туристический кластер, факторное пространство влияния, интегральный показатель эффективности создания кластера, развитие внутреннего туризма, занятость трудоспособного населения*

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Об авторах: **Лукманова Инесса Галеевна** — доктор экономических наук, профессор кафедры экономики и управления в строительстве; **Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ);** 129337, г. Москва, Ярославское шоссе, д. 26; РИНЦ ID: 655039, Scopus: 57190412717, ResearcherID: B-4128-2016, ORCID: 0000-0002-2835-8181; lukmanova@mgsu.ru;

Судакова Анна Александровна — преподаватель кафедры экономики и управления в строительстве; **Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ)**; 129337, г. Москва, Ярославское шоссе, д. 26; РИНЦ ID: 1101710, Scopus: 57221745186, ORCID: 0000-0002-2274-636X; sudakovaaa@mgsu.ru.

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Л.И. Павлова. Эвкалипты. Офорт.

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Silka D.N.
Burlutsky N.A.

Cost management technologies for construction projects in the context of introduction of information modelling

The overall business environment in the country has increased the importance of support for industries and raised pressure on the financial system. The construction industry holds a special place due to its set of socio-economic objectives, including the construction of housing, medical and education facilities, infrastructure in populated areas, etc. As of 2022, construction projects are to have digital information models to ensure data exchange between direct participants in the construction process, and in the course of interaction with state supervisory authorities. The article addresses the issue of pricing and construction cost estimation; the authors have identified the factors that prevent information modelling technologies from bringing extensive projected benefits. The authors emphasize the need for the state standardization of consolidated types of works, that make up a construction facility. This task is particularly relevant for an extensive list of social facilities, constructed within the framework of regular government procurement contracts. The compilation of catalogues of work types includes the development of flow charts and requires the involvement of versatile experts and specialists. Further, if these materials are available, cost parameters, or standard costs of structural solutions, become necessary and feasible. At present, there is a tiny set of approved standards, and their number does not grow. Some insignificant results have been achieved at the corporate level. The reason is the lack of a comprehensive approach, which is addressed in the article. Given the intensive implementation of information modelling technologies (IMT), IT companies get more and more involved in addressing the tasks and problems of the construction industry. Hence, they can make a significant contribution to new cost management technologies.

Keywords: *information modelling technologies, construction, construction cost, estimates, economic efficiency*



Silka Dmitriy Nikolaevich,
Doctor of Economic Sciences, Assistant professor, professor; The Russian Presidential Academy of National Economy and Public Administration (RANEPA); bldng 1, 84 Vernadsky Avenue, Moscow, Russian Federation; ID RISC: 657150, ORCID: 0000-0002-0357-0530; silka-dn@ranepa.ru



Burlutsky Nikolay Aleksandrovich,
applicant; The Russian Presidential Academy of National Economy and Public Administration (RANEPA); bldng 1, 84 Vernadsky Avenue, Moscow, Russian Federation; mcua3@yandex.ru

INTRODUCTION

When construction projects are implemented, stakeholders tend to effectively apply information modelling technologies and use various special-purpose tools to automate business processes of project preparation and implementation. The main driver of application of information modelling software is the responsibility of contractors to draft the project documentation in the form of digital models for public contracts implemented as of 2022. Given that the government procurement far exceeds commercial construction, digitalization at the stages of design, construction, and operation of construction projects is accompanied by numerous grave problems. Hence, in 2021, the government procurement under the Federal Law 223 reached 9.3 trillion rubles, which exceeded the value for previous period by 15 %. Procurement under the Federal Law 44 reached 9.4 trillion rubles, which is 11 % more than in 2020[1], [2]. The shares of construction works and services within the framework of Federal Laws 223 and 44 exceeded 80 and 55 %, respectively. Against this background, the efficiency of information modelling technologies depends on the availability of information and reference materials in the digital form, including, inter alia, libraries of design solutions and cost standards broken down by types of work. The priority task is to develop libraries to ensure the efficient application of information modelling techniques. Experience has proven [1–3] that the industry does not possess such materials in full and the relevance of their development increases due to the requested transition to digital models.

MATERIALS AND METHODS

Experts and researchers point out the need to develop and implement mutually coordinated solutions at all stages of the project life cycle to ensure an effective transition to building information modelling technologies (IMT) [4–6]. BIM is to encourage the innovative development of the construction industry [7]. Besides, experts consider independent functional areas of application of information modelling technologies, which are crucial for the work process organization at construction enterprises. Hence, the authors of [6] consider the problem of enhancing the accuracy of estimates at different levels of construction projects. The method of construction budgeting using the information modelling technology is analyzed. Attention is drawn to the fact that 3D models cannot be used to calculate construction costs. The authors analyzed the breakdown of the workforce cost and its share in construction costs.

1 The volume of procurement in Russia by companies with state participation increased by 15 % in 2021. Date Views: 11.04.2022. URL: www.tass.ru/ekonomika/13569315?utm_source=rts-tender.ru&utm_medium=referral&utm_campaign=rts-tender.ru&utm_referrer=rts-tender.ru

2 RTS-tender: the volume of purchases of state companies in Russia increased by 15 % in 2021. Date Views: 11.04.2022. URL: www.rts-tender.ru/about/news/31012022

The cost analysis, made within the framework of a project simulated as a 3D model, is highly sophisticated, and it takes account of various architectural, design and other solutions. Given the array of construction resources, currently available on the market, one should know that methods of developing and presenting the future appearance of a construction facility vary. Therefore, selection of the criteria determining the final project concept to be accepted for implementation is an important issue. Obviously, cost management is the key point. In turn, cost management in information modelling programmes, or BIM, is a rather complex issue. Let's consider the principles of building information models to understand its essence.

Development of information modelling systems is a time consuming process. It encompasses initial data collection, staff training, organization of interaction within and between teams, accumulation of experience, reference materials and libraries of ready-made 3D solutions, which can significantly accelerate the design and implementation of a construction project. The experience of foreign countries [8, 9] shows that companies using sophisticated information modelling systems, including BIM, having been developing in this field for many years and even decades. Besides, it is not only the level of development and the capacity of individual businesses that is crucial, but also the development of private and public institutions promoting the use of BIM solutions by the industry as a whole and individual enterprises, in particular.

Therefore, the analysis of standard technical documentation in Russia shows proactive standardization of relevant processes and regulation of activities. To date, more than eight standards have been developed, namely GOST R 57310-2016, 57311-2016, 57563-2017, 57295-2016, 12006-2-2017, 12006-3-2017, 22263-2017, 57309-2016, 58439.1-2019, 58439.2-2019, which regulate:

- information handling guidelines;
- documentation requirements;
- management guidelines;
- data organization and exchange;
- knowledge libraries, etc.

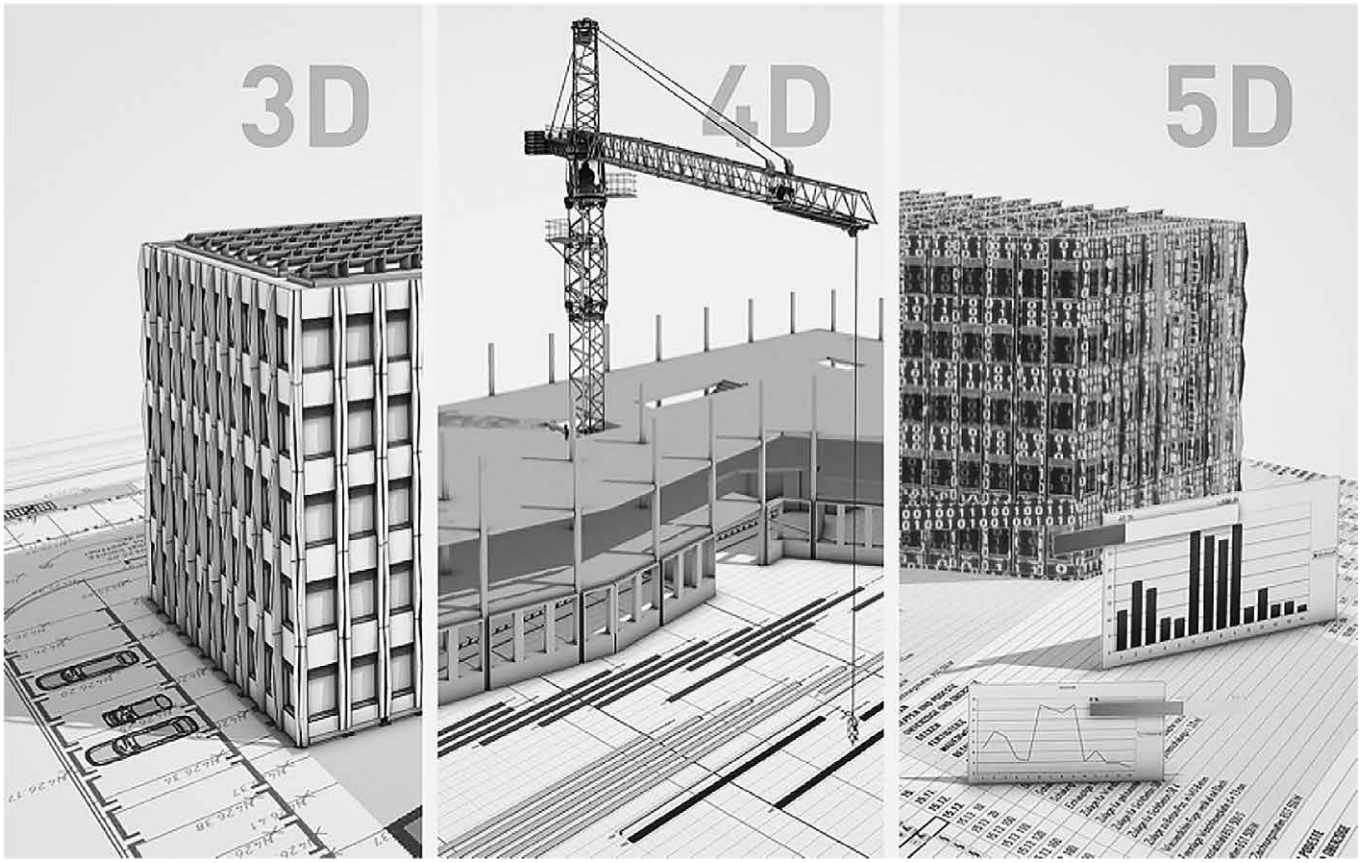
In addition, there are sets of rules SP 301.1325800.2017, 328.1325800.2017, etc., that contain the terminology and requirements for an information model, rules of information exchange between systems, etc. The model has three main levels (Fig. 1) depending on the applicable rules/regulations, the amount of information, the level of complexity of an information model and the presence of factors that may accelerate the project implementation. Further, 6D and 7D modelling affects operation stages, repairs, and reconstruction of the facility, etc. Hence, the ability and willingness of a construction organization to work at each of the 3–5D levels is a proof of its high competence.

The diagram in Fig. 1 shows that value management is at the top level. Critical factors that influence the ability of investors, customers, and contractors, involved in a construction project, to make management decisions are concentrated in the value parameters. Therefore, a construction company must be able to use BIM to promptly evaluate the proposed solutions, select and compare alternative options. The analysis of the pricing system in the construction industry shows that the design and estimation method is used for a detailed calculation of the cost of construction. The method is labour-intensive and assumes the availability of the readymade design documentation, including calculations, listed items and amounts of work, etc. Standard construction prices (SCP) are used to make an initial assessment of the project. The mission of SCP is to provide insight into the cost of a completed construction facility using its general characteristics. SCP are developed by the Ministry of Construction of Russia, and the database has SCPs broken down by the types of structures, including residential buildings, office buildings, educational facilities, etc. SCPs are the tool employed to calculate the cost of a construction facility at the stages of contribution of state funds and disbursement of budget proceeds and schedule the construction process. If the unit cost of a square meter of a construction facility is available, its total cost is calculated using the design floor area. A provisional standard cost indicator is provided in Table 1.

Hence, the final cost of a construction facility represents one figure, and it is impossible to determine the cost of an individual component to compare different construction options. The compilation has approximate design solutions illustrated in Fig. 2. For example, if piles are used in foundations, and the room partition is made of gypsum structures, or tongue-and-groove boards. Since no amounts or costs are specified, it is impossible to make swift changes in BIM cost modelling.

Table 1. An excerpt from "Consolidated Standard Construction Prices" NTSS 81-02-01-2022. Compilation 01. Residential Buildings

SECTION 3. MULTIFAMILY RESIDENTIAL BUILDINGS MEDIUM-RISE BUILDINGS (3–5 FLOORS)		
Indicator code	Parameter	Construction price as of 01.01.2022, thousand rubles
Table 01-03-001 Medium-floor residential buildings (3–5 floors) with a precast-monolithic frame **Indicator:** 1 m² of the total floor area of an apartment		
01-03-001-01	Medium-floor panel residential buildings (3–5 floors) with precast-monolithic frame with an apartment area of 5,100 m²	48.07
Table 01-03-002 Medium-floor residential buildings (3–5 floors) made of bricks **Indicator:** 1 m² of the total floor area of an apartment		
01-03-002-01	Medium-floor residential buildings (3–5 floors) made of bricks with an apartment area of 1,200 m²	67.69
01-03-002-02	Medium-floor residential buildings (3–5 floors) made of bricks with an apartment area of 3,200 m²	50.27
01-03-002-03	Medium-floor residential buildings (3–5 floors) made of bricks with an apartment area of 3,850 m²	43.33



3D BIM model
Information model executed at the design stage, it includes 3D geometry of the facility and attributive data of its components

4D BIM model
Information model drawn on the basis on the 3D model and supplemented by the solutions on construction organization as well as realized in the format of facility's change in time

5D BIM model
Information model drawn on the basis of the 3D model and supplemented by the data on the cost of works and materials

Fig. 1. Evolution of BIM solutions

Another tool that can meet the requirements of cost modelling is a set of standard prices for structural solutions (SPSS). The register of standard technical documents of the Ministry of Construction of Russia has "State Cost Standards".

Here, consolidated pricing standards applicable to structural solutions "81-02-22-2014) Part 22. Highways" are used[3]. We can conclude that the construction of a facility is broken down into certain types of independent assignments, and each has cost indicators. Hence, the construction of roads is broken down into the following items of work.

Section 01. Site preparation for construction.
Section 02. Road formation.
Section 03. Road wear.
Section 04. Man-made structures.
Section 05. Road furnishing.
Section 06. Installation of sidewalks and curbs.
Section 07. Road service buildings and facilities.

The list of work assignments, cost indicators and standard prices are provided for each position in each section (see Table 2).

Various alternative structural and design solutions, depending on the needs of the customer and future users of a construction facility, can be assessed using the cost indicators available for individual types of work. It should be admitted that the principle of deriving cost indicators for each type of works is widely used in the foreign practice. In contrast to the method of application of itemized state cost standards (GESN), a cost indicator allows for a less laborious initial estimation of the cost of a construction facility with a high degree of accuracy, as all fixed and variable costs are specified in this indicator (including the projected profit and overheads). The use of itemized state cost standards (GESN) is possible, as it allows for a clarification in terms of construction materials, other local issues, and in terms of the budget documentation, developed on the basis of the design documentation.

There is a strong demand for BIM-linked cost budgeting solutions. The reason is the deficit of resources at state institutions, lack of research support and task setting, insufficient links with the business community. And all these problems should be solved together. The following actions must be taken to improve the situation:

1) classification of construction facilities within the framework of a state order, breakdown of construction work and formation of cost indicators;

2) identification of types of work, development of flow charts and their approval within the framework of state reference books,

3 State Estimating Standards Consolidated Standards of the Price of Structural Solutions (NTsKR 81-02-22-2014) Part 22. Automobile roads. Technical part. Date views: 11.04.2022. URL: www.minstroyrf.gov.ru/docs/10281/?sphrase_id=1545290

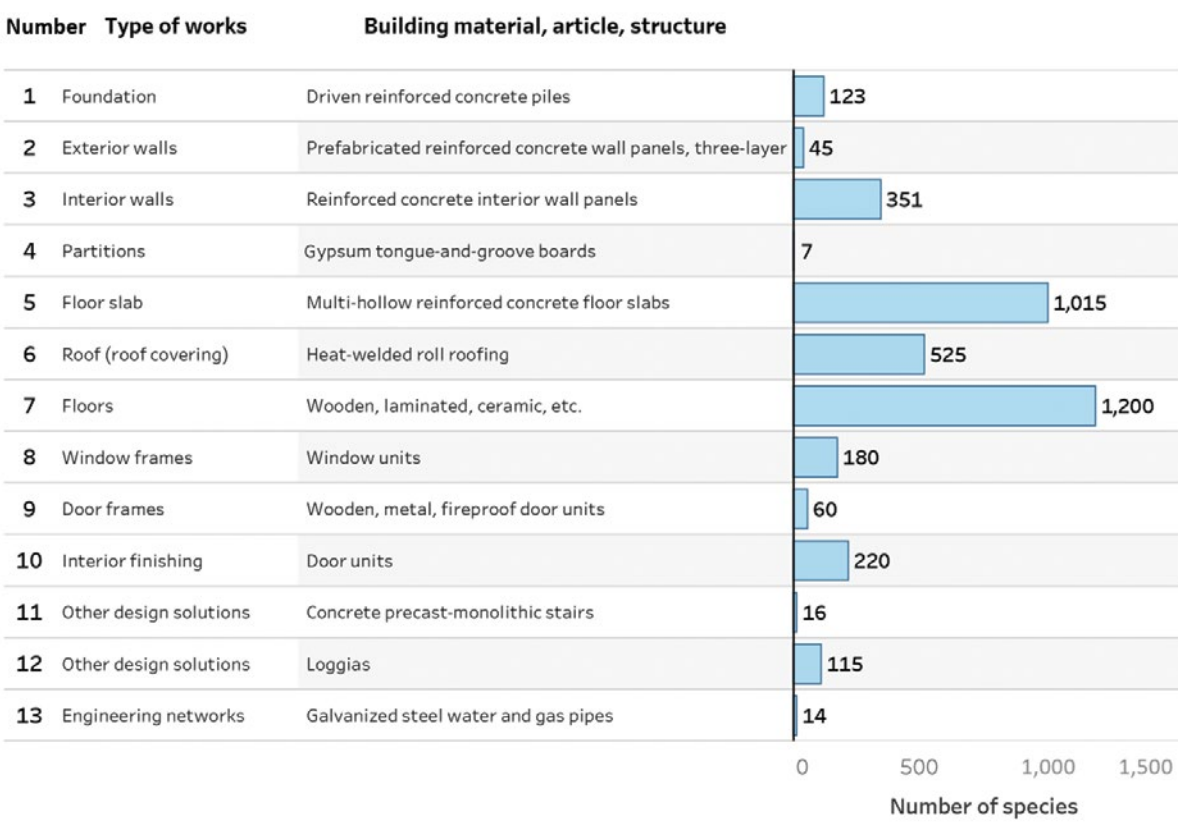


Fig. 2. The number of options for a residential building that has 6–10 floors according to Construction Price Standards 81-02-01-2021

for example, itemized state cost standards (GESN), Federal Unit Rates (FER), etc. Flow charts are needed to:

- systematize work processes, identify the need for resources to perform construction work on a particular construction site and develop standard costs for structural solutions (SPSS);

3) maintenance of catalogues of construction resources, which include all resources available in the SPSS. This approach allows for the state monitoring of the cost of construction resources in a more targeted way and focuses on the interests of public customers and contractors. Currently, there is a system of construction resources monitoring, which is too general, and, therefore, it does not respond to the needs of public customers;

4) development of volumetric and quantitative characteristics of construction resources in flow charts to update various indicators and have costs monitored by any interested persons.

It should be noted that this work can be only organized at the initiative of the Ministry of Construction of Russia and its subordinate structures due to the fact that the development of flow charts and cost

Table 2. An excerpt from the compilation of the standard price of highway design solutions SPSS 81-02-22-2014

Section 01. Site preparation for construction
Table 22-01-001 Tree felling
Composition of work:
01. Felling of trees. 02. Cutting of bushes. 03. Removal, unhooking, and skidding of tree-long logs. 05. Uprooting of stumps. 06. Shoveling dirt. 07. Area cleaning. 08. Loading, moving and unloading of stumps.
Measurement: 100 items

Cost indicator	Standard prices (rubles) as of 01.01.2014			
	22-01-001-01	22-01-001-02	22-01-001-03	22-01-001-04
Remuneration of construction workers	5,574.53	7,189.14	9,944.15	11,949.10
Operation of machines	8,836.12	9,089.74	11,816.13	13,724.46
Material resources	—	—	—	—
Equipment	—	—	—	—
Total	**14,410.65**	**16,278.88**	**21,760.28**	**25,673.56**

solutions requires a large number of design documentation. Another important task is to make flow diagrams. This task involves some research as criteria for such diagrams are unavailable. Let's make a list of basic principles to be applied to the generation of these diagrams.

Firstly, a flow diagram should specify a list of works to be performed on other sites, for example, items of work dealing with floors, ceilings, walls, foundations, etc.

Secondly, the flow diagram should contain interrelated items of work. For example, the installation of a monolithic reinforced concrete floor slab, beams and columns includes the installation of scaffolding and formwork. In addition, some items of work use gas cylinders, discs for angle grinders, welding electrons, etc. as materials and resources. It is difficult to assign specific rates to such resources when a traditional construction work budget, such as the one specified in the GESN, is made. Therefore, the generalization of work and resources, which in the end allows making a concrete slab with columns and beams, takes into account all auxiliary processes to identify a standard price of a particular structural solution. Subsequently, it expands the capabilities of information modelling (BIM).

RECOMMENDATIONS

Experts believe that over the past three years a quarter of the state contracts worth more than 4 trillion rubles were terminated, which led to an increase in problematic construction projects across the country. The industry predicts that by the end of 2022 the number of broken contracts will have increased by 20 %[4]. At the same time, according to the authors, advanced administrative actions will accelerate the implementation of IMT and increase the efficiency of construction clearly, although it will not eliminate any chronic problems. Basically, builders do not have enough money to complete the work. The approach, proposed by the authors, that is, their proposal to systematize and classify construction work using flow diagrams is a way to construct and building pursuant to an order, which is critical to the success of public construction projects. The basis of this systematization is a mechanism for preparing materials (libraries), to ensure a faster and more efficient design development for a construction project via the use of readymade digitized modules in the 3D format and a swift state expert examination procedure. Further, standard prices for structural solutions (SPSS) should become an efficient instrument at the stage of elaboration of the project concept by the customer within the limits of the funding. At the earliest stage, such a mechanism enables to abandon a project concept that will be impossible to implement in the future. Since the government takes no initiative to intensify the development of standards, the business community should do it themselves. Large enterprises, whose errors are extremely expensive, can develop price standards for design solutions based on their own experience and completed projects. Further, it is necessary to summarize the budget-related documents, certificates of work performed and other materials that specify the actual costs incurred in the process of construction. A large amount of information and digital data requires the use of specialized software. In terms of the methodology, some information can be extracted from the SPSS collections approved in the past to be updated for the future use. It is also advisable to address the research undertakings implemented in the past [10–12].

CONCLUSIONS

The current challenge of accelerated transition to information modelling technologies has identified chronic problems in the construction pricing methodology. The unavailability of tools, needed to identify costs at all stages of a construction project, limits the implementation of digital solutions. In addition, since no tasks are set by the state, anticipated ITM benefits cannot be obtained soon. In this regard, the construction business community, acting in alliance with developers of specialized software for the construction industry, should concentrate on developing specialized regulatory and reference libraries. In fact, they can start developing a system of digital standards for technical documents. The ability to simulate the cost of a construction facility using pre-calculated items of work improves the effectiveness of construction concepts, while the transparency of pricing in terms of consolidated types of work helps to identify weaknesses in project schedules and manage future risks.

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Технологии управления стоимостью строительных проектов при внедрении информационного моделирования

Общая экономическая обстановка в стране делает критически важной поддержку отраслей, увеличивая нагрузку на финансовую систему. Особое место занимает сфера строительства с массой социально-экономических задач, в том числе по строительству жилья, объектов медицины, образования, инфраструктуры населенных пунктов и др. С 2022 года реализация строительных проектов должна осуществляться с применением цифровых информационных моделей для обмена данными как между непосредственными участниками строительства, так и при взаимодействии с государственными контролирующими органами. В статье рассматривается проблема ценообразования и сметного нормирования строительной деятельности и определяются факторы, которые препятствуют получению высокого ожидаемого эффекта от применения технологий информационного моделирования. Авторы указывают на необходимость государственной стандартизации укрупненных видов работ, из которых складывается объект строительства. Особенно актуальной данная задача является для широкого перечня объектов социального назначения, которые выполняются в рамках регулярных государственных закупок. Создание каталогов видов работ включает в себя разработку технологических карт и требует привлечения экспертов и специалистов разного уровня. Далее, при наличии таких материалов необходимым и возможным становится разработка стоимостных показателей — нормативов цены конструктивных решений. В настоящее время имеется лишь совсем небольшая часть утвержденных нормативов. Их состав не расширяется. Наблюдаются незначительные результаты на корпоративном уровне. Причина состоит в отсутствии комплексного подхода, который раскрывается в статье. С учетом активного внедрения ТИМ, IT-компании начинают все больше включаться в задачи и проблемы отрасли строительства и для разработки новых технологий управления стоимостью могут внести существенный вклад.

Ключевые слова: *технологии информационного моделирования, строительство, стоимость строительства, сметы, экономическая эффективность*

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Об авторах: **Силка Дмитрий Николаевич** — доктор экономических наук, доцент, профессор кафедры инвестиционно-строительного бизнеса; **Российская академия народного хозяйства и государственной службы при Президенте Российской Федерации (РАНХиГС)**; Москва, пр-т Вернадского, д. 84, стр. 1; РИНЦ ID: 657150, ORCID: 0000-0002-0357-0530; silka-dn@ranepa.ru;

Бурлуцкий Николай Александрович — соискатель; **Российская академия народного хозяйства и государственной службы при Президенте Российской Федерации (РАНХиГС)**; г. Москва, пр-т Вернадского, д. 84, стр. 1; mcua3@yandex.ru.

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Panteleeva M.S.

Calculation of the private investor's income in the housing and utilities sector in the context of transition to long–term tariff regulation

The article considers the necessity of transition of housing and utility services to the long-term tariff setting system. This task was set by the Government of the Russian Federation in June 2021 as part of the approval of the "Concept for the introduction of tariff setting mechanisms for organizations engaged in regulated activities for the long term". Current annually indexed tariffs on housing and utility services don't let the housing economy develop, as they are not attractive to private investors and aggravate the conflict between the owners of residential premises and management organizations. Over the years, the lack of social trust and shortage of budgetary funds have substantially reduced the quality of housing in Russia. And the state of the housing stock in the country today needs mass overhauls using energy efficient materials and innovative technologies; otherwise, the number of accidents in residential buildings will only increase. This requires additional investment, as budgetary sources are only able to cover certain types of work and volumes of financing. Russia needs a new system of tariff formation, which would be able to take into account all the features of the housing and utilities sector and the possibility of financing, given the monopolistic structure of this sector. The paper proposes a conceptual approach to calculating the long-term value of the housing and utilities tariff by redistributing the excess profits of monopolies in favour of the private investor. An important condition for the implementation of the proposed approach is the maintenance of the rate of construction in the Russian Federation and the values of long-term average and marginal costs for the production and provision of utilities.
Keywords: *housing and utility services, tariff, profit, natural monopoly, resource provider, energy efficient repair, state regulation*



Panteleeva Margarita Sergeevna,
Candidate of Economic Science, Associate Professor of the Department of Organization of Construction and Real Estate Management; Moscow State University of Civil Engineering (National Research University) (MGSU); 26 Yaroslavskoe Shosse, Moscow, 129337, Russian Federation; ID RISC: 654336, Scopus: 57194441387, ResearcherID: ABB-6750-2021, ORCID: 0000-0003-4275-5244; Panteleevams@mgsu.ru

INTRODUCTION

The pricing system, which has been applied in the housing and utilities sector of the Russian Federation since 1999, continues to limit the profitability of enterprises that provide services despite the ongoing changes and indexation of tariffs for public services [1–4]. This policy does not stimulate an increase in the quality of services and the reduction of costs by utility services providers, as reducing costs leads to a decrease in the price per unit of service and the absolute value of the profit of enterprises. As a result, today's pricing system in the housing and utilities sector leads to the fact that companies are interested in growth rather than in cost reduction despite the expansion of the market, which is associated with the planned growth of annual housing commissioning according to the Ministry of Construction, Housing and Utility Services.

The commissioning of the total area of housing per 1,000 people increased from 207 sq. m in 2000 to 631 sq. m in 2021, an increase of 13 % compared to 2020. In the housing stock in 2021 there was an average of 28.9 sq. m of total living space per inhabitant compared to 22.6 sq. m in 2010 [5].

The factor of increasing growth of commissioned housing put into service and the cost approach to the formation of prices for utility services hinders the inflow of investment resources in the housing and utilities sector, as the use of standard cost prices as a basis for price formation leads to inconsistency of the latter with the structure of real financial needs of the enterprise.

The current pricing system ignores the demand factor, or the willingness and ability of consumers (organizations, households, and the budget) to pay the appropriate price for the services of appropriate quality.

One of the most acute problems is cross-subsidization (cross-subsidies) [6], when different groups of consumers have access to the same type of utilities at different rates. On the one hand, cross-subsidization is a state measure of social support of the population, on the other hand, it leads to some negative consequences, including the distribution of most of the subsidies to households with high incomes. At the same time, industrial enterprises, which subsidize preferential tariffs for the population and budget organizations, find themselves in the most difficult situation.

In these conditions, it becomes impossible to forecast when the housing and utility services sector will reach the break-even mode of operation.

The lack of orderly pricing and tariff policy also leads to highly differentiated costs of housing and utility services for different regions and municipalities of the Russian Federation (Table 1).

