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05.23.22 Градостроительство, планировка сельских населенных пунктов

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**Уважаемые читатели!**

Жилищный рынок России является одним из ключевых сегментов народного хозяйства с высокой социально-экономической значимостью. Особенностью современного жилищного строительства является высокий уровень инвестиционной привлекательности данного типа рынка, при этом объемы вводимого жилья в 2020–2021 гг. достигли рекордных показателей. Наличие большого количества застройщиков, подрядных, кредитных организаций, физических лиц (покупателей жилья) и других участников рынка формирует сложную партнерскую деловую среду с высоким уровнем риска. Ежегодно свыше 1 млн покупателей жилья инвестируют собственные средства через застройщиков в размере около 4 трл руб., что сопоставимо с 20%-ным уровнем планируемого дохода государственного бюджета страны на текущий год.

Высокая значимость реализации государственной стратегии формирования рынка доступного жилья предъявляет особые требования к социальной и экономической ответственности ключевого участника жилищного рынка — застройщика — к своим обязательствам перед покупателями жилья (дольщиками).

Главными особенностями проектного финансирования объектов с рынка жилищной недвижимости по сегменту многоквартирных жилых домов являются: обязательность заключения договора долевого участия; государственная регистрация сделок; постоянный ежеквартальный мониторинг финансового состояния застройщиков; публичность застройщика на основе проектной декларации; контроль застройщика со стороны СПО; контроль за достаточной величиной уставного капитала застройщика; наличие возможности банковского контроля за целевым использованием средств застройщиков по сметам эскроу; наличие проблемных объектов и обманутых вкладчиков, а также незавершенность экономического механизма государственного регулирования территориальных первичных жилищных рынков РФ.

К негативным аспектам такого развития следует отнести также прогнозируемое увеличение показателей концентрации на жилищных рынках. Это уже привело к значительной ликвидации мелких и средних девелоперских компаний и доминированию крупного бизнеса. Конкурентная среда ухудшилась, и получает все большее развитие олигопольный тип рынка, когда 12–15 строительных групп уже в состоянии контролировать до 70–80 % всех объемов строительства МКД. Эта ситуация, помимо международных санкций, ведет к дополнительному увеличению стоимости жилья и уменьшению его доступности. Этим и другим проблемам жилищной политики будет посвящена программа национальной конференции «Жилье и городская среда», проводимой 20–21 октября 2022 г. в НИУ МГСУ при поддержке и участии Минстроя РФ, Минэкономразвития РФ, Минопромторга РФ, Минсельхозстроя РФ и профильных комитетов Госдумы РФ.

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АКЦЕНТЫ НОМЕРА

**Чернышов Л.Н.,
Нелюбов А.В.**

Современные технологии, оборудование и методы контроля и управления становятся достоянием объектов ЖКХ в процессе их создания или обновления (модернизации, реконструкции, капитального ремонта), которые осуществляются и финансируются в соответствии с федеральными, региональными, муниципальными или корпоративными планами и программами на основании утвержденных проектов.

**Грабовый П.Г.,
Баронин С.А., Волгин В.В.**

Актуальность исследований определяется важностью как выявления существующих трендов промышленного строительства индустриальных парков в России как инновационного сегмента строительного рынка, так и формирования прогнозных мер государственного регулирования ускоренного высокопроизводительного промышленного строительства IP.

**Бороздина С.М.,
Искандаров Д.З.**

Ключевым подходом, используемым для синтеза показателей, является анализ информационных потоков, учитывающих перспективы реализации ИСП на территории ОЭЗ и оценку эффективности участия предприятия ИСС в возведении объекта строительства, основанного на анализе финансово-хозяйственной деятельности изучаемого объекта (предприятия ИСС) и расчете доходности и рентабельности инвестиционных вложений.

**Симионова Н.Е.,
Симионов Р.Ю.**

Сложившаяся ситуация снижает инвестиционную привлекательность строительной отрасли, что неизбежно приводит к потере экономической стабильности.

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Тенденции рынка жилья в 2022 году в России

АКЦЕНТЫ НОМЕРА

Мишланова М.Ю.

В статье представлены направления дальнейшего совершенствования методологии освоенного объема для оптимизации управления строительными проектами.

**Шейна С.Г.,
Федоровская А.А.**

Концепция долгосрочного социально-экономического развития Российской Федерации предопределяет обеспечение устойчивого развития сельских территорий, а также повышение уровня жизни сельского населения.

**Гогина Е.С., Гульшин И.А.,
Спасибо Е.В.**

Сегодня, наряду с повышением качества очистки сточных вод на очистных сооружениях, стоит задача интенсификации процессов с целью обеспечения их энергоэффективности.

**Нгуен Тиен Нам,
Хоанг Тхи Хань Ван**

Использование теплоизоляционных материалов является важным решением для снижения энергопотребления в зданиях и сооружениях.

Волков Р.В.

В статье проанализированы организационно-правовые формы университетов России и порядок взаимодействия государственного университета с собственником имущества.

**Сарченко В.И.,
Хиревич С.А.**

Рынок инжиниринговых услуг играет весомую роль в экономике, поскольку именно он соединяет науку и промышленность.

**Стерник С.Г.,
Мальгинов Г.Н.**

В 2021 г. благодаря господдержке и льготной ипотеке ситуация на рынке улучшилась, однако в первом квартале 2022 г. этому помешал мощный фактор геополитического влияния в виде монетарного шока, грозящего финансовым кризисом.

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2022 housing market trends in Russia

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Chernyshov L.N., Nelyubov A.V.

Modern technologies, equipment and methods of control and management become the property of housing and communal services facilities in the process of their creation or renovation (modernization, reconstruction, capital repairs), which is carried out and financed in accordance with federal, regional, municipal or corporate plans and programs based on approved projects.

Grabovyy P.G., Baronin S.A., Volgin V.V.

The relevance of the research is determined by the importance of identifying current trends in the industrial construction of industrial parks in Russia as an innovative segment of the construction market, and the formation of predictive measures of state regulation of accelerated high-performance industrial construction.

Borozdina S.M., Iskandarov D.Z.

The key approach that used to synthesis of indicators is the analysis of information flows that take into account of prospects of implementation the ICP on the territory of SEZ and assessment effectiveness of participation of the ICS enterprise in construction of building, based on the analysis of financial and economic activities of studied object (the ICS enterprise) and calculation of profitability and profitability of investments, reflecting the likelihood of the process of integration of SEZ and ICS enterprises.

Simionova N.E., Simionov R.Yu.

The current situation reduces the investment attractiveness of the construction industry, which inevitably leads to a loss of economic stability.

Mishlanova M.Yu.

The article presents the directions of further improvement of the Earned Value method for optimizing the management of construction projects.

■ Chernyshov L.N.
Nelyubov A.V.



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Methodology of professional transformation of housing and utility services

The article presents prerequisites for the transformation of the personnel potential at housing and utility service providing enterprises due to organizational, technical and technological changes in the industry associated with the saturation of capital construction facilities with modern high-tech equipment and intelligent systems.

The author emphasizes that the evolution of professions is much faster against this background. The requirements for an employee are shifted from the field of performance of functional duties to achieving the final result that the person seeks to achieve.

The present-day labour market will require employees to be guided by a new concept based on the principles of "lifelong learning". There will no longer be one profession for the lifetime – one will have to constantly adapt to changes in the labour market. The ability of an employee to adapt to the needs of the labour market and expand one's competencies becomes more important than the specialty.

Advanced technologies, equipment and methods of control and management become the property of housing and utilities service provision facilities in the process of their creation or renovation (modernization, reconstruction, capital repair), implemented and financed in accordance with federal, regional, municipal or corporate plans and programmes based on approved projects.

In turn, the introduction of intelligent technologies in housing and utility services leads not only to the emergence of new and the loss of unclaimed industry professions, but also to the emergence of "hybrid" professions, which may entail a combination of diverse, traditionally "incompatible" skills and abilities.

The "key" to solving the problem of adapting current qualifications in the labour market to the requirements dictated by the technological revolution is the implementation of the directions of the National Qualifications System, the main elements of which are the introduction of professional standards in the field of labour and education.

Keywords: automation of housing and utility facilities and systems, updating of educational programmes and professional standards, intelligent technologies and equipment, qualifications, training areas, education modules, employers, educational institutions, educational trajectories, qualification levels, education levels

Today, only a lazy person does not talk about the use of digital technologies in everyday life and production, as well as the necessary personnel transformation at an enterprise in this regard. Indeed, since the 1990s, the Internet has changed our world much more noticeably than any other phenomenon.

Nevertheless, most people have a vague idea (if at all) how artificial intelligence is developing and what impact it can have on their lives. However the fact that the technological revolution can oust individual professions from the labour market and form a class of "superfluous" people does not leave anyone indifferent.

The growing pace of technological progress is so intense that it does not allow us to predict what the labour market will be in the next 15–20 years. During this period, not only the concept of "lifetime employment" may become obsolete, but also the concept of "profession for life", which we were previously guided by. It's no secret that the choice of profession was one of the most important decisions for a person until recently. This is no longer the case today.

In the past, machines competed with humans in brute physical strength, whereas in the intellectual sphere, humans had a huge advantage. In the process of manual labour automation:

- in agriculture, the peasant found work at the factory;
- in industry, the worker found work at enterprises in the sphere of urban economy or trade.

Such a change of professions was possible because it required minimal retraining.

An employee dealing with digital, information and communication technologies and artificial intelligence requires not only higher qualifications, but also software and business skills: the ability to analyze and communicate with colleagues, clients and, most importantly, to understand human emotions.

Thus, professions have always evolved one way or another, but now it happens faster and faster. The requirements for an employee are shifted from the field of performance of functional duties to achieving the final result that a person shows or seeks to achieve [1].

Although technological progress is associated with changes in the content of professions in the field of housing and utility services, many of them are boring and monotonous and it does not make sense to save them in the near future. Hardly anyone dreams of becoming a janitor, stoker or passport officer.

It is generally believed that machine learning and artificial intelligence systems will change literally everything from driving a car and treating patients to creating "smart" cities and works of art. This will lead to the disappearance of traditional professions and the emergence of new and hybrid (mixed) professions, that will urge an employee to acquire new knowledge, skills and abilities.

Thus, the modern labour market will require employees to be guided by a new concept based

on the principles of “lifelong learning”. There will no longer be one profession for life — you will have to constantly adapt to changes in the labour market. The ability of an employee to adapt to the needs of the labour market and expand their competencies becomes more important than the specialty [2].

How realistic is this scenario for the municipal economy, which is traditionally associated with housing and utility services?

The first question that we should answer is: “What is the scale of application of digital, information, communication and intelligent technologies in the housing and utility industry and what are their consequences for workers involved in this activity?”

The draft “Strategies for the development of the construction complex, housing and utility services until 2030” emphasizes that “...the market of housing and utility services is gradually turning into a high-tech field of activity, thanks to the saturation of capital construction facilities with automated systems, technologies and equipment...” [3].

In turn, the professional expert community believes it is unlikely that artificial intelligence and robots will “capture” the sphere of maintenance and repair of civil buildings, municipal engineering infrastructure and landscaping. It will be difficult, at least, in the near future, to get a robot to replace a plumber or an electrician servicing engineering systems inside buildings, specialists who must have a wide range of technical knowledge, skills and abilities and act in unpredictable situations.

At the same time, employees engaged in managing people and processes (collecting and processing various information about the condition of the enclosing structures of buildings and structures, their engineering systems, forming plans and tasks for maintenance and repair works) can be replaced by artificial intelligence elements installed on the computer of a management company [4].

At the same time, it should be understood that the structure of the housing stock and the engineering infrastructure in each of the 24 thousand municipalities is different in terms of the technical condition and level of engineering improvement.

The reality is that people still live in houses with stove heating and amenities in the yard, boiler rooms are serviced by a stoker who feeds coal into the furnace with a shovel, and water is distributed through the street network to the water column, from which the population collects it in buckets. These housing and utilities facilities will continue to need workers whose level of professionalism does not require special knowledge, skills or abilities. Unlike specialists servicing buildings, structures and engineering systems equipped with digital technologies.

Hence, the second question arises: “What is the reaction of the professional community to the challenges that the technological revolution dictates to us and what exactly is it expressed in?”

The question is complex and there is no unambiguous answer to it, but the understanding is that this is a double-way traffic system.

Modern technologies, equipment and methods of control and management become the property of housing and communal services facilities in the process of their creation or renovation (modernization, reconstruction, capital repairs), which is carried out and financed in accordance with federal, regional, municipal or corporate plans and programs based on approved projects.

As a rule, construction, modernization or reconstruction projects are developed on the basis of relevant technical specifications and undergo an appropriate examination, which is a guarantee that the most advanced, highly efficient and energy-saving

materials, equipment and technologies will be used in the project (otherwise why engage in modernization and reconstruction).

In turn, organizations and employees who will maintain “updated” housing and utility facilities must have the necessary competencies (knowledge, skills and abilities), which are the subject of industry-wide professional standards (PS) in accordance with the legislation.

Taking into account that a single organization is not able to develop, coordinate with the professional community and ensure the approval of the PS, these tasks are usually solved by industry-wide associations (associations) — Roskommunenergo, the Russian Association of Water Supply and Sanitation (RAW), the National Association of Organizations Managing Apartment Buildings and others [5].

These entities, acting as the founders of the Council for Professional Qualifications in Housing and Utility Services (CPQ Housing and Utility Services), form and update “their” industry-wide framework of qualifications, taking into account the emergence of new specialties and changes in qualification requirements for the most popular professions in connection with the emergence of new materials, equipment and technologies.

Thus, the Association of Water Supply Enterprises, based on the results of the monitoring of the industrial labour market, is actively updating the current and developing new professional standards and qualifications, taking into account a transition to digital models of management of water supply and sanitation enterprises.

In 2019–2020, the PS “Specialist in water supply and sanitation technologies (aquatronics)” was developed and the PS “Specialist in the organization of operation of water supply and sewerage networks” and “Specialist in the operation of wastewater treatment facilities” were updated. PS are documents that represent the labour functions of modern specialists necessary to ensure the staffing requirements of a modern water supply and sanitation enterprise. The standard consolidates labour functions that take into account:

- automation of technological processes taking into account digital technologies and production optimization tasks;
- the possibility of updating federal state educational standards (FSSES) and basic professional educational programmes (BPEP) for educational institutions;
- the possibility of developing current professions without a radical revision of the staffing of enterprises [6–8].

In accordance with these PS, new, modern types of qualifications have been approved, including:

- a technician, or an operator of automation equipment for water supply and sanitation systems (level 5 qualification);
- a water engineer (level 6 qualification);
- a process engineer in charge of automated and automatic water supply and sanitation systems (level 6 qualification);
- a data analyst in charge of operation of water supply and sewerage networks (level 6 qualification);
- a system engineer of water supply and sewerage infrastructure of municipalities (level 6 qualification).

In 2021 and 2022, this work continued. Digital technologies used at the agricultural facilities are reflected in the updated and developed PS:

- a specialist in the operation of water pumping stations;
- an operator of the ozonator plant;

- ▶ a specialist of the automated control panel of the water supply and sanitation system of the Ministry of Defense;
- a specialist in the operation of urban colour and music fountains [9, 10].

A similar work is performed by associations of organizations managing residential buildings that collect, sort, process and dispose of municipal solid waste, municipal energy enterprises.

It is no secret that the management and maintenance of residential and public buildings is determined, among other things, by the growth rate of their automation.

The number of automated products and systems is a key factor ensuring the efficient, safe, convenient and environmentally friendly operation of buildings. In addition, automation has a significant impact on all elements of a building, especially with regard to heating, ventilation and air conditioning systems, as well as the process of interaction with users.

Building automation products include special hardware and software tools and services for the development and implementation of building automation and management systems.

Hardware includes sensors; actuators and devices (control valves, regulators, etc.); controllers that perform local control functions; communication controllers (routers, gateways, etc.), cables and cable fittings designed to build networks of the required topology, compatibility and performance; as well as computers for system workflow management, monitoring and dispatching building management systems.

The above-mentioned intelligent systems, installed at residential and public buildings during their construction, reconstruction or major repairs, are taken into account by associations of employers in the housing sector in the process of updating current and developing new PS as of 2019:

- a specialist in apartment building management;
- a specialist in the operation of civil buildings;
- a locksmith of household sanitary systems and equipment;
- an electrician of electrical systems and equipment;
- a specialist in charge of operation of intelligent systems of residential and public buildings;
- a specialist in commercial real estate management [11, 12].

In accordance with these PS, new qualifications have also been developed to consolidate the labour functions related to the use of digital technology elements and reflect current trends in changing the names of professions aimed at increasing the prestige of this type of activity: a service manager, an auditor of the technical condition of buildings, an operator of automated building systems, a data analyst in charge of maintenance and others [13].

By responding to new modern sector-wide qualifications, the professional community timely responds to the emergence of new high-tech technologies and equipment, which saturate buildings and their engineering systems, but also creates the conditions for updating relevant educational programmes of institutions of higher, secondary vocational and supplementary education to train specialists necessary for the modern labour market, enabling industry enterprises to increase the level of professionalism of the personnel capable of effective maintenance and repair.

In turn, the introduction of intelligent technologies into housing and utility services leads not only to the emergence of new and the loss of unnecessary industry professions, but also to the emergence of "hybrid" professions, which may include

a combination of diverse, traditionally "incompatible" skills and abilities.

According to the official research, "hybridization" has already reformatted more than 250 professions in various sectors of the economy, and in the next 10 years the number of "hybrid" types of work should double.

The "hybrid" method of labour organization has several significant advantages. It is economically profitable. It is much cheaper for an enterprise to pay for the work of "hybrid" specialists than to re-recruit workers with the necessary qualifications, which becomes prohibitively expensive. Hybrid specialists are able to "grow" and master new skills directly at the enterprise.

To work in a hybrid specialty, a specialist requires not one or two skills, but a whole set, and it is these people who will be the most popular ones on the labour market.

Burning Glass analysts analyzed about a billion vacancies. According to their data, a trend towards hybridization of professions is increasing, a demand for versatile specialists is growing rapidly, as so is the difference between salaries in hybrid and simple positions. Hybridized professions pay 20–40 % higher than the corresponding traditional professions [14].

In addition, hybrid professions that are difficult to automate are a big plus for an employee who has mastered such a profession. If specialists of "simple" professions can be replaced with artificial intelligence, the machine will not cope with "hybrid" ones.

At the same time, hybrid professions are not a new trend.

Thus, in the field of municipal energy, the emergence of hybrid professions was due to a sufficiently large number of small enterprises: small boiler houses, including those with thermal networks departing from them, small electric grid enterprises, diesel power plants (DPP) with outgoing electric networks (located, as a rule, in the areas that have no centralized power supply). The service staff of such enterprises is scarce and is focused on combining professions. For example, an electrician maintains both overhead and cable electrical networks, other equipment, including substation equipment. The driver of the DPP also maintains metering devices on outgoing power lines, and the power lines themselves.

In addition, in this area of housing and utility services, high-tech devices and equipment are being intensively introduced, hence, employees of industrial enterprises are to improve and update their qualifications that meet modern labour market requirements.

By monitoring the industry-wide labour market, the experts of the Russian "Municipal Energy" Association, have been updating professional standards since 2019:

- a maintenance worker in charge of pumping and compressor installations of the engineering infrastructure;
- a specialist in the operation of heating network equipment;
- a specialist in the organization of the operation of overhead and cable municipal power lines, the maintenance of automated systems and equipment used by the enterprises in charge of municipal heat and power supply to consumers.

In the housing sector, for example, a "House master" can become such a profession, which will include two types of professional activities: a plumber and an electrician. To master a hybrid profession, it will be necessary not just to study, but to purposefully plan what knowledge, skills and abilities you need to master to get the appropriate profession. As for the "house master", there

is already a FSES "Master of housing and utility services" for his training, within which students today choose a qualification of a plumber or electrician¹.

A similar practice will be implemented for mid-level workers, such as foremen, technicians, engineers engaged in the organization of housing and utility services. The basic competencies of such a specialist assume that he must possess the necessary skills and abilities that allow him to analyze information at all elements and systems of buildings, structures and the surrounding area, based on the use of digital technologies to predict the required amount of maintenance and repair.

The emerging waste-processing industry is characterized by extensive automation and artificial intelligence elements at all stages of the production process, starting from collection, when automated accounting of accumulation of fractions and volume (mass) is carried out; transportation is controlled by the Glonass system; and waste is sorted using robotics.

Experience shows that in this sector of housing and utility services workers with high qualifications will also be required to perform the work in the "manual" mode, and using high-tech equipment and technologies. Today, traditional industry professions are already "closed" by the description of qualification requirements in the relevant professional standards. In accordance with the recommendations of the public law company "Russian Environmental Operator" (PLC "REO"), the Ministry of Natural Resources of the Russian Federation approved a list of professional standards to be developed in 2020–2021, which should describe the requirements of professional qualifications for more than 60 professions that are actually functioning today in the industrial labour market: a specialist in solid municipal waste management; a specialist in waste processing; a specialist in chemical and biological treatment of water effluents, processing and disposal of municipal solid waste; a specialist in digitalization in the field of solid municipal waste management; an employee of robotic installations for thermal neutralization of municipal solid waste (MSW); a specialist in the procurement of secondary material resources; a specialist of an incinerator; a worker in charge of composting MSW fractions; a worker in charge of processing MSW fractions into energy-efficient fuel; a specialist in sorting MSW [15].

In the process of updating current and developing new PS, industry associations of employers "give life" to new and most popular hybrid professions in housing and utility services.

At the same time, experts involved in the development and updating of PS proceed from the fact that most hybrid professions require:

- a technical component;
- an ability to collect, interpret and visualize data;
- an ability to master the tools for the maintenance of innovative systems and equipment;
- awareness of industry laws, standards and regulations;
- awareness of communications and an ability to forecast the behaviour of consumers of services.

In addition, the leadership abilities of an employee who is able to convey his thoughts to colleagues, users and providers of housing and utility services will find a place in the new PS.

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Методология профессиональной трансформации сферы жилищно-коммунального хозяйства

В статье представлены предпосылки трансформации кадрового потенциала предприятий ЖКХ, обусловленные организационно-техническими и технологическими изменениями в отрасли, связанными с насыщением объектов капитального строительства современным высокотехнологичным оборудованием и интеллектуальными системами.

В этих условиях эволюция профессий происходит значительно быстрее. Требования к работнику смещаются из области исполнения функциональных обязанностей на достижение конечного результата, который показывает человек или которого он стремится достичь.

Современный рынок труда потребует от работников руководствоваться новой концепцией, основанной на принципах «образование на протяжении всей жизни». Одной профессии на всю жизнь больше не будет — придется постоянно адаптироваться к изменениям на рынке труда. Умение работника предприятия адаптироваться под потребности рынка труда и расширять свои компетенции становится важнее специальности.

Современные технологии, оборудование и методы контроля и управления становятся достоянием объектов ЖКХ в процессе их создания или обновления (модернизации, реконструкции, капитального ремонта), которые осуществляются и финансируются в соответствии с федеральными, региональными, муниципальными или корпоративными планами и программами на основании утвержденных проектов.

В свою очередь, внедрение интеллектуальных технологий в ЖКХ приводит не только к появлению новых и утрате невостребованных отраслевых профессий, но и к появлению «гибридных» профессий, которые могут включать сочетание разнообразных, традиционно «не сочетающихся» умений и навыков.

«Ключом» к решению проблемы адаптации существующих квалификаций на рынке труда к требованиям, которые диктует технологическая революция, является реализация направлений Национальной системы квалификаций, основные элементы которой, — это внедрение профессиональных стандартов в сферу труда и образования.

Ключевые слова: автоматизация объектов и систем ЖКХ, актуализация образовательных программ и профессиональных стандартов, интеллектуальные технологии и оборудование, квалификация, направления подготовки, модули образования, работодатели, учреждения образования, образовательные траектории, уровни квалификации, уровни образования

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Sustainability of industrial construction in the context of development life cycles of industrial parks

The authors address the sustainable construction of industrial parks (IP) in the process of its development. Towards this end, they simulate the life cycles of their operation. To accelerate the development of industrial infrastructure and ensure the competitiveness of its industrial potential in the age of economic turbulence, a model of environmentally friendly industrial development is proposed.

The research hypothesis is formulated as the implementation and management of sustainable industrial construction in the segment of industrial parks as a contemporary type of industrial parks (IPs). The following items were used as the main sustainability indicators of high-performance development systems applied to the industrial construction of industrial parks: construction intensity; the cumulative consumption of resources; the duration of local stages in the life cycle of the industrial construction of IPs; the reduction in the labour costs at the junction of cooperative relationships; the business continuity of the industrial construction of IPs within the framework of an ecologically friendly development system; the adaptability of the life cycle of a managing company to external conditions; the system of tax incentives in IPs and their transformation potential and efficiency; the sophistication of logistic and transport infrastructures of IPs; the efficiency of life cycle of business projects developed by the residents of IPs, patterns of public-private partnerships, and the life cycles of ecologically friendly industrial development of IPs.

A high demand for the development of current theoretical and practical approaches to high-performance industrial construction of industrial parks predetermines the relevance of this area of research. The involvement of the IP market allows to establish the national industrial infrastructure to ensure the accelerated launch of competitive business projects. In this regard, models of industrial development of the innovative segment of industrial construction become a tool of state control focused on augmenting the country's competitive industrial potential and, hence, they assume high nation-wide importance for the national economy.

The research objective. The develop methodological approaches and practical recommendations for simulating the life cycles of industrial parks, the accelerated reproduction of their real estate based on the models of ecologically friendly industrial development and sustainable growth.

The object of research. The evolving national market of industrial parks as a special innovative market segment of construction focused on the accelerated and high-capacity industrial construction of IPs.

Results. An update of the problematic modernization of the industrial construction market of industrial parks as an innovative segment of the construction market in a turbulent economy; generalization of domestic and international experience in the field of sustainable development of territories based on models of eco-industrial parks, "green" construction and certification of projects; methodological author's approach to functional structuring and criteria-based assessment of managerial-engineering reliability, sustainability and efficiency of the life cycles of eco-development of industrial parks; modeling of multivariate and situational indicators of criteria-based assessment of the sustainability of the life cycles of eco-development of industrial parks.

Keywords: industrial construction, life cycles, industrial parks, eco-industrial parks, industrial development, eco-development, organizational and technical reliability, sustainability, effectiveness, brownfield, greenfield, corporate alliance

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INTRODUCTION

The relevance of the research is determined by the importance of identifying current trends in the industrial construction of industrial parks in

Russia as an innovative segment of the construction market, and the formation of predictive measures of state regulation of accelerated high-performance industrial construction. Formation of an industrial infrastructure capable of ensuring the accelerated launch of competitive business projects involves the elaboration of models of sustainable industrial development. IP industrial construction should be considered as a kind of national strategy to accelerate the socio-economic national development.

The IP industrial construction market can be identified as a special variety of professional activity of a property developer. In this case, a specialized corporate target alliance of participants is formed as

a system of business partners with the main performers — the management organization. It attracts to the partner alliance the residents, construction, logistics, transport, operational, service, resource companies and state as well as municipal authorities. The emergent qualities of corporate business partnership in industrial construction for the creation of industrial parks are resulting from the integration of business processes for the implementation of special purpose investment projects and resident programs.

IP industrial construction should be attributed to the actively developing innovative segment of the construction market. The establishment of this segment of construction is an effective case of the national strategy of stabilization and acceleration of socio-economic industrial growth in a turbulent economy. The IP market ensures accelerated

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▶ reproduction of large industrial real estate facilities to implement investment projects and resident programs, which provides a high-speed increase in the competitive industrial potential of the regional territories. One of the significant reasons for such acceleration to ensure the industrial competitiveness of the country is the application of the management concept of the entire life cycle of IP industrial construction. Among the main goals of the management company are actual structural and functional tasks — pre-investment feasibility studies of IP construction programs and modernization of state incentive strategies, with consideration to preparatory and main periods of construction, operation, renovation and liquidation.

IP industrial construction should be considered as a variety of the national strategy to accelerate the socio-economic growth of the country. This allows to generate specialized organizational and economic mechanisms for accelerated construction and efficient operation of industrial real estate facilities of residents using the methodology of sustainable industrial development.

Special attention is required to monitor and develop functioning organizational structures of IP management based on specialized corporate alliances and organizational and economic mechanisms of their interaction in the life cycles of industrial parks development and operation. The establishment of a partnership alliance is initiated by the management company, as the executor of the state industrial acceleration policy, at all stages of the life cycle of IP industrial construction. This management body is integrated into the public-private partnership system, is established by regional state structures and is responsible both for the investment attractiveness of IP for residents and for the effectiveness of all stages of the life cycle, that is, the final efficiency of the entire partner business system of the industrial park.