The difference in the cost of housing and utilities services across the regions reaches from 20 to 50 times and more (Table 1). It should be noted that the difference in the number of tariffs for public utilities in the subjects of the Russian Federation are due to the following reasons [7]:

- the difference in the volume of sales of public utilities;
- levels of energy intensity of the installed equipment;
- the degree of depreciation of networks and equipment, which affect the costs required to maintain the systems of utility infrastructure;

Table 1. Housing and utilities tariffs in different regions of Russia in 2022 [5]

City of the Russian Federation	Electricity, rub./kWh	Heating, rub./Gcal	Hot water, rub./m³	Gas, rub./m³	Overhaul, rub./m²	Garbage, rub./person
Moscow	5.92	2,546.83	211.67	6.83	25.5	18.86
Moscow region	5.73	2,535.11	164.58	6.35	9.07	893.2/m³
St. Petersburg	4.82	1,818.29	109.1	6.56	9	5.13/m²
Volgograd	4.51	1,756.24	135.14	8.95	6.56	514.4/m³
Novosibirsk	2.8	1,467.82	114.54	6.12	7.72	59.88
Kazan	3.93	1,809.7	21.42	5.72	6.11	71.95
Rostov-on-Don	5.75	2,386.62	65.03	6.32	9.92	84.4
Irkutsk	1.17	1,466.72	93.61	2.75	7.87	576.5/m³
Grozny	2.81	2,045.68	18.56	4.94	6.72	93.53

- availability of own water production sources or use of purchased water;
- peculiarities of the process of provision of utility services by each supplier.

In addition, the growth of tariffs for public utilities is always several times higher than the growth of real disposable income of the population (Table 2).

Over the past 8 years, the discrepancy between the dynamics of real income, housing and utility service tariffs averaged 4 %. This means that the population has insufficient funds for timely payment of utility bills at the rates set by the state.

Given the importance of these problems, as well as the existing powers of regional and local authorities in the field of pricing and tariff setting, which do not allow for a strict regulation of these processes at the federal level, the author proposes a new approach to the formation of the market value of housing and utility services tariffs. This approach is the basis for an open adequate pricing and tariff setting procedure in respect of housing and utility services that encompasses private capital.

MATERIALS AND METHODS

The approach proposed by the author for market-driven tariff setting is based on the "Concept for introducing tariff setting mechanisms for organizations engaged in regulated activities for a long-term period" approved by the Russian Federal Antimonopoly Service on June 29, 2021 (No. 6571p-P51), developed by the Federal Antimonopoly Service of Russia (No. 6571p-P51 of June 29, 2021) [12]. The implemented mechanisms should be based on long-term planning, protection of consumers' interests and ensuring reliable operation of the infrastructure sector. One of the key ideas of the Concept is to create conditions for return of investments in the housing and utilities sector, as well as their modernization, while protecting consumers from unreasonable growth of tariffs by setting maximum indexes.

Table 2. Growth of housing and utilities tariffs in relation to inflation growth and real income of the population (compiled from [8–11])

Year	Growth of housing and public utilities tariffs, in %	Inflation growth, %	Dynamics of the real disposable income of the population, in %
2016	4.0	5.4	–4.5
2017	4.6	2.5	–1
2018	3.7	4.3	0
2019	4.1	3.0	–1.5
2020	3.73	4.9	–8.5
2021	4.6	8.39	1.2
2022 (March)	4.5	16.7	1.1

To implement the "Concept of long-term tariff setting", this study examined the models of various market structures. Particular attention was paid to natural state monopolies, which include resource supplying organizations of the Russian Federation according to the Federal Law "On Natural Monopolies" adopted in 1995 [13].

In addition to the concept of the natural monopoly, this law defines the main areas of state regulation, such as:

- transportation of oil and oil products and gas through main pipelines;
- transmission of electrical and thermal energy;
- railroad transportation, etc.

The law also defines one of the main methods for regulating the activities of natural monopolies: price regulation limiting the maximal values of tariffs.

In this regard, to provide residents with utility services of sufficient volume and quality, it is necessary to develop such solutions that do not allow any infringement of their interests.

When justifying the need for the demonopolization of the housing and utility services sector and the development of competitive relations, the Federal Law completely excludes consumers of housing and utility services from the subjects of legal relations, arguing that competition is understood as "rivalry between economic entities, in which independent actions of each of them are excluded or limit the possibility of each of them to unilaterally influence the general conditions of circulation of commodities".

Thus, the most difficult regulation problems to be solved by natural monopolies, including resource supply companies, remain:

- processes of production and consumption of utility services that are inseparable in time;
- saturated public services market;
- non-price regulation of utility services production;
- public utility services for consumers.

RESULTS AND DISCUSSION

To solve the identified problems of natural monopolies, one of three options can be used:

- establishment of an unregulated private monopoly;
- establishment of a private monopoly regulated by the state;
- implementation of economic activities of the state.

In this case, as the world experience of regulating natural monopolies shows, of all the above variants the first one is really dangerous. The second variant is possible to implement under the condition of clear state regulation with the conclusion of long-term public contracts with private businesses.

To implement it, it is necessary to refer to the fundamentals of natural monopolies. This will make it possible to identify the economic categories capable of supporting the concept of a new long-term tariff setting system in the housing and utilities sector.

A natural monopoly is a market structure in which it is economically feasible to concentrate the production of a product or service in a single enterprise. Natural monopolies are characterized by network structures in which fixed costs are high. Competition here is impossible due to the high costs of producing and distributing products of natural monopolies [14].

A characteristic and most important distinctive feature of pricing in the market of natural monopolies is the reduction of the long-run average cost until the saturation of demand and, simultaneously, the impossibility to achieve economically efficient production volumes due to the limited market demand [15]. This situation is depicted in Fig. 1, where the line of branch demand (*D*) crosses the line of long-run average total costs (*LATC*) until their minimum is reached. In the long run, the graphs of long-term average total costs (*LATC*) and long-term marginal costs (*LMC*) do not intersect.

Prices for products and services of natural monopolies are set (regulated) by the state. Two situations are possible (Fig. 1):

1) the state sets a fixed price $P_1 = LATC \Rightarrow E_1$ — the break-even point;

2) the state sets a fixed price $P_2 = LMC \Rightarrow E_2$ — the breakeven point (socially optimal price), only if the state subsidy equal to $(LATC - LMC) \cdot Q_2$ is paid. At the socially optimal price the maximum efficiency of resource allocation is achieved. It is at this price that it is profitable for the firm to produce that volume of production, which corresponds as much as possible to the demands of consumers.

For the purposes of long-term tariff setting, it is necessary to reduce (cancel) the amount of state subsidies, which represent cross-subsidies, and to bring private investors into the housing and utility sector.

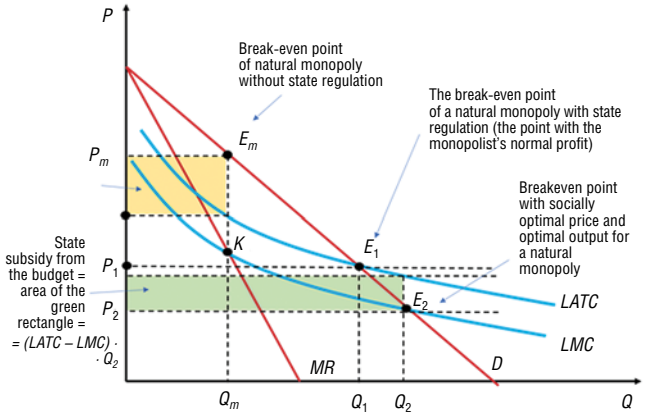


Fig. 1. Pricing in the natural monopoly market

To achieve this goal, the author of the article proposes the following measures:

1) to reduce the operating costs of an apartment building through energy-efficient repairs. And energy-efficient repairs should be conducted at the expense of the private capital;

2) to keep the housing and utilities tariffs at the level of P_2 (see Fig. 1) by changing the source of funding.

Let us consider how these measures can be used to regulate the market of housing and utility services (the market of natural monopolies).

Fig. 2 shows the operation of the monopoly market of housing and utility services in the long run (at least 10 years from now). In this case *LATC* and *LMC* remain practically unchanged, as in the long term the total volume of demand (*AD*) for housing and utility services continues to grow. *AD* is growing as a consequence of growing housing construction in the Russian Federation according to the Development Strategy of the Russian Federation until 2035 (the Ministry of Construction announced improvement of housing conditions for, at least, 5 million families a year in 2019–2024 [16]). It is assumed that the new housing stock is energy-efficient and does not require energy-efficient overhauls. As a result, under such conditions the natural monopoly market will demonstrate the effect of scale of production. It is important to note that the scale of production occurs at the expense of intensive factors of production: the use of new energy-efficient building materials in construction/repair and the introduction of innovative technologies for their management.

Further, to keep the tariff for housing and utility services at the level of P_2, it is necessary to reduce the volume of consumed

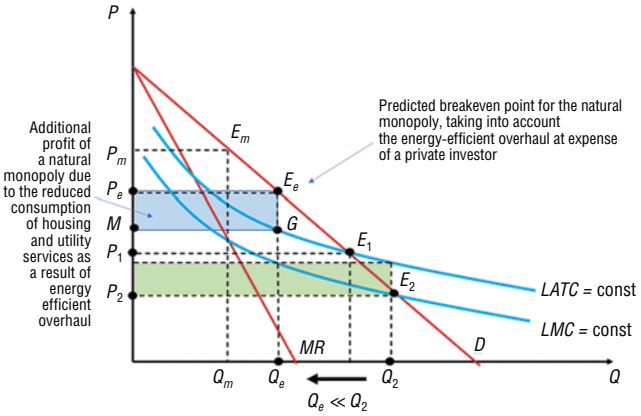


Fig. 2. The concept of tariff setting in the housing and utility services market through the involvement of private capital in energy-efficient repair

housing and utility services from Q_2 to Q_e. This can be done using the Energy Efficient Repair procedure. This procedure makes it possible to reduce the energy consumption in an individual apartment building by 30 % on average in Russia (see Table 3).

Table 3 shows the results of the analysis of energy-efficient repairs of apartment buildings in different regions of the Russian Federation using the case of replaced heating systems. The analysis was made by the Foundation for Assistance to the Reform of the Housing and Utilities Sector [17] and Danfoss LLC, which sells Danfoss products in Russia, the products of the world's leading manufacturer of energy-efficient solutions for construction [18]. The results of the analysis prove that energy-efficient repair significantly saves the volume of consumed resources and allows to restrain the level of tariffs on housing and utility services.

Table 3. Examples of energy-efficient capital repair projects in different regions of the Russian Federation: heat savings (compiled by the author according to [17, 18])

Address	Floors of the apartment building	Applied technical solutions	Heat savings per year
Kazan city, 11 Korolenko str.	5 floors 4 entrances	Installation of an automated control unit for the heating system (Danfoss)	195 thous. rub. (18 %)
Ufa city, 29 Sharieva str.	9 floors 4 entrances	Installation of an automated control unit for the heating system (Danfoss)	500.0 thous. rub. (45 %)
31/1 Podvoiskogo St., St. Petersburg	9 floors 5 entrances	Balancing valves; thermostatic regulators	780.0 thous. rub. (28 %)
Azov, 97 Zoya Kosmodemyanskaya St.	4 floors 2 entrances	Balancing valves; thermostatic regulators	115.0 thous. rub. (28 %)
Altai Krai, Barnaul city, 228 Petrov St.	5 floors 4 entrances	Installation of an automated control unit for the heating system; Improving the thermal protection of the roof (slab insulation (mineral wool), thickness — 5 cm); Improvement of heat protection of windows in common areas (glass and single-chamber glass unit (12 cm distance between glasses) in separate polyvinylchloride sleeves); Sealing of exterior entrance doors with the installation of door closers	461.4 thous. rub. (28 %)
Belgorod region, Belgorod city, Koneva street, 7	13 floors 1 staircase	Installation of an automated control unit for the heating system (Belimo two-way valve; OVEN controller; DAB circulation pump; Danfoss pressure transmitter)	489.56 thous. rub. (30.21 %)
Vladimir region, Kolchugino city, 25, Maksimova str.	6 floors 4 entrances	Increase thermal protection of exterior walls (mineral wool (stucco facade), insulation thickness — 10 cm); Installation of nodes control and heat supply; Heating energy supply control units (Grundfoss circulation pumps; Centrifugal pumps; Control valves; Automatic control panel)	1,708.5 thous. rub. (51.25 %)
Vologda region, the city of Vologda, Dal'naya st., 30	5 floors 4 entrances	Installation of an automated individual heating unit (circulation pump Grundfos, two-way valve, pressure sensor, outdoor temperature sensor, immersion temperature sensor, Siemens controller)	428.96 thous. rub. (26.67 %)
Kaliningrad region, Kaliningrad city, Marshal Baghramyan str. 6–12	10 floors 3 entrances	Improvement of thermal protection of the roof (mineral wool, insulation thickness — 10 cm); Improving thermal protection of exterior walls; Sealing of exterior entrance doors with the installation of door closers	1,137,704 thous. rub. (33.45 %)
Novosibirsk region, the city of Berdsk, Lenina st. 10/3	5 floors 4 entrances	Installation of an automated control unit for the heating system (Danfoss); Other overhaul works (not energy efficient)	393,503 thous. rub. (28.36 %)
Republic of Udmurtia, Izhevsk, 124 Pushkinskaya St.	10 floors 3 entrances	Installation of an automated control unit for the heating system (WILO circulation pump; control valve and heating controller Siemens); Repair of pipelines of in-house heating system in combined with thermal insulation	1,285,036 thous. rub. (33.09 %)

The only barrier to energy-efficient repair is its high cost. However, this barrier can be removed by attracting private investment to this activity. To do this, it is necessary to establish a system of return on investment that is profitable for businesses.

The author of the article proposes to calculate the future profit of a private investor investing in energy-efficient repair by using the lost super-profit of the natural monopoly in the long term with the market equilibrium point unchanged. This profit will be equal to the additional profit (super profit) of the natural monopolist with the new consumption volume Q_e, price P_A, *LATC* and *LMC* remain unchanged in the long run, i.e. without state regulation. The value of this profit is equal to the area of the blue rectangle in Fig. 2. It can be calculated using (1):

$$TR_e = Q_e \cdot P_e, \quad (1)$$

where TR_e is additional profit (super profit), which could be obtained by the resource supplying organizations (natural

monopolies), if the state did not interfere in the process of pricing and the cost of resources could be raised to P_e.

In addition, the monopolist's super-profit at point E_e can be calculated as the area of the rectangle R_eE_eGM using (2):

$$TR_e = (D - LATC) \cdot Q_e = (Q_e - LATC) \cdot Q_e, \quad (2)$$

where D is the utility demand; $LATC$ mean long-term average total costs of producing and selling utilities; Q_e is consumption of utility resources, after the energy-efficient repair.

For the market equilibrium to remain at the point E_e and the value of the housing and utility services tariff not to change, it is necessary to ensure that the private investor receives this additional profit TR_e. That is, to attract a private investor, the condition must be met (3):

$$TR_e \geq NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+R)^t}, \quad (3)$$

where NPV is the net discounted income of the private investor; t is the time period; n is the number of time periods; CF is the amount of cash flow (outflows and inflows); $R = (1 + r) \cdot Jn$ is the inflation-adjusted discount rate; r is the discount rate; Jn is the inflation rate.

Formula (3) allows estimating the total amount of investments of the private investor and the long-term tariff on housing and utility services at the given production costs and the predicted level of inflation. However, to guarantee the value of the tariff for housing and utility services in the long run, it is important to consider the profit of a private investor earned thanks to the energy-efficient capital repair. Table 4 shows the structure of housing and utility services tariffs, differentiated by funding sources, before and after the energy-efficient repair made at the expense of a private investor.

CONCLUSION

The proposed approach to assessing the income of a private investor in the housing and utilities sector is only the first step of the global process towards getting the business community involved in solving the problems of this sector. The proposed approach is a conceptual basis for market pricing in the housing and utilities sector but it requires more detailed elaboration on the following issues: forecasting the inflation index, taking into account market risks; determining the percentage ratio of the housing and utilities tariff structure at different stages of operation of an apartment building; estimating long-term average and marginal costs of energy resources generation/delivery; forecasting the supply of housing in the market and the purchasing power of Russian citizens.

Table 4. Structure of utility tariffs by source of funding before and after energy-efficient repairs financed by a private investor

Structure of the housing and utility services tariff (name of the housing and utility services source of provision/ financing) BEFORE energy-efficient repairs	Brief description of the housing and utility services source of provision/ financing	Structure of the housing and utility services tariff (name of the housing and utility services source of provision/financing) AFTER energy-efficient repairs
Management organizations	Based on the management contract, provides services for the maintenance and repair of the common property in the apartment building, services for its management, as well as provides utility services to persons using the premises in the apartment building	Management organizations
Supplying organization	Organization or individual entrepreneur who sells utility resources and delivers them to the walls of the house	Supplying organization
Contractor of utility services	A legal entity or individual entrepreneur who directly supplies utilities to apartments or other premises of the house. From the boundaries of the building to each consumer utility services are supplied either by the management company, or the same supplying organizations (in cases stipulated by law)	Contractor of utility services
—	Businesses that specialize in generating energy and extracting natural resources from the earth's Subsoil, waters, and forests by technical means	Resource companies
Housing and Public Utilities Fund and the region	Subsidies from the Housing and Utilities Fund and the region are available in a limited amount (up to 10 % of the energy-efficient capital repairs cost). They are allocated in the presence of co-financing from the region, which is not always possible	Housing and Public Utilities Fund and the region
—	An individual or legal entity providing its own funds for a reasonable energy-efficient capital repair	Private investor

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Расчет дохода частного инвестора ЖКХ в условиях перехода на долгосрочное тарифное регулирование

В статье рассматривается необходимость перехода жилищно-коммунального хозяйства на долгосрочную систему тарифообразования. Данная задача была поставлена Правительством РФ в июне 2021 года в рамках утверждения «Концепции внедрения механизмов тарифообразования для организаций, осуществляющих регулируемые виды деятельности, на долгосрочный период». Существующие и ежегодно индексируемые тарифы на ЖКХ не позволяют развиваться жилищному хозяйству, так как не являются привлекательными для частных капиталов и вызывают усугубление конфликта между собственниками жилых помещений и управляющими организациями. Отсутствие социального доверия и недостаток бюджетных средств на протяжении многих лет существенно снижают качество жилого фонда РФ. Состояние жилого фонда в стране сегодня таково, что без массового проведения капитальных ремонтов с использованием энергоэффективных материалов и инновационных технологий количество аварий в жилых зданиях будет только увеличиваться. Для этого нужны дополнительные инвестиции, так как бюджетные источники в состоянии покрыть только отдельные виды работ и объемы финансирования. России нужна новая система формирования тарифов, которая смогла бы учесть все особенности отрасли ЖКХ и возможности финансирования с учетом ее монопольной структуры. В статье предлагается концептуальный подход к вычислению долгосрочного значения тарифа на ЖКХ за счет перераспределения сверхприбыли монополий в пользу частного инвестора. Важным условием реализации предлагаемого подхода является сохранение темпов строительства в РФ на ближайшие 10 лет и значений долгосрочных средних и предельных издержек на производство и предоставление коммунальных ресурсов.

Ключевые слова: *жилищно-коммунальное хозяйство, тариф, прибыль, естественная монополия, ресурсоснабжающая компания, энергоэффективный ремонт, государственное регулирование*

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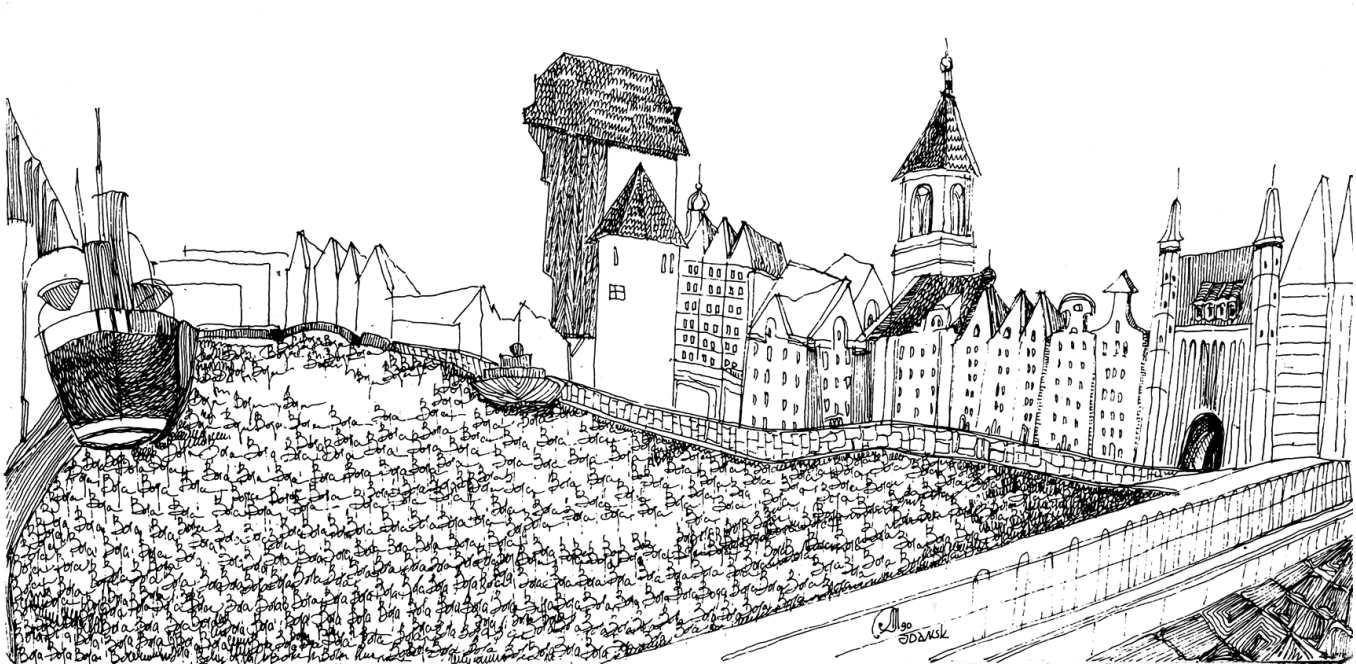
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Об авторе: **Пантелеева Маргарита Сергеевна** — кандидат экономических наук, доцент кафедры организации строительства и управления недвижимостью; **Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ)**; 129337, г. Москва, Ярославское шоссе, д. 26; РИНЦ ID: 654336, Scopus: 57194441387, ResearcherID: ABB-6750-2021, ORCID: 0000-0003-4275-5244; Panteleevams@mgsu.ru

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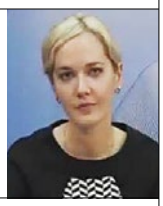
Reconstructing existing urban development in the context of green architecture

The sustainable transformation of urban space is associated with various factors, such as an increase in the density of residential buildings, an increase in the number of floors of business and administrative zones and the intensive development of related infrastructure, as well as a significant change in the functional orientation of individual urban development zones. The central and historical zones have the greatest potential for the modernization of the urban environment. Comprehensive renovation of urban development, as the most significant criterion for the sustainable development of the urban environment, is the most important aspect of its development and is aimed at creating comfortable living conditions and effective use of the capabilities of the construction complex, such as engineering, production, and others.

The relevance of the research addressed in this article is explained by the need to make an organizational model for the reconstruction of existing buildings and to choose the most optimal trajectory of their development and effective use. The article discusses the general principles of development of an organizational and technological model that allows to evaluate and optimize the ways of development using the principle of green reconstruction, as well as the optimized use of urban space.

Particular attention is focused on the need to form and introduce the concept of green reconstruction into the urban environment by integrating elements of landscaping and energy conservation into the spatial structure of buildings. This trend is caused by the pressing need to improve the ecological quality of the urban environment to improve the comfort of life of the urban population, restore the disturbed balance of interaction between man and the natural environment and ensure the sustainable development of the urban environment taking into account the current trends.

Keywords: *green reconstruction, green architecture, urban space, regeneration, reconstruction, organizational model, development of urban environment, urban development, energy conservation*



Akristiniy Vera Alexandrovna,
Candidate of Technical Sciences, Associate Professor of the Department of Organization of Construction and Real Estate Management; Moscow State University of Civil Engineering (National Research University) (MGSU); 26 Yaroslavskoe Shosse, Moscow, 129337, Russian Federation; ID RISC: 689002, ResearcherID: AAE-8964-2022, ORCID: 0000-0002-6488-420X; akristiniyva@mgsu.ru

INTRODUCTION

Currently, the most significant trend in the development of urban environment is to determine the optimal options for the development of new territories and reconstruction of existing areas. In recent years, reconstruction of urban development remains an important constituent of capital construction and urban planning. This trend is due to the natural "aging" of real estate objects, which is accompanied by the physical and moral wear and tear.

Reconstruction of real estate objects solves a number of important tasks, allowing to improve living conditions, such as quality and comfort; equips buildings with modern engineering equipment, extends the service life and increases energy efficiency. These criteria increase the attractiveness of urban development and make buildings safer and more environmentally friendly. Various organizational and engineering solutions are invested in the reconstructed buildings; hence, individual methods and approaches are required during reconstruction. The relevance of the problem under consideration lies in the fact that in the present-day reality, a new vector is needed for the development of approaches to planning reconstruction works that would meet modern requirements, as well as the fundamental principles of sustainable environment, such as comfort, environmental friendliness, safety, energy efficiency. The model of green reconstruction can become a necessary approach to reconstruction in the current conditions, and it will be based on cutting-edge achievements of the construction industry [1].

As a rule, reconstruction results in the possibility of achieving certain indicators, such as economic effect, reduction of physical wear, change of spatial planning parameters of objects, increase in the usable area, increase in the comfort of living, introduction of innovative technologies and materials, extension of the life cycle of the building.

Having analyzed the above, we can conclude that reconstruction is the most important factor in the production cycle of real estate objects, as well as a special type of investment and construction activity.

The need for reconstruction is caused by the following reasons:

- inconsistency of the existing urban planning structure, increasing functional and environmental pressures on the urban environment;
- insufficiently efficient use of housing stock;
- increase in moral and physical deterioration of the building;
- need to change the functional purpose of the object.

The reconstruction of buildings is conducted in order to improve the quality and comfort of living, increase the useful area of the building, equip the building with modern engineering equipment, increase the period of operation of the real estate object, increase the level of energy efficiency, improve the architectural expressiveness of the object, bring the building to meet modern requirements of regulatory documentation, increase the structural and operational reliability of the object. From a social point of view, the task of reconstruction is to

make more efficient use of urban space, update the planning structure of the city, equalize the living conditions of the population in various urban areas. From a technical point of view, the effectiveness of reconstruction is shown in the use of modern building materials, structures and technologies. The economic efficiency of reconstruction is achieved by carefully developing economic justifications, determining the scale and order of demolition and modernization of existing buildings, taking into account the improvement of the use of urban territory and proportionality in the order and volume of reconstruction of the housing stock and the stock of public buildings. Proceeding from the above, reconstruction is an important type of construction, and also plays a significant role in the reproduction cycle of real estate objects in connection with its technical, economic and socially significant tasks [2].

PROBLEM AREA REVIEW

Modern trends in the development of urban areas determine the conditions in which it is necessary to make optimal decisions on the choice of methods for the reconstruction of urban construction. An actual mechanism is the introduction of green architecture tools to increase the criteria for the effectiveness of urban space reconstruction. The process of green reconstruction involves reducing resource consumption and minimal environmental impact during the production of works and at the stage of operation of similar facilities. Energy efficiency can be achieved in different ways at each stage. When designing the architectural part, it is necessary to use materials and structures with high thermal insulation properties. When planning spaces, it is necessary to apply solutions for the use of natural light, to shield heating from the sun.

The reviewed foreign experience of implementing the standards of green reconstruction demonstrates the trends of increasing environmental friendliness and energy efficiency not only of individual objects, but in general the creation of a green urban environment [3].

For example, in Sweden, the idea of eco-building is supported at the state level, and it is not only about individual green buildings, but in general about creating a sustainable urban environment. So, in Malmo, the municipality initiated the Eco-City Augustenborg project (Fig. 1). In addition to the reconstruction of buildings, improved waste disposal, the use of solar energy, the creation of a botanical garden with an area of 10 thousand square meters on the roofs of houses were introduced here. But the biggest change was the transition to an open storm sewer system with channels and ponds that collect and purify rainwater instead of underground pipes. As a result, the energy efficiency of the district has increased significantly — by about 35 %. And the overall impact on the environment decreased by 20 %. The Olidham area in Umeo has implemented tools to reduce energy consumption and create a safer and more comfortable environment. Solar batteries were installed on the roofs of houses: they generate about 350 thousand kWh of electricity per year. New ventilation and heat recovery systems have been launched in the buildings, and energy-saving LED lamps have been installed. Umeo has a cold climate, but the district heating supply in this area is well developed, and it is 99 % independent of fossil fuels. To further reduce energy consumption, washing machines in buildings were connected to the district heating system [4].

By 2050, the city authorities in Paris intend to reduce the level of carbon dioxide emissions into the atmosphere by 75 %. In this regard, a large-scale project called “2050 Paris Smart City” was developed, which represents several types of towers with different environmental characteristics (Fig. 2).

“Mountain towers” will be characterized as bioclimatic peaks that will combine various renewable energy sources. During the day, photovoltaic and heat shields will be able to generate electricity and hot water. Numerous balconies with green spaces will serve as a filter for residents. In addition, watering and fertilizing of these plants will be conducted at the expense of reused water and biocompost from organic waste. “Antismog towers” implies the construction of a 23-kilometer corridor that will run through the center of Paris along abandoned railway lines. These territories are planned to be transformed into park areas, bike paths and urban gardens, towers erected in the immediate vicinity of them will be designed to filter harmful emissions into the atmosphere, including smog. The structures of these structures will be constructed from modern materials with the function of generating electricity through axial wind turbines and flexible photovoltaic panels. “Photosynthesis towers” involves the transformation of existing buildings into a vertical park, using bioreactors powered by green algae [5].

With a detailed examination of the foreign experience of urban reconstruction, it can be argued that the most significant results of reconstruction were achieved in Germany, Finland, Sweden, France and Poland.



Fig. 1. Eco-City of Augustenborg, Sweden (botanical garden). URL: https://www.arrivalguides.com



Fig. 2. "2050 Paris Smart City", France (project). URL: https://www.novate.ru/

In Germany, one of the well-known methods of reconstruction is used, such as building decompression, in which the building is rearranged with the dismantling of its individual elements and the transformation of the space-planning structure into a new form, for example, a large section or terrace. A similar method of reconstruction was proposed by the architect Sh. Forster, while the projects of reconstructed houses began to be called "urban villas". The main idea of the architect is connected with the transformation of panel buildings into a new form and thereby prolonging their life cycle. Under these conditions, a new image is being given to the areas of panel development by increasing the comfort and architectural expressiveness of housing, the creation of a traditional German garden city in their place [6].

The building conditions in Finland are characterized by a cold climate, and therefore the reconstruction is aimed in most cases at improving the energy efficiency of buildings. The main task of the reconstruction will be based on the introduction of modern engineering solutions and improvement of existing engineering devices, which will contribute to reducing resource costs (water supply, heating and electricity) through the introduction of indoor climate control systems, optimization of lighting modes and heat and humidity conditions.

In Russia, the trends of green reconstruction are being implemented less intensively, which is explained by a number of problematic aspects, such as the harsh climate and high operating costs. In addition to the above, the conducted analysis of the problem area of the study revealed the following groups (Table 1).

MATERIALS AND INSTRUMENTS

Reconstruction is a special kind of construction, and it has a number of features, such as:

- need to perform reconstructive work in cramped conditions;
- possibility of combining the execution of construction and installation works and the functioning of the building;
- need to conduct a technical inspection of the property before starting the design work;
- large amount of work on the dismantling of building structures, as well as the need to replace or strengthen them;
- limited accessibility to some structures that require detailed inspection;
- need to take into account individual space — planning decisions;
- performing specific work;
- increased danger during reconstructive work, especially during work performed without eviction of residents;
- features of technological schemes used in reconstruction;
- high density of buildings.

One of the most important factors that relates to the peculiarities of the reconstruction of buildings is the presence of constraint during the reconstruction work. The constraint is expressed in the limited front of the work, in the difficulties of using construction equipment, machines and mechanisms, as well as in the difficult conditions of storing construction materials. According to the types

Table 1. Analysis of urban development reconstruction problems

Organizational	Technological
Disruption of the timing of reconstruction work, their displacement, as a consequence, an increase in the duration of reconstruction, late provision of documentation, violations of the deadlines of work by subcontractors, changes in the sequence of work, interruptions in resource supply, lack of specialists of the required qualifications	Violations of the technological regulations for the production of works, the appearance of unforeseen works due to incomplete technical inspection of buildings, changes in the numerical and qualified personnel of performers, violation of safety regulations; reduction in the intensity of work in cramped conditions
Managerial	**Financial**
Untimely decision-making, operational planning errors, incompetence of management	Increase in cost during the production of works, as a consequence, a decrease in the effectiveness of the project

of constraint, it can be divided into internal and external. External tightness can be characterized by the ratio of the free area of the construction site to the area of the land plot necessary for the rational organization of construction, the placement of machines and mechanisms, i.e. construction equipment, storage of structures and materials, as well as the location of a household town. The external tightness shows the working conditions on the construction site. Internal constraint refers to the presence of obstacles in the intra-object space. For example, such restrictions as: special equipment that is technically impossible to dismantle or its elimination is economically unprofitable, existing building structures. Internal tightness determines the construction technology, linking reconstructive work in time and space, characterizes the conditions of the organization of workplaces, the limitations of the formation of the front of work, as well as the difficulty of intra-object movement of the building structures used. An important factor in choosing the method of reconstruction is the technical condition of the building, therefore, before the start of reconstruction work, an inspection of the existing building is necessarily conducted [7].

Currently, one of the priority tasks is energy conservation. This is due to the shortage of basic energy resources, the increasing cost of their extraction, as well as global environmental problems. This problem should be solved with the help of reconstruction of buildings. The diverse experience of energy-efficient construction in the world presents the possibility of dividing it into two main directions — energy-passive and energy-active construction. The construction of an energy-intensive building provides an opportunity to exclude the use of a heating system, since such a building is characterized by low heat consumption. Passive construction is designed to provide a comfortable environment in the building, provided that the consumption of thermal energy is reduced, the operation of cooling systems, ventilation and artificial lighting is optimized. These conditions are provided by the use of additional insulation of enclosing structures, the introduction of recovery systems that collect and store warm air from the ventilation system inside the premises, the system for collecting precipitation in the form of rainwater. An energy-active house is characterized by the use of new technologies and modern control systems to reduce the energy load and ensure the independence of the building from external energy sources, ensuring independent energy generation [8].

Resource — and energy-saving technologies have become widespread:

- process automation systems;
- local and autonomous power and heat generation systems;
- cogeneration systems.

The cogeneration system is a complex of complex technical equipment designed for the joint production of electricity and heat. The cogeneration plant includes the following elements: an internal combustion engine, a generator, a heat exchanger system and a control system that allows the installation to be controlled both on-site and from a remote location via a computer or cell phone. Such installations are decentralized energy sources, which means that this system operates in direct proximity to the place of consumption, in this regard, the costs of energy pipelines and energy losses during transportation are significantly reduced (Fig. 3) [9].

Modern technologies can significantly reduce energy consumption, reduce maintenance costs and increase efficiency coefficient. It also provides great savings if, instead of separate central heating points, an individual heating point is placed in the building, equipped

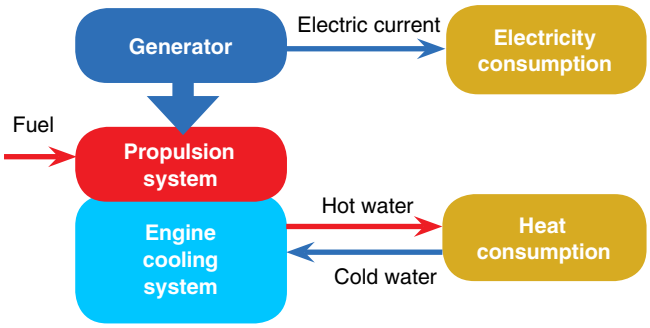


Fig. 3. General scheme of cogeneration

with modern silent pumps, compact and efficient plate heat exchangers. Another area of resource saving and environmental friendliness is the technology of green construction, which can also be used during reconstruction.

Green construction is a full cycle of design, construction and operation of buildings, the main concept of which is the effective introduction of innovative technologies and materials, as well as compliance with environmental safety standards throughout the life cycle of buildings. The main task of such construction is to reduce the level of consumption of energy resources, as well as to increase the comfort of the indoor environment. The construction of such buildings seeks to save money through the introduction of modern management, control and optimization of all systems [10].

Technologies of green construction:

- combined heat and power generation;
- production of green bricks from recycled materials, which are very light in weight and have improved insulation properties;
- use of secondary raw materials in the manufacture of a number of building materials and structures (bricks, flooring, window frames and doors) in order to reduce the consumption of natural resources;
- priority to external glazing of buildings in order to maximize the use of solar energy and, as a result, reduce the cost of heating and lighting of the building;
- implementation of BIPV (Building Integrated Photovoltaics) — modern autonomous installations for converting solar energy into electrical energy using a new generation of solar modules integrated into the building structure (facade or roof) (Fig. 4).

Considering modern technologies that need to be implemented in the reconstruction, it is impossible not to mention the “intelligent” systems of the building. Such systems by automating control systems are designed to ensure control of energy consumption and increase the controllability of engineering systems at home. Such a Building Management System consists of two subsystems: dispatching and automation of engineering systems. The peculiarity of such a building is the integration of individual subsystems into a single managed complex. The automation and dispatching system of the building's engineering equipment provides automatic control, regulation, necessary interlocks, protection from emergency modes, as well as centralized automatic control and remote control of the building's engineering systems. The latest video monitoring, fire and burglar alarm systems — lead to an increase in the safety of the building. Also, novelties are being introduced for such systems, for example, automatic transmission of meter readings, a system for monitoring water leakage, for operational analysis of consumption and emerging problems, which will



Fig. 4. Application of BIPV technology (Building-integrated photovoltaics). URL: https://www. ardexpert.ru/

reduce the amount of resource consumption, or video intercoms to increase security [10, 11].

The recuperation system is also an example of innovative options, such a system takes air from the toilet, cleans it from harmful impurities, heats or cools it, depending on the set mode, and only then feeds it to the apartment. The concept of a smart building creates conditions for saving resources for heating, cooling, water supply and waste collection. Intelligent solutions provide stability, a degree of safety, additional characteristics to preserve the value of assets for the owner. Asmart building is a combination of energy, technology, telecommunications and other building systems that facilitate the automation of advanced construction methods.

The latest aeroponics biotechnology is being introduced, capable of revolutionizing the provision of conditions for vertical and surface gardening. This biotechnology represents artificially created climatic conditions for plant growth and development in the complete absence of soils and substrates, where plant roots are freely placed in an aeroponic model and receive a nutrient solution by spraying in the form of mist or microdrops, which ensures the presence of an air-nutrient medium (Fig. 5).

Aeroponics has many advantages that determine the expediency of its use in the packaging of a green reconstruction, the main ones are the supply of a nutrient solution, and other processes are controlled by a computer and correspond to the phases of plant development; crops grown on aeroponics are characterized by a particularly high rate of growth and maturation; environmental friendliness associated with the use of a closed-loop system a cycle in which there is no complete utilization of the nutrient solution, there is no use of pesticides, soil or substrates. The aeroponics method allows for accurate and rapid control over all technological processes of plant growth and development, while being characterized by a high energy and material intensity of technology.

The practice of using smart-glass is currently widespread in the field of green reconstruction. Its characteristics represent the possibility of introducing it into the glazing system of reconstructed buildings. A special complex of nano-sprays allows you to save on lighting, keep warm and prevent excessive heating from sunlight (Fig. 6) [11].

STUDY RESULTS

The important tasks of the digital age include meeting the needs of the population and making a profit for the investor. Advanced technologies make it possible to extract additional efficiency and profitability in all spheres of urban life, increase the level of sustainable development, open up prospects for new ways of construction and reconstruction and arrangement of living space. The existing system of organizational and technological



Fig. 5. Examples of aeroponics technology application. URL: https://www.greenhouses.ru/

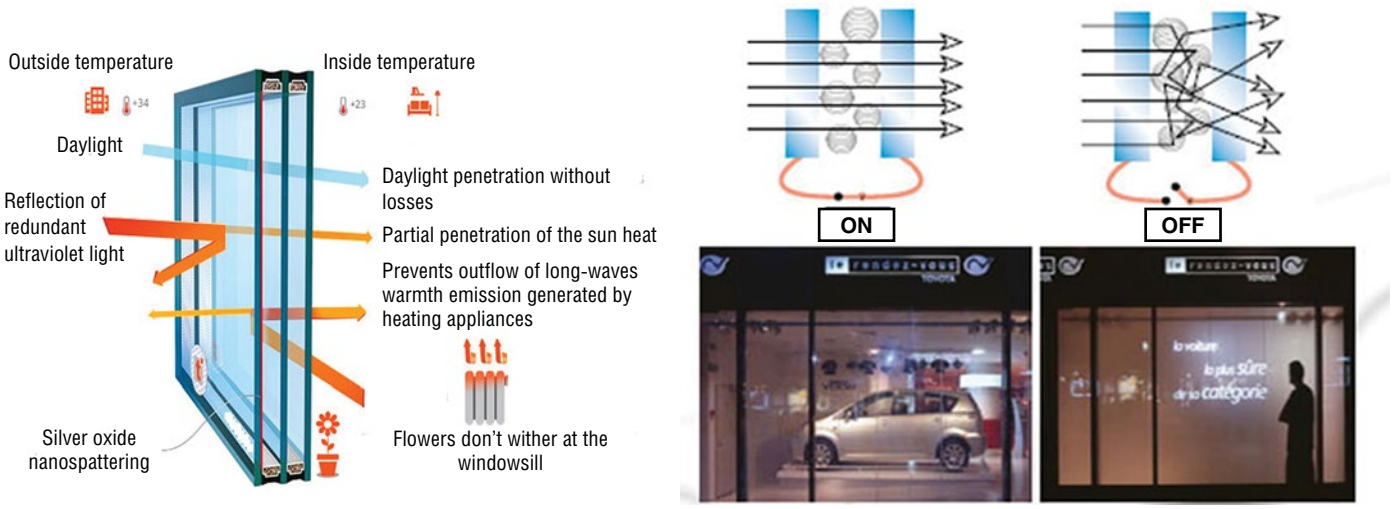


Fig. 6. Smart-glass device schematic. URL: https://www.almaokna.kz

methods of reconstruction in modern realities requires modernization and new approaches to this activity, both at the design stage and at the stage of reconstruction work. Such improvements can be expressed in the form of a schematic model of green reconstruction. Such a model will allow to achieve maximum efficiency of the project taking into account environmental friendliness, energy efficiency, safety and comfort [12].

Green reconstruction is an innovative reconstruction that applies various modern technologies to improve the quality of life, increase its competitiveness, while ensuring that the needs of current and future generations are met in terms of economic, social, environmental and technical aspects. The concept of green reconstruction differs from other concepts in that it does not focus only on information and communication innovations, but it is also focused on achieving a new level of quality in management, organization and control during reconstruction (Fig. 7).

Elements of the model of green reconstruction.

1. Technologies.
2. Ecological safety.
3. Safety.
4. Comfort.
5. Quality.

The concept of green reconstruction is associated with environmental friendliness, innovation, high-tech clusters, information and communication technologies. Since green ecological and technological changes in the development of the urban environment are largely associated with an increase in the efficiency of the use of all types of natural resources, environmental friendliness becomes a key element of the green design. The concept of green reconstruction cannot be implemented without smart management of all components of the organizational model, which in turn cannot be implemented without human participation. All this is created by specialists for the well-being of the population, to ensure the quality and comfort of living, which is also the key elements of the concept [13].

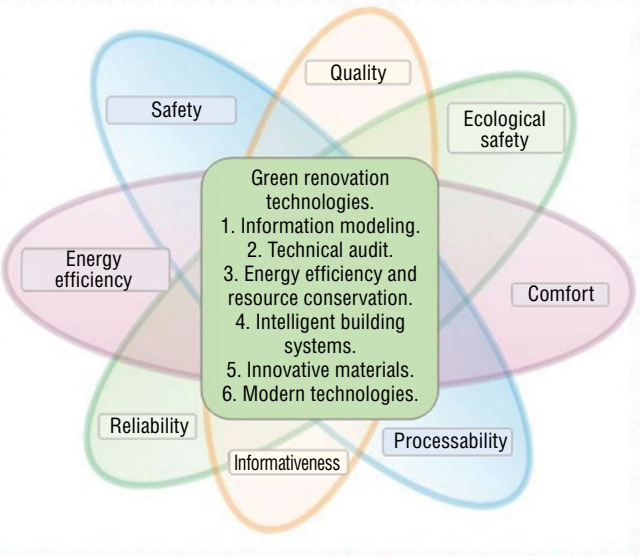


Fig. 7. Organizational model of green reconstruction

Table 2. Opportunities and threats to the implementation of green reconstruction

Opportunities	Threats
Improving the quality of life and comfort of living	High cost of innovative technologies
Improving the quality of reconstruction process management	Project risks are high
Solving pressing economic and social problems through the introduction of innovations	Lack of demand from the unprepared population
Improving resource efficiency	High dependence on the supply of components from abroad
Reducing the time spent on the implementation of projects	
Reduction of financial costs in the field of resource conservation	

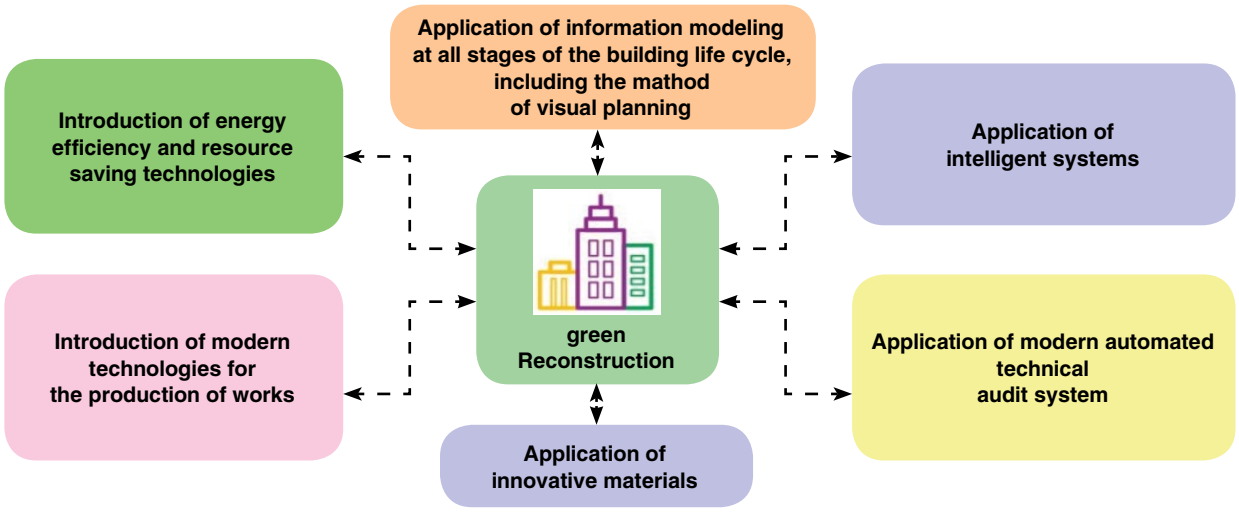


Fig. 8. Components of the green reconstruction model

In the Table 2 the possibilities and threats of the implementation of the green reconstruction model are considered.

The components of the model can be implemented individually or in certain combinations, depending on the goals of the project.

The analyzed methods and approaches to reconstruction have shown a certain "conservatism" in the organization of reconstruction, which is why there is an increasing need to improve these methods with the help of modern technologies of green architecture and information modeling. The modern approach to the organization of reconstruction creates conditions for saving resources, reducing the time of work, improving the efficiency and environmental friendliness of projects (Fig. 8) [14, 15].

CONCLUSION

The reconstruction of real estate is a complex multifaceted problem. The solution of this kind of issue in each specific situation takes into account the following aspects: technical, environmental, economic, social, aesthetic and resource. The improvement and introduction of new progressive technologies into the reconstruction process will stimulate the subsequent increase in efficiency and contribute to the development of green reconstruction, as well as determine the success of its social, urban planning and technical tasks. It is reasonable and environmentally justified to consider the introduction of green technologies into the processes of reconstruction of urban environment objects, in the structure of which spaces for landscaping are structurally designed — terraces, winter and summer gardens, green balconies, facade landscaping, as well as stylobate-platform platforms for landscaping are formed on top of the operated flat coverings of buildings and structures. Such a direction has a sufficiently large environmental potential, which can be effectively implemented in objects of various functional purposes. The trend of green reconstruction has a conceptual focus on improving the ecological quality of the urban environment and the introduction of innovative technological solutions.

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Реконструкция сложившейся застройки в контексте «зеленой» архитектуры города

Развитие городской среды связано не только с увеличением плотности жилых кварталов, повышением этажности деловых районов и интенсивным развитием инфраструктуры, но и изменением функционального назначения отдельных городских зон. Наибольший потенциал развития внутригородских территорий располагается в центральных и исторических зонах. Одним из важнейших аспектов развития городской среды является проведение комплексной регенерации территорий сложившейся застройки города, направленное на создание благоприятных условий проживания и эффективное использование производственного, инженерного, научного и других потенциалов строительного комплекса.

Актуальность исследования, рассмотренного в данной статье, обусловлена необходимостью создания организационной модели по реконструкции сложившейся застройки и выбора наиболее оптимальной траектории их развития и эффективного использования. В статье рассмотрены общие принципы разработки организационно-технологической модели, позволяющей оценить и оптимизировать пути развития при использовании принципа «зеленой» реконструкции, а также оптимизации в использовании городского пространства.

Особое внимание акцентируется на необходимости формирования и внедрения в городскую среду концепции «зеленой» реконструкции путем интегрирования элементов озеленения и энергосбережения в объемно-пространственную структуру зданий. Данная тенденция вызвана острой необходимостью повышения экологического качества городской среды для улучшения комфортности жизни городского населения, восстановления нарушенного баланса взаимодействия человека и природной среды и обеспечения устойчивого развития городской среды с учетом современных тенденций.

Ключевые слова: *«зеленая» реконструкция, «зеленая» архитектура, городское пространство, регенерация, реконструкция, организационная модель, развитие городской среды, застройка города, энергосбережение*

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Об авторе: **Акристиний Вера Александровна** — кандидат технических наук, доцент кафедры организации строительства и управления недвижимостью; **Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ);** 129337, г. Москва, Ярославское шоссе, д. 26; РИНЦ ID: 689002, ResearcherID: AAE-8964-2022, ORCID: 0000-0002-6488-420X; akristiniyva@mgsu.ru.

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Dmitriev A.N.
Mustafin I.G.

Analysis of digital ERP products used in construction to create a digital corporate innovations management environment

This article discusses the digitalization of development companies as the arrangement of digital activities and resources of the construction industry, including a digitized programme for the manufacturing and distribution of construction products, including the digitization of external relationships (cooperation chains) and in-house business processes in each construction company. This means that all processes must be digitized. The main focus is the introduction of ERP systems. The results of the study show that many Russian construction companies are deeply concerned about digital transformation and the need to digitalize construction technologies to move to a new technology stage. The study supports the management of construction companies willing to grasp the current state of affairs, identify their position amid global digital transformation processes and areas that need special attention to innovations development. Efficiency assessment not only offers an opportunity to calculate the budget for a future project and trustworthily assess all the resources needed for its implementation, but also enables developers and builders to successfully reorganize in-house business processes and tighten control over the system functionality determining business involvement and a detailed description of functions required to achieve corporate goals and objectives. The digitalization of management innovative systems will enable executives to coordinate goals and objectives pursued by the company, its individual departments and top managers, have a clear understanding of the functions, responsibilities and requirements for employees to build an effective corporate management system, generate a target business model towards the implementation of a corporate information system. The complexity of using ERP systems is explained by intricate relationships between an investor, a construction customer, a general contractor, innovations subcontractors (inventors), and resulting specific features of construction scheduling.

Keywords: *digital revolution, increasing productivity, innovative processes*



Dmitriev Alexander Nikolaevich,
Doctor of Technical Sciences, Professor of the Department of Project and Program Management, Capital Group; Plekhanov Russian University of Economics (PRUE); 36 Stremyanny Lane, 115054, Moscow, Russian Federation; alexander.dmitriev@inbox.ru



Mustafin Ildar Gazinurovich,
Postgraduate student, Deputy Project Manager; Plekhanov Russian University of Economics (PRUE); 36 Stremyanny Lane, Moscow, 115054, Russian Federation; Ildar.mustafin91@list.ru

Recently, leading development companies have been intensively introducing automated systems in various areas of development businesses. The emphasis is placed on the design process, construction control, simulation of projections and the distribution arm, as well as the optimization of the product quality and customer feedback. These systems help to consolidate all departments and corporate functions on a single platform. All departments refer to one and the same database to optimize data sharing. Digital transformation is one of strategic corporate priorities. At the same time, some factors determine quantitative tasks achievable through the implementation of digital transformation projects. A significant share of companies — 46 % — identified corporate units responsible for the introduction of new digital technologies. A smaller number of companies managed to design a working procedure. Only 25 % of respondents responded that they had managed to develop the culture of ongoing transformations in terms of the use of digital technologies, 20 % had made a list of requirements for the competencies of employees in the digital technology sector and only 15 % had implemented an effective motivation system to ensure the efficiency of digital technology projects. The goal of foreign companies is to build an integrated management system that allows analyzing all processes in the real time mode.

The companies that are customers of the development sector have a fundamental tool: a single platform for managing a development and construction project.

First of all, it is necessary to indicate which business processes can be adapted (changed) to the present-day reality. If the process cannot be adapted, then one should think about replacing it with a new one. When working with processes, one should bear in mind that their indicators should be entered into the PDM system, while processes themselves should, first of all, be focused on handling the data of the digital counterpart of a product [1].

Automated ERP systems are most widely spread in the construction industry today. They are part of a corporate information system designated for automated planning, accounting, control and analysis of all major business processes and solving business problems of a construction enterprise [2].

Automated systems, that are available on the market, have different sets of functions and a modular structure [3]. Nevertheless, there is a certain set of functions that can be considered as the basic ones for software products. Their principal tasks include the development of a capital construction platform, annual investment budgets and schedules of project work; development and analysis of strategies concerning the financing, development, commissioning of fixed assets; work projection and control; control over the material and technical support of construction projects; management of financial and contractual

support of capital construction undertakings; issuance of analytical reports [4].

THE PRACTICAL APPLICATION OF ERP IN DAY-TO-DAY OPERATIONS OF LEADING DEVELOPMENT COMPANIES

As for the Tekta Group, an automated system supervises construction with the help of 1C: ERP Construction Organization Management. The system is in charge of several large-scale residential development projects[1]. The register of work, performed within the framework of one project, can have up to dozens of thousands of lines. 10,000 specialists and workers are involved in the projects. The system prognosticates processes to take place at construction facilities, drafts the project documentation and coordinates assessments, collects applications for construction materials, analyzes the consumption of materials and funds, monitors the performance and timing of construction work.

Towards this end, accounting systems were developed to ensure the successful operation of corporations [5].

The system was installed at 200 workstations. The information accumulated by the system was transferred to the new platform and integrated with "1C: Accounting", "1C: Payroll and Personnel Management", with a CRM system and a corporate portal constructed on the basis of 1C-Bitrix.

The software makes a list of tasks for each project and indicates the amount of work to be performed, deadlines, and costs. At each stage of construction, the amount of work may be adjusted, new items of work can be added, prices may be changed, and all adjustments are demonstrated by the ERP system [6]. The software also helps to find contractors. As a result, forecasting and approving processes have become more productive; scheduling has been optimized [7].

THE IMPLEMENTATION OF "1C: HOLDING MANAGEMENT" BY PIK GROUP OF COMPANIES

PIK Group of Companies has been on the domestic market for more than 30 years. Over the years, the company has managed to implement large-scale residential projects (more than 270 thousand apartments) not only in Moscow, but also in other cities of Russia. To increase the effectiveness of forecasting, accounting and monitoring of operational parameters, the company needed a unified CPM system. Current CPM-class IT solutions help companies to improve the efficiency of business management, provide mechanisms for the detailed analysis of operations and forecasting through the integrated automation of processes compatible with forecasting and situational modeling, budgeting, financial consolidation, operational control (including KPIs) and reporting.

The 1C: Holding Management system was chosen as the basic software, since it addresses a wide range of issues. A forecasting model was also designed to match the current methodology of budgeting and management accounting [8]. As a result, the company selected 1C: ERP 2.0.

Further, the company is going to integrate its budgeting and quality management, computerize its maintenance and repair management operations and production processes [9].

By now the 1st stage of the ERP system implementation has been completed and the following work has been performed:

- entry of opening balances/assistance in entering opening balances;
- remote instruction of users;
- individual training sessions in the customer's office;
- integration with other software belonging to the "1C: Enterprise" system.

The analysis of ERP systems and innovative digital products used to develop a digital corporate management environment, including the use of BIM data to design budgets and deadlines, is shown in Table. These products were introduced into corporate project management systems by the leading Moscow development companies; they have been efficiently used for a number of years [10].

However, the analysis has shown that currently used digital ERP products are focused neither on planning or implementing innovative products and technologies, nor on their funding, that can be performed through the establishment of venture funds at companies, which could further increase their efficiency by means of suggested new business processes(Fig. 1). Hence, the task is to use digital ERP products to develop algorithms for evaluating and selecting innovations to be introduced into projects with the help of BIM according to proposed algorithms(Fig. 2).

Digital ERP products used to design a digital corporate management environment

Company	Name of Innovation	Type of innovation	Description	ERP Product Features	Origin
Digital ERP products for creating a digital corporate management environment	Build Visor	Organizational	Task Manager for construction projects: a list of stages and tasks, document storage, coordination and contacts	• Deadlines and performers are determined for each task. Project participants can discuss the work progress, add work reports, attach photos and documents; • all construction plans, documentation, uploaded photos are stored in one place and available to all project participants; • all project participants see each other and are always in touch	FRII, 2018

1 SP 333.1325800.2017. Information modeling in construction. Rules for the formation of an information model of objects at various stages of the life cycle.