Clarification of the problematic situation and consideration of its essential content make it possible both to confirm the relevance of the chosen field of research, and to focus on promising managerial-engineering, economic and organizational mechanisms for improving IP industrial construction.

Research has revealed that the legal framework for the development and operation of IP is determined by the Federal Law "On Industrial Policy"¹ and by a number of Orders of the Government of the Russian Federation^{2, 3} [1]. The focus on accelerated rates of industrial construction makes it possible to reduce the regulatory terms of investment cycles for the capital construction facilities two-fold, and the timing of the launch of residents' business projects and reaching their project capacity is significantly reduced compared to traditional local schemes of such construction.

The investment appeal and economic efficiency of the industrial parks projects are confirmed by the data of analytical reports provided by the Association of Industrial Parks⁴. It has been ascertained that the main trend of the Russian industrial parks market is

a steady increase in their number, an increase in the number of residents, jobs and investments [2–4].

Some authors point out [5] that the economic feasibility of IP development has passed the stress test due to the pandemic period of 2020–2021, and Western sanctions against Russia related to Ukraine, but studies conducted on the number of residents and jobs in industrial parks show that, on the contrary, there is no negative dynamics.

The author's research suggests that there is a steady growth in the number of national industrial parks from 80 in 2013 to 334 in 2020. The annual growth rate of jobs is 18.4 %, resulting in an increase from 56,773 to 185,395 in 2020. A steady increase in the number of IP residents from 958 to 3,498 with an average annual growth of 20.3 % is provided. The total value of investments in industrial parks amounted to 1.6 trillion rubles in 2020, twice exceeding the statistics of 2013.

As the analysis has demonstrated, one of the most important trends in domestic and global economic development is the use of the concept of sustainable development⁵. Similar domestic sustainable development goals have been approved for Russia. This is confirmed by the report of the Analytical Center under the Government of the Russian Federation "On the goals of sustainable development of Russia" [6].

The Government of the Russian Federation has updated the priority of sustainable development on the basis of Order of the Government of the Russian Federation No. 1587 of September 21, 2021 and specific Order No. 1912 of July 14, 2021^{6, 7}. Criteria in the field of financing sustainable development projects are approved here, official terminology in the field of implementation of sustainable development projects is given, the institutional state development tool — the State Development Corporation "VEB.RF" — has been approved. According to federal legislation⁸, it is assigned the function of a methodological center in the field of preparation and implementation of investment projects of sustainable development with contributing of non-budgetary funds to competitive projects.

Industrial construction is a priority of sustainable development. This is confirmed by the Order of the Government of the Russian Federation No. 1912-r dated July 14, 2021⁷. No doubt, the variety of the industrial development market in the segment of the construction of industrial parks is a sphere of transformation into sustainable industrial IP construction. This circumstance determines the relevance of theoretical and practical simulation of sustainable industrial construction of industrial parks based on eco-development models.

The performed studies of the mechanisms of sustainable development [7] implementation, taking into account modern regulatory requirements of town-planning [8], prove the emergence of a new evolutionary stage in the development of industrial construction, including one via construction of industrial parks based on the simulations of eco-oriented reproduction of industrial real estate.

1 On Industrial Policy in the Russian Federation : Federal Law of December 31, 2014 No. 488-FZ.

2 About Industrial (Industrial) Parks and Managing Companies of Industrial (Industrial) Parks : Order of the Government of the Russian Federation as of August 4, 2015 No. 794.

3 About strategic planning in the Russian Federation : Order of the Government of the Russian Federation as of October 30, 2014 No. 1119 and of August 11, 2015 No. 794, FZ-172 of June 28, 2014.

4 Association of industrial parks of Russia. URL: https://indparks.ru/upload/iblock/5b4/Blok2021_WEB_4.compressed.pdf (Accessed August 23, 2022).

5 Sustainable development goals. URL: <https://www.un.org/sustainabledevelopment/ru/sustainable-development-goals/> (Accessed August 23, 2022).

6 On approval of criteria of sustainable development projects (including "green") in the Russian Federation and requirements to the system of verification of sustainable development projects (including "green") in the Russian Federation : Order of the Government of the Russian Federation as of September 21, 2021 No. 1587. URL: <http://government.ru/docs/all/136742/> (Accessed August 23, 2022).

7 The national goals and the main directions of sustainable (including "green") development of the Russian Federation : Order of the Government of the Russian Federation of July 14, 2021 No. 1912-r. URL: <http://government.ru/docs/42795/> (Accessed August 23, 2022).

8 About the state corporation of development "ВЭБ.РФ" amended and revised, in accordance with the Federal Law No. 332-FZ of July 2, 2021 "On amendments to certain legislative acts of the Russian Federation and recognizing void Part 11 of Article 8 of the Federal Law." On the innovation center Skolkovo : The Federal Law of May 17, 2007 No. 82-FZ. URL: <http://pravo.gov.ru/proxy/ips/?docbody=&firstDoc=1&lastDoc=1&nd=602263689> (Accessed August 23, 2022).

The literature review has shown that in the IP industrial construction market segment, there is now a trend for the construction of environmentally oriented industrial parks. Among others, the paper of A.V. Dubovchenko is interesting, analyzing the subject of the development of eco-industrial parks [9], and the article by V.I. Tochka and S.V. Rantner [10] studying issues of environmental aspects of industrial park management.

The global priority of sustainability and "greenness" determines the need for the creation of models and state strategies to boost the competitive industrial potential of the country based on IP eco-development models.

This type of industrial construction market is a specialized sort of project financing and public-private partnership. It is established that modern national trends in the development of industrial potential determine the strategic vector of high-performance reproduction of industrial real estate in industrial parks as a special set of industrial investment projects and sustainable development programs.

The identification of the problematic situation updates the theoretical and practical need to improve the prevailing models of eco-development of IP industrial real estate from the perspective of sustainable development projects. The task of developing industrial parks in Russia that operate on the principles of a closed-loop economy or a cyclical economy is quite justified and acceptable. This type of economic doctrine requires compliance with the principle of resource renewal based on the concept of effective waste management. A transition from a simplified procedure involving the collection, sorting and disposal of waste to a complex sustainable business system is required. It should include both the design of industrial products in industrial parks, and at the same time the renewal of production resources. The procedures of eco-industrial parks should include waste management, their cyclic processing, taking into account the projecting of the service life, the principles of waste reduction and the production of by-products. Such a business approach in the functioning of IP considers waste as a valuable secondary resource. In this regard, the experience of China [11] and the achievements of this country in the field of eco-industrial parks functioning are interesting. Traditional industrial parks do not focus on creating an industrial ecology. In eco-industrial parks, on the contrary, the activities of industrial enterprises of various industries are considered. At the same time, benefits are generated from the exchange of resources based on the closed value chains while reducing waste, reusing it and increasing environmental efficiency. The priority of such eco-IP is the use of the principles of "clean" production, industrial ecology and circular economy. It has been identified that typical eco-industrial parks of the People's Republic of China include both industrial production, research, residential and business zones, and a service area. The application of the waste management principle and the exchange of by-products are mandatory. China's waste management practice using innovative sources of financing for these types of "green" projects is very interesting. They actively attract non-budgetary resources issuing "green" bonds, loans or credit lines. China has a program National Demonstration Eco-Industrial Park, created in the early 2000s. As of 2020, there are 55 national eco-industrial parks in the country and 52 more eco-industrial parks are under development. This experience is undoubtedly interesting for implementation in Russia [12, 13].

The issues related to the development of eco-industrial parks both in Russia and abroad are the promotion of a "clean" city, "clean" territories, "clean" industries, "clean" investment projects and investment programs, as well as the intensification of the implementation of domestic and international environmental management standards in all development areas.

These prerequisites determine the need to improve the accelerated industrial construction of all types of industrial facilities, including industrial parks and industrial zones as "clean" territories, "clean" productions etc. It is this approach that should be ensured when structuring sustainable territorial business systems of IP industrial construction as a special type of models of ecological industrial development.

In Russia, this field of activity began to develop rapidly relatively recently. The need for nationwide "clean" standards in all types of activities is becoming more and more obvious every year.

The scope of problems of such "clean" sustainable development reinforces the need to model and manage the entire life cycle of IP eco-development. Currently, there is no unified eco-development assessment system neither in design, construction, nor in operation. There is also no unified legal framework for the large-scale implementation of the eco-development principles, "green" and "clean" cyclical construction in the investment and construction sector. The problematic issues of this approach include the inevitable increase in the cost of "green" industrial construction projects boosted by supplementary eco-development standards requirements. This necessarily requires new approaches to the definition of project efficiency, taking into account the "green" construction.

One of the factors restraining the development of ecological construction, including industrial, is the cost of certification. This undoubtedly increases the costs of "green" capital construction projects. Most developers in Russia do not consider these additional costs appropriate. In addition, "green" standards require the eco-friendly construction materials, which also increases the investment cost of eco-development. In this regard, stimulating the priorities of the expansion of "green", "clean" industrial construction in Russia becomes the top priority. The statement of research objectives in the field of ensuring the competitiveness of "green" construction with a circular economy, as well as competitive ecosystems of industrial construction and eco-development of industrial parks, becomes a national economic problem.

A review of the performed domestic research studies on the subject of eco-development, "green" construction [14–18], as well as foreign sources of information [19–27], indicates a profound lack of elaboration of the issues studied. The review confirms the prospects of structuring eco-oriented life cycles of sustainable industrial eco-development IP models, the relevance of assessing their value and managing this type of value, taking into account the economy of closed cycles.

Domestic practice of ecological, "green" development in our country is at the start. Whereas in such countries as the USA it occupies already 20 % of the market, and in the European countries about 15 %, in Russia it doesn't exceed 1 %. The relevance of the research is determined by the importance of identifying current trends in the industrial construction of industrial parks in Russia as an innovative segment of the construction market, and the formation of predictive measures of state regulation of accelerated high-performance industrial construction.

THEORETIC RESEARCH APPROACHES

When simulating the life cycle structure W_j of industrial park (IP) industrial construction projects in the eco-development system GD_{ip} , it is necessary to use the principles of functional system modeling. This suggests using as functional constituent of GD_{ip} a functional four-dimensional space consisting of subsystems:

► 1. *Firstly*, a set of specialized functions-tasks Q_o focused on the target results of ensuring integrated sustainability of both certain stages of the GD_{ip} life cycle and the entire W_j .

Various types of sets of local q_i functions form particular subsystems of the GD_{ip} eco-development, implemented at different stages T^{-i} of the GD_{ip} life cycle. Ultimately, the integrated set of T^{-i} forms an integral life cycle of eco-development in the form of the continuance of T_o .

In the most general form, the integral value of Q_i is equal to the sum of the local functions of q_i (1), which concurrently means the functional synthesis of an integral GD_{ip} system that strives to ensure maximum effectiveness D according to the reliability criteria s of the D_s type.

$$Q_o = \sum q_i = q_1 + q_2 + \dots + q_i = f(GD_{ip}) \rightarrow D_s(\max). \quad (1)$$

The following nine basic GD_{ip} subsystems are suggested as separate local functions for the formation of GD_{ip} subsystems:

GD_{ip1} — environmental management functions for the implementation of IP eco-management, monitoring and environmental optimization of design solutions in the life cycles of T_o and development of qualification requirements of sustainability according to the GD_{ip1} criterion for their assessment implementation and optimization;

GD_{ip2} — functions of ensuring infrastructure reliability and external environment quality;

GD_{ip3} — functions of ensuring reliability in the field of architectural, space-planning and design solutions of IP;

GD_{ip4} — functions of ensuring reliability in the field of comfort (aerothermal, light, acoustic) and the indoor environment;

GD_{ip5} — functions of ensuring reliability in field of sanitary protection quality and recycling, implementation of closed cycle economy;

GD_{ip6} — functions of ensuring reliability in the field of rational water use and regulation of wastewater disposal;

GD_{ip7} — functions of ensuring reliability in the field of energy saving and energy efficiency (Reduction of heat energy consumption for heating and ventilation of building; reduction of heat energy consumption for hot water supply; reduction of electricity consumption; reduction of specific total primary energy consumption by engineering systems; use of secondary energy resources);

GD_{ip8} — functions of ensuring reliability on environmental protection in the process of industrial construction and the subsequent demolition of capital construction facilities in order to minimize the impact of materials used in construction, waste generation during construction works, as well as the implementation of measures to protect and restore the environment during construction;

GD_{ip9} — functions of ensuring the life safety in terms of providing backup infrastructure for power, water and heat supply, as well as other elements of industrial, transport, social and logistics infrastructure of IP.

The implementation of the entire set of GD_{ip1-9} tasks forms the structuring of the GD_{ip} integrated system at all stages of T_o local functional tasks of industrial eco-development.

In this study, the authors consider the implementation of particular local functional tasks. The entire set of functional tasks of GD_{ip1-9} in the process of their implementation forms the integrated sustainability of industrial IP construction in the GD_{ip} system at all stages of the IP development system life cycle.

In the criteria simulation of the local and complex efficiency of GD_{ip} sustainability processes, it is suggested to apply the methodological apparatus for the formation of sustainability efficiency through

the organizational and technical reliability of GD_{ip} processes. At the same time, we also consider it necessary to use indicators to minimize the total ownership cost of a portfolio of industrial real estate, considered as part of IP for residents who may be owners and tenants.

2. *Secondly*, the research paradigm applied provides for the necessity and possibility of considering the life cycle of industrial eco-development IP as a functional and reliable system consisting of separate life cycle phases or stages of the industrial status of eco-development T^{-i} , the sum of which forms an integral monolith T_o of the GD_{ip} life cycle. In the most general form, the entire T_o life cycle equals to the fractional sums of T_{ij} , which is shown in (2).

$$T_o = \sum T^{-i}. \quad (2)$$

Thus, the basics of the structuring of stages and their duration within the life cycles of industrial eco-development IP are determined by the rational expediency of singling out separate T_o stages, which are formed as functions-stages responsible for a separate discrete target function of the entire T_o structuring. The number of $i-j$ stages is the subject of forecasting and methodological modeling. It is suggested to simulate the structure of life cycles W_o through the singling out of local functions-stages (w^{-i}), i.e. $W_o = \sum w^{-i}$. Hereby:

$$T_o(W_o) = \sum (T^{-i}(w^{-i})). \quad (3)$$

3. *Thirdly*, it is suggested to use eight levels of managing industrial eco-development IP (φ_{1-8}) when simulating organizational structures of sustainability regulation:

φ_1 — international level of sustainability management of industrial ecosystems of IP construction;

φ_2 — state level of sustainability management (national);

φ_3 — state level of sustainability management at the regional level of constituent entities of the Federation;

φ_4 — municipal level of sustainability management;

φ_5 — level of sustainability management of individual specialized IP projects;

φ_6 — level of sustainability management of IP withing the framework of special economic zones;

φ_7 — procedural sustainability management of IP based on corporate, national and international standards;

φ_8 — sustainability management as the expanding eco-development system based on business partnership and integrated initiatives;

φ_9 — business process level of sustainability management of IP investment projects.