End of the Table

Company	Name of Innovation	Type of innovation	Description	ERP Product Features	Origin
Digital ERP products for creating a digital corporate management environment	Adept	Techno-logical	ERP for construction management includes software for calculating and verifying the cost of design and survey, a construction project management system, budgeting software, an electronic document management system and a portal for monitoring construction work and maintaining executive documentation	• 30 % cost reduction thanks to a single repository of the estimate documentation; • the possibility of using the database of the estimate documentation; • the work of employees of 61 power plants at all branches in a single system	Private investor, 2020
	Gectaro	Product-focused	A service for construction and repair management. Helps to control estimates, work schedules, finances, supplies, construction, tasks, documents and reports	• Reduction of the estimate preparation time from 7 days to 1 day; • search for and identification of problems in schedules; • real-time monitoring of all that's happening at the facilities; • optimization of 33 % of working time and investment in scaling; • transparency of reporting, optimal communication between colleagues in different departments	A state-owned bank, 2019
	Traceair	Organiza-tional	A cloud service that calculates the amount of work performed, for example, earthworks, using drones and compares it with estimates and acts of work performed	• The accuracy of control over the pre-set standard parameters of contractors' work is up by 10–15 % and reduces initial estimated costs by about 10 %	International investor, 2017
	Skyeer	Product-focused	Online platform for data management and instant analysis	• Orthotransformed image in natural colour rendering for accurate determination of positions of construction facilities; • digital topographic model. • three-dimensional textured overview model; • values of vegetation indices needed to determine the biomass of crops and analyze their development patterns; • using a thermal imager to make videos to identify sources of heat loss from buildings; • video recording and real-time broadcasting	VTB, 2019
	Mobile solutions for construction	Techno-logical	Digital solutions for construction control: monitoring the quality of construction work, consultations made using mobile devices, monitoring the amount of building and assembly work performed and the project deadlines, assurance of occupational safety and control over the process of construction in terms of fire, industrial and environmental safety	• Interaction between the construction control service and contractors in a single information space; • access to up-to-date project documentation and data on facilities; • all information about detected and eliminated violations is available 24/7; • breakdown by category; • research data on contractors, types of work, categories of comments and deadlines for corrective actions, employees of construction supervision authorities; • flexible integration of the product with 1:C, BIM, CAD and PDM systems in operation within the company	Skolkovo, 2018

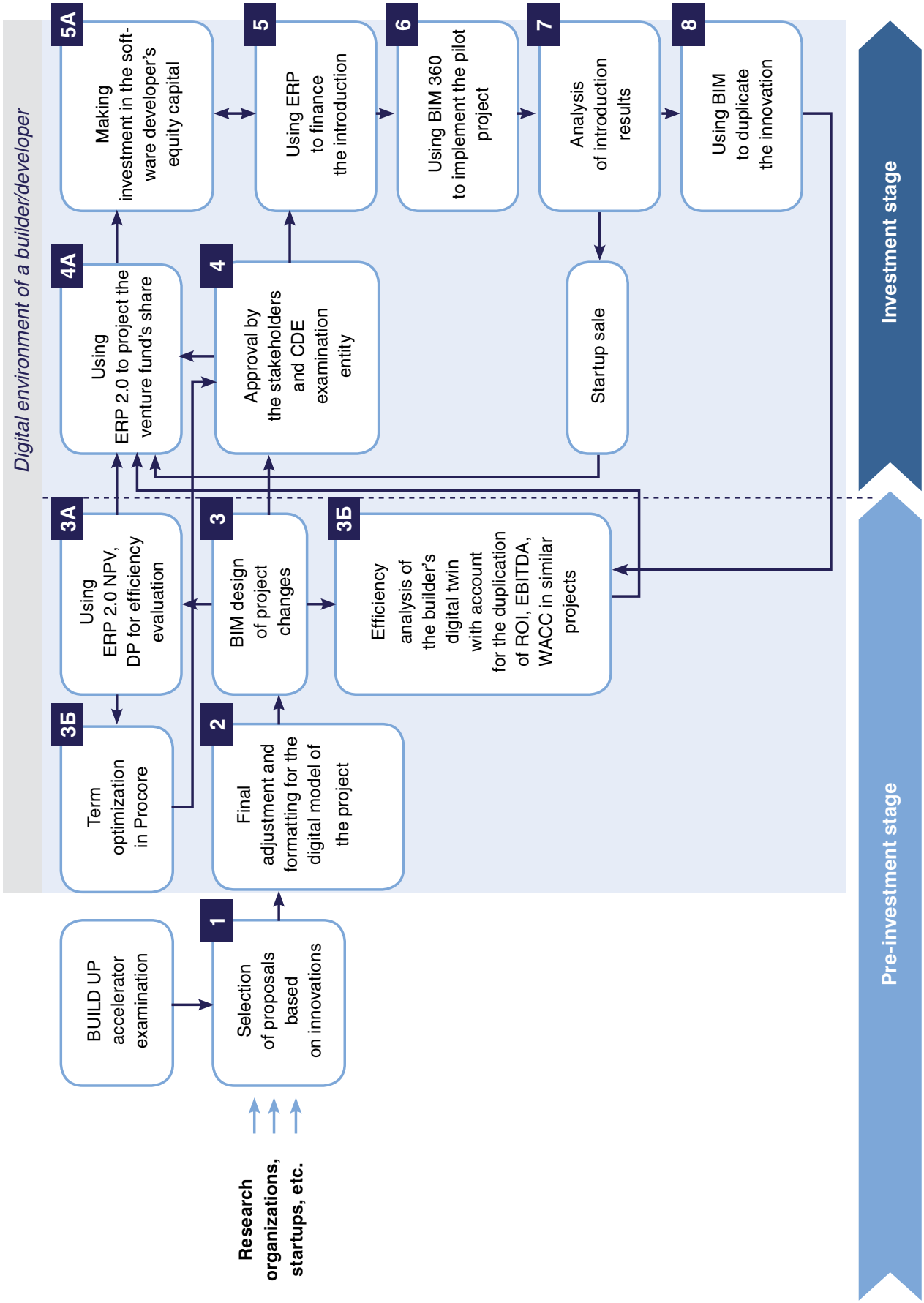


Fig. 1. Stages of an investment and construction project typical for a developer

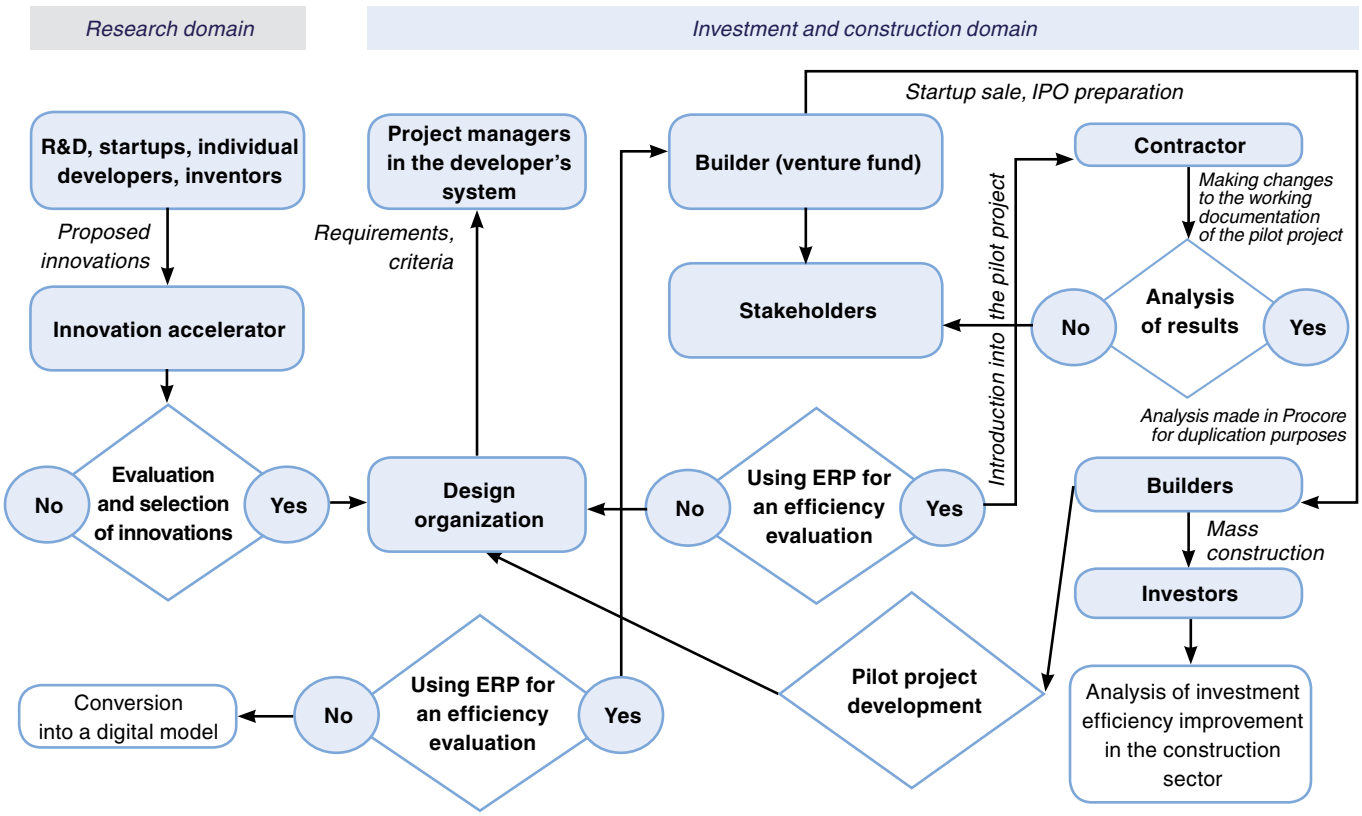


Fig. 2. Proposals on the algorithm of digital innovation management in the organizations of the investment and construction sector

CONCLUSIONS

- The study has proven the need to clarify the digital transformation procedure in construction based on the innovative system integration of current planning and controlling procedures for investment and construction projects [11, 12].
- Digital transformation needs a single digital platform, including an information model of the project life cycle and digital corporate management platforms based on 1C and PROCORE, which will significantly increase the effectiveness of investment programmes and projects at all levels of the construction management hierarchy [13].
- Information flows attributed to the main business processes need to be harmonized taking into account the methodology of digital changes and a functional approach to in-house audits, examination of innovative designs and budgets, construction control and bank support [14].
- To further improve the efficiency and competitiveness of companies, it is necessary to develop suggested algorithms for evaluating and selecting innovations in the digital environment of builders and real estate developers. Algorithms will simulate their implementation using BIM and forecast supplementary effects for corporate customers[2].

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Анализ используемых в строительстве цифровых продуктов ERP для создания цифровой среды управления компанией

В данной статье рассматривается проблема цифровизации девелоперских структур как организация цифровой деятельности и управление ресурсами в строительстве, включающее оцифрованную программу производства и осуществления строительной продукции, которая, в том числе, предусматривает оцифровку внешних взаимосвязей (кооперационных цепочек) и внутренних бизнес-процессов в каждой строительной компании. Это значит, что все процессы должны быть оцифрованы. Основное направление — внедрение ERP систем. Итоги исследования показали, что многие российские строительные компании существенно озабочены цифровой трансформацией и необходимостью цифровизации строительных технологий для перехода на новый технологический этап. Проведенное исследование окажет поддержку руководству строительных компаний в понимании текущей ситуации, их места в глобальной цифровой трансформации и направлений, которым надо уделять особое внимание. Оценка эффективности дает не только возможность рассчитать бюджет будущего проекта и реально оценить все ресурсы, которые потребуются для его реализации, но и успешно реорганизовать бизнес-процессы организации и усилить контроль за функциональностью системы — определения вовлечения бизнеса и детального описания требуемых функций для решения поставленных целей и задач. Реализация мероприятия по автоматизации системы управления позволит согласовать цели и задачи, стоящие перед компанией, с целями и задачами, стоящими перед отдельными подразделениями и топ-менеджерами, четко понять функции, ответственность и требования к сотрудникам для построения эффективной системы управления компанией, сформировать целевую бизнес-модель компании для внедрения корпоративной информационной системы. Сложность применения ERP-систем в данной индустрии обусловлена такими особенностями строительного производства, как наличие весьма сложных взаимоотношений: инвестор – заказчик строительства – генеральный подрядчик – субподрядчики, и вытекающими отсюда особенностями календарного планирования.

Ключевые слова: *цифровая революция, повышение продуктивности, инновационные процессы*

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Об авторах: **Дмитриев Александр Николаевич** — доктор технических наук, профессор кафедры управление проектами и программами Capital Group; **Российский экономический университет имени Г.В. Плеханова (РЭУ им. Г.В. Плеханова)**; 115054, г. Москва, Стремянный пер., д. 36; alexander.dmitriev@inbox.ru;

Мустафин Ильдар Газинурович — аспирант, заместитель руководителя проекта; **Российский экономический университет имени Г.В. Плеханова (РЭУ им. Г.В. Плеханова)**; 115054, г. Москва, Стремянный пер., д. 36; Ildar.mustafin91@list.ru.

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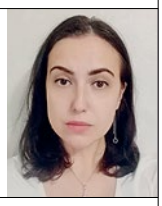
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Koroleva O.N.
Koroleva E.N.
Speranskaya N.Yu.

Implementation of national project “Small and Medium–Sized Entrepreneurship and Support for an Individual Entrepreneurial Initiative” in a large Siberian city

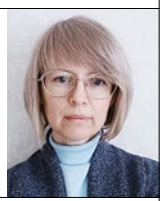
National projects are devised by the authorities to improve the quality of life in each federal subject and municipality. Each national project has a long-term of implementation. Hence, the topic of this research applies to each city, region, and the whole Russia. The social character of small and medium-sized businesses is particularly important. All federal projects, launched within the framework of the national project “Small and medium-sized entrepreneurship” have long terms of implementation and are capital intensive.
The article discusses the actions and indicators of the municipal programme “Development of entrepreneurship in the city of Barnaul in 2015–2024” implemented in Barnaul, the largest Siberian city. The authors have conducted a methodological analysis and econometric assessment of its import and export potential to identify its constituents that need attention (the import substitution potential and the deterministic export potential). The authors have identified the main problems of the national project implementation and proposed solutions to optimize the development of small and medium-sized businesses in the municipality and improve the standard of living in each Russian region.
Presently, the successful implementation of the national project “Small and medium-sized entrepreneurship” is of utmost importance for the country's economic development.
Keywords: *small and medium-sized entrepreneurship, Barnaul city, national project, municipal programme*



Koroleva Olga Nikolaevna,
Graduate student; Altai State University (ASU); 61 Lenin Ave., Barnaul, 656049, Russian Federation; Leading specialist of the Department of Budget Forecasting and Financing of subordinate institutions of Planning and Financial Management; Ministry of Social Protection of the Altai Territory; 69 Partizanskaya St., Barnaul, 656056, Russian Federation; olg4.koroleva@yandex.ru



Koroleva Elena Nikolaevna,
docent of the Department of Regional Economics and Management; Altai State University (ASU); 61 Lenin Ave., Barnaul, 656049, Russian Federation; korka9919@mail.ru



Speranskaya Natalia Yurievna,
director of the Institute of Biology and Biotechnology; Altai State University (ASU); 61 Lenin Ave., Barnaul, 656049, Russian Federation; speranskaj@mail.ru

INTRODUCTION

Altai Krai is located at the intersection of cargo flows, not far from the regions that have raw materials and processing enterprises important for foreign trade operations.

Altai Krai is an export-oriented region: the share of export operations in its total trade turnover exceeds 60 % [1].

In 2016, Altai Krai had trade partners from 92 countries, including former Soviet republics and other states, in 2017 their number reached 98 countries, in 2018 — 106 countries, and in 2019 the number of foreign trade partners went down slightly to 105 [1].

Over the last five years Barnaul’s foreign trade turnover has increased from 267.7 million US dollars to 270.7 million US dollars.

It should be noted that the value of the trade turnover, if assessed in natural indicators, is dominated by exports: it was 79.54 % in 2016, 84.37 % in 2017, and 85.65 % in 2018 [1].

In general, in 2018 the value of exports went down by 4.3 % compared to 2017. However, there is an increase in the export of timber, pulp and paper products (13.9 % in 2017 compared to the previous year, and 20.8 % in 2018), supplies of metals and metal products went up 7.8-fold in 2018 compared to 2016; as for the mineral raw materials, their supply went up 62-fold.

However, the exportation of other goods was down 12 % in 2018 compared to 2017. If assessed in natural indicators, the exports of food products and agricultural raw materials rose 27 % in 2018; the exports of mineral raw materials rose 27-fold, and the exportation of machinery, equipment, and vehicles was up by almost 1.8 times [2].

If we break down the exports by commodity groups, we can notice a large share “Food products and agricultural raw materials” (35.87; 46.07; 44.72 and 42.45 % in 2016, 2017, 2018 and 2019, respectively); as well as “Other groups of goods” (36.59; 22.47; 20.53; 27.42 % in 2016, 2017, 2018 and 2019, respectively) [2].

As for the structure of exported commodities, the share of “Other goods” decreased in 2018 by 16.1 % compared to 2016. The share of textile materials and products decreased by 2.17 %. At the same time, there was a rise in the share of metals and metal products, which reached 6.43 % in 2018 compared to 2016. The share of “Machinery, equipment and vehicles” went down from 9.46 to 5.63 % from 2016 to 2019.

In 2017, the value of import to Barnaul was worth 76.28 million US dollars, compared to 2016; the value increase equaled 15.8 million US dollars, or 26.2 %. The physical volume of imported goods rose by 11 %. In 2018, the import to Barnaul reached 83,847 million US dollars, which meant an increase worth 7.56 million US dollars, or 10 % compared to 2017. The physical volume of imported goods increased by 19.9 %. For the first nine months of 2019, the value of import reached 52.5 million US dollars [3].

The analysis of the Barnaul import operations has proven an increase in the import of food products and agricultural raw materials (its total value

rose by 91 % in 2017 compared to the previous year, and 2 % in 2018); the import of machinery, equipment and vehicles rose by 37.8 % in 2017 and by 13 % in 2018. In terms of natural indicators, it should be noted that the volume of imported products of chemical and related industries rose by 65.4 %; the export of timber, pulp and paper products rose 3.4-fold. The export of machinery, equipment and vehicles decreased by 8.3 % and the import of other goods was down by 33.3 % [3].

MATERIAL AND METHODS

The external business environment is described by objective statistical data and analysis, as well as the official information provided by local government authorities and subjects of the Russian Federation [4]. Nevertheless, statistical indicators of corporate activities cannot always truly convey the business environment in a particular city. Therefore, a study on the entrepreneurs' opinions, obtained by means of questionnaires, becomes a more informative data source used to assess urban business environments [5].

A survey was conducted among 20 small and medium-sized businesses in Barnaul to study its economic potential and identify the main problems.

The topic of the survey was "Assessment of the development of small and medium-sized businesses in Barnaul". Urban businesses were to answer 15 questions, assess the criteria of a favourable business environment on a 3-point scale.

1. The indicator is practically not manifested/not characteristic.
2. The indicator is slightly (rarely) manifested.
3. The indicator is highly characteristic and clearly manifested.

In addition to assessing the state of entrepreneurial activity, the purpose of the survey was to identify the main reasons for corporate success.

The survey identified the following problems: the purchasing power, the lack of qualified specialists, and high taxation.

As a result of the study, it was found that most of the raw materials and materials used for production purposes were purchased from suppliers based in Barnaul and the Altai Territory, and purchasers were willing to replace their suppliers based in other regions.

The main problems, associated with the sale of products in Barnaul, include a decline in the purchasing power of the population, and high costs of local products sold in other regions due to transport expenses.

The analysis of cooperation between Barnaul enterprises and other Russian regions in 2017–2018 has identified the main partners: Kemerovo (5.20 % of flour exports and 1.88 % of cereal exports in 2018), Omsk (1.49 % of flour exports and 5.79 % of cereal exports in 2018), Novosibirsk (17.03 % of flour exports and 21.21 % of cereal exports in 2018), the Tomsk region (1.10 % of flour exports in 2018), Krasnoyarsk Krai (6.36 %), cities of the Moscow Region (16.68 % of grain exports in 2018) and St. Petersburg (22.55 % of grain exports in 2018), the republics of Altai and Tatarstan [6].

In 2017–2018, the top food products, imported from Barnaul, included sausage, butter, milk, meat, poultry, etc.; fuels and lubricants, including diesel fuel, gasoline, heating oil, petroleum bitumen; building materials, such as Portland cement, rolled ferrous metals, corrugated asbestos cement sheets, prefabricated construction products, etc. The following food products were exported from Barnaul: flour (the export growth rate reached 99.96 % in 2018/2017), cereals (the export growth rate reached 152.29 % in 2018/2017), vegetable oil (the export growth rate reached 43.42 % in 2018/2017), pasta, confectionery (the export growth rate reached 184.61 % in 2018/2017), meat (126.24 %) and semi-finished meat (99.52 %), agricultural products (animal food), perfumes, cosmetics, medicines, detergents [6].

The leading Barnaul organizations, engaged in export and import activities, include JSC "Barnaul Brewery", LLC "Barnaul Halvah Factory", LLC "Altai Confectionery", LLC "ProdsnabAltai", LLC "Agro-industrial company «ZLATA»", CJSC "Soyuzmuka", LLC NPF "Altai Bouquet", LLC "Renaissance Cosmetics", JSC BMK "Melangist Altai", LLC "NOVA Factory of Finishing Materials", LLC "Vostok", LLC "Alfit plus", LLC "TC Agroindustria", Altaylestechmash LLC, Energo-Sila LLC, Lyubava LLC, Energotech LLC, Specialist LLC, Altai Grain Plant LLC [7].

According to the statistical data, 31,581 organizations and 19,634 individual entrepreneurs are engaged in the economic activity in the city of Barnaul. By 2019, the total number of organizations and individual entrepreneurs had plummeted; the number of organizations had decreased by 5 % by 2018, while the number of sole proprietors had risen by 4 % [8].

The share of processing enterprises, including electric energy, gas and steam providers, exceeds 42 %; the share of air conditioning providers is 13.2 %; the share of the companies, engaged in information and communication activities, is 11.2 %, the share of health and social services providers is 11.9 % [8].

Wholesale and retail trade reaches 61.6 % of the turnover of small business enterprises, while 15 % of the turnover goes to manufacturing; 6.5 % — to construction; 3.5 % — to real estate transactions; 3.0 % — to hotels and catering enterprises [9].

The same types of activities are the leaders among small enterprises in terms of shipped goods of their own production: 32.3 % — manufacturing; 14.2 % — construction; 13.4 % — wholesale and retail trade; 8.8 % — real estate operations; 7.6 % — transportation and storage; 6.3 % — agriculture, forestry, hunting, fishing and fish farming.

Indeed, manufacturing activities, wholesale and retail trade, construction are the leaders among the small enterprises in Barnaul.

As for the breakdown of local manufacturers, 25 % are engaged in food production; 24 % are engaged in the production of rubber and plastic products; 15 % make other vehicles and equipment.

JSC PO "Altai Tire Plant" is the leader of the chemical industry in the Altai Territory in terms of output.

The following types of economic activities are most popular in the city of Barnaul: food production, production of rubber and plastic products, production of other vehicles and equipment [10].

Production of other vehicles and equipment demonstrates intensive growth. Large industrial enterprises, such as JSC "Altayvagon" and JSC "Barnaul Wagon Repair Plant", LLC "AMZ" are engaged in this type of production activities.

The amount of work performed has risen by 33.8 % over 5 years [11].

Hence, it is advisable to draw a conclusion that the following production activities are developing in Barnaul:

- manufacturing of textile products;
- manufacturing of clothing;
- manufacturing of rubber and plastic products;
- production of finished metal products, except for machinery and equipment;
- production of electrical equipment;

- manufacturing of other vehicles and equipment;
- water supply and sanitation;
- organization of waste collection and disposal;
- pollution elimination activities;
- retail trade;
- catering.

In turn, the following areas of economic activity are at a standstill in terms of the amount of shipped goods, produced by the local manufacturers in the city of Barnaul:

- food production;
- printing activities and copying;
- production of other non-metallic mineral products;
- production of computers, electronic and optical products;
- repair and installation of machinery and equipment.

RESULTS

The main obstacle to the development of the local business environment is the low awareness about government support programmes, financial, infrastructural and information assistance.

Many indicators of the Barnaul business environment have been highly appreciated (the assessment was made on a 3-point scale), but the business climate of the region cannot be considered favourable. The average score is 2.0, or "few factors of a favourable business environment". According to the results of the study, the most problematic areas are the accessibility and transparency of government programmes, tax legislation, and bureaucracy.

DISCUSSION

The municipal programme "Entrepreneurship development in the city of Barnaul in 2015–2024" was launched within the framework of the national project "Small and medium-sized entrepreneurship and support for an individual entrepreneurial initiative" [12].

The objectives to be attained within the framework of this Programme in 2021 include:

- a 48.6 % increase in the share of urban budget revenues to be generated by small and medium-sized businesses (hereinafter referred to as MSPs);
- a 3 % increase in the number of items of municipal property on the list of property designated for the provision of support to MSPs;
- an increase in the number of MSPs, supported within the framework of the Programme (to 320 MSPs);
- an increase in the number of employees of small and medium-sized businesses, including individual entrepreneurs, to 145,364.

In 2020, the following measures were taken in support of business entities within the framework of the Programme:

- publication of three issues of the newsletter "Entrepreneur of Barnaul" (350 thousand rubles);
- organization of an exhibition and fair within the framework of the second stage of the Rowing and Canoeing World Cup (1,300 thousand rubles);
- organization of an exhibition and fair of goods produced by local manufacturers (1,400 thousand rubles);
- organization of the exhibition and fair "Gastronomic Festival in Barnaul" within the framework of the City Day (1,250 thousand rubles);
- generation of awareness about the Barnaul entrepreneurship on information portals in the Internet (250 thousand rubles);
- organization of specialized weekend food fairs (400 thousand rubles).

4,950 thousand rubles were spent on the above-mentioned Programme activities [13].

The following activities were conducted within the framework of this program:

- on May 20 – May 23, 2020, a fair was organized in Malo-Tobolskaya Street as part of the second stage of the Rowing and Canoeing World Cup. Products and souvenirs, made by Barnaul and Altai commodity producers and craftsmen, were sold there. Various master classes were taught;
- as part of the celebration of the City Day on September 11, 2020, the Gastronomic Festival was held by 25 catering enterprises, such as Bakhetle, Mountain Pharmacy, Chocolate Factory, Logovskaya Cheese Factory, etc. Two thematic photo areas were organized; master classes were taught in Malo-Tobolskaya Street. More than 10,500 guests participated in the event.

At the same time, 3 newsletters, namely, Newsletter 20, Newsletter 21, and Newsletter 22 "Entrepreneur of Barnaul" were issued [13]. The newsletters provided information about small and medium-sized manufacturers in Barnaul (such as LLC "Tasty Life", LLC "Plant of Mechanical Presses", LLC "CD «Children's Health»", LLC "Diaf", LLC "World of Batteries", and others), business environment improvements by the urban authorities, the operation of the urban and regional infrastructure in support of entrepreneurship, the implementation of programmes and projects focused on getting local residents engaged in entrepreneurial activity, the generation of awareness about the fundamentals of entrepreneurship, generation of business ideas and information campaigns focused on creating a positive image of an entrepreneur.

A festive event was held at the celebration of the Day of Russian Entrepreneurship in 2020. 42 urban entrepreneurs received awards from the Government of the Altai Territory, the Altai Regional Legislative Assembly, and the Barnaul administration.

A session on "Interaction between businesses and government authorities towards the sustainable socio-economic development of Barnaul" was held within the framework of the 7th Congress of Business Associations in Barnaul. After the event, local businesses shared their ideas about the improvement of the investment attractiveness of the city, the development of local trade, services, manufacturing enterprises.

The session was held in the conference hall of the Tsentralnaya Hotel. It was attended by the executives and representatives of local business companies, such as JSC HC "Barnaul Machine Tool Plant", CC "TSB Altayskiye Zakroma", LLC "Dveridoff", LLC "Teisi", etc., as well as urban authorities.

Local entrepreneurs also promote entrepreneurship in the city of Barnaul on the Internet. 19 articles about entrepreneurship were published by Altapress.ru in 2020. The most memorable articles are:

- "How Barnaul's «Taste Studio» conquers the Russian catering market";
- "If there is cargo, there will be a truck": a disabled Barnaul resident speaks about his delivery business that he manages without getting up from his chair;
- "From the Baltic area to the Far East": the Barnaul company "NOVTECH" supplies products all over Russia and abroad.

8 questions were asked on the official website of the city, in the section "Online consulting of entrepreneurs". Answers were

prepared pursuant to the deadlines set by the law. The questions dealt with:

- the installation of trade pavilions and kiosks — 4;
- unauthorized trade in Spartak Square — 2;
- advertising facilities (whether it is necessary to certify a contract for the installation and operation of advertising facilities) — 2.

Since 2019, the authorities have maintained this page on Instagram. In 2020, 159 items of business information were posted there, which was 3 times as much as in 2019.

The authorities publish information on regional financial support, regional competitions, seminars and round table discussions, most recent information on changes in the decree of the Governor of the Altai Territory dated 31.03.2020 No. 44 "On certain measures to prevent the importation and spread of the new coronavirus infection COVID-19", etc.

By the end of 2021, the national project boasted the following attainments:

- the share of small and medium-sized enterprises in the urban budget revenues reached 57.3 %;
- the number of MSPs who obtained information support as part of the Programme implementation reached 136 entrepreneurs;
- the number of employees of small and medium-sized enterprises, including individual entrepreneurs, reached 144,980 [14].

CONCLUSIONS

The following problems hinder the Programme implementation:

- the lack of statistical data on the calculation and generation of project performance targets;
- unscrupulous performers win municipal procurement contracts.

Despite a trend towards a reduction in the number of small and medium-sized enterprises, the turnover has increased in the city of Barnaul, i.e. legal entities and individual entrepreneurs work more efficiently than before. According to the statistics, in 2019 the number of small enterprises fell by 134 compared to 2018 and equaled to 1,508, the number of employees went down by 414, respectively. Despite the reduction in quantitative indicators, the turnover increased by 1.2 times to 167 billion rubles, the amount of investments went up 2.8 times to 8 billion rubles [14].

In general, the following types of activities are developing in Barnaul:

- education (11 %);
- transportation and storage (6.8 %);
- information and communication activities (5.6 %);
- professional, scientific, technical activities (5.1 %);
- activities of hotels and catering establishments (3.4 times);
- health and social services (9.2 %).

Hence, the following strategic areas of growth of small and medium-sized businesses in the city of Barnaul can be identified [15]:

- food production (dairy products, meat, vegetable oils, grain products, fruit and berries, production of dietary supplements made of natural raw materials);
- production of children's goods, including children's knitwear;
- textile and clothing industries, knitted thread and fabric;
- manufacturing of leather goods, shoes, bags, suitcases;
- production of computers, electronic and optical products;
- development of hotel service.

In addition, the following short-term tasks can be listed.

1. An increase in the number of exhibitions and fairs of goods made by local producers, provided that the epidemiological situation is favourable.