4. *Fourthly*, the spatial-temporal functional organization of IP reproduction processes in industrial eco-construction requires singling out of a special functional type of capital construction facilities in the form of territorial specialized systems by types of cluster portfolios of reproducible industrial real estate (Ω^*). This is predetermined by the specialization of IP residents' activities and the targeted territorial specialization of the IP themselves.

The presented four-component elements of the research paradigm of theoretical and practical simulations of methodological approaches and recommendations for structuring the life cycles of accelerated industrial construction and the efficient functioning of industrial parks based on sustainable eco-development model, allowed us to develop a fundamental functional GD_{ip} model. The authors define it as an integral dynamically adaptive structure composed of consolidated interacting local functional-target subsystems presented in formula (4), controlled by four main criteria of mini-max:

$$GD_{ip}(W_o) = [[(Q_o) \cap (W_o) \cap (\Phi_{1-8})] \cap [(w^{i-j}) \cap (\Omega^x)]] \rightarrow (E_{ij}^{nm}; E_{PDij}^{sf}; R_{pd}^m) \rightarrow (C_{own}^{\min}), \quad (4)$$

where E_{ij}^{nm} — the organizational and economic reliability of W_o life cycles of IP industrial construction indicator that demonstrates a maximizing tendency; E_{PDij}^{sf} — the organizational and economic reliability of operation of an industrial eco-development system indicator that demonstrates a maximizing tendency; R_{pd}^m — the overall GD_{ip} sustainability performance indicator that demonstrates a maximizing tendency; $C_{own}^{\min}$ — total cost of ownership of industrial real estate for IP residents' indicator that demonstrates a minimizing tendency.

Thus, taking into account the formulated research paradigm, it is determined that to simulate the structure of the life cycle stages of an industrial eco-development W_o type IP, it is necessary to identify four target functional subsystems GD_{ip} :

- sustainability function-task Q_o ;
- functions-stages w^{i-j} on structuring common life cycles — W_o ;
- functional-stages of sustainability management — Φ_{1-8} ;
- the functional types reproduced a cluster-portfolios of the industrial real estate Ω_x .

The quantitative assessment of the criteria applied to organizational and economic reliability of GD_{ip} life cycles is methodically defined by the authors as the extent of mutual compliance between key investment and construction decisions consistently designed by both the IP management company and residents at various stages of the GD_{ip} life cycle. Other criteria assessments were also accomplished within the framework of the initiative study and are based on existing methodological approaches to their calculation, with view of the specifics of the subject of study. To determine the integral values of organizational and technical reliability, sustainability and efficiency, the authors used the T. Saati method and the theory of reliability. Within the framework of this approach, an appropriate methodological apparatus has been worked out for the quantitative assessment of all accepted criteria of GD_{ip} functioning.

The authors' methodological approaches represent their research position, do not pretend to be complete and are intended for further testing and elaboration.

RESULTS

One of the particular results of the study is the implementation of conceptual clarifications in relation to the accepted subject of research. In the most general form, it is proposed to identify the concept of industrial eco-development of industrial parks as a system of professional activity in the field of accelerated high-performance industrial construction, consisting of a specialized management company and residents involved in public-private partnership, with targeted activities based on sustainability functions-tasks, functions-stages of structuring life cycles, functional levels of sustainability management and functional cluster portfolios of reproducible industrial real estate facilities, regulated by indicators of reliability, sustainability, performance and cost of ownership.

IP industrial eco-development models allow for accelerated industrial construction and the establishment of corporate target alliances of business partners (residents, management company, construction, logistics, transport, operational, etc. companies) united by the process of ecological and sustainable reproduction of industrial land and property real estate complexes.

At the same time the target criteria for the efficient accelerated industrial construction of large complex industrial facilities in IP are

the maximum ecological and economic efficiency, productivity, reliability at a minimum total cost of the industrial real estate ownership for various residents.

The most important trends of the national market for the construction of industrial parks features a steady increase in this market segment with an average annual growth of about 23 % per year over last 8 years. At the same time industrial parks were established in 66 regions, which means a twofold increase compared to 2013.

It's a fact that the market capacity of the national market of industrial construction of IP increased from 789 billion rubles in 2013 to 1,700 billion rubles in 2021 featuring a total growth index of 2.1 times for this period and an average growth index of 14.2 % per year.

The steady trend of development of industrial parks is also backed by both growth in the number of jobs, and total area of industrial parks in operation. The analysis shows that the number of jobs rose from 16,315 in 2013 to 41,627 in 2020 with average annual growth rate of about 20 %. Also, the total areas of existing parks demonstrate an average annual increase of 24 %. It grew from 56,773 ha in 2013 to 165,395 ha in last year.

A study of industrial parks by their types showed that in Russia there is a predominant development of industrial parks of the green-field type — it is about 60 %.

Most industrial parks are private in Russia (about 70 %). The efficiency of IP investments is in line with the ratio of infrastructural costs to production investments that equals 1 to 10.

The study of statistic data proves the success of the national market of industrial parks. It is assumed that its current growth may be limited to 310, and this number will meet the current demand for this type of industrial construction.

Moreover, a promising trend in the development of IP is the development of ecological industrial parks in Russia, functioning on the principles of a closed-loop economy. For these purposes, it is necessary to elaborate a special national standard and test it in one of the Russian regions.

When adding the life cycle sustainability indicator to the GD_{ip} structuring methodology, authors pilot-tested it at Severny Almaz industrial park in the East Siberian region at the early stages of its design.

It is assumed that GD_{ip} performance and the mini-max criterion adherence can ensure the maximally efficient sustainable accelerated industrial construction of IP. It means that efficiency, reliability, integral sustainability is maximized, and cost of ownership of industrial real estate in IP is minimized for residents. For initial testing, the authors focused on the criteria of organizational and economic reliability of life cycles as variety of the sustainability index GD_{ip} .

When calculating the organizational and economic reliability of the life cycle of industrial eco-development IP, calculations are made at various stages of W_o . At the same time, the unit indices of the E_{ij}^{nm} of the GD_{ip} system at the final stage of commissioning W^v always dissipate (decrease) compared to the unit base value at the zero stage. Four stages are used in calculations — from the stage of prospective preparation of industrial construction IP W^i , land development IP W^l , investment and construction development IP W^m to the operational development IP cycle W^v .

As a methodological basis for E_{ij}^{nm} calculations related to the life cycles of industrial construction, indicators of the intensity of construction and installation works are calculated with regard to their mutual correspondence (I–II–III–IV). The correspondences

► system was defined via 2 components. Firstly, through indicators of the terms of construction T . Secondly, through the indicators of the value of investments V . The obtained values can be illustrated by the following calculations with L_{rel}^O system (III–II) data:

$$E_{ij}^{nm}[T] = \{T(0)[W^I] = 5.25 \text{ years}\} / \{T(0)[W^{III}] = 7.75 \text{ years}\} = 0.72;$$

$$E_{ij}^{nm}[V] = \{V(0)[W^I]\} / \{V(0)[W^{III}]\} = 0.85;$$

$$E_{ij}^{nmO}[W^{I-III}] = 0.72 \cdot 0.85 = 0.61.$$

Thus, the reliability according to the indicator of organizational and economic reliability for the first stage of the construction life cycle of the Severny Almaz industrial park in terms of construction intensity was 0.61.

Additionally, the integral efficiency of GD_{ip} was calculated using the T. Saati method, a synthesis of seven local subsystems: organizational and economic reliability of construction in GD_{ip} ; business activity; potential capacity; innovation; system performance; profitability; environmental potential of IP investment projects. Eventually, the final efficiency of P_{pd} for the first stage of industrial construction was estimated at 2.822, which is illustrated by the formula (5):

$$R_{PD(t)}^{norm} = 0.9 \cdot 1.1 \cdot 1.2 \cdot 1.1 \cdot 1.8 \cdot 1.25 = 2.822. \quad (5)$$

According to the calculations, the actual complex efficiency was 2.912, which confirms the efficiency of GD_{ip} management.

The pilot-testing of this technique is experimental and incomplete due to problems in collecting some data. The interpretation of the obtained results and the essence of the methodology require further elaboration and doesn't aspire to be complete.

DISCUSSIONS

The research has proven the relevancy and complexity of theoretical and practical task to simulate the development of the national market of industrial construction of IP from the viewpoint of eco-development and sustainable development. In this regard, this diversity determines the multiplicity of the evolution of the methodological approach.

Debatable issues are the following.

1. The relevance of updates in the field of national standards applicable to ecological industrial parks and the corresponding models of eco-development IP. It is also necessary to provide for the upgrade of industrial parks in operation into the ecological ones using a closed-loop economy.
2. The need to upgrade GD_{ip} models corresponding to four types of industrial parks: a private park of greenfield type; a private park of Brownfield type; state park of greenfield type; a state park of Brownfield type; mixed models.
3. The application of the theory of organizational and technical reliability and efficiency of the industrial construction IP life cycles requires further adjustments from the modeling positions in GD_{ip} of its individual subsystems and the mechanism of their integrative synthesis in a single indicator.
4. Performance indicators of the ecological and economic efficiency of the IP cyclical economy, as well as the relevance of the formation of specific models of efficiency and productivity, require update at the national and international level of standards for

the verification of industrial construction to assess the "greenness", reliability and integrated sustainability of IP life cycles.

5. We assume that a promising area of research is the need for more detailed studies on the theory of the ownership cost of industrial real estate for IP residents in the early pre-investment phases of the feasibility study of industrial parks construction.

The controversial issues mentioned in this article reflect only a small part of the problems of the development of IP industrial construction management methodologies. The authors express confidence that these studies will provide an opportunity to develop a creative approach for all interested parties to the issues in focus.

CONCLUSIONS

The research conducted has proven the importance of studying issues of the industrial construction development of industrial parks based on simulating life cycles of their functioning as sustainable models of industrial development. This will ensure accelerated development of industrial infrastructure in order to create competitive industrial potential in a turbulent economy. Perfecting the industrial parks market allows to establish national industrial infrastructure ensuring the accelerated start of competitive business projects. In this regard, studies on modelling government tools to regulate the growth of competitive industrial potential of the country, gain high national economic significance.

The author's vision of the national market of industrial parks growth is proposed, the author's methodology of eco-industrial development is elaborated. This enables to identify potential for accelerated industrial construction of IP. Undoubtedly, the establishment of corporate target alliances of business partners (residents, management company, construction, logistics, transport, operational, etc. companies) united by the process of ecological and sustainable development will ensure stabilization of national economy in the context of present-day challenges.

The studies performed made it possible to specify the concept of industrial eco-development of industrial parks as a system of professional activity for accelerated and high-performance sustainable industrial construction. We consider very perspective to model activity of a specialized management company, residents and public-private partnership system based on sustainability functions-tasks, functions-stages of structuring life cycles, functional levels of sustainability management and functional cluster portfolios of reproducible industrial real estate, regulated by integral indicators sustainability and cost of ownership.

It is quite evident that author's vision of sustainable development enables to generate an additional eco-development value chain for the state regulating systems, managing companies and resident investors who would benefit from the accelerated construction of large industrial real estate facilities featuring the environmental priority of cyclic economy.

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Устойчивость промышленного строительства в жизненных циклах деvelopeмента индустриальных парков

Исследована проблематика устойчивого развития промышленного строительства индустриальных парков (ИП) на основе моделирования жизненных циклов их функционирования. С целью ускоренного формирования промышленной инфраструктуры для создания конкурентоспособного промышленного потенциала в условиях турбулентной экономики предложена модель промышленного экологического деvelopeмента.

Научная гипотеза исследования — создание и управление устойчивым промышленным строительством по сегменту индустриальных парков как современная разновидность ИП. В качестве основных индикаторов устойчивости высокопроизводительных деvelopeмента систем промышленного строительства ИП приняты: интенсивность строительства; уровень потребления совокупных ресурсов; продолжительность локальных этапов жизненного цикла промышленного строительства ИП; сокращение трудозатрат на этапах кооперированных связей; уровень устойчивости функционирования

промышленного строительства ИП в системе эко-деvelopeмента; адаптивность функционирования жизненного цикла управляющей компании к внешним условиям; наличие системы налоговых преференций в ИП; степень развитости логистических и транспортных инфраструктур ИП; результативность жизненных циклов бизнес-проектов резидентов ИП и моделей государственно-частного партнерства, и жизненных циклов промышленного экодеvelopeмента ИП.

Актуальность данной области исследований предопределяется значительной востребованностью проблематики развития действующих научно-практических подходов в области высокопроизводительного промышленного строительства индустриальных парков. Формирование рынка индустриальных парков позволяет создавать национальную промышленную инфраструктуру, которая обеспечивает ускоренный запуск конкурентоспособных бизнес-проектов. В этой связи, модели промышленного деvelopeмента инновационного сегмента промышленного строительства являются инструментарием государственного регулирования по наращиванию конкурентоспособного промышленного потенциала страны, таким образом приобретают высокую народнохозяйственную значимость.

Цель исследования. Разработка методических подходов и практических рекомендаций по моделированию жизненных циклов ускоренного промышленного строительства и эффективного функционирования промышленных парков на основе моделей устойчивого экологического развития.

Объект исследования. Развивающийся национальный рынок промышленных парков как особый инновационный сегмент строительства, ориентированный на ускоренное и высокопроизводительное промышленное строительство ИП.

Результаты. Актуализация проблемной модернизации рынка промышленного строительства промышленных парков как инновационного сегмента строительного рынка в условиях турбулентной экономики; обобщение отечественного и зарубежного опыта в области устойчивого развития территорий на основе моделей экологических промышленных парков и систем зеленого строительства и сертификации проектов; методический авторский подход по функциональной структуризации и критериальной оценке организационно-технической надежности, устойчивости и результативности жизненных циклов экологического развития промышленных парков; моделирование многовариантных и ситуационных показателей критериальной оценки устойчивости жизненных циклов экологического развития промышленных парков.

Ключевые слова: промышленное строительство, жизненные циклы, промышленные парки, эко-промышленные парки, промышленный развитие, экологический развитие, организационно-техническая надежность, устойчивость, результативность, вторичная застройка, строительство «с нуля», корпоративный альянс

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Indicators characterizing integration between investment construction companies and special economic zones in the course of implementation of an investment and construction project

The article addresses the generation of indicators characterizing the process of integration of investment and construction enterprises (ICE) and special economic zones (SEZ) in the course of implementation of investment and construction projects (ICP). The objective is to examine the external and internal environments of the subjects of interaction, given that these environments have factors of the meso-environment and the micro-environment. The key approach, used to synthesize the indicators, includes the analysis of information flows that take into account the prospects for the implementation of an ICP in a SEZ, and the efficiency assessment of the involvement of an ICE enterprise in the construction of a building, based on the analysis of financial and economic activities of the object under study (an ICE enterprise), the calculation of the rate of return and the cost effectiveness of investments, demonstrating the likelihood of integration of SEZ and ICE enterprises. The integrated monitoring of the information environment of impacts, produced by the entities of various origin, allows developing indicators of qualitative and quantitative characteristics of the subject of research with account taken of the external and internal effects that contribute to integration, or externalities and internalities. Having identified the nature of the influence, produced by external and internal effects, one can predict the scope of benefits and costs for interacting parties and demonstrate the strengths and weaknesses of potential integration of ICE enterprises and SEZ in the course of implementation of an investment and construction project. The monitoring results are presented as matrices of absolute and relative indicators that need to be brought to unified dimensions. The authors of the article suggest using a new system of indicators to attain strategic development goals set in the documents governing the improvement of the construction industry by solving the problem of the spotty siting of SEZs to implement sophisticated and unique ICPs.

Keywords: *special economic zones, investment construction enterprises, investment and construction project, integration, externalities, internalities*

INTRODUCTION

Currently, the prospects for using SEZs as an instrument of the cluster approach to certain types of construction work are specified in strategic policy documents^{1, 2}. The lack of well-coordinated plans of urban and spatial development of subjects of the Russian Federation has ended in the spotty siting of integrated development areas having the real estate infrastructure required for the implementation of sophisticated and unique industrial projects. One of the top-priority solutions is to take support measures and boost the demand for land use planning tools among the business community to consolidate the private and public capital towards improving the industrial and infrastructure-focused construction sector, identify the prospects for integration between ICE enterprises, as carriers of production factors, and SEZs as fundraising tools^{1, 2} [1]. However the lack of an unbiased assessment of the interaction potential, prognosticated benefits and costs of consolidated efforts, advantages of investment and construction activities in SEZs trigger the demand for relevant indicators [2]. External and internal environments, that translate into factors of meso- and micro-environments, serve

as the basis for the synthesis of indicators. It is generally accepted that indicators characterize quantitative or qualitative constituents of the phenomenon under study. Within the framework of the study, quantitative indicators convey the sale volume (or an ICP) [3, 4], calculated in monetary units or labour costs per unit of time. The data, needed to develop quantitative indicators, are extracted from accounting and management reporting documents, statistical data provided by authorized state statistics bodies, and information available in open sources. The mission of qualitative indicators is to demonstrate and evaluate the effectiveness of an enterprise in conditions of limited resources, and it is expressed in relative values. If applied to the purpose of the study, qualitative indicators are the values that are used to calculate the return on investments and an increase in the total value of the corporate capital as a result of integration.

The purpose of the article is to present the devised set of indicators and areas of their application within the framework of interaction between ICE enterprises and SEZs in the course of implementation of an ICP [3, 5]. The main tools, used to analyze and theorize the subject of research, include theories of infographic modeling [6–8], the P.K. Anokhin theory

¹ Strategy for the development of the construction industry, housing and utilities in the Russian Federation through 2030 with a forecast for the period up to 2035. URL: <https://www.minstroyrf.gov.ru/upload/iblock/672/V-Strategiya-na-sayt-i-GASU.pdf> (date of access: 22.05.2022).

² Strategy for the innovative development of the construction industry of the Russian Federation through 2030. URL: https://stroim.su.ru/uploads/user_files/files/str_2030.pdf (date of access: 24.05.2022).

of functional systems [7], the theory of externalities, and the theory of growth poles developed by Francois Perroux [9]. The results of the research methodology are presented in the form of matrices containing relative and absolute indicators.

METHODS

According to the P.K. Anokhin theory of functional systems and the theory of infographic modeling [6, 7], based on the analysis of various information flows and a need for the comprehensive monitoring of external and internal environments and a set of indicators, future indicators should be distributed between the foci of monitoring to convey formation and application processes within the framework of an ICE enterprise willing to conduct investment and construction activities in a SEZ.

At the first stage of the study, the proposed system of indicators was structured in compliance with its purpose. Indicators were distributed among the foci of the integrated monitoring of the collaborative environment and presented in Fig. 1.

The collaborative environment, that encompasses investment construction enterprises and a SEZ, is monitored to identify the benefits of an ICP project, including the commercial and social

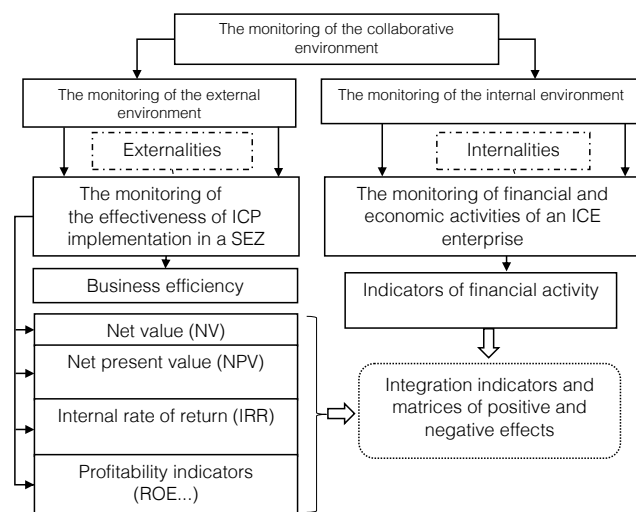


Fig. 1. The foci of the integrated monitoring of a collaborative environment

efficiency, demonstrated by external and internal effects that contribute to the integration or disintegration of interaction subjects. A matrix of absolute and relative indicators is formed on the basis of the monitoring results, that represent a combination of financial performance of an ICE enterprise willing to get involved in the implementation of an ICP.

The next stage of the study is focused on the generation of a management subsystem aimed at the integration of ICE enterprises with SEZ for the purpose of implementation of an ICP. Fig. 2 shows the route of input and output information from meso- and micro-environments, surrounding the subjects of interaction, and the decision-making by the person, who is responsible for integration and applies the proposed system of indicators [10, 11].

The management subsystem demonstrates the route of data towards the person responsible for interaction and integration.

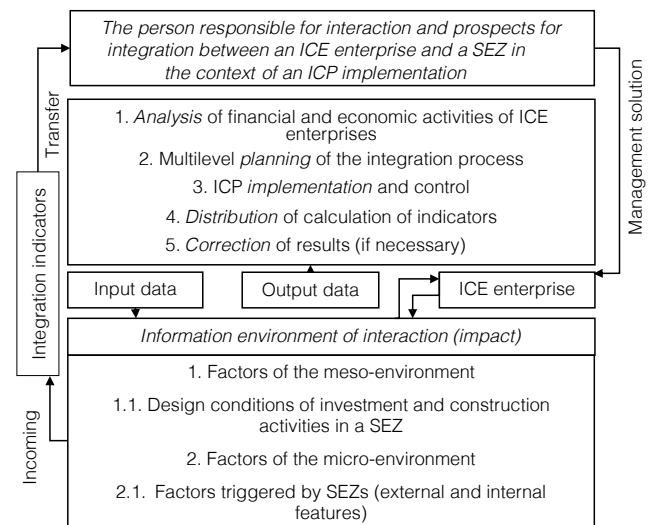


Fig. 2. A management subsystem for the integration between ICE and SEZ enterprises in the course of implementation of an ICP

An important characteristic of the subsystem is its ability to trace the relationship of the decision-making process in terms of the application of integration indicators and their potential change, since the information environment is rather dynamic than inert, and it has a response effect on the process of integration.

An essential stage of research is the identification of the properties of a set of integration indicators. Table 1 has a summarized description of the properties to be considered in the course of synthesizing indicators to make them relevant to the goals of scientific research.

Therefore, indicators of integration of ICE enterprises and

Table 1. Properties of indicators of integration between an ICE and SEZ enterprises in the course of implementation of an ICP

Property	Summarized description
Balance	The combination of financial and non-financial characteristics used to develop a set of indicators
Comparability	The availability of a benchmark that ensures the validity and objectivity of indicators
Retrospection	Account must be taken of time as an aspect of dynamic change in the project parameters and the environment of influences
Aggregation	Consolidation of individual indicators into a single indicator containing summarized information
Multi-stage nature	Usability of indicators at various stages of integration of ICE enterprises and a SEZ

a SEZ in the course of implementation of an ICP can be synthesized with account for the application of the research methodology and identification of areas in the environment to be subjected to integrated monitoring with account taken of the data coming from various information sources.

► RESULTS

Indicators of integration between ICE enterprises and a SEZ within the framework of implementation of an ICP correspond to the two types of monitoring: the monitoring of the internal environment, represented by the indicators of the analysis of financial and economic activities of an ICE enterprise willing to operate in a SEZ, and the monitoring of the external environment, characterized by the indicators describing the implementation of an ICP in a SEZ and the extent of involvement of an enterprise in a project [12, 2]. Table 2 has a list of relative and absolute indicators of financial and economic activities of an ICE enterprise.

Table 2. Indicators of financial and economic activities of an ICE enterprise in the process of integration with a SEZ

Absolute indicators		Relative indicators	
Revenue	R_{SEZ}	Coefficient of autonomy	C_a
Gross profit	P_{gr}	Coefficient of financial dependence	$C_{f.d}$
Cost of sales	CS	Capital productivity	CP
Inventory and costs	IC	Return on assets	R_a
The total value of sources of reserves and costs	TVR	Coefficient of current liquidity	C_l
Sufficiency of the working capital of an enterprise	SOWC	Coefficient of solvency	$C_{s.r}$
Tax deductions	T	Coefficient of capitalization	C_c

The proposed set of indicators demonstrates the financial stability of an enterprise, the structure of its capital, and the loan to equity ratio. These indicators demonstrate the solvency of an enterprise, its ability to honour the debt obligations, which is of key importance for integration prospects.

The next group of indicators encompasses effectiveness indicators of ICE enterprises and their involvement in ICPs [12–15], calculated using the formulas of simple and compound interest with account taken of the time factor, or the calculation of cash flows [16], presented in Table 3.

These interrelated indicators determine the nature of influence of external and internal effects of integration expressed through matrices of absolute and relative indicators presented in (1) and (2).

$$A = \begin{bmatrix} \dots & Y_1 & Y_2 & \dots & Y_m \\ X_1 & a_{11} & a_{12} & a_{13} & a_{1n} \\ X_2 & a_{21} & a_{22} & a_{23} & a_{2n} \\ \dots & \dots & \dots & \dots & \dots \\ X_n & a_{n1} & a_{n2} & \dots & a_{nm} \end{bmatrix}, \quad (1)$$

$$B = \begin{bmatrix} \dots & Y_1 & Y_2 & \dots & Y_m \\ X_1 & a_{11} & a_{12} & a_{13} & a_{1n} \\ X_2 & a_{21} & a_{22} & a_{23} & a_{2n} \\ \dots & \dots & \dots & \dots & \dots \\ X_n & a_{n1} & a_{n2} & \dots & a_{nm} \end{bmatrix}. \quad (2)$$

Table 3. Efficiency indicators of the ICP implementation in SEZs and the involvement of ICE enterprises

Absolute indicators		Relative indicators	
Net value	NV	Profitability index	PI
Net present value	NPV	Internal rate of return	IRR
Duration of preparatory work in case of implementation of an ICP in a SEZ	$T_{d,p}$	The ratio of the time of preparatory work to the time of construction and installation work in a SEZ	C_c
The time needed to obtain documentation and permits from authorized government agencies	$T_{d,p,g}$	—	

The task of the matrix is to predict possible benefits and costs of integration by generating patterns of interaction on the basis of intersections between the two above-mentioned groups of indicators.

Patterns are prospects for interaction, identified using the values of monitoring indicators of X_i , the 1st subject of interaction (the ICE enterprise), and Y_i , the second subject (the SEZ), and an in-depth study of the characteristics of patterns. The matrix conveys a certain dependence between the actions taken by ICE enterprises operating in SEZs.

Similarly, the matrix of relative integration indicators of ICE enterprises and a SEZ is shown in (3).

However, the applicability of these matrices is not limited to determining the possible effects of integration. In case of uncertainty, the matrix will have the form shown in (3).

$$C = \begin{bmatrix} \dots & E_1 & E_2 & \dots & E_m \\ D_1 & c_{11} & c_{12} & c_{13} & c_{1n} \\ D_1 & c_{21} & c_{22} & c_{23} & c_{2n} \\ \dots & \dots & \dots & \dots & \dots \\ D_n & c_{n1} & c_{n2} & \dots & c_{nm} \end{bmatrix}. \quad (3)$$

In case of uncertainty, the integration matrix is a means to assess various options for the development of interaction, when events, generated by the environment, such as E_i , are unknown or random. Subject D_i performs one of the procedures.

DISCUSSION

Given the research results, the authors believe that the development of indicators, needed to integrate ICE enterprises with SEZs, must be based on the study of the external and internal environments of the subjects of interaction. The key approach, that provides for the synthesis of relevant indicators, is the analysis of information flows and identification of possible effects of interaction between the economic entities of different origin. Selected areas of integrated monitoring, related to the analysis of financial and economic activities of an ICE enterprise and the assessment of its effectiveness during the implementation of an ICP in a SEZ, are used to identify important aspects of interaction, which are further expressed in matrices of absolute and relative indicators.

The proposed decision-making subsystem of interaction and subsequent integration of ICE enterprises and SEZ opens up broad prospects for studying and improving the decision-making process.

CONCLUSION

The authors of the article believe that the value of the study lies in the applicability of its results and methodology to various areas towards improving the performance of ICE enterprises. The matrices of absolute and relative indicators of integration predict patterns of interaction, which in the future will allow identifying a certain reliance on the actions taken by ICE enterprises and SEZs to clarify the problem of disproportion in the siting of the territories of integrated development that are necessary for the implementation of technically complex and unique construction projects.