2. More information needs to be found and generated to prepare issues of the newsletters titled "Entrepreneur of Barnaul".

3. Information on the entrepreneurial activity must be posted on the Internet information portals (including information graphics and texts).

The above approaches can ensure the optimal development of small and medium-sized entrepreneurship both in Barnaul and other cities of the Russian Federation.

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Реализация национального проекта «Малое и среднее предпринимательство и поддержка индивидуальной предпринимательской инициативы» на территории крупного города Сибири

Национальные проекты разработаны органами власти в целях достижения нового качества жизни населения каждого субъекта и муниципального образования и носят долгосрочный характер, поэтому тема работы является актуальной не только для каждого города, но и регионов, а также России в целом. Особо выражен социально значимый характер мероприятий сферы малого и среднего бизнеса. В созданном национальном проекте «Малое и среднее предпринимательство» все федеральные проекты рассчитаны на долгосрочную перспективу и имеют высокие показатели по расходованию денежных средств.

В статье рассматриваются индикаторы и мероприятия муниципальной программы крупнейшего города Сибири — Барнаула «Развитие предпринимательства в городе Барнауле на 2015–2024 годы», авторами проведен методологический анализ и эконометрическая оценка потенциала импорта и экспорта, выделены его компоненты, на которые следует обратить внимание (потенциал импортозамещения и детерминированный потенциал экспорта) по г. Барнаулу. В статье обозначены основные проблемы при реализации национального проекта и предложены пути их решения для оптимального развития перспектив малого и среднего бизнеса на территории муниципального образования. Данные предложения могут служить основой развития малого и среднего предпринимательства для повышения уровня жизни населения каждого региона России.

В целях реализации достижения наилучших результатов путем выполнения индикаторов национального проекта «Малое и среднее предпринимательство» предложено в плановом порядке организовывать выставочно-ярмарочные мероприятия товаров местных производителей. Это особенно актуально в текущем периоде экономического развития страны.

Ключевые слова: *малое и среднее предпринимательство, город Барнаул, национальный проект, муниципальная программа*

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Об авторах: **Королева Ольга Николаевна** — магистрант; **Алтайский государственный университет (АлтГУ)**; 656049, г. Барнаул, пр-т Ленина, д. 61; ведущий специалист отдела бюджетного прогнозирования и финансирования подведомственных учреждений планирования и финансового управления; **Министерство социальной защиты Алтайского края**; 65605, г. Барнаул, ул. Партизанская, д. 69; olg4.koroleva@yandex.ru;

Королева Елена Николаевна — доцент кафедры региональной экономики и управления; **Алтайский государственный университет (АлтГУ)**; 656049, г. Барнаул, пр-т Ленина, д. 61; korka9919@mail.ru;

Сперанская Наталья Юрьевна — директор Института биологии и биотехнологии; **Алтайский государственный университет (АлтГУ)**; 656049, г. Барнаул, пр-т Ленина, д. 61; speranskaj@mail.ru.

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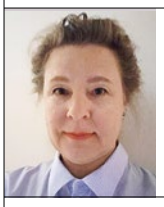
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D'yachkova O.N.

The territory of the republic of Sakha (Yakutia): a review of the environmental resource

The author has reviewed the indicators characterizing the environmental situation in the Republic of Sakha (Yakutia) and its districts. The indicators include land management, areas of territories, population size and density, car density, the impact of economic activities on natural water bodies and atmosphere air, production and consumer waste management, areas of forest reserves and specially protected natural areas (PNA), investments into environmental protection and rational use of natural resources, and the operating costs of environmental protection. The author applied the system analysis of statistical information and textual methods of extracting knowledge from specialized literature. The author employed sampling and analysis of indicators comprising the index of the quality of urban environment in each city and town of the Republic of Sakha (Yakutia) in 2018–2020. The information about the environment of the Republic of Sakha (Yakutia) and its districts, if taken in aggregate, allows analyzing its environmental resource, the impact on natural constituents of the environment, as well as conducting a comparative analysis with other items, taking into account the availability of forest lands and protected natural areas.
Keywords: *sustainable development, environmental safety, environmental protection, urban economy, specially protected natural area, indicator, ecology, Urban Environment Quality Index*



D'yachkova Ol'ga Nikolaevna,
Candidate of Technical Sciences, Associate Professor, Associate Professor of the Department of Construction Technology; Saint Petersburg State University of Architecture and Civil Engineering (SPbGASU); 4 Vtoraya Krasnoarmeiskaya St., Saint Petersburg, 190005, Russian Federation; ID RISC: 750897, ORCID: 0000-0003-0605-0343; dyachkova_on@mail.ru

The ecological system of an urbanized area evolves under the influence of natural and anthropogenic factors [1–3]. Retrospective and predictive analyses of these impacts and methods of their minimization are relevant for the sustainable development of areas [4, 5]. Given the concentration of economic activities, the density of urban and rural population, as well as harsh environmental conditions in the Republic of Sakha (Yakutia), environmental sustainability of districts is an important factor of the quality of life [6, 7], including urban landscaping coupled with digital transformation and simulation of the urban economy towards the optimal development of urban areas [8–10]. Natural green spaces make populated areas attractive; they include forests, specially protected natural areas, and green planted areas [11–13].

For the purpose of the article, a set of environmental parameters, presented in annual statistics reports, was studied [1, 2, 3].

The Republic of Sakha (Yakutia) is located in the north-east of Russia; its territory occupies 1/5 of the country and 50 % of the Far Eastern Federal District. The northern part of the republic is located in the Arctic zone; its central part is located in the subarctic (continental) climate zone, and its southern part is located in the temperate, or continental, zone (Fig. 1). In the areas of extreme continental climate, the difference in air temperatures reaches 100 °C, from +40 °C in summer to –60 °C in winter. The cold pole of the northern hemisphere is located in Oymyakon.

The population of the Republic of Sakha (Yakutia) is 982.0 thousand people, of which the rural population is 330.9 thousand people (as of January 1, 2021). The population density is 0.32 residents/km^2.

As of 2019, its GRP amounted to 1,220.3 billion rubles; its GRP per capita reached 1,258.7 thousand rubles.

The republic has one urban district, that is, the city of Yakutsk, and 34 districts (Fig. 2).

The environmental situation in the Republic of Sakha (Yakutia) is being monitored: a set of indicators and their dynamics are regularly monitored; problems are studied and solutions are developed [14] (Fig. 3).

Republican land resources (308,352 thousand hectares) are divided into the following categories (Fig. 4):

- agricultural land (19,446.6 thousand hectares),
- land of settlements (231.1 thousand hectares),
- industrial and other special-purpose categories of land (139.1 thousand hectares),
- protected natural area (PNA) (12,996.9 thousand hectares),
- forest land (252,818.9 thousand hectares),
- waters (2,136.0 thousand hectares),
- reserve land (20,583.7 thousand hectares).

The share of urban settlements in the total area of settlements is 39.7 %, while the share of rural settlements is 60.3 %. Within the boundaries of cities, towns and rural settlements, the area of agricultural land occupies 31.6 %, built–up areas — 25.9 %, forests and shrubs — 18.4 %, water bodies — 5.1 %, roads — 3.3 %, swamps — 2.7 %, disturbed lands — 0.7 %, other areas — 12.3 %.

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Fig. 1. The Republic of Sakha (Yakutia) on the map of Russia: 8 — the Arctic zone of the republic consisting of Abysky, Allaikhovsky, Anabar, Bulunsky, Verkhnekolymsky, Verkhoyansky, Zhigansky, Momsky, Nizhnekolymsky, Oleneksky, Srednekolymsky, Ust-Yansky and Even-Bytantaysky districts



1	Abysky
2	Aldan
3	Allaikhovsky
4	Amginsky
5	Anabar
6	Bulunsky
7	Verkhnevilyuysky
8	Verkhnevilymsky
9	Verkhoyansky
10	Vilyuysky
11	Gorny
12	Zhigansky
13	Kobyaysky
14	Lensky
15	Megino-Kangalassky
16	Mirninsky
17	Momsky
18	Namsky
19	Neryungrinsky
20	Nizhnekolymsky
21	Nyurbinsky
22	Oymyakonsky
23	Oleneksky
24	Olekminsky
25	Srednekolymsky
26	Suntarsky
27	Tattinsky
28	Tomponsky
29	Ust-Aldan
30	Ust-Maysky
31	Ust-Yansky
32	Khangalassky
33	Churapchinsky
34	Eveno-Bytantaysky
35	Gorod Yakutsk

Fig. 2. Districts of the Republic of Sakha (Yakutia)

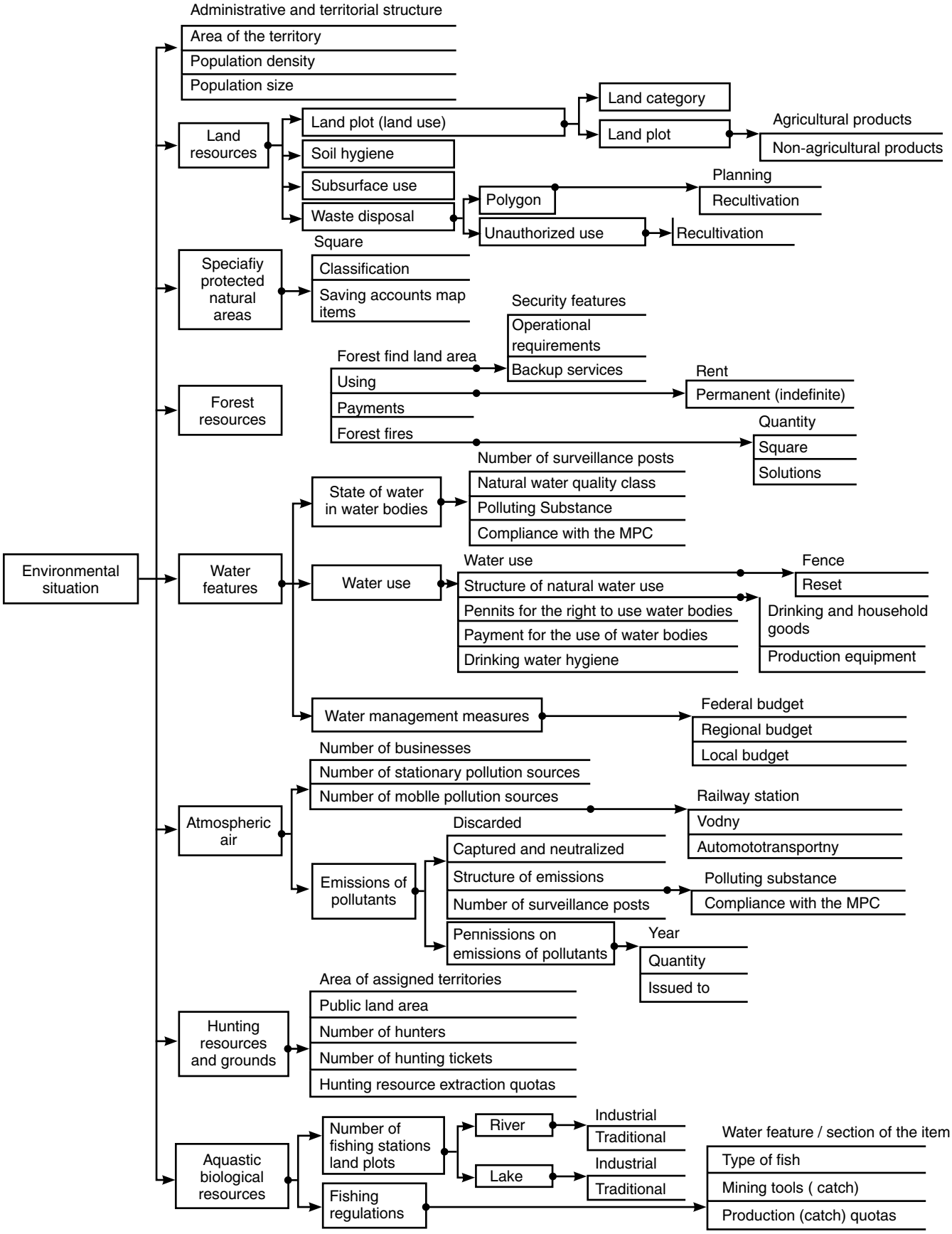


Fig. 3. The block scheme of parameters characterizing the environmental situation in the Republic of Sakha (Yakutia)

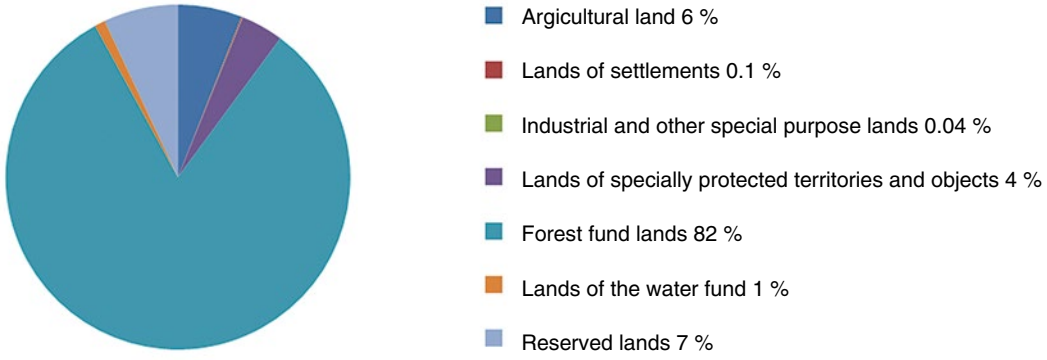


Fig. 4. Categories of land in the Republic of Sakha (Yakutia)

The atmosphere air is monitored at 7 stations in 4 cities of the Republic of Sakha (Yakutia). In 2020, total emissions reached 298.0 thousand tons which was 1.6 thousand tons less than in 2019.

The amount of emissions from stationary sources (288,190 thousand tons in 2019; 286,319 thousand tons in 2020) is largest among the subjects of the Far Eastern Federal District. Compared to 2019, emissions were down by 0.6 %. In 2019, the share of emissions in five large industrial centres was 67.7 %; in 2020, it reached 67.2 % of total emissions in the republic. The largest portion of emissions is attributed to the Mirninsky district (40.7 % in 2019; 28.2 % of the total emissions in the republic in 2020), Neryungrinsky district (9.4 % in 2019; 12.6 % in 2020), Lensky district (9.1 % in 2019; 16.9 % in 2020) and Aldansky district (4.5 % in 2019; 6.0 % in 2020). In Yakutsk, atmospheric emissions were 3.9 % in 2019, and 3.3 % in 2020.

In 2020, atmospheric emissions from mobile sources reached 11.65 thousand tons, including motor transport emissions that reached 10.66 thousand tons, and railroad transport emission of 0.99 thousand tons. In 2016, 318,968 motor vehicles were registered in the republic; 319,585 units were registered in 2017; 322,949 units in 2018; 325,859 units in 2019, 326,573 units in 2020 (Table 1). Road transport emissions rose by 0.2 thousand tons compared to 2019, although they were 8 times smaller than in 2010.

In 2020, the amount of fresh water taken from natural water bodies was 7 % less than in 2010; in 2019, the difference was mere 1 % in Sakha (Yakutia). The total intake of fresh water in 2019 amounted to 211.35 million m^3; in 2020 it was 203.77 million square meters. The percent of water taken from natural surface water bodies was 67.81 % / 68.89 %, and the percent of water taken from natural underground sources was 32.19 % / 31.11 %, respectively. Household and drinking water use decreased by 8.48 % compared to 2019. As for agricultural water, its consumption went down by 23.08 %, while water consumption for production needs increased by 0.18 %. In 2020, water recycling and re-supply (1,300.97 million m^3) exceeded the figures of 2019 by 33.86 million square meters. In 2020, water consumption was maximal in Mirninsky district (22.64 % of total consumption in the republic), Neryungrinsky district (19.05 %), Megino-Kangalassky district (12.23 %), Yakutsk (13.64 %), Lensky (8.39 %) and Aldansky (6.67 %) districts. The basins of the Lena, Vilyu and Aldan rivers are the largest containers of fresh water in the republic. Household water consumption per capita plummeted from 55.9 million square meters in 2010 to 34.9 million square meters in 2020.

In 2020, the water disposal rate was 3.5 % smaller than in 2019 and 8.1 % higher than in 2010. In 2020, the wastewater discharge into surface water bodies (151,94 million m^3) was down by 5.52 million cubic meters compared to 2019. The following types of wastewater are identified according to the degrees of contamination: insufficiently treated wastewater — 47.25 %, standard clean wastewater (untreated) — 48.20 %, contaminated untreated wastewater — 1.63 %, standard treated wastewater — 2.92 %. In 2020, the amount of contaminated wastewater, discharged without treatment (2,48 million m^3), was 8.1 % smaller than in 2019 and 75.0 % smaller than in 2010. In 2020, the amount of contaminated and insufficiently treated wastewater, discharged into water bodies (71.80 million cubic meters) was 10.9 % smaller than in 2019 and 5.4 % smaller than in 2010. 86.4 % of wastewater discharged into surface water bodies is generated in Mirninsky district (18.62 % of the total discharge), Ust-Maysky district (16.92 %), Neryungrinsky district (16.75 %), Yakutsk (14.89 %), Megino-Kangalassky district (14.82 %), Aldansky (4.4 %) district, respectively. The largest amount of polluted water was discharged into the basins of the Lena (70.63 million m^3), Aldan (37.87 million m^3), Vilyu (11.28 million m^3) and Indigirka (1.46 million m^3) rivers.

In 2020, same as before, the Republic of Sakha (Yakutia) was the largest generator of waste among the subjects of the Far Eastern Federal District. Waste generation has not changed compared to 2019, but it is 4.3 times higher than in 2010 (124,457 million tons). The amount of waste decreased by 6 % compared to 2019 (280,777 million tons), but it exceeds the 2010 figures more than 8 — fold (31.39 million tons). In 2020, the value of the waste storage index exceeded that of 2010 (112,249 million tons) by 26,277. In 2020, the amount of waste went up 1.5-fold in comparison with 2010 (87,358 million tons). The amount of neutralized waste was up 220-fold in comparison with 2010 (0,006 million tons). The total amount of municipal solid waste reached 0,348 million tons. The structure of waste management is shown in Fig. 5.

Given their economic and environmental significance, forests, located on the forest land, are divided into protective forests — 33 million hectares, operational forests — 95 million hectares and reserve forests — 127 million hectares. In the republic, forests are located not only on forest lands, but also on the lands belonging to other land categories, including lands of settlements (0.03 million hectares) and PNA lands (1 million hectares). As the time progresses, the area of forest lands gets smaller due to conversion of its parts into lands of other categories. 50.7 % of the republic's territory is covered with forests.

Table 1. The number of motor vehicles registered in the Republic of Sakha (Yakutia)

Number	District	Population in 2020, thousand persons		Number of motor vehicles, items				
		urban	rural	2016	2017	2018	2019	2020
1	Abyysky	1,973	1,943	415	426	436	436	436
2	Aldansky	34,859	3,957	13,980	13,766	13,800	14,008	14,013
3	Allaikhovsky	2,111	0,615	349	391	369	375	375
4	Amginsky	–	16,855	3,126	3,222	3,367	3,425	3,419
5	Anabar	–	3,672	480	508	522	532	527
6	Bulunsky	4,745	3,756	473	521	524	533	523
7	Verkhneviluysky	–	21,180	3,777	3,845	3,837	3,887	3,852
8	Verkhnekolymsky	2.68	1,304	430	454	497	504	488
9	Verkhoyansky	4,752	6,237	1,066	1,208	1,127	1,146	1,127
10	Vilyuysky	13,982	11,125	5,865	5,886	6,030	6,099	5,991
11	Gorny	–	12,264	3,363	3,520	3,577	3,613	3,549
12	Zhigansky	–	4,179	431	431	502	518	516
13	Kobyaysky	3,538	8,537	3,134	3,178	3,278	3,305	3,287
14	Lensky	31,767	4,694	20,862	20,991	21,344	7,133	21,406
15	Megino-Kangalassky	4,387	27,011	12,424	12,434	12,682	21,568	12,654
16	Mirninsky	69,524	2,374	43,681	43,965	44,371	44,600	44,600
17	Momsky	–	4,051	450	386	502	12,778	527
18	Namsky	–	25,094	6,034	6,084	6,111	540	6,145
19	Neryungrinsky	73,794	1,107	28,606	28,803	29,041	6,183	29,560
20	Nizhnekolymsky	2,514	1,714	498	491	552	584	592
21	Nyurbinsky	9,761	13,982	6,977	7,149	7,089	2,916	6,951
22	Oymyakonsky	5,065	2,791	2,774	2,537	2,858	3,998	3,260
23	Oleneksky	–	4,326	400	350	419	9,539	443
24	Olekminsky	9,102	15,290	3,869	3,875	3,971	425	3,972
25	Srednekolymsky	3,470	3,842	537	496	563	562	587
26	Suntarsky	–	23,680	6,264	6,076	6,319	6,374	6,430
27	Tattinsky	–	16,271	4,663	4,679	4,716	4,754	4,795
28	Thomponsky	7,176	5,407	3,701	3,300	3,776	3,818	3,908
29	Ust-Aldansky	–	20,515	2,642	2,647	2,840	2,878	2,940
30	Ust-Maysky	5,222	2,041	1,525	1,425	1,631	1,658	1,685
31	Ustyansky	3,862	3,173	2,276	2,055	2,347	2,381	2,464
32	Khangalassky	15,660	17,361	9,244	9,230	9,493	5,298	9,536
33	Churapchinsky	–	21,107	5,093	5,115	5,223	29,415	5,185
34	Even-Bytantaysky	–	2,879	287	285	307	307	364
35	Yakutsk	341,126	16,567	119,272	119,818	118,928	119,769	120,755

The system of specially protected natural areas in the Republic of Sakha (Yakutia) is a regional constituent of the PNA network in Russia. As of 01.01.2021, dimensions of PNA reach 1,166,720 km², and it occupies 37.85 % of the region's territory (Fig. 6). If compared to the 2019 figures, the area of PNA of regional and local significance has increased by 52.9 thousand hectares.

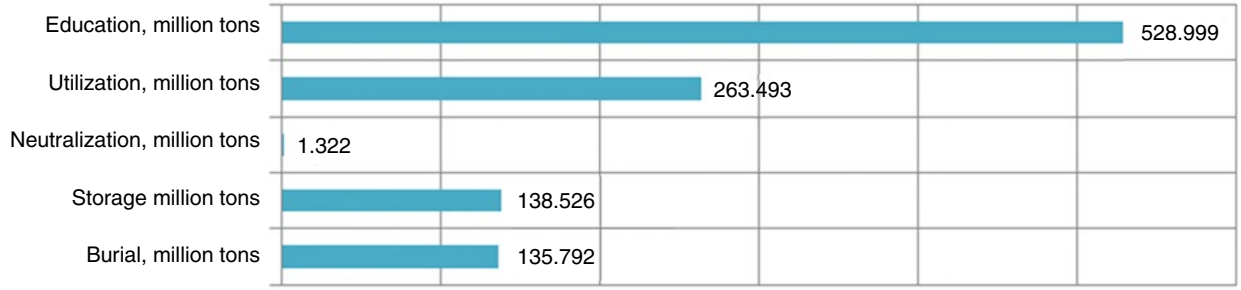


Fig. 5. The structure of waste management in the Republic of Sakha (Yakutia) in 2020

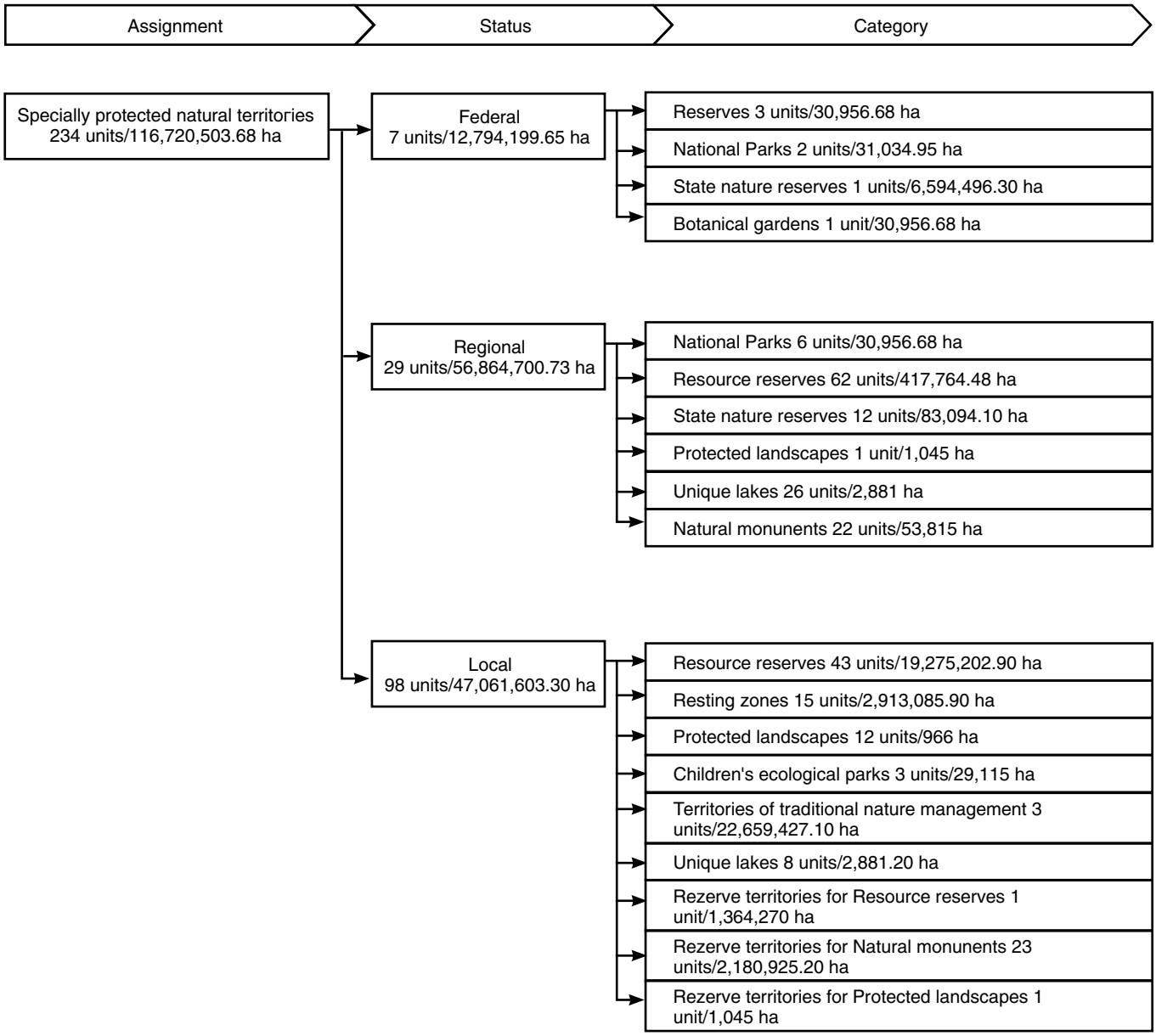


Fig. 6. The structure and composition of protected areas in the Republic of Sakha (Yakutia)

PNAs preserve the species, ecosystems, landscapes and the geographical diversity of the region; it protects the habitats of 134 species of animals and 337 species of plants listed in the Red Books of the Russian Federation and the Republic of Sakha (Yakutia). The PNA of the Aby ulus occupies 24.01 % of its territory, Aldansky ulus — 29.1 %, Allaikhovsky ulus — 41.3 %, Amginsky ulus — 25.3 %, Anabar ulus — 89 %, Bulunsky ulus — 47.4 %, Verkhneviluysky ulus — 23.3 %, Verkhnekolymsky ulus — 34.5 %, Verkhoyansky ulus — 18.2 %, Vilyuysky ulus — 26.9 %, Gorny ulus — 33.9 %, Zhigansky ulus — 35.07 %, Kobyai ulus — 23.3 %, Lena ulus — 19.6 %, Megino-Kangalassky ulus — 20.2 %, Mirninsky ulus — 18.3 %, Momsky ulus — 34.6 %, Namsky ulus — 13.2 %, Neryungrinsky ulus — 22.9 %, Nizhnekolymsky ulus — 48.3 %, Nyurbinsky ulus — 23.5 %, Oymyakonsky ulus — 16.2 %, Oleneksky ulus — 36.7 %, Olekminsky ulus — 16.6 %, Srednekolymsky ulus — 22.8 %, Suntarsky ulus — 29.2 %, Tattinsky ulus — 37.8 %, Tomponsky ulus — 31.9 %, Ust-Aldansky ulus — 30.8 %, Ust-Maysky ulus — 28.8 %, Ust-Yansky ulus — 22.2 %, Khangalassky ulus — 60.8 %, Churapchinsky ulus — 20 %, Evenо-Bytantaysky ulus — 21.3 %, Yakutsk — 25.7 %.

Table 2 shows dimensions of protected areas and the population of districts in the republic.