An important result of the study is the visual representation of the management decision-making subsystem designated for collaborative interaction. It illustrates the route of output and input information coming from meso- and micro-environments. The ability to examine the relationship between the indicators of integration and decision-making by the person responsible for interaction allows for a more comprehensive study of the aspects of a dynamic environment that has a multi-level structure of factors of influence.

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Показатели интеграции предприятий инвестиционно-строительной сферы и особых экономических зон при реализации инвестиционно-строительного проекта

Статья посвящена изучению и формированию показателей, характеризующих процесс интеграции предприятий инвестиционно-строительной сферы (ИСС) и особых экономических зон (ОЭЗ) при реализации инвестиционно-строительных проектов (ИСП). Решение этой задачи заключается в исследовании внешней и внутренней среды, окружающей субъекты взаимодействия, представленной факторами мезосреды и микросреды. Ключевым подходом, используемым для синтеза показателей, является анализ информационных потоков, учитывающих перспективы реализации ИСП на территории ОЭЗ и оценку эффективности участия предприятия ИСС в возведении объекта строительства, основанного на анализе финансово-хозяйственной деятельности изучаемого объекта (предприятия ИСС) и расчете доходности и рентабельности инвестиционных вложений, отражающих вероятность осуществления процесса интеграции ОЭЗ и предприятий ИСС. Применяемый комплексный мониторинг информационной среды воздействия различных природо-возникновения позволяет разработать показатели, которые от-

ражают качественные и количественные характеристики предмета исследования, связанного с выявлением внешних и внутренних эффектов, способствующих интеграции — экстерналий и интерналий. Определение характера влияния внешних и внутренних эффектов дает возможность спрогнозировать величину выгод и издержек для сторон взаимодействия, демонстрируя сильные и слабые стороны возможной интеграции предприятий ИСС и ОЭЗ при реализации ИСП. Результаты мониторинга представляются в виде матриц абсолютных и относительных показателей, которые необходимо привести к единой размерности. Авторы статьи предлагают применять разработанную систему показателей для осуществления целей стратегического развития, изложенных в программных документах по совершенствованию строительной отрасли, связанной с решением проблемы диспропорции размещения ОЭЗ, которые необходимы для реализации технически сложных и уникальных ИСП.

Ключевые слова: особые экономические зоны, предприятия инвестиционно-строительной сферы, инвестиционно-строительный проект, интеграция, экстерналии, интерналии

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Market capitalization of construction companies: the specifics of the valuation of assets and liabilities within the framework of the cost approach

The market capitalization of a company should be viewed as a strategic indicator of economic growth. The assessment of the market capitalization of an enterprise entails the application of three standard approaches, including the cost approach based on the assessment of assets and liabilities. The application of the net asset method in the valuation process provides for the adjustment of balance sheet indicators; assets and liabilities obtain market valuations. Adjusted net assets can reflect the investment attractiveness of companies, having significant amounts of work in progress, substantial profitability fluctuations, which fully applies to the construction industry. Accounts receivable and accounts payable are part of the monetary relations of an enterprise; they have a specific circulation pattern, that predetermines the methodological problems of their market valuation. This article explores possible approaches to adjusting the book value of receivables and payables, suggests corrective factors, including the time period for debt repayment, financial capabilities of an enterprise. Proposed approaches to the discount rate are to take into account the time factor. A system of indicators and a methodology for adjusting overdue debts are proposed to assess the financial condition of the debtor.

Keywords: business valuation, cost approach, assessment of accounts receivable, assessment of accounts payable, cost factors, taking into account the time factor, debt adjustment



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INTRODUCTION

The general state of the construction industry can have a negative impact on the activities of construction contractors. In recent years, the construction industry has demonstrated a positive trend, or a growing amount of work performed. In 2020 and 2021, the growth in the amount of work reached 100.7 and 100.6 %, compared to the previous year. At the same time, the business confidence index has remained low since 2020. Despite the growing amount of work performed, the availability of construction machines, whose service life exceeds the standard depreciation period, remains at a high level in the industry. In particular, in 2021, the share of near-end-of-life construction machines ranged from 33.6 to 63.0 %, which boosts the risks for construction companies.

The current situation reduces the investment attractiveness of the construction industry and inevitably reduces its economic stability. Under such conditions, the market capitalization of a construction organization becomes a universal criterion for the financial and economic activities of a company¹. The corporate market value assessment and use as a management indicator will solve the following most important tasks [1]:

- solving investment problems, focused on attracting investors, merging companies;
- identifying the effectiveness of long-term management solutions related to the modernization of current industries and establishing

new ones; developing new types of products; entering new markets.

Valuation standards ensure the use of three approaches to the market value of a company, including cost, income and comparative ones. Features of the application of these approaches and corresponding methods are considered in the works of domestic and foreign scientists² [2–8]. From the standpoint of assessing the investment attractiveness of companies, it is advisable to determine the market capitalization using the cost approach, which is based on determining the market value of corporate assets and liabilities. Despite its significant labour intensity, the cost approach allows to reliably display the property status, its dynamics, weaknesses and possible points of growth.

The cost approach allows determining not only the direction of business development, but also development tools, since both assets and liabilities are assessed. This approach to valuation is dominant in the valuation of companies whose activities entail large sets of property, significant amounts of work in progress, fluctuations in profitability, large indicators of receivables and payables. These features are typical for the construction industry.

Accounts receivable, like bills of exchange, IOUs, and other similar securities, can circulate on the free market in a specific form. This specificity lies in the fact that accounts receivable are not goods and can be realized in the form of an assignment of claims. Therefore, there are certain restrictions

¹ Federal State Statistics Service. URL: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/finance (accessed: July 10, 2022) (rus.).

² Kozyr Yu.V. Assessment of receivables. URL: <http://srroo.ru/upload/iblock/ada/ada317715bf57d213fbab1cd38ba3db5.pdf> (accessed: February 10, 2022) (rus.).

► imposed on the market valuation of this asset. Accounts payable are also part of the financial relations of an enterprise; their value affects the market value of a business undertaking, risks and uncertainties.

The study of approaches and specific methods for assessing the receivables and payables allows us to conclude that the assessment tools conveying the activities of construction companies have not yet been generated in full in the current economic environment. Given the importance and the problematic nature of the assessment of receivables and payables, we consider them in more detail.

METHODS OF MARKET VALUATION OF RECEIVABLES AND PAYABLES

According to the Federal Standard of the Market Valuation (Federal Standard No.8)³, two valuation hypotheses might be used when a cost approach is applied to evaluate a company: a business entity is either considered as a growing concern or its winding-up and sale of assets is expected. In any case, the market valuation of the company's assets and liabilities is required. Potential assessment approaches are considered in the works of domestic scientists² [1, 4, 9, 10]. The economic instability triggers non-payments, a mismatch between the real and nominal values of receivables and payables; therefore, the assessment needs to take into account trends in the development of the economy, including a particular industry.

The analysis of current approaches to valuating receivables shows that two stages are considered:

- the analysis and grouping of receivables subject to the parameters of debtors;
- the adjustment of the book value of receivables based on a proposed ratio (or several ratios) to get to the market value of an asset.

In the course of valuation, receivables are divided in two types: delayed receivables (still to be paid) and overdue receivables (past due). Ways to evaluate overdue and delayed receivables are different since as of the date of valuation overdue receivables are already depreciated and the prospects to collect delayed receivables are still to be ascertained.

The following information should be taken into account when receivables are analyzed [7]:

- the history of collecting receivables; the percentage of overdue or unpaid receivables in the total debt owed to a specific debtor;
- possible trends in the depreciation of receivables as a result of inflation and other factors at the present stage of economic development in a specific sector of economy;
- the probability of bad debts subject to the industry where the debtor belongs;
- the corporate payment deferment policy;
- the corporate behaviour in relation to the repayment of liabilities when accumulating receivables.

In case of a guaranteed repayment, no receivables are adjusted and their market value shall be equal to the book value. Bad debts are of zero value [7].

Almost all and every research into the market valuation of receivables is focused on finding a mechanism of determining the depreciation of receivables, but approaches differ. For instance, only the factor of inflation is suggested to be taken into account and used to calculate the current value of receivables by adjusting it for each overdue month. Monthly inflation is taken as a discount rate and by the way of discounting one can determine the loss of value of receivables in the i -th period and then cumulatively for the whole period of being overdue [11].

The ratio method of valuation is based on the following formula⁴:

$$C = C_B k_o, \quad (1)$$

where C is a market value of receivables, monetary units; C_B is the book value of receivables, monetary units; k_o is the receivables depreciation ratio, unit fraction.

The method allows for unbiased results, if the depreciation ratio can be linked to parameters of a specific debtor, probability of collection, overdue period, which requires the systematization of receivables of a specific company using the above attributes.

A more thorough look into the valuation problem is implemented in a method of adjustment ratios used to adjust the book value of receivables⁵. The market value of the debt is calculated according to the formula C :

$$C = C_B \Phi = C_B \frac{1}{(1+i_o)^t} [k_1 d_1 + k_2 d_2 + \dots + k_j d_j], \quad (2)$$

where C_B is the balance sheet value of accounts receivable; Φ is the cumulative ratio of a decrease in the book value of debt, unit fraction; i_o is the discount rate corresponding to a return on risk-free investments, unit fraction; k_{1-j} are the ratios describing the depreciation of receivables using various factors, monetary units; d_{1-j} are the weights of ratios k_{1-j} , unit fraction.

Depreciation ratios, provided for by this method, reflect the factors listed below: the financial condition of the debtor, the financial collateral for the receivables, the debtor's goodwill, the period when receivables are overdue. The share of the said ratios in the total result is determined by experts using weights.

Yu.V. Kozyr² proposes a differentiated approach to discounting the nominal value of receivables. Specifically, in case of doubtful receivables the discount rate shall be formed based on a risk-free rate and the market risk premium and in case of receivables, the collection of which is beyond any doubt, the rate is to be calculated as follows:

$$i = \frac{i_D + i_K}{2}, \quad (3)$$

where i_D is the average interest rate for deposits, unit fractions; i_K is the average interest rate for deposits, unit fractions.

M.O. Ilyin⁶ proposes to determine the discount rate as the weighted average cost of capital:

$$i = i_D d_E + i_K d_B, \quad (4)$$

3 Federal valuation standard "Business valuation (FSO No. 8)". Approved by Order of the Ministry of Economic Development of Russia No. 326 (dated June 1, 2015). (rus.).

4 Coefficient method for estimating receivables. URL: <http://www.inbico.ru/metodologiya/debitorskayazadolgnost/83koefficientnayametodikaocenkidebitorskoizadolgnosti.html> (accessed: December 13, 2021) (rus.).

5 National college of appraisers. Methodology for estimating receivables. URL: <http://www.inbico.ru/metodologiya/42?debitorskayazadolgnost/81?metodikaocenkidebitorskoizadolgnostinko.htm> (accessed: July 30, 2022). (rus.).

6 Ilyin M.O. Methodological problems of estimating the value of the rights to claim receivables. URL: <https://srosov.ru/content/files/00/18/2d.pdf> (accessed: December 13, 2021). (rus.).

where i_D is the weighted average cost of capital, unit fractions; d_E is the share of equity, unit fractions; d_B is the share of debt, unit fractions.

As for the probability of collecting receivables, calculation is based on the following formula⁶:

$$C = C_B \frac{1}{(1+i)^t} p, \quad (5)$$

where t is a period of time between the date of valuation and the most probable forecasted date of collection of receivables; p is an integral ratio of repayment probability, unit fractions.

To determine the probability of return, the Harrington scale, adapted for assessment purposes, was proposed, according to which the probability of return ranges from 0 (bad debt) to 1.0 (absolutely reliable)⁶.

The use of the scale requires exhaustive information about the debtor, its goodwill, payables, structure of current assets, prospects of receiving income and its growth.

Hence, one can conclude, that approaches to valuating receivables, choosing reasons for adjustment, methods for reasoning discount rates and period are quite ambiguous.

RESEARCH RESULTS AND RECOMMENDATIONS FOR THE VALUATION OF RECEIVABLES

Figure shows the logical scheme we propose to value receivables as part of property approach to business valuation.

The proposed method of determining the market value of receivables requires that the account is taken of the two factors: the time factor of depreciation and the financial status of a debtor as a potential opportunity to settle the liabilities. Bearing the time

factor in mind, we propose adjusting both overdue and delayed receivables using various discount periods and given the probability and time of repayment. The following approaches to determining the overdue period t_p to be taken into account are in place.

Overdue receivables:

$$t_p = t_o + t_e,$$

where t_o — period of being overdue, months; t_e — expected time of collection, months.

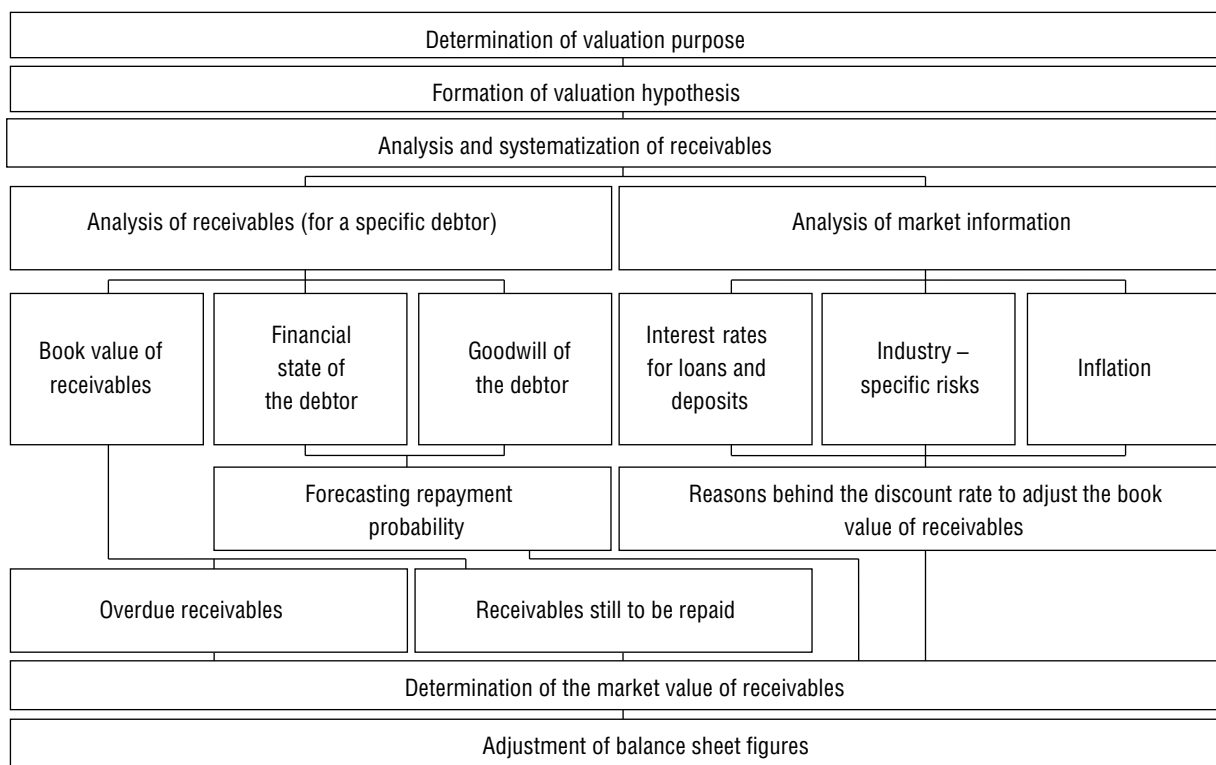
Delayed receivables:

$$t_p = t_e.$$

A risk-free capital investment rate, valid as of the date of valuation, should be used as a discount rate.

To assess the company's solvency, we recommend using relative liquidity ratios differing in terms of liquid assets treated as sources of coverage of short-term obligations, specifically [12]:

- cash ratio k_{CR} shows what part of current liabilities might be covered by the most liquid assets of the debtor (reference value $k_{CR} \geq 0.2$);
- critical liquidity ratio k_{CL} shows what part of current liabilities might be covered in the nearest time (reference value $k_{CL} \geq 1$);
- current liquidity ratio k_{CRL} shows the payment potential of the debtor provided that the settlements with its debtors are timely, and the sale of products is well-paced (reference value $k_{CRL} \geq 2$);
- for financially unstable debtor companies additional indicators of financial stability might be used and their values might be a reason for a probable period of debt repayment. These indicators include⁴:



- 1) equity ratio k_a (reference value $k_{CR} \geq 0.5$);
- 2) current asset coverage ratio k_{CAC} (reference value $k_{CAC} \geq 0.1$).

During the adjustment of the book value of receivables its share in the total value of assets shall be taken account of: if this share exceeds 30 %, this is deemed critical and might materially affect the future proceeds of the company [2]. That factor is the one to be born in mind for the purpose of forecasting the income flow during the business valuation.

The assessment of accounts payable is an assessment of the company's ability to obtain borrowed funds, since its share in the capital structure is the criterion used to assess the reliability of the borrower. A change in this indicator affects the company's liquidity and solvency indicators. To assess the state of accounts payable with subsequent adjustment, the following indicators are analyzed [12]:

- the average amount of accounts payable;
- the turnover ratio of accounts payable;
- the period of repayment of accounts payable;
- the share of accounts payable in the current liabilities.

For the purpose of assessing the value of the company, accounts payable are analyzed as a whole. The balance sheet value of its credit and loan liabilities is adjusted taking into account the interest rates of banks [13]. To make the final conclusions about the cost of accounts payable, it is advisable to focus on the criterion of the optimal ratio of accounts receivable and accounts payable, taking into account the fulfillment of the following condition [14]:

$$R_{adm} + \Delta OP \geq \Delta OC + LRR + P_{adm}, \quad (6)$$

where R_{adm} — allowable receivables; ΔOP — a change in the operating profit associated with the production and sale of products; ΔOC — a change in operating costs associated with the production and sale of products; LRR are the losses due to the untimely repayment of receivables; P_{adm} — allowable accounts payable.

For an in-depth analysis of accounts payable, it is necessary to analyze the balance of liabilities as of the end of the period according to the terms of formation. A comparative analysis of accounts payable and accounts receivable, determination of the company's net credit position will allow to more reasonably determine its market capitalization.

CONCLUSIONS

As seen from the analysis of the present investment and construction area, the number of factors, that can have a negative effect on a construction business, grows. This requires new strategic

management targets of a construction business. One of potential approaches is managing market capitalization, which requires the market valuation of balance sheet figures. The most problematic assets to be valued are accounts payable and accounts receivable. The availability of situation-specific and various solutions is the reason behind numerous valuation approaches and methods. Having considered the current views and solutions, the authors focus on an approach based on the economic balance as the most suitable method of capitalization management. Special focus is placed on selecting methods of valuating receivables as the least studied aspect of the problem. Authors limited themselves to considering a cost approach without detracting from the importance of income and comparative approaches.

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Рыночная капитализация строительных компаний: специфика оценки активов и пассивов в рамках затратного подхода

Рыночную капитализацию компании следует рассматривать как стратегический показатель экономического роста. Оценка рыночной капитализации предприятия предусматривает применение трех стандартных подходов, включая затратный подход на основе оценки активов и обязательств. Применение в процессе оценки метода чистых активов предусматривает корректировку балансовых показателей, активы и обязательства получают рыночные оценки. Скорректированные чистые активы способны отражать инвестиционную привлекательность компаний, имею-

щих значительные объемы незавершенного производства, существенные колебания показателей доходности, что в полной мере относится к строительной сфере. Дебиторская и кредиторская задолженности являются частью денежных отношений предприятия, имеют специфику обращения, что предопределяет методические проблемы их рыночной оценки. В данной статье исследованы возможные подходы к корректировке балансовой стоимости дебиторской и кредиторской задолженности, предложены корректирующие факторы, среди которых временной период погашения долга, финансовые возможности предприятия. Предложены подходы к формированию ставки дисконта для учета фактора времени. Предложена система показателей для оценки финансового состояния должника, методика корректировки просроченной задолженности.

Ключевые слова: оценка бизнеса, затратный подход, оценка дебиторской задолженности, оценка кредиторской задолженности, факторы стоимости, учет фактора времени, корректировка задолженности

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An earned value method in a smart system of construction project management

The article presents a brief overview of methods used to estimate the implementation of investment and construction projects. The advantages of the earned value method, areas of its development and prospects for its application in smart systems of construction project management are addressed. The author has developed a rhombus tolerance technique to standardize the implementation of construction projects and automatic deviation control. The valuation dependence on the value of construction and installation work is considered as an aspect of formation of a field of acceptable project implementation indicators. A dynamic dependence and correlation between the number of project assignments, valuation and schedule are revealed. The decomposition of project indicators into component groups is presented. Basic deviations, arising during the project implementation, including the total expenditure deviation, the deviation of the valuation of a unit of work, the productivity deviation, the deviation of the number of works, the deviation of the valuation of resources and the deviation from the schedule. The signal function of deviations of an implemented investment and construction project indicators is considered. Relevant management functions of the earned value methodology are identified. The author lists the basic situations that entail the implementation of signaling functions in the system of intelligent management of construction projects based on the earned value method. Situational precedents are identified as a methodological basis for future case modeling. The comparability of the earned value methodology and relevant construction engineering techniques is identified. Fundamental iterations of the implementation of the earned value methodology are developed. A decision-making algorithm, based on the principles of smart management, is presented for investment and construction projects. The author presents the areas of further improvement of the earned value method to optimize the management of construction projects.

Keywords: *an investment and construction project, an earned value method, deviation management, decision-making*

INTRODUCTION

We present a review of current approaches to assessing the valuation of investment and construction projects at the stage of their implementation [1–15]. The traditional method used to analyze the project valuation uses the concepts of the planned valuation of work according to the schedule and the valuation of the work, which is actually done. The traditional method of assessing the project valuation is simple and easily accessible, but it has the following disadvantages: there is no estimate of the project completion degree; the work, which is actually done at the expense of the money spent is not considered; there is not information about such project indicators as value and time; it is not possible to predict the future performance of the project work.

Project managers should have a lot of information about the execution of work relative to the plan, about the compliance with the schedule, about the deviations and their nature to make effective management decisions. These tasks can be solved by the earned value management (EVM) methodology that controls the main project parameters, including its planned, actual and earned valuation. According to the Project Management Body of Knowledge [10], the earned value management method conveys the actual physical progress of the project and the integration of the most important areas of project management, such as content, time and cost.

The application and development of the EVM methodology are studied in different ways [3]:

- modification of EVM model indicators; the earned schedule concept;
- using fuzzy logic and implementing a probability approach to improve estimates of real projects;
- control metrics for the adequate evaluation of the volatility impact on the project implementation;
- analysis of the EVM model dependence on experts' judgments;
- analysis of advantages and critical success factors of the EVM model in construction projects;
- the EVM model and quantitative methods of the control theory;
- analysis of the EVM model as the methodological basis of the theory of management decision-making;
- the EVM model as a component of investment analysis.

The earned value management methodology significantly expands the evaluation, in particular, prospects for automatic deviation management¹ [16–19]. Continuous earned value management of a project ensures early warning signals of project problems and opportunities, accurately and reasonably predicts its full or partial implementation,

¹ Sultanov I.A. Management of the mastered volume and timely solutions. URL: <http://projectimo.ru/realizaciya-proekta/metod-osvoennogo-obema.html> (rus.).

the risks of budget overruns and missed deadlines, penalties, and the launch of competing projects.

RESEARCH METHODOLOGY

A systematic approach, basic principles of the standard cost system, methods of economic and mathematical modeling, valuation parameters characteristic of an investment and construction project, decomposition methods of the project valuation and identification of deviations, projected prospects of an adaptive management model, methodological elements of software development and algorithm formation were applied to achieve the goal of the research.

RESULTS AND DISCUSSION

The earned value management method entails the use of a report on the earned value, the time-focused allocation of planned and actual values, planned amounts of work performed within the framework of a project, including the planned value, the actual value, and the earned value.

The controlled implementation of an investment and construction project is based on analytical indicators that convey the deviation of relevant accounting indicators from the planned ones. Control operations may be conducted for all component groups; methods of model differentiation are used in this study. Component groups are formed with account taken of the basic tasks of project management: objects, construction and installation works, structural elements, costs, resources, etc. The methodological plan is differentiated by absolute and relative indicators of each component group, which is further integrated into common implementation indicators of an investment and construction project.

At the micro-level of elementary work performed within the framework of an investment and construction project, project valuation can be considered as a linear dependence between the valuation and value of construction and installation works (Fig. 1). The variability of the valuation of an investment and construction project forms a diamond tolerance for standardizing processes of project implementation and deviation management.

The advantages of the earned value method allow to identify the dynamic dependence and correlation between the basic parameters of an investment and construction project implementation, including valuation, amount of work and schedule. For a detailed description of the studied dependencies, we will decompose the basic indicators of the earned value method to project unit indicators.

For example, the concept of the unit valuation of work V_{sp} , widely used in construction, allows to analytically decompose the valuation by the deviation factor — the unit valuation or the amount of work- and decomposition of the planned and actual value of work allows, in addition to all of the above, to control production P .

$$PV = PV_{sp} \cdot PQ = PV_{sp} \cdot PP \cdot T, \quad (1)$$

$$AV = AV_{sp} \cdot AQ = AV_{sp} \cdot AP \cdot T, \quad (2)$$

$$EV = PV_{sp} \cdot AQ = PV_{sp} \cdot AP \cdot T, \quad (3)$$

where PV_{sp} is the the planned unit valuation of construction and installation works; PQ is the planned amount of construction and installation works for the planned time; PP is the planned production;

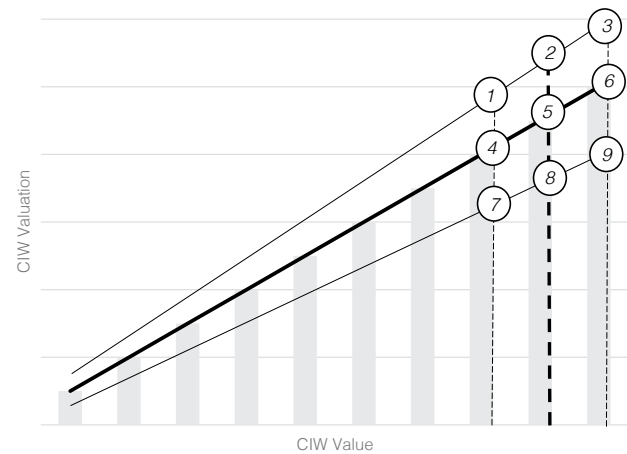


Fig. 1. Valuation variability of an investment and construction project: 1 — actual valuation of the overspending in terms of the actual backlog value; 2 — actual valuation of the overspending in terms of the planned value; 3 — actual valuation of the overspending in terms of the actual lead value; 4 — earned valuation of the backlog; 5 — planned valuation of the planned value; 6 — earned valuation of lead; 7 — actual valuation of actual backlog value savings; 8 — actual valuation of planned value savings; 9 — actual valuation of actual lead value savings

T is the control period; AV_{sp} is the actual unit valuation of construction and installation works; AQ is the actual amount of work performed during the planned time; AP is the actual production.

Single rates, presented in (1)–(3) by the type of work, allow to identify the use of resources for the implementation of these types of work in the future. A similar decomposition of the valuation of an investment and construction project can be performed in relation to objects, structural elements, costs, resources, implementers and other groups of components.

Given the basic methodological principles, the total deviation of the cost as of the date of control is the amount derived from the difference between EV , the earned valuation of the work performed, and AV , the actual valuation of the work performed:

$$\Delta C = EV - AV. \quad (4)$$

In (4), the indicator of the unit valuation of work and its deviation from the planned significance $\Delta V = (5)$, the indicator of production and its deviation from the planned significance $\Delta P = (6)$ are used:

$$\Delta C = PV_{sp} \cdot AQ - AV_{sp} \cdot AQ = (PV_{sp} - AV_{sp}) AQ = \Delta V_{sp} \cdot AQ, \quad (5)$$

$$\begin{aligned} \Delta C &= PV_{sp} \cdot AP \cdot T - AV_{sp} \cdot AP \cdot T = \\ &= (PV_{sp} - AV_{sp}) AP \cdot T = \Delta V_{sp} \cdot (PP + \Delta P) T. \end{aligned} \quad (6)$$

We will also consider the deviation of the amount of construction and installation works in natural terms as of the date of control. Similarly to the above, we assume a positive significance corresponding to favourable conditions and a negative significance corresponding to unfavourable conditions.

$$\Delta Q = PQ - AQ. \quad (7)$$

Then

$$AQ = PQ - \Delta Q, \quad (8) \quad \blacktriangleright$$

$$\Delta C = \Delta V_{sp}(PQ + \Delta Q). \quad (9)$$

In fact, we have proven the above (5) using other logical justifications.