Table 2. Socio-ecological indicators of districts in the Republic of Sakha (Yakutia)

Number	District	Area, thousand sq. km	Population, residents	Population density, persons/sq. km	Forest area, million hectares	PNA area, hectares
1	Abyysky	69.4	3,916	0,056	6.7	1,666,300
2	Aldansky	156.8	38,816	0.25	15.56	4,562,611
3	Allaikhovsky	107.3	2,726	0,025	2.28	4,430,836
4	Amginsky	29.4	16,855	0.57	2.81	74,430.8
5	Anabar	55.6	3,672	0,066	0.45	4,840,562
6	Bulunsky	55.6	8,501	0.15	9.0	10,615,755.3
7	Verkhneviluysky	42.0	21,180	0.5	3.8	978,391
8	Verkhnekolymsky	67.8	3,984	0.06	6.6	2,340,717
9	Verkhoyansky	134.1	10,989	0,082	5.1	2,442,274
10	Vilyuysky	55.2	25,107	0.45	5.1	1,486,253
11	Gorny	45.6	12,264	0.27	4.4	1,535,890
12	Zhigansky	140.2	4,179	0.03	13.7	4,915,022
13	Kobyaysky	107.8	12,075	0.1	10.2	2,515,347
14	Lensky	77.0	36,461	0.47	7.4	1,511,704
15	Megino-Kangalassky	11.7	31,398	2.68	0,923	237,169
16	Mirninsky	165.8	71,898	0.4	16.03	3,035,660
17	Momsky	104.6	4,051	0.04	10.4	3,620,388
18	Namsky	11.9	25,094	2.1	0.93	157,381
19	Neryungrinsky	98.9	74,901	0.76	11.67	2,272,465
20	Nizhnekolymsky	87.1	4,228	0.05	1.8	4,206,163.86
21	Nyurbinsky	52.4	23,743	0.45	4.88	1,233,932
22	Oymyakonsky	92.2	7,856	0.09	8.9	1,497,910
23	Oleneksky	318.1	4,326	0.01	29.3	11,665,180
24	Olekminsky	160.8	24,392	0.15	13.1	2,669,841
25	Srednekolymsky	125.2	7,312	0.1	12.2	2,859,772
26	Suntarsky	57.8	23,680	0.4	5.3	1,687,669
27	Tattinsky	19.0	16,271	0.9	1.7	717,897
28	Thomponsky	135.8	12,583	0.1	12.86	4,335,896
29	Ust-Aldansky	18.3	20,515	1.1	1.6	564,638
30	Ust-Maysky	95.3	7,263	0.08	9.3	2,748,589
31	Ustyansky	120.3	7,035	0.06	3.7	2,676,399
32	Khangalassky	24.7	33,021	1.3	1.8	1,503,490
33	Churapchinsky	12.6	21,107	1.7	1.06	252,025
34	Even-Bytantaysky	55.6	2,879	0.05	5.1	1,183,906
35	City of Yakutsk	3.6	357,693	94.4	0.26	92,565

The amount of investments into environmental protection and rational use of natural resources reached 4,188,735 thousand rubles, operating environmental protection costs for the same year were 10,574,974 thousand rubles. The share of waste management costs was the largest one (Fig. 7).

The quality of urban environments has been regularly analyzed by the Ministry of Construction, Housing and Utilities of the Russian Federation. The quality index of the urban environment is published each year. In 2018–2020, the index was calculated for the 13 cities of the Republic of Sakha (Yakutia), including one large city (250 thousand – 1 million residents), 1 medium size town (50–100 thousand residents) and 11 small towns (25–50 thousand residents, 5–25 thousand residents and less than 5 thousand residents) (Table 3). Here is the breakdown of the cities by the number of residents: over 50 thousand — Yakutsk and Neryungri, 10 to 50 thousand — Mirny, Lensk, Aldan, Udachny and Vilyuysk, 5 to 10 thousand — Nyurba, Pokrovsk, Olekminsk and Tommot, 1 to 5 thousand — Srednekolymsk and Verkhoyansk. All cities of the region are located in the conventionally severe climate zone pursuant to the Method[4] that takes account of the influence of climate features on urban environments.

Hence, some environmental indicators of the Republic of Sakha (Yakutia) and its districts, presented in the article, characterize the anthropogenic loads on its natural water bodies and atmosphere air, as well as local compensatory factors, such as forest lands and PNA.

In the Republic of Sakha (Yakutia), The largest area is occupied by the Oleneksky district (318.1 thousand km^2).

The maximum population density is in the city of Yakutsk (94.4 residents/km^2).

The maximum population is in the city of Yakutsk (357,693 thousand residents). The maximum number of rural residents is in the Megino-Kangalassky district (27,011 thousand residents).

In the Mirninsky district, atmosphere air (emissions from stationary sources in 2019 — 117,512 thousand tons; in 2020 — 80,925 thousand tons) and water bodies (in 2020, water consumption was 46.13 million m^3; wastewater discharges into surface water bodies was 28.29 million m^3) are subjected to the maximum anthropogenic load. The maximum number of motor vehicles is registered in the city of Yakutsk (120,755 units).

The largest areas of the forest land (29.3 million hectares) and PNA (11,665,180 hectares) are in the Oleneksky district.

The data submitted by all cities of the republic were used to calculate the urban environment quality index for 2018–2020. Udachny, Neryungri and Yakutsk scored more than half of the maximum number of points in terms of three of six types of urban spaces evaluated to calculate the index. The Republic of Sakha (Yakutia) is one of the largest regions of Russia in terms of forest areas; however, out of 13 cities, only Yakutsk scored more than half of the maximum number of points when green spaces were assessed. Highest quality areas are concentrated in the Lensky, Olekminsky, Ust-Maysky and Aldansky districts. About 90 % of forests have Dahurian larch, pine, cedar, spruce, birch and aspen[5].

Table 3. Urban environment quality index of the cities of the Republic of Sakha (Yakutia)[5]

District	Urban population, thousand residents	Year	ST, score						Index, score
			ST_1	ST_2	ST_3	ST_4	ST_5	ST_6	
Aldansky	Tommot 6.7	2018	8	13	12	12	8	31	84
		2019	13	22	10	10	15	31	101
		2020	14	26	11	13	18	33	115
	Aldan 20.4	2018	24	26	16	17	21	23	127
		2019	18	26	17	16	18	22	117
		2020	18	31	16	15	20	22	122
Verkhoyansky	Verkhoyansk 1.1	2018	16	22	2	16	7	14	77
		2019	18	23	9	13	15	23	101
		2020	17	26	12	15	19	27	116
Vilyuysky	Vilyuysk 11.3	2018	20	21	9	11	9	15	85
		2019	19	25	8	12	8	23	95
		2020	19	25	8	20	9	27	108
Lensky	Lensk 23.3	2018	26	23	17	13	17	29	125
		2019	25	27	14	13	15	30	124
		2020	22	19	15	22	18	31	127
Mirninsky	Udachny 12.2	2018	37	17	17	12	14	37	134
		2019	39	25	15	11	10	35	135
		2020	31	31	15	15	14	35	141
	Mirny 35.4	2018	24	22	13	16	20	32	127
		2019	23	26	12	16	21	33	131
		2020	20	25	13	23	22	34	137
Neryungrinsky	Neryungri 59.0	2018	32	18	18	29	31	34	162
		2019	41	22	16	22	23	32	156
		2020	42	27	24	28	27	33	181

4 Method of calculation of the urban environment quality index, approved by the Decree of the Government of the Russian Federation dated March 23, 2019. No. 510-r.

5 Urban Environment Quality Index. URL: https://xn----dtbcccdtsypabxk.xn--p1ai/#/regions/483 (access date: 19.03.2022).

End of the Table 3

District	Urban population, thousand residents	Year	ST, score						Index, score
			ST_1	ST_2	ST_3	ST_4	ST_5	ST_6	
Neryungrinsky	Neryungri 59.0	2018	32	18	18	29	31	34	162
		2019	41	22	16	22	23	32	156
		2020	42	27	24	28	27	33	181
Nyurbinsky	Nyurba 9.8	2018	19	16	15	14	11	22	97
		2019	17	19	14	17	10	31	108
		2020	17	28	14	18	16	36	129
Olekminsky	Olekminsk 9.1	2018	13	25	15	17	9	20	99
		2019	14	28	12	17	9	24	104
		2020	18	30	12	21	15	24	120
Srednekolymsky	Srednekolymsk 3.5	2018	13	33	7	16	16	23	108
		2019	14	27	7	18	19	27	112
		2020	14	28	9	22	20	25	118
Khangalassky	Pokrovsk 9.5	2018	21	21	14	14	13	15	98
		2019	21	24	12	12	12	24	105
		2020	19	26	13	17	14	25	114
City of Yakutsk	Yakutsk 330.6	2018	25	23	27	24	20	28	147
		2019	23	20	21	22	16	31	133
		2020	26	29	31	30	26	39	181

The following abbreviations are used in the table: ST — type of urban space, ST_1 — housing and adjacent spaces, ST_2 — street and road network, ST_3 — green spaces, ST_4 — public and business infrastructure and adjacent spaces, ST_5 — social and leisure infrastructure and adjacent spaces, ST_6 — urban space, Index — Urban Environment Quality Index.

Symbols:

14	Scored less than half of the maximum number of points
39	Scored more than half of the maximum number of points

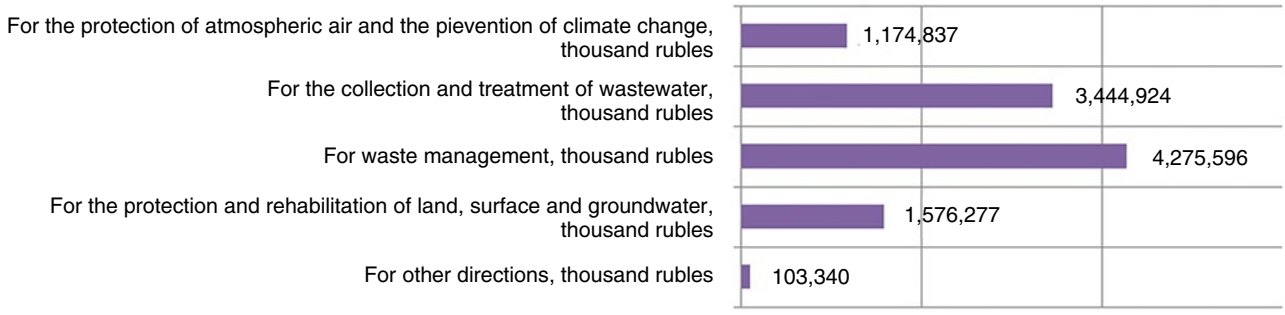


Fig. 7. The structure of operating environmental protection costs in the Republic of Sakha (Yakutia)

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Экологический ресурс территории республики Саха (Якутия): обзор

Выполнен обзор показателей, характеризующих состояние экологической обстановки в республике Саха (Якутия) и ее районах, в том числе рассмотрены землеустройство, площади территорий, численность и плотность населения, обеспеченность жителей автомототранспортными средствами, нагрузки от хозяйственной деятельности на природные водные объекты и атмосферный воздух, структура обращения с отходами производства и потребления, площади лесного фонда и особо охраняемых природных территорий, объем инвестиций, направленных на охрану окружающей среды и рациональное использование природных ресурсов, текущие (эксплуатационные) затраты на охрану окружающей среды. Использованы системный анализ статистической информации и текстологические методы извлечения знаний из специальной литературы. Разработана интеллект-карта некоторых характеристик состояния экологической обстановки на территории республики Саха (Якутия). Проведена выборка и анализ показателей индекса качества городской среды для всех городов республики за период 2018–2020 гг. Рассмотренные аспекты экологической информации по республике Саха (Якутия) и по районам в комплексе позволяют анализировать экологический ресурс их территорий, влияние на природные объекты окружающей среды, а также проводить сравнительный анализ с другими субъектами, учитывая наличие сохраненного лесного фонда и охраняемых природных территорий и объектов.

Ключевые слова: *устойчивое развитие, экологическая безопасность, охрана окружающей среды, городское хозяйство, особо охраняемая природная территория, показатель, экология, индекс качества городской среды*

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Об авторе: **Дьячкова Ольга Николаевна** — кандидат технических наук, доцент, доцент кафедры технологии строительного производства; **Санкт-Петербургский государственный архитектурно-строительный университет (СПбГАСУ)**; 190005, г. Санкт-Петербург, ул. 2-я Красноармейская, д. 4; РИНЦ ID: 750897, ORCID: 0000-0003-0605-0343; dyachkova_on@mail.ru.

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Volkov R.V.

Russian universities: analysis of structural changes, challenges and development trends

The higher education system of the Russian Federation has undergone significant changes over the past 15 years, and the President of the Russian Federation has set ambitious university development goals: by 2030, world-class scientific, educational and research centres are to be established (Instruction of the President No. Pr-589, 1a dated March 28, 2020), a network of modern campuses is to be set up and university dormitories are to be constructed, overhauled or reconstructed (Instruction of the President No. Pr-419 1g, z dated March 17, 2021).
Starting this year, an increase in the number of students at the Russian universities is projected, which is primarily related to demographic indicators.
The article analyzes changes in the structure of Russian universities and suggests development forecasts, classifies the universities depending on the organizational form and categories, founders and subordination, involvement in the ongoing projects and programmes. The development trends of the universities, both private and public, their assets are outlined. The case of the Russian University of Transport illustrates the existing challenges and trends in the development of the state university related to the university's asset complex.
Keywords: *higher education, classification of universities, university assets, depreciation*



Volkov
Roman Vyacheslavovich,
Candidate of Economic Sciences, First Vice Rector; Russian University of Transport (RUT); bldg. 9, 9 Obraztsova St., GSP-4, Moscow, 127994, Russian Federation; ID RISC: 872062; volkov-su4@mail.ru

INTRODUCTION

As of 2021, the higher education system of the Russian Federation has encompassed 803 universities; they have 4,044 thousand students and about 165 thousand cadets of law enforcement structures.

Higher education aims to ensure the training of highly qualified personnel in all major areas of socially useful activities meeting the needs of society and the state, to fulfill the needs of a person in intellectual, cultural and moral development, to deepen and expand education, scientific and pedagogical qualifications[1].

Graduates of institutions of general secondary education are allowed to master higher education programmes. It takes 11 years to complete general secondary education in Russia. Thus, the majority of students of higher education institutions are aged from 18 to 22 years (more than 62 % of the total number of students in 2020 and 2021).

Having studied the statistical data on the 2020 population of the Russian Federation[2], as well as the data on the number of students of higher education institutions in 2005–2021[3, 4], we provide summarized information in Table 1.

Columns 1, 2 show statistical data on the population aged 0 to 37 years. Columns 3, 4 contain relevant data on the population aged 18 to 22 years in 2020, and forecasted from 2005 to 2038, with no adjustment for a possible decline and increase in population (mortality, migration). Column 5 has relevant data on the number of students of higher educational institutions in 2005–2021, and a forecast for 2022–2038, equal to the multiplication of the population aged 18–22 years (column 3) by the involvement rate obtained by dividing the number of students by the population aged 18 to 22 years, and equal to 0.6 (column 6).

Having studied Table 1, we can draw the following conclusions:

- for the period from 2005 to 2021, there was a decrease in the population aged 18 to 22 years by 45 % (from 12,611.5 to 6,899.0 thousand people), which affected a 42 % decrease in the number of students of higher educational institutions (from 7,064.6 to 4,044.2 thousand);
- not more than 60 % of school graduates, aged 18 to 22 years, enter higher education institutions;
- as of 2022, a gradual increase in the population aged 18 to 22 years and students entering higher education institutions is projected; by 2034, the population aged 18 to 22 years will reach about 9,577.4 thousand people, which, in turn, will lead to an increase in the number of students by 42 % compared to 2021 (from 4,044.2 to 5,746 thousand people).

The forecast does not take into account migration-related changes, including an increase in the number of students studying at Russian universities within the framework of an admission quota for foreign students. Since March 2022,

1 On Education in the Russian Federation : Federal law of December 29, 2012 No. 273.

2 Statistical bulletin “Population of the Russian Federation as of January 1st, 2021, by gender and age group”. Federal State Statistics Service (ROSSTAT). Moscow, 2021. URL: https://rosstat.gov.ru/compendium/document/13284

3 Form No. VPO-1 “Data on the institutions, performing educational activities for educational programs of the higher education — programs of a bachelor degree, specialist program, Master’s programs”.

4 No. VPO-2 “Data on material, technical and information base, financial and economic activity of the educational organization of the higher education”, the Ministry of Science and Higher Education of the Russian Federation. Statistical data. The higher education. URL: https://minobrnauki.gov.ru/action/stat/highed/?ysclid=l0v60b4apy

Table 1. Various age group in 2020 with the actual and expected data on the number of students[5]

2020		Population (aged 18–22), persons	Years	Number of students, persons	Involvement rate (ratio of student number/population (18–22 years))	
Age (years)	Population, persons					
1	2	3	4	5	6	
1	1,537,954	—	2039	—	—	Expected data
2	1,642,782	—	2038	—	—	
3	1,784,718	8,812,050	2037	5,287,230	0.60	
4	1,909,745	9,203,557	2036	5,522,134	0.60	
5	1,936,851	9,485,642	2035	5,691,385	0.60	
6	1,929,461	9,577,409	2034	5,746,445	0.60	
7	1,924,867	9,430,460	2033	5,658,276	0.60	
8	1,876,485	9,205,039	2032	5,523,023	0.60	
9	1,762,796	8,993,291	2031	5,395,975	0.60	
10	1,711,430	8,736,103	2030	5,241,662	0.60	
11	1,717,713	8,418,165	2029	5,050,899	0.60	
12	1,667,679	8,152,510	2028	4,891,506	0.60	
13	1,558,547	7,943,528	2027	4,766,117	0.60	
14	1,497,141	7,723,483	2026	4,634,090	0.60	
15	1,502,448	7,520,241	2025	4,512,145	0.60	
16	1,497,668	7,349,306	2024	4,409,584	0.60	
17	1,464,437	7,216,664	2023	4,329,998	0.60	
18	1,387,612	7,060,246	2022	4,236,148	0.60	
19	1,364,499	6,899,095	2021	4,044,203	0.59	Actual data
20	1,346,030	6,778,350	2020	4,049,333	0.60	
21	1,336,517	6,752,231	2019	4,068,327	0.60	
22	1,343,692	6,832,414	2018	4,161,672	0.61	
23	1,361,493	7,026,363	2017	4,245,885	0.60	
24	1,444,682	7,277,966	2016	4,399,487	0.60	
25	1,539,979	7,658,399	2015	4,766,479	0.62	
26	1,588,120	8,247,085	2014	5,243,455	0.64	
27	1,724,125	9,004,758	2013	5,691,157	0.63	
28	1,950,179	9,836,361	2012	6,073,900	0.62	
29	2,202,355	10,691,764	2011	6,490,000	0.61	
30	2,371,582	11,518,747	2010	7,049,800	0.61	
31	2,443,523	12,164,844	2009	7,418,800	0.61	
32	2,551,108	12,528,302	2008	7,513,100	0.60	
33	2,596,276	12,668,125	2007	7,461,300	0.59	
34	2,565,813	12,722,681	2006	7,309,800	0.57	
35	2,511,405	12,611,774	2005	7,064,600	0.56	
36	2,498,079	12,318,497	2004	—	—	
37	2,440,201	12,067,020	2003	—	—	

5 Data are provided in the form No. VPO-1 “Data on institutions, performing educational activities through educational programs of higher education: bachelor’s degree programmes, specialist program, master’s programmes”, the data is available on the official site of the Ministry of Science and Higher Education of the Russian Federation. Data are also provided on various age groups and extracted from the statistical bulletin “Population of the Russian Federation by Gender and Age as of January 1, 2021” on the official Rosstat website.

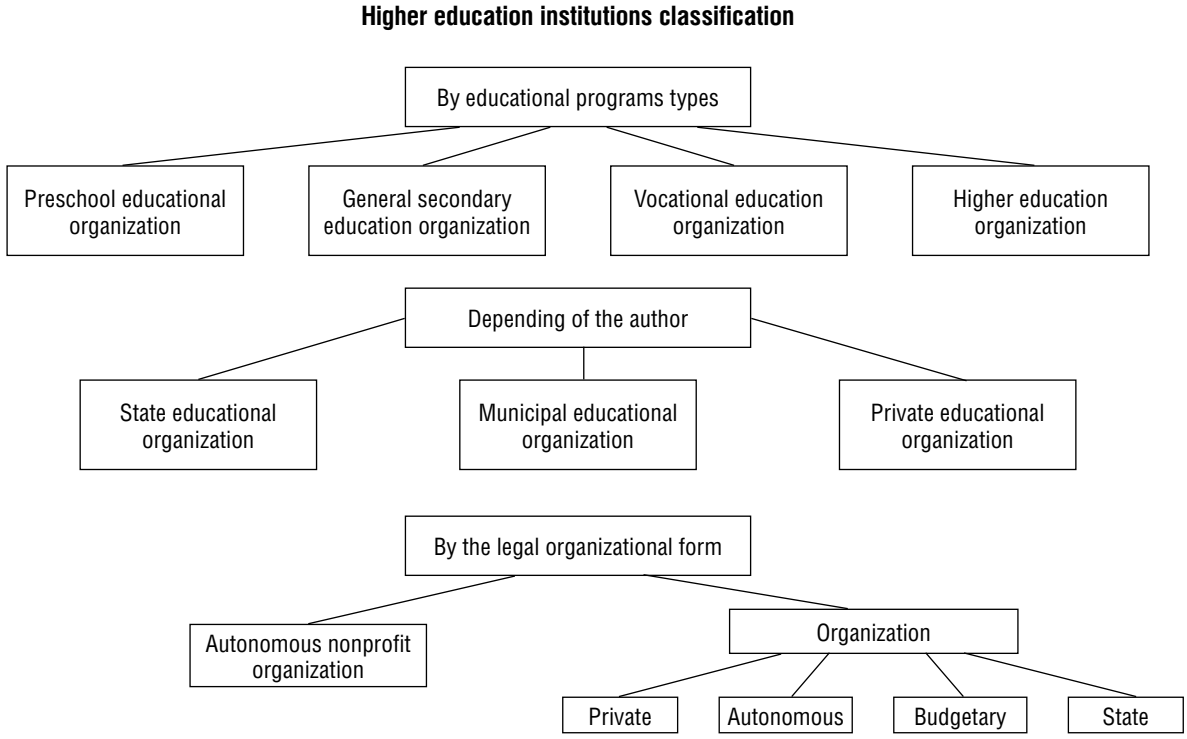


Fig. 1. Classification of the educational institutions

Russian students arriving from abroad, as well as foreign students arriving from the Donetsk People's Republic, Lugansk People's Republic and Ukraine, can continue their studies at the universities of the Russian Federation free of charge within the framework of the foreign student quota[6].

CLASSIFICATION OF UNIVERSITIES

An educational institution is a non-profit organization that carries out educational activities on the basis of a license as the main type of activity[1].

Here is a classification of educational institutions (Fig. 1).

Educational institutions are divided into types according to the educational programmes, the implementation of which is the main purpose of their activities. The following types of educational institutions implementing basic educational programmes are available in the Russian Federation:

1) preschool educational institution is an educational institution that conducts educational activities through educational programmes of preschool education, supervision and care of children as the main purpose of its activity;

2) a general education institution is an educational institution that conducts, as the main purpose of its activities, educational activities through educational programmes of primary general, basic general and (or) secondary general education;

3) a vocational education institution is an educational institution that conducts educational activities through educational programmes of secondary vocational education and (or) vocational training programs as the main purpose of its activity;

4) an educational institution of higher education is an educational institution that conducts educational activities through educational programmes of higher education and research activities as the main purpose of its activity[1].

An educational institution is established in the form set by the civil law for non-profit organizations:

- institutions, which have state institutions, municipal institutions and private (including public) institutions;
- autonomous non-profit organizations.

A non-profit organization is an organization that does not have profit-making as the main goal of its activities and does not distribute its profits among the members[5].

A private educational institution is an educational institution established in accordance with the legislation of the Russian Federation by an individual or individuals and (or) a legal entity, legal entities or their associations, with the exception of foreign religious organizations[1].

A unitary non-profit organization that does not have membership and is established on the basis of property rights of residents and (or) legal entities for the purpose of providing services in the fields of education, health, culture, science and other areas of non-profit activity[7] [6, Article 123.24] is an autonomous non-profit organization.

An institution is a unitary non-profit organization established by the owner to perform managerial, socio-cultural or other non-commercial functions[6].

6 Website of the Ministry Science and Higher Education of the Russian Federation. URL: https://minobrnauki.gov.ru/press-center/news/?ELEMENT_ID=48557&lang=ru&ysclid=l0weai6mbd

7 Civil Code of the Russian Federation.

A private institution is a non-profit organization established by the owner (a citizen or a legal entity) to perform managerial, socio-cultural or other non-commercial functions[8].

An autonomous institution is a non-profit organization established by the Russian Federation, a subject of the Russian Federation or a municipal entity to perform work, provide services for the purpose of exercising the powers of state authorities provided for by the legislation of the Russian Federation, the powers of public authorities in a federal territory, the powers of local self-government bodies in the fields of science, education, health, culture, mass media, social security, employment, physical culture and sports, and also in other areas in cases established by federal laws (including when carrying out activities to work with children and youth in these areas)[9].

A state public institution is a state (municipal) institution that provides state (municipal) services, operates and (or) performs state (municipal) functions to ensure the implementation of the powers of state authorities (state bodies) or local self-government bodies provided for by the legislation of the Russian Federation, the financial support of whose activities is carried out at the expense of the relevant budget based on the budget estimates[7].

A budgetary institution is a non-profit organization established by the Russian Federation, a subject of the Russian Federation or a municipal entity to perform works, provide services to ensure the exercise of the powers provided for by the legislation of the Russian Federation, respectively, of the state authorities (state bodies), public authorities of the federal territory or local self-government bodies in the field of science, education, health, culture, social security, employment of the population, physical culture and sports, as well as in other areas[7].

The analysis of the distribution of higher education institutions by subordination is given in the summary Table 2.

It should be noted that 221 out of 587 state universities are in the jurisdiction of the Ministry of Science and Higher Education of the Russian Federation which makes only 37 % of their total number.

The breakdown of the number of universities by categories and projects is summarized in the Table 3.

The Lomonosov Moscow State University, St. Petersburg State University are the leading classical universities of the Russian Federation. The legal statuses of the Lomonosov Moscow State University and St. Petersburg State University are defined by the Federal law of November 10, 2009 No. 259-FZ “About the Lomonosov Moscow State University and the St. Petersburg State University”.

The Government of the Russian Federation may assign categories of “the federal university” and “the national research university” to higher education institutions. When assigning the category of the “federal university” or “national research university” to an educational institution of higher education, an indication of the assigned category is included in the name of this institution.

To ensure personnel training towards the integrated socio-economic development of the subjects of the Russian Federation, the Government of the Russian Federation may establish an educational institution of higher education in the form of an autonomous institution belonging to the category of a “federal university”. When establishing a federal university, the Government of the Russian Federation takes into account suggestions of the legislative and executive authorities of the subjects of the Russian Federation

Table 2. Distribution of higher education institutions by subordination as of December 31, 2021

Total	803
State organizations	587
In the jurisdiction of federal executive bodies — total	457
Supreme Court of the Russian Federation	1
Ministry of Health of the Russian Federation	47
Ministry of Foreign Affairs of the Russian Federation	2
Ministry of Culture of the Russian Federation (Russian Academy of Arts)	47
Ministry of Science and Higher education of the Russian Federation	221
Ministry of Education of the Russian Federation	33
Ministry of Agriculture of the Russian Federation	54
Ministry of Sport of the Russian Federation	14
Ministry of Transport of the Russian Federation	1
Ministry of Economic Development of the Russian Federation	1
Ministry of Justice of the Russian Federation	1
Government of the Russian Federation	8
Federal Service for Intellectual Property	1
Federal Customs Service	1
Federal Agency for Air Transport	3
Federal Agency for Railway Transport	8
Federal Agency for Sea and Inland Water Transport	5
Federal Agency for Fishery	5
Federal Communications Agency	4
In the jurisdiction of law enforcement ministries and departments — total	86
Ministry of Defence of the Russian Federation	27
Ministry of the Interior of the Russian Federation	20
Ministry of Civil Defense, Emergencies and Disaster Relief of the Russian Federation	6
Federal Penitentiary Service	8
National Guard Troops Federal Service of the Russian Federation	4
Federal Security Service of the Russian Federation	13
Federal Guard Service of the Russian Federation	1
System of the Prosecutor’s Office of the Russian Federation	5
Investigative Committee of the Russian Federation	2
In the jurisdiction of territorial subjects of the Russian Federation and municipalities — total	44
Private organizations	216

Data are provided in the form No. VPO-1 “Data on institutions, conducting educational activities through educational programmes of higher education, including bachelor, specialist and master’s programs from among the programmes listed on the official site of the Ministry of science and higher education of the Russian as of January 1, 2021”. Information on law enforcement agencies is available on the websites of departments and universities.

8 About non-profit organizations : Federal law No. 7 dated January 12, 1996.

9 About autonomous organizations : Federal law No. 174 dated November 3, 2006.

Table 3. Data on the number of universities broken down by categories and projects as of December 31, 2021

Category	The university with a special status	Federal university (2006–2014)	National research university (2008–2011)
	2	10	29
Project	Flagship universities (2016–2017)	Global universities Project 5–00 (2013–2020)	Global universities Priority 2030 (2021–2030)
	33	21	46 (plan–100)

prepared on the basis of programmes for the socio-economic development of the subjects of the Russian Federation.

The category "national research university" is assigned to an educational institution of higher education based on the results of a competitive selection of programmes for the development of higher education institutions aimed at the development of educational and research activities, modernization and improvement of the material and technical base and socio-cultural infrastructure of an educational institution, development of academic mobility of its students, researchers and lecturers, taking into account the contribution of the educational institution into the research and engineering development priorities of the Russian Federation, as well as for the staffing of priority development areas of research, technology, machinery, economics, social security, towards the development and implementation of high technologies[1].

The "Flagship University" project is to establish a regional university through the merger of existing higher educational institutions, towards the development of the subject of the Russian Federation that obtains highly qualified specialists for its local labour market. These specialists will be able to solve relevant problems of the regional economy and implement educational and innovative projects together with the region and its enterprises. Flagship universities are determined by the results of a competitive selection conducted by the expert council of the Ministry of Science and Higher Education of the Russian Federation.

The purpose of the 5–100 project was to maximize the competitive position of a group of leading Russian universities in the global market of educational services and research programmes[10]. The project was implemented within the framework of the Decree of the President of the Russian Federation dated May 7, 2010 No. 599 "On Measures to Implement State Policy in Education and Science", Decree of the Government of the Russian Federation dated October 29, 2012 No. 2006-r "On approving the action plan on the development of leading universities to increase their competitiveness among the world's leading centres for research and education", and Decree of the Government of the Russian Federation dated March 16, 2013 No. 211 "On measures of state support of the leading universities of the Russian Federation to increase their competitiveness among the world's leading scientific and educational centers". The selection of universities was carried out by the Council for Competitiveness Improvement of the Leading Universities of the Russian Federation from among the world's leading scientific and educational centres, whose members were approved by the orders of the Government of the Russian Federation.

The successor of the 5–100 project is the Priority 2030 programme, the purpose of which is to make a large group of universities that will become leaders in generating new research knowledge, technologies and developments to be contributed to the Russian economy and social sector[11]. The programme is implemented pursuant to Decree No. 729 of the Government of the Russian Federation dated May 13, 2021 "On measures to implement the programme of strategic academic leadership Priority–2030".

Certain benefits obtained by a flagship or global university in terms of opportunities associated primarily with additional financing of the activities of such universities from the budget system of the Russian Federation depends on the organizational and legal form and the university category, the founder and subordination of the university to certain state authorities, on the participation of the university in the ongoing projects.

PROBLEMS IN THE OPERATION OF UNIVERSITIES AND DEVELOPMENT OF THE UNIVERSITY ASSET COMPLEX

The state of the university property is of great importance for the university, since it influences the choice of applicants, students, teachers and researchers.

An analysis of the number of universities, their students, and areas of university campuses for the period from 2013 to 2021 is summarized in the Table 4.

Table 4 has proven the following trends the period of 2013–2021:

- a 29 % decrease in the number of students (from 5,691 to 4,044 thousand people), while the student number decrease rate at public universities was 22 % (from 4,755 to 3,699 thousand people), at private universities — 62 % (from 936 to 354 thousand people);
- 26 % reduction in the total number of universities (from 969 to 717) and the downsize of university branch networks by 64 % (from 1,482 to 528), while the reduction rate of public universities was 13 % (from 578 to 501 pcs.), private universities — 45 % (from 391 to 216);
- the total area of university buildings decreased by only 3 % (from 65.2 to 63.2 million m^2), while public universities by 2 % (from 61.9 to 60.8 million m^2), private universities by 29 % (from 3.2 to 2.3 million m^2).

10 Official website of Project 5–100. URL: https://www.5top100.ru

11 Official website of the Priority–2030 Program. URL: https://priority2030.ru

Table 4. Data on the number of universities, students, and the university campuses area, 2013–2021[12, 13]

Years	Number of universities, units				Number of students, thousand persons					Campus area, thousand sq.m				
	Total	Branches	State	Private	Total	State	Share, %	Pivate	Share, %	Total	State	Share, %	Private	Share, %
2013	969	1,482	578	391	5,691	4,755	83.6	936	16.4	N/d	N/d	N/d	N/d	N/d
2014	950	N/d	548	402	5,243	4,402	84.0	841	16.0	N/d	N/d	N/d	N/d	N/d
2015	896	1,079	530	366	4,766	4,061	85.2	705	14.8	65,206	61,911	94.9	3,295	5.1
2016	818	840	502	316	4,399	3,874	88.1	526	11.9	63,738	61,059	95.8	2,680	4.2
2017	766	651	500	266	4,246	3,823	90.0	423	10.0	62,887	60,483	96.2	2,404	3.8
2018	741	596	496	245	4,162	3,783	90.9	379	9.1	63,198	60,926	96.4	2,273	3.6
2019	724	563	495	229	4,068	3,736	91.8	332	8.2	63,452	61,112	96.3	2,340	3.7
2020	710	549	497	213	4,049	3,715	91.7	334	8.3	63,200	60,867	96.3	2,333	3.7
2021	717	528	501	216	4,044	3,690	91.2	354	8.8	N/d	N/d	N/d	N/d	N/d
Growth rate	**26 %**	**64 %**	**13 %**	**45 %**	**29 %**	**22 %**	–	**62 %**	–	**3 %**	**2 %**	–	**29 %**	–

A decline in the population aged 18 to 22 years led to a decrease in the number of students (part 1 of this article), which in turn affected the reduction in the number of universities due to the liquidation of private universities and consolidation of public universities. At the same time, by 2021, the share of state university students had reached 91 % (in 2013 — 83 %), the share of the area of university campuses of state universities reached 96 % (in 2013 — 93 %).

Data on the number of state universities in the context of organizational and legal forms is summarized in the given Table 5.

Analysis of data on the number of state universities in the context of organizational and legal forms allows us to draw the following conclusion: in 2013 to 2021, there was a decrease in the number of state universities due to the mergers and transformations of budgetary institutions (from 514 to 440 units) and state-owned institutions (from 21 to 1 unit), while the number of autonomous institutions has increased from 43 to 57 units, also due to transformation of the organizational and legal form of budgetary and state-owned institutions.

Having studied the data on the use and technical condition of university real estate for the period from 2013 to 2020, we arrange this information in the summary Table 6–8.

Table 5. Data on the number of state universities in the context of organizational and legal forms

Years	Total*	Autonomous organizations	Budgetary organizations	State organizations
2013	578	43	514	21
2014	548	N/d	N/d	N/d
2015	530	52	476	2
2016	502	52	449	1
2017	500	52	446	1
2018	496	50	443	1
2019	495	51	441	1
2020	497	54	441	1
2021	501	57	440	1

* 86 universities of law enforcement departments that have an organizational and legal form state and budgetary institutions are not taken into account

Table 6. Data on use of real estate (for 2020)

Name		Total	Education and laboratory buildings			Dormitories	Other
			Total	Indoor sports facilities	Public catering		
Total	area	63,200,106	41,844,402	2,432,626	1,147,536	15,629,950	5,725,754
	share	100 %	66 %	4 %	2 %	25 %	9 %
Private institutions	area	2,332,789	1,986,363	138,957	62,448	176,392	170,034
	share	100 %	85 %	6 %	3 %	8 %	7 %

12 Form No. VPO-2 “Data on material and information base, financial and economic activity of the educational institution of the higher education” from the official site of the Ministry of Science and Higher Education of the Russian Federation (data on law enforcement departments is not considered).

13 Data are provided by the form No. VPO-1 “Data on the institutions, performing educational activities for educational programs of the higher education – programs of a bachelor degree, specialist program, Master’s programs”.

Table 7. Data on the technical status of real estate, and rented property and the property offered for rent (for 2020)

Name		Total	Rented out	Under repair	In need of repair	Dangerous structures	Rented
Total	area	63,200,106	603,405	1,365,378	12,465,918	563,475	1,528,378
	share	100 %	1 %	2 %	20 %	1 %	2.5 %
Private institution	area	2,332,789	39,954	7,956	800	0	910,463
	share	100 %	1.7 %	0.3 %	0.03 %	0 %	39 %

Table 8. Data on the number of buildings commissioned and in which major repairs were carried out in the period 2001–2020 (for 2020)

Types of the higher education institutions	Total facilities	Commissioned in 2001–2020	Major repairs in 2001–2020	Total of commissioned and with major repairs in 2021–2020	Share
Total	11,334	1,446	4,870	6,316	55 %
State-owned	10,704	1,286	4,556	5,842	54 %
Private	630	160	302	462	73 %

Having analyzed the data for the period from 2013 to 2020, systematized in Table 6–8, the following conclusions can be drawn:

- the asset complexes distribution rates by purpose were approximately at the same level each year, while a significant difference in the provision of dormitories for universities was revealed (the share of dormitories area to the total area of campuses: in general, 25 % for universities, 8 % for private universities);
- the asset complex distribution rates by the technical status were approximately at the same level in each year, with the exception of the university property in need of repair, which increased from 13 % (in 2013) to 20 % (in 2020) largely due to the deterioration of the technical status of the state university asset complexes, in particular, dormitories (in 2020 more than 31 % of the total area of dormitories were subject to major repairs);
- a significant share of the property is rented by private universities — about 39 %, while state universities rent no more than 2.5 %;
- the property complex of private universities is in a better technical condition than the property complex of public universities: private universities have no property in the emergency condition, less than 1 % is under repair and subject to repair; public universities have more than 23 % of similar property; 73 % of private university buildings are in a state of effective operation (the duration of effective operation before major repairs — 20 years according to industry construction standards VSN 58-88 (p)), state universities have only 54 %.

Thus, the following pattern has been established: the share of students studying at state universities increases annually, while the infrastructure status of state universities deteriorates and the "usable" areas that can be involved in the educational process decrease. The projected growth in the number of students in the coming years will require the infrastructure development by state universities.

ANALYSIS OF THE PRINCIPAL TYPE OF ACTIVITY AND THE ASSETS OF THE RUSSIAN UNIVERSITY OF TRANSPORT

Having studied the case of the Russian University of Transport, we will analyze the university assets.

The Russian University of Transport (MIIT) is a leading national transport university, the largest Russian industrial university, a base talent pool for staffing and research support of the transport industry and its development.

The University was founded on June 4 (May 23, old style), 1896, the day when Emperor Nicholas II approved the decision of the State Council to establish the Moscow Engineering School of the Ministry of Railways. In the period from 1998 to 2007, the University repeatedly underwent the procedure of reorganization by joining various educational institutions of the Ministry of Transport of the Russian Federation (later the Federal Agency for Railway Transport).

In 2015, the university was renamed as "The Emperor Nicholas II Moscow State University of Railways" Federal state budgetary educational institution of higher education.

In 2016, the university was transferred to the Ministry of Transport of the Russian Federation, and in 2017 it was renamed as the Federal state budgetary educational institution of higher education "Russian University of Transport". In 2019, the status of the institution was changed from state-funded to autonomous.

The University has one of the largest campuses in Moscow. On the balance sheet of the university there are 108 buildings with a total area of 357.8 thousand m^2. More than 30 thousand students study at the university (as of 1.01.2022).

The results of the inventory of the technical status of the university assets, conducted in 2020, within the framework of which the amount of physical wear was determined in relation to each university building, proved the average amount of physical depreciation of the assets as 42 % (D_{pp}); it was calculated using the formula:

$$D_{pp} = \frac{\sum_{i=1}^{m} D_b \cdot S_b}{S_{pp}},$$

where D_{pp} is the average rate of physical depreciation of assets, %; m is the number of buildings included in a pool of buildings used to determine the physical deterioration of the university assets; D_b is the physical depreciation of a building, %; S_b is the total area of a building, m^2; S_{pp} is the total area of the assets equal to the total area of the buildings, m^2.

Various formulations and methods are used to identify the depreciation of real estate facilities. The degree of loss of initial resistibility is taken as a measure of physical depreciation in quantitative analysis. At the same time, the service life of any building (service life) is always shorter than the period of complete exhaustion of resistibility by the bearing construction (service life limit), the building is never operated until the moment of destruction. In addition to the assessment of physical depreciation, it is important to estimate functional (moral) obsolescence, which is associated with factors of consumer behaviour and demand that have a subjective nature (the degree of compliance of the facility with modern functional requirements, consumer standards, consumer (customer) preferences). External (economic) depreciation is a decrease in the cost of a building due to the negative impact on the facility of changes in its external environment caused by environmental, economic, political, social, urban planning or other external factors [1].

Taking into account the above, the technical status of the university assets, identified using the indicator of "normative physical depreciation" (according to accounting data, amortization is such an indicator) can be pictured in the form of a linear graph (Fig. 2).

The Russian university of transport was not previously included in any of the abovementioned categories, projects, programmes, and it was under the jurisdiction of the Federal Agency for Railway Transport. In this regard, the last targeted infrastructure upgrade was carried out in 1997 at the expense of the budget system of the Russian Federation. A significant portion of the university assets needed modernization in 2020, and after the transfer of the university into the jurisdiction of the Ministry of Transport of the Russian Federation, significant changes took place due to the retargeting of the university.

In accordance with the Orders of the Government of the Russian Federation dated February 2, 2020 No. 230-r, dated March 20, 2021 No. 691-r, a subsidy from the federal budget was provided to the Russian university of transport in 2020 and in 2021 to upgrade the infrastructure of the university, including major repairs and anti-terrorist security of facilities.

In compliance with the Order of the President of the Russian Federation dated March 23, 2018 No. Pr-518 p. 1d on the establishment of multifunctional engineering cluster "Obraztsovo" at the University, in 2020 the Russian university of transport obtained a subsidy from the federal budget for capital investments in the design, construction and reconstruction of seven capital construction facilities with a total area of 245.4 thousand m^2.

In 2021, the Russian university of transport entered the list of universities-winners of the Priority 2030 programme, and it received federal grants for the track titled "Territorial and (or) Industry Leadership".

By the end of 2021 (the year of the 125th anniversary of the Russian university of transport), the financial support obtained from the federal budget made it possible to upgrade part of the assets of the Russian university of transport (22.3 thousand m^2 or 7 % of the total fund), and reduce the average depreciation of the assets from 42 to 40 %.

The implementation of multifunctional engineering cluster "Obraztsovo" project will upgrade 123.9 thousand square meters of its area (34 % of the total area) and allow constructing new buildings with an area of 121.5 thousand m^2, which in turn, in accordance with the schedule, will reduce the average asset complex depreciation rate from 40 to 21 % and "extend" the average service life of the assets until 2066.

Thus, for infrastructure development of the state universities, whose property complex is predominated by buildings of the late 19th–early 20th century, additional state support is crucial. Specific mechanisms and modern management methods applicable by budgetary institutions are to increase the efficiency of their activities.

ASSET MANAGEMENT AT STATE UNIVERSITIES

Due to the failure to perform repair and construction works, the life cycle of buildings is reduced and the period of existence is shortened. Due to no timely repair works the operation of buildings leads to excessive consumption of energy resources, hence, an increase in the cost of housing and utility services and an increase in the cost of emergency recovery work [2].

The term "Real estate management" implies setting goals and objectives, planning, prioritization, arrangement and implementation control, reporting, implementation assessment and real estate infrastructure efficiency analysis to support the organization activities, based on the users' needs in the infrastructure and the requirements of the organization mission and strategic goals [3].

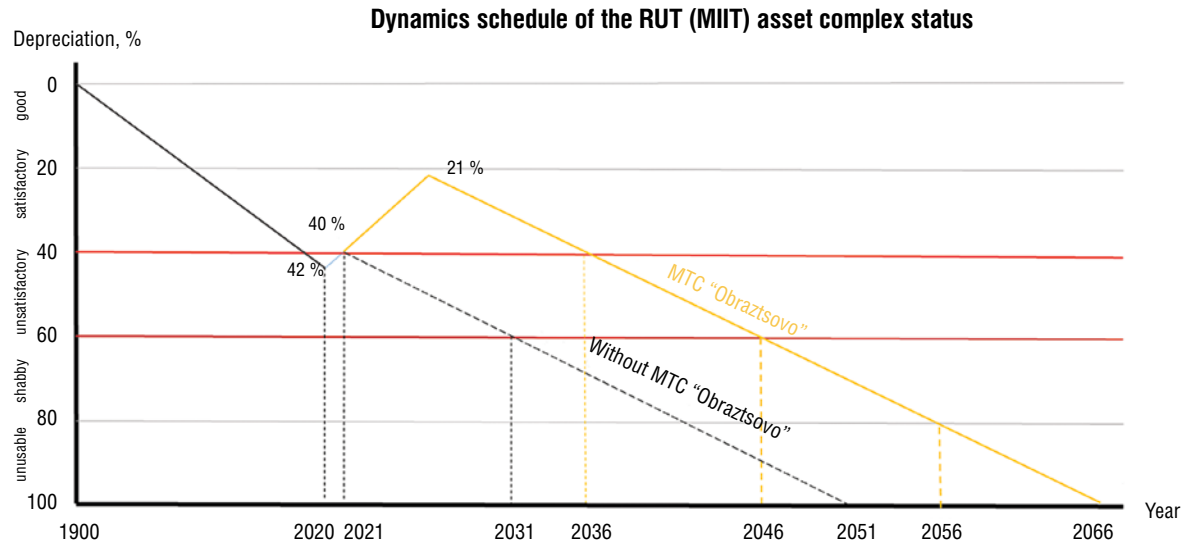


Fig. 2. Dynamics schedule of the technical status of transport assets of the Russian university

Professional real estate management can extend the life cycle of a real estate facility and increase its value by reducing the actual physical and functional depreciation, as well as reducing damage from external depreciation. At the same time, the main goal of professional real estate facility management according to the Property Management model is to achieve maximum income for the owner and increase the cost of the building while creating comfortable conditions for users, tenants or customers of this facility. This activity is carried out by specialized management companies — surveying companies [4].

As for the assets of state universities, there are a number of restrictions established by the legislation of the Russian Federation, as well as related to the fact that state universities can dispose of their property only upon an agreement of the state body acting on behalf of the owner of the property — the Russian Federation, a subject of the Russian Federation, a municipality.

Thus, effective management mechanisms used in the Property Management model cannot be used by state universities in full.

CONCLUSION

The structure of universities has undergone significant changes over the past 15 years:

- there has been a reduction in the number of universities due to the termination of activities by private universities and consolidation of the state ones, a decrease in the student-age population and the state policy pursued;
- today, less than 9 % of all students study at private universities; the area of the assets of private universities is 4 % of the total area, while about 39 % of the property is rented;
- in general, private assets have obtained a normal technical status: less than 1 % of the property needs repair;
- the share of the property held by the state universities subject to repair is annually increasing and today it reaches 23 %; dormitories are in the worst condition, more than 31 % are subject to major repairs.

Starting this year, Russian universities expect an increase in the number of students due to the demographic indicators and an increase in the number of students studying within the framework of the quota for foreign students, which in turn will require effective measures to upgrade the state universities infrastructure to a proper status, especially dormitories. Thanks to the implementation of tasks set by the President of the Russian Federation about the establishment of world-class research, educational and scientific centers, a network of modern campuses is set up and the measures are focused on construction, major repairs and reconstruction of university dormitories to upgrade the infrastructure of universities that will enter the related programmes.

The country's economic development is inextricably linked to the training of personnel in all sectors of the Russian economy; therefore, a systematic upgrade of the university infrastructure alongside with the development and implementation of mechanisms of effective management of its assets is required.

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Анализ изменений в структуре университетского корпуса страны. Проблемы и тенденции развития

Система высшего образования Российской Федерации за последние 15 лет претерпела значительные изменения, при этом Президентом Российской Федерации поставлены амбициозные задачи в развитии университетского корпуса до 2030 года, в том числе по созданию научно-образовательных и научных центров мирового уровня (поручение от 28.03.2020 № Пр-589 п. 1 а), созданию сети современных кампусов и реализации мероприятий по строительству, капитальному ремонту и реконструкции университетских общежитий (поручение от 17.03.2021 № Пр-419 п. 1 г, з).

С текущего года прогнозируется увеличение численности студентов российских вузов, которое в первую очередь связано с демографическими показателями.

В статье проведен анализ изменений в структуре университетского корпуса страны и представлены прогнозы в перспективах развития, классифицирован университетский корпус в зависимости от организационно-правовой формы и категорий университетов, от учредителей и подчиненности университетов, от включения университетов в перечень реализуемых проектов и программ. Описаны тенденции в развитии имущественного комплекса университетов как частных, так и государственных, приведены основные различия. На примере Российского университета транспорта рассмотрены существующие проблемы и тенденции развития государственного университета, связанные с имущественным комплексом университета.

Ключевые слова: *высшее образование, классификация университетов, имущественный комплекс вузов, износ*

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Об авторе: **Волков Роман Вячеславович** — кандидат экономических наук, первый проректор; **Российский университет транспорта (РУТ (МИИТ))**; 127994, ГСП-4, г. Москва, ул. Образцова, д. 9, стр. 9; РИНЦ ID: 872062; volkov-su4@mail.ru.

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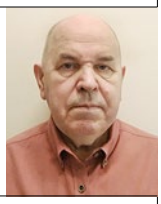
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Lukinov V.A.

Classification of living conditions in housing accommodations

In this article the author analyzes the values of per-capita housing supply, the main parameters of living environments that describe their comfort, and the criteria of comfortable living in housing accommodations developed by the author. He has analyzed the current legislation and recommendations of non-governmental organizations concerning the classification of housing accommodations by the level of their comfort. The author has conducted comparative analyses of the main Russian and European parameters of energy consumption and thermal comfort in housing accommodations. The author has set guidelines to identify good living conditions: a comfortable housing accommodation and its location, norms of per-capita housing space, indoor climate (firstly, thermal comfort), availability and quality of infrastructure. The author believes that living conditions are good when the two components are in place: the availability of comfortable accommodation, utilities, social and transport infrastructure. He has formulated the definition of comfortability of living environments, comfortability of housing accommodations and comfortable living conditions as viewed by families and single residents. The author has developed the main criteria of comfortable living conditions for a family. According to the author, a family owns a comfortable accommodation or leases low-rent municipal accommodations; the accommodation has, at least, 18 m² for each family member who occupies one family room; the apartment has, at least, 2 bathrooms. The author believes that living conditions in single-family houses and apartment houses can be comfortable, discomfortable and non-comfortable. The author lists 6 levels of living conditions for Russian residents and the criteria for this breakdown. This article supplements the method of integrated residential property management applied in our country.

Keywords: *living conditions, living environment, housing accommodations, comfortability of living environments and housing accommodations, apartment house, single-family house, housing per capita, criteria of comfort, discomfort and non-comfort of living conditions for a family or a single*



Lukinov Vitaly Alexandrovich,
Doctor of Economics, Professor; Department of Organization of Construction and Real Estate Management; Moscow State University of Civil Engineering (National Research University) (MGSU); 26 Yaroslavskoe shosse, Moscow, 127337; ID RISC: 690308, Scopus: 57190407564, ResearcherID: AAE-8836-2022, ORCID: 0000-0001-9544-35-22; LukinovVA@gic.mgsu.ru

Nowadays, the Russian Federation has a legal framework that regulates the compliance of development, construction and operation of buildings, renovation of urban areas with architectural and planning, physicochemical, ergonomic, engineering, sanitary and epidemiological parameters. However, there are no theories or practical recommendations for evaluating the living conditions of residents [1–3].

The author suggests that, firstly, the living conditions of a family or a single depend on the fact if the family is accommodated comfortably or less comfortably (in an apartment of an apartment house, in a single-family house); secondly, on the average floor area per person (preferably more than one room per person) and the indoor climate; thirdly, on the infrastructure.

The population resides in single-family or multi-family residential buildings suitable for permanent residence and having different levels of comfort. In accordance with building codes and regulations (codes of rules), a single-family residential building is a detached house consisting of a separate apartment (one residential autonomous unit), that has a set of premises intended for permanent, long-term or short-term residence (including seasonal, vacation, etc.) of a single and/or a family [4], and a residential apartment building that has two or more apartments, common areas and common engineering systems [5].

In some regions, attempts are made to develop comfortability criteria for living environments. For instance, Moscow has rules and regulations governing urban development. Subject to these regulations, all Moscow districts and quarters are divided into 4 groups [6] based on their comfort level:

- comfortable;
- relatively comfortable;
- discomfortable;
- maximally discomfortable.

All Moscow accommodation units are divided into 2 categories:

- apartment houses and single-family houses of the 1st category. They include residential buildings with changeable minimum floor areas and unlimited maximal floor areas. The floor area varies from 30 to 50 m² per person in the houses belonging to the 1st category. In higher standard (more comfortable) residential buildings, the floor area exceeds 50 m² per person;
- residential buildings of the 2nd category include buildings whose floor area does not exceed 30 m² per person.

Moscow authorities have made an integrated evaluation of comfortability of urban areas (the living environment coupled with social and transport infrastructure). However, the comfortability is not the subject of evaluation.

For the purpose of advertising and selling, the Guild of Real Estate Agents of Russia has developed a classification of new buildings for the primary housing market that includes 4 groups of buildings based on the comfortability level: the economy class (now the standard class); the comfort class and the comfort plus; the business class, and the premium class (luxury residences) [7].

Some regulatory documents have definitions of technical, engineering and epidemiological parameters of housing accommodations. E.g., the engineering infrastructure of an apartment house is a set of constructions, systems, elements, power receivers, cables, pipes, devices and other equipment that is needed to ensure a safe and comfortable environment in an apartment house. Comfortable living conditions as a category of the epidemiological status are complied with when actual qualitative and quantitative parameters of public services, indoor climate and cleanliness comply with the requirements specified in the project design documentation. Apart from these notions, indoor climate is defined as a set of indoor climate conditions that affect the human body by combinations of temperature, humidity and air velocity [8].

The only applicable federal document, that is indirectly related to the official assessment of comfortability in living accommodations, is the RF Government Decree dated September 27, 2021 "Determining the energy efficiency class of apartment buildings" that identifies 9 energy efficiency classes of buildings from the top (A++) to the bottom (G) one and authorizes the design, development and construction of buildings, belonging to A and B energy efficiency classes [9].

Regulatory documents in effect have definitions, quantitative and qualitative characteristics of living accommodations and the comfortability of living environments. Nonetheless, the currently used method of residential property management has neither any terms, nor any definitions of comfortability of living accommodations that should take account of the residential area per person, infrastructure, technical and economic criteria characterizing the living conditions of families or single residents.

Comfortability means good living conditions in a living environment. The author believes that good living conditions represent a combination of the following two components:

- a family or a single holds a comfortable apartment or a house;
- residents of comfortable dwellings have access to utility, social and transport infrastructure.

A living environment has some buildings located in the same area, adjacent areas, non-residential buildings and engineering structures, roads and driveways, parks and public gardens that are part of utility, social and transport infrastructure. The living environment is considered to be comfortable when all standards of design, development and renovation are met. Hence, the comfortability of a living environment can be defined as good living conditions in residential houses in an urban district; they arouse a set of positive psychological and physiological sensations in humans [10].

The comfortability of living accommodations (a single-family house, an apartment in an apartment house) means compliance with the following regulatory technical, economic, architectural design and epidemiologic standards:

- engineering infrastructure (hot and cold water supply, water disposal, energy supply, HVAC, fire safety, etc.) that ensures good living conditions in apartment and single-family houses and provision of all necessary services to residents;
- good indoor climate in living accommodations;
- a spacious kitchen (the floor area of, at least, 10 m^2), two bathrooms and a balcony;
- ceiling height above 2.75 m;
- preferably rectangular rooms and non-linear space design;
- car-free courtyard, a ground parking lot located, at least, 10 meters away from the house walls and entrance.

Living conditions for residents represent a set of numerous good conditions that are met simultaneously:

- good location of a single-family or an apartment house and its comfortability class;
- the floor area and ceiling height;
- comfortable indoor climate;
- high-quality utility services;
- high-quality public services and green curtilage;
- a car-free courtyard, a sufficient number of ground and underground parking lots;
- engineering, social and transport infrastructure.

Now the problem to be solved by real estate market players (developers, designers, owners of residential properties and management companies) is to ensure comfortable living for residents (families or singles). The most essential stage of this problem resolution is to develop the theoretical criteria of comfort and comfortability of living environments and living accommodations and to classify the comfortability levels.

The main parameters developed in Russia for a good indoor climate are stated below:

- the indoor temperature (16–28 °C);
- air ventilation (not less than 20 m^3/h/pers.);
- the relative air humidity (25–60 %) [8].

Luxury and business class living accommodations have car-free courtyards, because they have closed and guarded curtilages and a sufficient number of packing lots. It is most likely that comfort class accommodations cannot meet these requirements as they have few parking lots and underground parking facilities. The problem of ground packing lots can be solved by building free municipal packing lots as it is done in most West European countries; another way is to oblige car owners to use paid ground parking lots and charge penalties for parking in yards. For now, this urban planning problem has not been solved and this is the reason why living conditions in comfort class accommodations are still relatively comfortable.

The author considers living conditions to be comfortable if the following criteria are met:

1) only one family lives in a house or in an apartment (a couple with or without kids);

2) a family (or a spouse) owns the accommodation or occupies it under a first-hand contract;

3) the floor area of an apartment is within average regional limits (from 18 to 28 m^2/pers depending on the subject of the Russian Federation);

4) the number of rooms (Q) exceeds the number of family members (N), at least, by 1 (family) room, or $Q > N$;

5) an apartment has, at least, 2 bathrooms.

If criterion 4 or 5 (see above) or both of them are not met (e.g., $Q = N$ and only 1 bathroom is available), the level of comfortability must be considered relatively high for a family. If more than 3 criteria are not met, the living conditions must be classified as discomfortable. If some constituents of the engineering infrastructure are missing in a single-family house or an apartment house (e.g., no water disposal or energy supply), the living conditions must be considered as non-comfortable.

The criteria of comfortability of a comfort class apartment house are the same for a single and a family, although the 5th criteria (see above) should not be taken into account. Moreover, the minimum acceptable kitchen floor area is 6 m^2 and more.

Any person spends most of his life (more than 60 %) in living accommodations and the life expectancy depends, to a great extent, on living conditions. People spend most of their effort and earnings on buying (building) comfortable living accommodations.

As of the year beginning 2022, the RF population was 145.6 million, 42 million of families and 44.9 million of singles [11]. The area of the RF housing is about 4.0 billion m^2, including 69.5 million apartments (that have 151 million rooms) [12]. The average floor area of housing is 27.5 m^2 per person, and the average number of rooms is 1.04 per person, about 1.5 and 1.3 times less than in Europe (over 40 m^2/pers. and 1.3 room/pers.). Nevertheless, this is not the most objective comparison as the share of the total area of living accommodations equipped with heating systems in Russia as of the year end 2020 was 87.5 of 100 % [12]. In Europe, the majority of living accommodations doesn't have heating systems (except for Scandinavian countries) and that's why living conditions in Europe cannot be considered comfortable in winter. Directive 2010/31/EU on the energy performance of buildings is in effect in the EU countries. This Directive has recommendations on reducing the energy consumption of existing buildings and buildings under construction as of 2021 closer to zero [13]. Moreover, the EN 16798 standard sets the essential parameters of indoor thermal comfort:

- min and max indoor air temperatures (from 16 °C in the winter season and up to 28 °C in summer);
- relative air humidity in the existing buildings shall vary from 20 to 70 %, and in the new buildings — from 25 to 60 %;
- air ventilation from 0.15 to 0.21 m/sec in the winter season and up to 0.40 m/sec in summer;
- indoor air quality, e.g., average CO^2 concentration in existing buildings shall be 800 ppm, in new buildings — 500 ppm [14].

It is worth emphasizing that the Russian and European norms describing the main parameters of indoor thermal comfort are nearly the same. However, EU countries are far ahead of the Russian Federation in terms of the design and construction of new buildings whose energy consumption is closer to zero.

The total floor area of living accommodations equipped with all types of engineering systems in the beginning of 2021 was 2.73 billion m^2 that reaches 69.5 % of total living accommodations in the country [15]. This means that the ratio of comfortable living accommodations in Russia does not exceed 69.5 % and the ratio of non-comfortable accommodations is below 30.5 %. Rural population and some urban residents, residing in single-family and apartment houses, built more than 65 years ago, live in non-comfortable accommodations. It is noteworthy that about 13.2 % of all urban residents have apartments in apartment houses and comfortable all-season single-family houses [11].

The surveys made by the author allowed identifying the main criteria for evaluating and classifying comfortability in living accommodations:

- super-comfortable;
- highly comfortable;
- comfortable;
- relatively comfortable;
- discomfortable;
- non-comfortable (see Table).

Super-comfortable living conditions are typical for the richest families of the Russian Federation who bought mansions (3-storeyed villas), having the total floor area of over 250 m^2, and/or luxury apartments in premium class apartment houses, or luxury accommodations. The housing floor area per person exceeds 50 m^2, and this value exceeds the European standard.

In Russia highly comfortable living conditions are similar to the European norms of housing per person (more than 40 m^2) when each family member has a separate room and some extra rooms (family rooms). Highly comfortable living conditions of wealthy families and citizens are typical for townhouse villages, premium and business class apartment houses that have high quality living environments.

Criteria of comfortability of living accommodations

Number	The comfort class of a house or an apartment house	The number of rooms (Q) in a single-family or an apartment house and the number of residents (N)	The floor area per resident, m^2/pers.	Energy efficiency class	Availability		Comfortability class
					Underground parking	Ground parking	
1	A single-family house having the floor area of over 250 m^2, a premium class apartment house	$Q = N + 3$ and more	More than 50	A++, A+, A, B	+	+	Super-comfortable
2	A single-family house having the floor area of 161–250 m^2, a business class apartment house	$Q = N + 2, 3$	More than 40 up to 50	A+, A, B	+	+	Highly comfortable
3	A single-family house having the floor area of 80–160 m^2, a comfort+ class apartment house	$Q = N + 1$	More than 28 up to 40	A, B, C, Д	+/–	+/–	Comfortable
4	A single-family house having the floor area of less than 80 m^2, a comfort class apartment house	$Q = N$	More than 18 up to 28	B, C, Д	–	+/–	Relatively comfortable
5	A standard class apartment house	$Q = N – 1, 2, 3$	Less than 18	B, C, Д, E	–	+/–	Discomfortable
6	Accommodations in which some basic amenities are unavailable	$Q = N + 1$, $Q = N$, $Q = N – 1$, $Q = N – 2, 3$	Not regulated	Д, E, F, G	–	+/–	Non-comfortable

Comfortable living conditions are typical for families and singles. They mean that one family member has 28–40 m² of accommodation space, and this value exceeds the average figures in Russia but does not reach the same figures in Europe. Such accommodations have, at least, two bathrooms, one room for each family member and one extra room (a family room). The drawback of Comfort Plus apartments is the lack of parking lots (normally one parking lot for 2 apartments).

Relatively comfortable conditions mean that one family member has 18–28 m² in an apartment, one room for each family member, and, at least, one bathroom. In Russia, most residents live in such apartments, as the average housing area per dweller varies from 18 to 28 m² in most regions of the country (e.g., in Moscow the housing area per dweller is 20.2 m², while 28 m² is average housing area per dweller in Russia). The housing space in a first-hand contract is 18–22 m² for each family member in most Russian regions [16].

Discomfortable living conditions are typical for families residing in small comfortable accommodations in which each family member has less than 18 m² or two families share an apartment/a house (an estimated quarter of all families in Russia share their accommodation with their parents) or rent their housing.

Non-comfortable living conditions mean:

- non-comfortable living accommodations (not equipped with necessary engineering systems, e.g., water disposal, etc.);
- rooms in shared flats, apartments and dormitories;
- unsafe houses;
- accommodations whose physical depreciation exceeds 60 %.

The notions and criteria of living conditions, developed by the author, supplement the integrated methodology of residential property management. The new theory serves as the basis for further research on real estate management and enables researchers and practitioners to classify the living conditions of Russian residents in a more substantiated way.

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Классификация условий проживания населения в жилых помещениях

В статье проанализированы показатели обеспеченности населения жильем, основные параметры жилой среды, отражающие ее комфортность, и разработаны критерии комфортабельности условий проживания населения в жилых помещениях. Рассмотрены действующие законодательные документы и рекомендации общественных организаций о классификации уровней комфортности жилых помещений. Проведен сравнительный анализ российских и европейских основных показателей, отражающих энергопотребление и тепловой комфорт для проживания населения. Автором разработаны основополагающие принципы, характеризующие благоприятные условия проживания населения: комфортность жилого помещения и его местоположение, нормативы обеспеченности каждого члена семьи комнатами и общей площадью квартиры (индивидуального жилого дома), состояние микроклимата в жилом помещении (в первую очередь теплового комфорта), наличие и качество функционирования инфраструктуры на окружающей жилой дом территории (в микрорайоне или квартале). Автор считает, что комфортабельные условия проживания населения достижимы при одновременном функционировании двух главных составляющих жилой среды: наличия комфортного жилого помещения и необходимой инфраструктуры (инженерной, социальной и транспортной). Сформулированы авторские определения комфортности жилой среды, жилого помещения и комфортабельных условий проживания семьи, одиноко проживающего человека. Автором разработаны основные критерии, отражающие комфортабельные условия проживания семьи. К ним относятся: проживание семьи в собственном комфортном жилом помещении (или по договору социального найма), обеспеченность каждого члена семьи общей площадью квартиры (дома) в размере не менее 18 м² и одной комнатой и, хотя бы, еще одной общей комнатой, наличие в жилом помещении, как минимум, двух санузлов. Автором проведена классификация условий проживания населения в жилых помещениях (индивидуальных (одноквартирных) жилых домах и в квартирах многоквартирных домов), которые могут быть комфортабельными, дискомфортабельными и некомфортабельными. Всего в статье выделено шесть уровней условий проживания российских граждан в жилых помещениях и приведены критерии, в соответствии с которыми рекомендуется определять класс комфортабельности проживания семьи или одиноко проживающего человека. Положения данной статьи дополняют методологию комплексного управления жилищным фондом страны.

Ключевые слова: *условия проживания населения, жилая среда, жилые помещения, комфортность жилой среды и жилых помещений, многоквартирный дом, индивидуальный (одноквартирный) жилой дом, обеспеченность одного человека общей площадью жилого помещения (комнатами), критерии комфортабельности, дискомфортабельности и некомфортабельности условий проживания семьи (человека)*

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Об авторах: **Лукинов Виталий Александрович** — доктор экономических наук, профессор кафедры организации строительства и управления недвижимостью; **Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ);** 127337, г. Москва, Ярославское шоссе, д. 26; РИНЦ ID: 690308, Scopus: 57190407564, ResearcherID: AAE-8836-2022, ORCID: 0000-0001-9544-35-22; LukinovVA@gic.mgsu.ru;

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Kurakova O.A.
Efimov K.V.

Formation of the consumer profile and preferences for private housing structures

This article presents an analysis of the market segment of private housing. To date, the market of private housing is quite popular with developers, who are interested in participating in such projects, since they are governed by well-known rules, and this will help them to enter a new developing market segment and achieve dominant positions there. Before implementation of private housing projects, it is necessary to have a coherent idea of potential consumers and their preferences. This knowledge will help the developer to think of the most effective corporate development strategy. To elaborate a development strategy in this area, it is necessary to identify the target audience of consumers, and subsequently create a clearer profile of an individual consumer. The analysis, presented in the article, shows that it is necessary to analyze the goals of end consumers as the main criterion needed to group target consumers. In this case, the final goals include weekend trips, permanent residence, country house/summer house. Characteristics of consumers were developed for each target group on the basis of their socio-demographic, psychographic and behavioral features. Consumer preferences of each target group were analyzed. The awareness of such preferences helps the developer to maximize profits from investment projects dealing with the construction of countryside real estate by producing the most popular product.
Keywords: *real estate, market analysis, consumer, strategy, developer, private housing construction*



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



Efimov Konstantin Vladimirovich,
post-graduate student of the Department of Organization of Construction and Real Estate Management; Moscow State University of Civil Engineering (National Research University) (MGSU); 26 Yaroslavskoe shosse, Moscow, 129337, Russian Federation; ID RISC: 1108778; efimkost@mail.ru

Over the last few years, it's been difficult to imagine the market of real estate without a private housing segment. Private housing has been among the top segments of the real estate market.

The inclusion of the individual housing segment in preferential mortgage lending programmes and Federal Law No. 476, which came into effect on March 1, 2022, have clarified some of the issues raised by the market players, and it will help large developers to gradually enter this market [1–4].

In their turn, developers are willing to participate in the projects that follow well-known rules, as this will help them to enter a new market segment, that is developing now, and take the lead there.

However, developers need to profile consumer of private housing projects to successfully operate in this market.

Before creating an ideal consumer profile, it is necessary to identify the target audience. In this case, there may be several target groups. The segmentation of the countryside real estate market was based on the goals of end consumers. Selected target groups are presented in Table 1.

Each goal has a unique target audience having unique requests for the house floor area, functionality, and location.

The largest target audience prefers the countryside real estate, intended for weekend trips and vacation stays in the country. The majority of potential buyers are married couples having higher education and two or more kids. The purpose of the purchase is to spend as much time outdoors as possible.

The desired parameters of the house include the floor area of 100 to 140 m^2, the location near large cities and along large motor roads. The main parameters of the target audience are shown in Fig. 1.

The second largest target audience prefers the countryside real estate intended for permanent residence. The purpose of buying such real estate is to get more spacious and comfortable housing, which is impossible to buy in a city for the same amount. This target audience is characterized by a high level of income [5–8].

The core target audience is married couples 35+ years old, having higher education and one or more children. They work as mid-level managers or run their own businesses. Here, 55 % of consumers are males. The average income per family member is the highest one and amounts to 112,000 rubles.

Potential buyers are interested in medium and large houses from 120 to 220 m^2, the average floor

Table 1. Target groups of consumers of private housing projects

Purpose of a single-family house	Goals	Interest of potential consumers, %
Weekend trips	Weekends and vacations	51.00
Permanent residence	Permanent residence	30.00
Country/summer house	Weekends and vacations in summer Permanent residence in summer	10.00 9.00

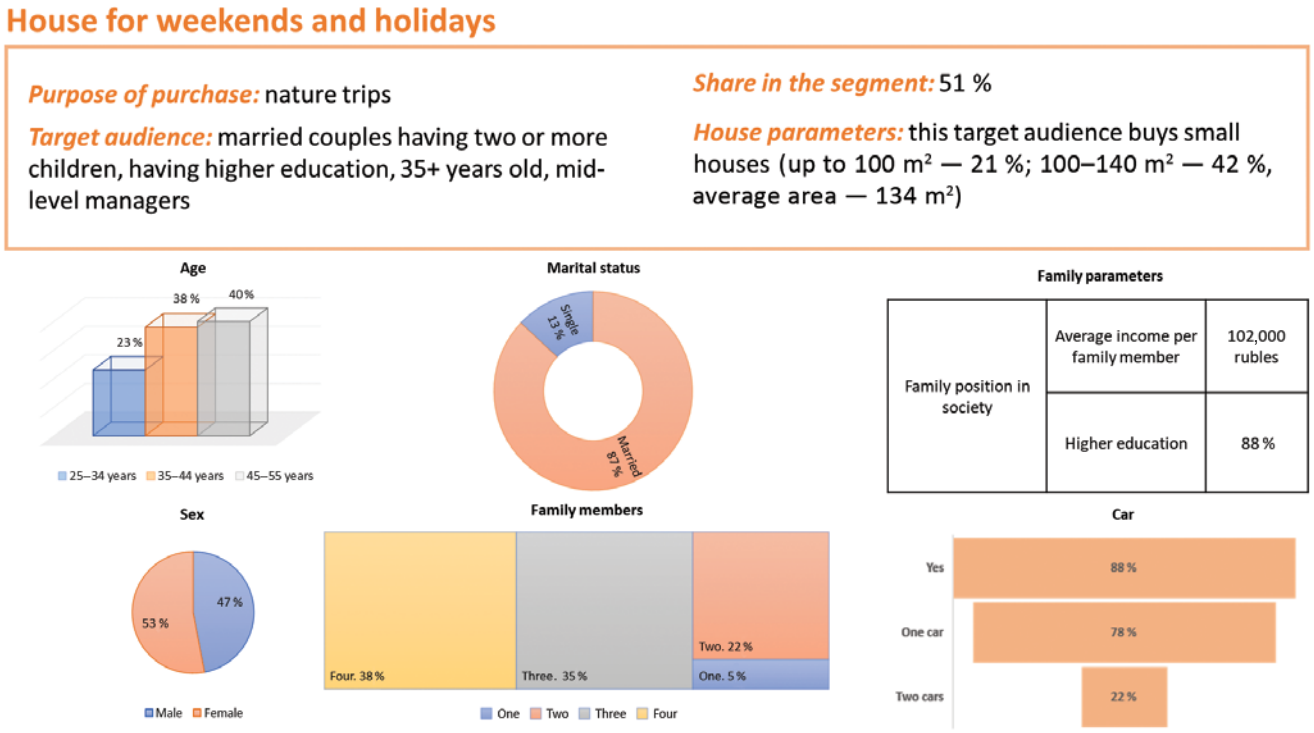


Fig. 1. The main characteristics of the target audience buying countryside real estate for weekend trips and vacation stays

area is 161 m². The share in the segment is 30 %. The main parameters of the target audience are shown in Fig. 2.

The smallest target audience in the segment of countryside real estate are people who buy country houses or summer houses to spend summer months there. This target audience consists of two subgroups. People who only want to stay in the country on summer weekends, and people who buy summer houses to spend their summer vacations there.

There are quite a few young people between the age of 25 and 34 in this target group. As a rule, buyers of this type of real

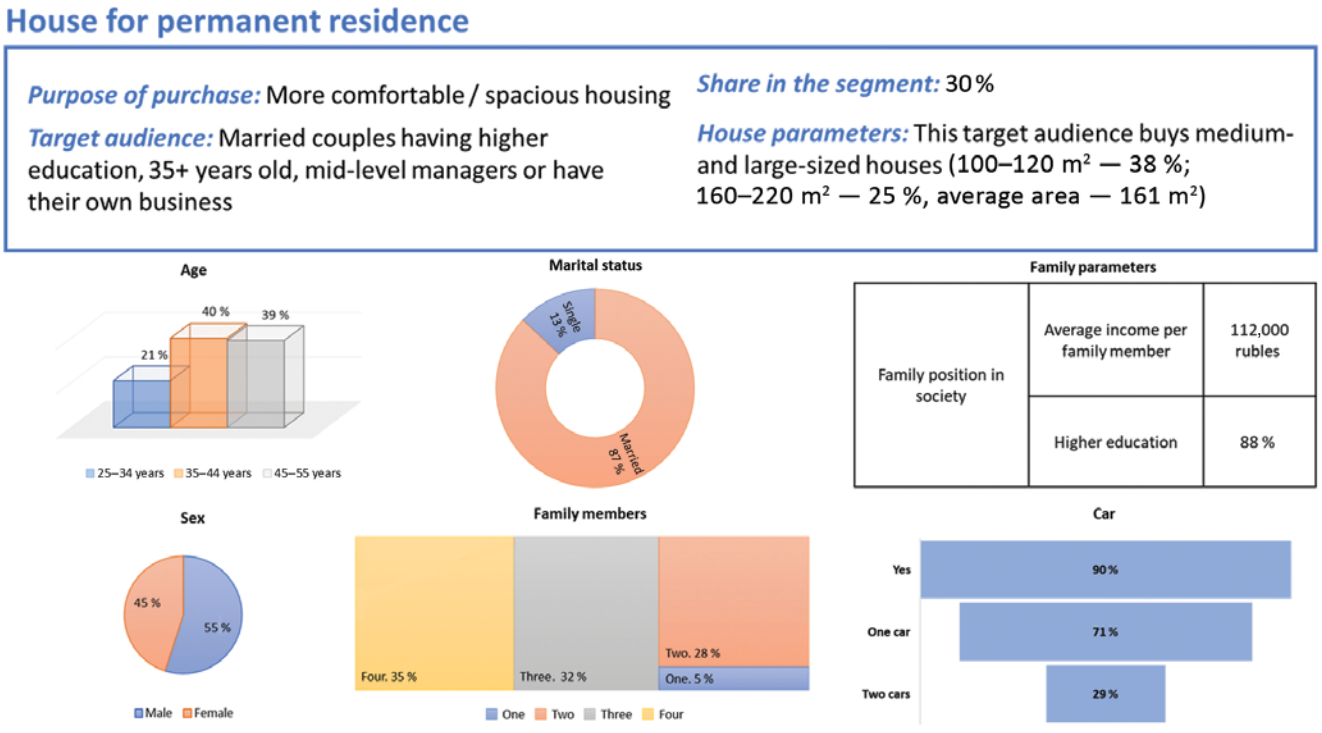


Fig. 2. Main characteristics of the target audience buying countryside real estate for permanent residence

estate focus on buying small houses from 100 to 140 m². The average area of the house is 108 m². The main parameters of the target audience are shown in Fig. 3.

Potential consumers of such houses have not yet managed to climb the career ladder and work as specialists of public and private companies.

In this category, only 72 % of buyers have higher education. The average income is 96,000 rubles per family member.

To create a consumer profile, one can refer to the main characteristics used in the marketing theory of market segmentation, namely:

- geographical;
- socio-demographic;
- psychographic;
- behavioural characteristics.

As for the first characteristic, only residents of Moscow and the Moscow region were considered in this study [9, 10].

The results of the analysis from the point of view of socio-demographic characteristics of consumers belonging to the target groups under consideration presented in Fig. 1–3 are shown in Table 2.

All target audiences have similar socio-demographic characteristics manifested by most potential consumers, such as the average age of about 35 years old, higher education, high average income per family member, and marital status, but each target audience has different psychographic and behavioural characteristics presented in Table 3.

By analyzing the psychographic and behavioural characteristics of potential buyers, one can get an idea which product each target audience will choose.

PARAMETERS OF ITEMS OF COUNTRYSIDE REAL ESTATE BROKEN DOWN BY THE PSYCHOGRAPHIC AND BEHAVIORAL CHARACTERISTICS OF EACH TARGET AUDIENCE

Depending on the purpose of purchasing suburban property, the criteria for choosing a facility differ for each target audience.

For example, the availability of central or independent heat supply in a country house is a more significant criterion for a house intended for year-round residence compared to a summer house [11, 12].

Table 2. Results of the analysis of socio-demographic characteristics of consumers

Name of the target audience/criteria	For permanent residence	For weekends	Country house, summer house
Age	35+	35+	25–35 and younger
Marital status, %	87	87	87
Higher education, %	88	88	72
Average income per family member, rubles	102,000	112,000	96,000
Occupation	Mid-level managers	Mid-level managers and heads of officers	Specialists

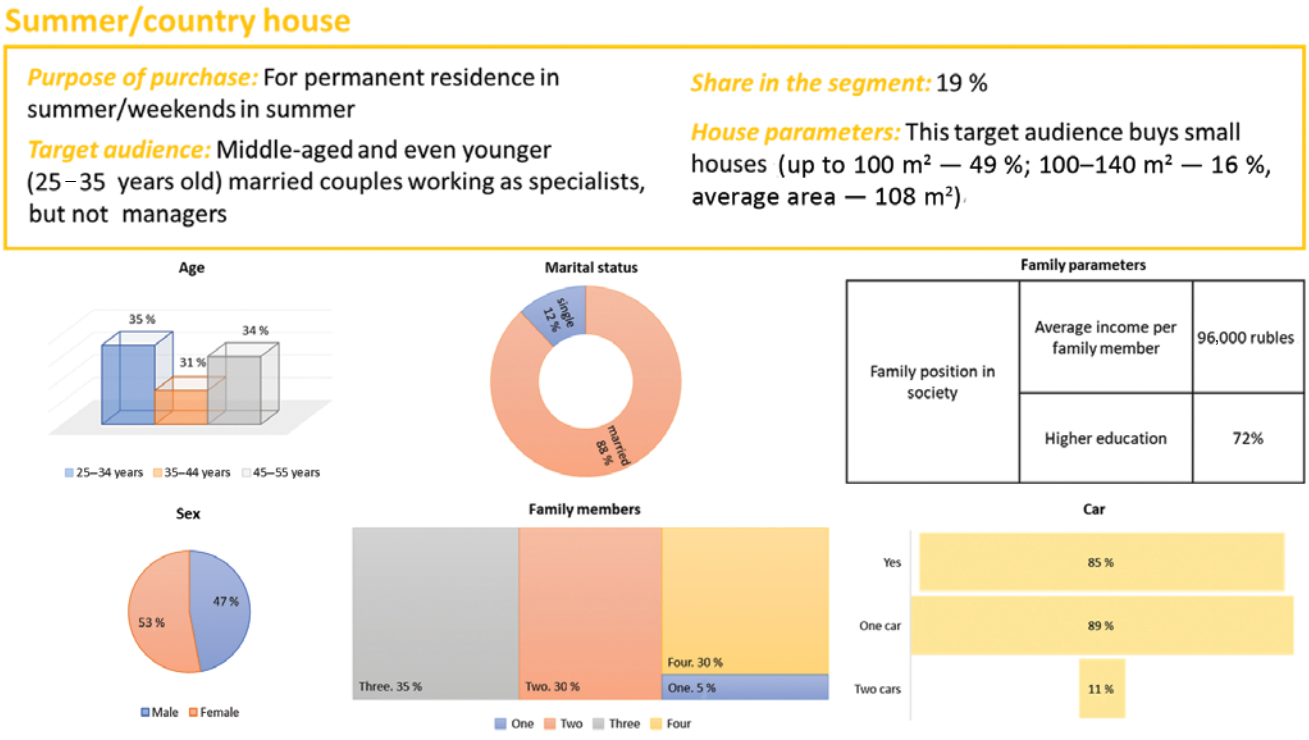


Fig. 3. Main characteristics of the target audience buying countryside real estate for use as a summer house/country house

Table 3. Behavioral and psychographic characteristics of target audiences

Weekend trips	Permanent residence	Country house/summer house
The house is bought to spend spare time with friends and family with no need to think about regulations and neighbours (noise)	The house is bought to ensure safety and comfort for children	The house is bought to own property and spend vacations outdoors
A basement/cellar is important, since it allows storing products, pickled food	Consider house purchasing more thoroughly as compared to other target audiences	Natural resources are important
A garden house, an area with barbecues are important	A playground, public rest areas in the territory of the settlement are important	A possibility to use mortgage lending is important, since buyers do not have enough own money
The pandemic became an incentive to buy a house	Try to envisage any unforeseen situations: utility failures, infrastructure development and possible developments nearby	Ready to buy a house with a standard design
Ready to invest in the house, since they want to live in it when they retire	–	–

If you rank all the criteria by their importance for each of the target consumer groups in the descending order, you will get the following table.

Table 4 shows that the price is the most important criterion for all groups of consumers choosing countryside real estate. And this criterion is of critical importance for buyers of summer houses and country houses.

Also, criteria related to space planning, structural solutions are important aspects. Such parameters include the availability of utilities (61 %), the area of the plot (51 %), the main parameters of the house (50 %). It should be noted that the less time a potential consumer plans to spend in the house, the less he or she is interested in the availability of central utilities at the facility.

Table 4. The importance of parameters of country real estate depending on the target audience

Reasons	Importance, %			
	Average, %	Weekend trips, 51 %	Permanent residence, %	Country house/summer house, 19 %
Price	74.00	75.00	66.00	84.00
Utilities (electricity, gas, sewerage, etc.)	61.00	64.00	67.00	46.00
Plot area	51.00	53.00	49.00	47.00
House parameters (area, style, material, number of storeys, etc.)	50.00	51.00	54.00	41.00
Natural objects in the walking distance	47.00	50.00	37.00	53.00
Distance from the city centre	43.00	43.00	50.00	32.00
Central or independent heat supply	33.00	33.0	45.00	14.00
Stores in the walking distance	32.00	31.00	35.00	28.00
Plot status (individual housing construction, gardeners' non-commercial partnership, personal subsidiary plot, etc.)	31.00	35.00	27.00	28.00
Accessibility/distance from relatives/work	24.00	21.00	28.00	27.00
Type of transaction (sold by the owner, etc.)	19.00	20.00	15.00	22.00
Conditions of the transaction (procedures, nuances)	18.00	19.00	17.00	18.00
Developer (reliable, trusted, etc.)	18.00	19.00	19.00	12.00
Deadlines	16.00	17.00	14.00	16.00
Social infrastructure facilities (kindergartens, playgrounds, etc.)	15.00	11.00	27.00	8.00

The next group of criteria that can affect the project are the parameters related to the location and characteristics of countryside real estate. The more time a potential buyer plans to spend in the country house, the less important is the criterion of the "availability of natural objects within walking distance". For example, the importance of this criterion for people who plan to permanently live in the country house is 37 % as opposed to 53 % of people who purchase countryside real estate to use it in summer. The opposite trend can be observed in the criterion "distance from the city centre": the more time you spend in the house, the more important its location is [13].

Another group of criteria that has a comparable impact on the project is the level of infrastructure development, which is highly dependent on the type of permitted use of a land plot. These criteria include the land status — 31 %, availability of stores within walking distance — 32 %, and availability of central or independent heat supply — 33 %.

If we consider the importance of the materials used to build a house, we can see from Table 5 that 35 % of buyers prefer masonry houses, while 2 % prefer frame buildings.

The size of the house is also of great importance, as it is proportional to its value. The larger the area is, the higher the value of the house is.

As can be seen from Table 6, houses with an average area of 100 to 149 m^2 are most popular with all consumer groups.

Evaluation of the criteria chosen by the target audience of countryside real estate is an important process for a developer or a person selling both their own and someone else's countryside real estate [14, 15].

The understanding of this process helps developers to maximize their investment project benefits by creating the most in-demand real estate products in the countryside.

The developer chooses the parameters that are of key importance for end consumers and uses them to develop a marketing strategy.

At the moment, the market of countryside real estate is growing vigorously. The awareness of the criteria, that are most important for the target audience, will help developers to sell houses at fair prices, and, hence, potential buyers will be able to choose houses thoughtfully using the parameters known in advance.

Table 5. The importance of materials for each target audience

Parameters	Importance, %			
	Average, %	Weekend trips, 51 %	Permanent residence, 31 %	Country house/summer house, 19 %
Brickwork (not in-situ)	35.00	41.00	35.00	31.0
Brickwork + in-situ (ceramic block)	27.00	32.00	30.00	28.00
Gas-concrete block	12.00	11.00	17.00	5.00
Glued laminated lumber	28.00	31.00	23.00	41.00
Cylindrical lumber	24.00	25.00	18.00	33.00
Light-frame house	10.00	9.00	4.00	23.00
Panelized house	4.00	5.00	1.00	10.00
Framework structure	2.00	3.00	1.00	5.00
Other	1.00	0.00	2.00	0.00

Table 6. Importance of the house size for each target audience

Area, m^2	Average, %	Weekend trips, 51 %	Permanent residence, 31 %	Country house/summer house, 19 %
Up to 70	4.00	1.00	1.00	15.00
70–99	19.00	19.00	11.00	34.00
100–149	39.00	43.00	38.00	27.00
150–159	14.00	16.00	12.00	14.00
160–199	9.00	9.00	11.00	7.00
200+	15.00	12.00	27.00	4.00

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Формирование портрета и предпочтений потребителя в отношении объектов индивидуального жилищного строительства

В данной статье представлен анализ одного из сегментов рынка объектов индивидуального жилищного строительства. На сегодняшний день рынок объектов ИЖС весьма популярен среди застройщиков. Застройщики заинтересованы в участии в таких проектах на заранее известных правилах, так как это поможет им выйти в новый, еще не до конца сформированный сегмент рынка и занять там лидирующие позиции. Прежде чем планировать реализацию проектов ИЖС необходимо иметь четкое представление о потенциальных потребителях и их предпочтениях. Такое знание поможет выработать застройщику наиболее эффективную стратегию развития своей компании в данном направлении. Для формирования стратегии развития в данном направлении необходимо определиться с целевой аудиторией потребителей, а впоследствии сформировать более четкий портрет индивидуального потребителя. Представленный в статье анализ показал, что для формирования целевых групп потребителей в качестве главного критерия формирования таких групп, необходимо использовать цели конечных потребителей. В данном случае в качестве конечных целей были определены следующие: поездки на выходные, постоянное проживание, дача/летний дом. Для каждой из целевых групп были сформированы характеристики потребителей исходя из их социально-демографических, психографических и поведенческих признаков. Дальнейший анализ был направлен на изучение предпочтений потребителей в рамках каждой из представленных целевых групп. Знание о таких предпочтениях помогает застройщику получать максимальную прибыль с инвестиционных проектов строительства объектов загородной недвижимости за счет создания наиболее востребованного продукта.

Ключевые слова: *недвижимость, маркетинговый анализ, потребитель, стратегия, застройщик, индивидуальное жилищное строительство*

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

Ефимов Константин Владимирович — аспирант кафедры организации строительства и управления недвижимостью; **Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ)**; 129337, г. Москва, Ярославское шоссе, д. 26; РИНЦ ID: 1108778; efimkost@mail.ru.

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