In addition to the above method of decomposition of the deviation of an investment and construction project valuation, we will consider the deviation of expanded valuation ΔC_R in respect of resources.

$$\begin{aligned} \Delta C_R &= EQR \cdot PVR - AQR \cdot AVR = \\ &= AQR_{sp} \cdot AQ \cdot PVR - AQR_{sp} \cdot AQ \cdot AVR = \\ &= AQR_{sp} (PVR - AVR) AQ = AQR_{sp} \cdot \Delta VR \cdot AQ, \end{aligned} \quad (10)$$

where R is the type of resources; EQR is the earned amount of resources (the planned amount of resources by the actual value of work); PVR is the planned valuation of resources; AQR is the actual amount of resources by the actual value of work; AVR is the actual valuation of resources; AQR_{sp} is the actual unit amount of resources per unit of work during the control period; ΔVR is the deviation of the resources valuation.

Based on the above (7)–(10), factors of deviation of resources and project indicators suggest a deviation in the amount of resources, the resource valuation, the amount of work performed. The deviation of the valuation of an investment and construction project includes basic components of the deviation of direct costs, deviations of overhead expenses, the price for the contractor's work and other components in general and in each subject phase.

In turn, on the date of control, the schedule deviation is determined by the difference between the earned valuation of the work performed and the planned valuation PV of the work according to the schedule. Similarly to the work value deviation in natural indicators, we assume a positive significance corresponding to the favourable conditions and a negative significance corresponding to unfavourable conditions.

$$\Delta S = EV - PV. \quad (11)$$

In the above (11), it is possible to associate a deviation from the schedule with the unit valuation of work, which illustrates the fundamental methodological significance of this valuation discrepancy compared to the discrepancy determined by (6):

$$\Delta S = PV_{sp} \cdot AQ - PV_{sp} \cdot PQ = PV_{sp} \cdot \Delta Q. \quad (12)$$

Formula (12) has a deviation from schedule ΔQ , expressed in natural units or in units of construction and installation work value. The deviation from the schedule can be rationally used together with methods of network planning: an estimate of the event parameters, works and the network schedule, simulation of the project implementation based on the formation of a set of works, their prioritizing, determining the necessary resources and tasks that must be solved to complete the project.

In this paper, the author presents the basic part of design deviations DS , ΔQ , ΔCR , ΔV_{sp} , ΔP , ΔVR , ΔS and recommendations for establishing other significant deviations in the course of implementation of investment and construction projects. Basic deviations DS , ΔQ , ΔCR , ΔV_{sp} , ΔP , ΔVR , ΔS serve as signals of the complex system and a chain of events, which further ensures automatic adaptive project management, such as the coding and implementation of one or more smart algorithms using a specially designed and structured database. The process of smart project management is based on monitoring the signals and factor indicators, their analysis

taking into account the impact on the target indicator, forecasting possible changes and conditions for the management of the object development process, evaluating alternative solutions when choosing the most effective management actions.

The EVM methodology provides project management with the necessary information that allows to:

- determine the common progress of the project;
- control deviations according to project indicators, identify trends and prevent possible deviations;
- justify the need for additional work funding, rescheduling and shifting the end of work stages, increasing the project team;
- reducing and preventing the risks of work performed on the basis of objective indicators;
- justifying the need to withdraw from the project or transfer it to other implementing structures;
- optimizing resources allocation across projects;
- developing and implementing an adequate motivation policy for the project team by linking the corporate goals and the project team;
- accumulating and summarizing quantitative and qualitative chronological information, making databases;
- identifying current problems in the project management field.

The possibilities of the smart management of investment and construction projects may be expanded through the use of a situational approach. The earned value methodology is the analytical basis for assessing the state of an investment and construction project; it assumes the following basic situations. The situation of "Ahead of schedule and budget overruns" has a dual character. On the one hand, unplanned circumstances can lead to the overspending of funds in the course of performing the scheduled work. On the other hand, the work can be performed ahead of the schedule and, accordingly, more money is spent. The situation of being "Behind the schedule and having budget overruns" occurs when the work is performed in violation of the planned schedule and in excess of the planned costs. This situation is negative.

The situation of being "Behind the schedule and having budget savings" is either neutral or positive. On the one hand, the work can be done behind the schedule and, accordingly, money can be saved. On the other hand, there may be real savings of money which is a positive fact. The situation of being "Ahead of schedule and having budget savings" is non-standard. On the one hand, given the accelerated performance of work, money can be objectively saved. On the other hand, the project work implementation may be ahead of the schedule and budget savings are possible for the reason of the subjective nature of violations in the project and estimate documentation, work planning, accounting policy.

The implementation of the earned value management methods in the smart management system, applied to investment and construction projects, involves the following iterations.

1. Definition of the value and detailing of project work.
2. Creating a hierarchical project structure.
3. Setting control tasks at the level of individual components and indicators.
4. Responsibility delegation and the management schedule development.
5. Evaluation of the actual project implementation, control of earned value indicators and cost effectiveness.
6. Optimization of project costs during its implementation, taking into account the identified trends.
7. Management of work in progress.

8. Management of identified trends in the implementation of all stages of the project.

The construction valuation engineering system allows to quickly estimate and predict the results of the project based on the earned value methodology, to make management decisions based on a case approach used within the framework of an investment technology for the smart management of construction projects (Fig. 2).

This algorithm includes integrated tools for the cost estimation of projects and prospects for the automatic adaptive management based on the deviations from the design parameters using modern economic models of development trends based on the earned value methods. The use of the methodology, addressed in this article, will make it possible to form a special structured database for the systematic implementation of a smart management system for investment and construction projects.

Methodological advantages can be listed as a result of a summarized research into the earned value methods: the ability to get an accurate idea of the project state, identify violations of the financial project model, implement corrective management measures. At the same time, it is possible to present directions for the further improvement of the earned value methodology: identification and optimization of interrelations between deviations from project indicators, development of qualitative estimates of situations, development of methods of indicative estimates, a rational combination of methods of accounting and evaluation of project parameters, improvement of methods used for the forecasting of the earned value of investment and construction works. An improved methodology for evaluating and analyzing project implementation indicators will improve adaptive management according to a special algorithm used for the optimal development of investment and construction projects.

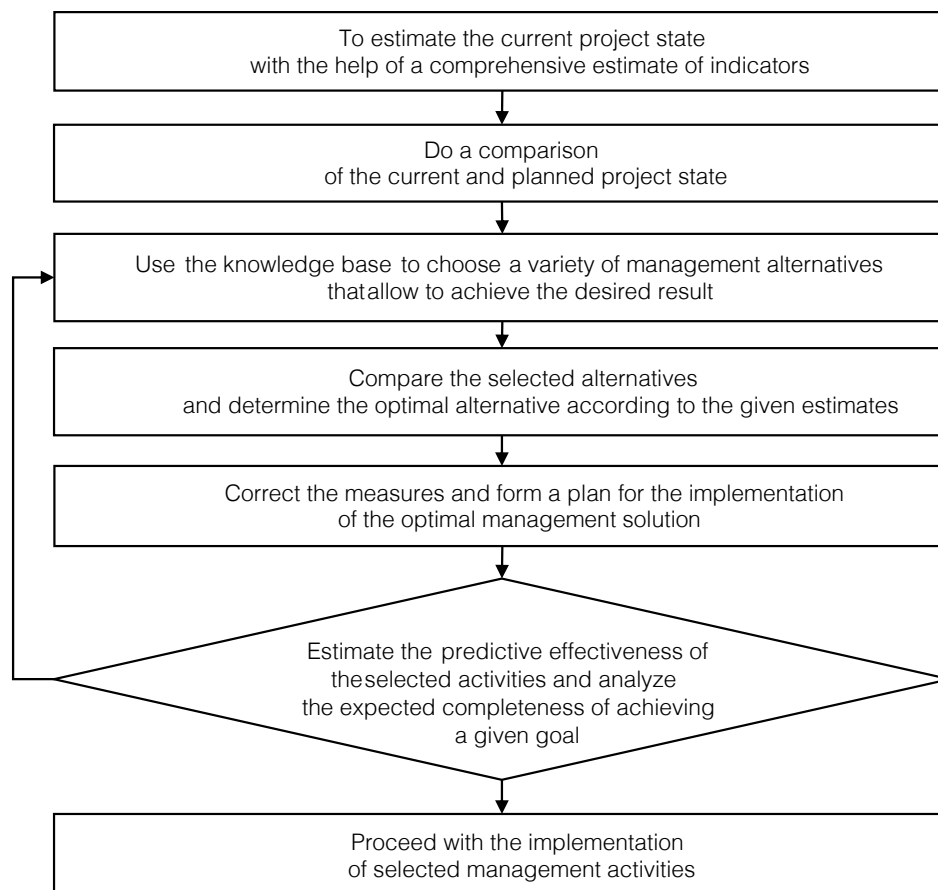


Fig. 2. A decision-making algorithm for the implementation of an investment and construction project

CONCLUSION

In this paper, indicators of deviations in the implementation phase of investment and construction projects are established, basic principles and specific features of the project management system are described using valuation engineering methods. A model of analytical indicators is developed; recommendations and formulas for the application of the earned value methods are presented to rise the efficiency of control of the valuation of an investment and construction project.

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Метод освоенного объема в интеллектуальной системе управления строительными проектами

Представлен краткий обзор методов оценки степени реализации инвестиционно-строительных проектов. Выделены достоинства метода освоенного объема, направления его развития и перспективы использования в интеллектуальной системе управления проектами. Автором разработан ромб-допуск для нормирования процессов реализации строительного проекта и автоматического управления по отклонениям. Рассмотрена зависимость стоимости от объема строительно-монтажных работ, как один из аспектов формирования поля допустимых показателей реализации проектов. Выявлена динамическая зависимость и взаимосвязь количества проектных работ, стоимости и расписания. Представлено разложение проектных показателей по компонентным группам. Определены базовые отклонения, возникающие при реализации проектов: общее отклонение по затратам, отклонение удельной стоимости работ, отклонение выработки, отклонение количества работ, отклонение стоимости затраченных ресурсов, отклонение расписания. Рассмотрена сигнальная функция полученных отклонений показателей реализации инвестиционно-строительного проекта. Выявлены актуальные управленческие функции методологии освоенного объема. В статье выявлены базовые ситуации для реализации сигнальных функций в системе интеллектуального управления строительными проектами на основе методологии освоенного объема. Идентифицированы ситуационные прецеденты состояния инвестиционно-строительных проектов, как методическая основа будущего прецедентного моделирования. Определена сопоставимость методологии освоенного объема и актуального строительного инжиниринга. Разработаны основные итерации внедрения методологии освоенного объема в систему интеллектуального управления проектами. Представлен алгоритм принятия решений в отношении реализации инвестиционно-строительных проектов, построенный на принципах интеллектуального управления. В статье представлены направления дальнейшего совершенствования методологии освоенного объема для оптимизации управления строительными проектами.

Ключевые слова: инвестиционно-строительный проект, метод освоенного объема, управление отклонениями, принятие решений

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Methodology for improving the agricultural suitability of land for the sustainable development of a territory

The concept of long-term socio-economic development of the Russian Federation predetermines the sustainable development of rural areas, as well as an increase in the standard of living among the rural population. These processes can be optimized within the framework of a competent urban planning policy by a geographic information system. Geoinformation systems ensure the sustainable development of a territory by using simulation tools to plan a set of environmental measures, as well as the measures to improve the agricultural suitability of lands. The article describes the data integration process towards the comprehensive assessment of the territory of the Russian Federation, describes the research methodology, and identifies the key factors that are behind the indicators of agricultural suitability of land. The authors present the preparatory stage, or data collection for a simulation model. The justification of development planning solutions for rural areas is provided as a detailed classification of lands and anthropogenic factors that affect the stability of the entire landscape system of a constituent entity of the Russian Federation. The method of an objective function and the use of the priority matrix is used to calculate the agricultural suitability of the territory. A set of environmental measures has been developed on the basis of the levels and types of damage and pollution of the territory of a constituent entity of the Russian Federation. The proposed set of measures is standard, although it includes an assessment of their effectiveness. The result of the study is presented in the form of the maps of the Rostov region, demonstrating the agricultural suitability of the territory for the crop production before and after the corrective measures. The conclusion discusses the prospects for the application of the simulation model, its versatility and advantages.

Keywords: sustainable development, rural settlements, simulation modeling, environmental sustainability, land suitability, agro-industrial complex, peripheral zones, territorial planning

Territorial development of rural settlements has long been based on a systematic approach. Theoretically, rural areas are studied using the geographical approach in conjunction with the assessment of socio-economic, environmental, and labour potentials. The Strategy for the sustainable development of rural areas of the Russian Federation (hereinafter — RF) for the period up to 2030¹ defines the sustainable development of rural areas, which includes the following list of simultaneous processes:

- an increase in the productivity of the agro-industrial complex (hereinafter — AIC) and the efficiency of agriculture;
- steady socio-economic development of territories;
- maintaining welfare, that is, ensuring the full employment of the rural population that will bridge the gap between the rural and urban population (up to 85 %);
- improvement of the level and quality of life among the rural population;
- rational use of natural resources [1].

The experience of various countries should be addressed to present the global development of rural settlements. The results of the analysis are provided below (see Fig. 1).

We should also mention the key foci of the EU policy that coincide with the development goals of rural settlements in the Russian Federation.

1. Sustainable rural development and environmental management, supporting the transition to climate-resilient agricultural production, forestry, and low-carbon food processing.

2. Innovative development of the agro-industrial complex and promotion of retention of labour and intellectual potential in the agro-industrial complex, forestry and rural areas in general.

3. Promotion of social inclusion, poverty reduction, and economic development of rural areas, the priority of preserving rural population.

4. Reproduction and more efficient use of land and other natural resources, environment-friendly initiatives in production [1].

The case study of rural development employs the following tools:

- geographic information systems and databases of agricultural land monitoring (EFIS ZSN as the information system on agricultural land) [3];
- databases on the status of parameters of socio-economic conditions in the RF subject, created in the ArcGIS ESRI environment (hereinafter — ArcGIS ESRI environment DB) developed in specific conditions and annually updated on the basis of the data provided by the Russian Federal State Statistics Service (Rosstat);
- data obtained as a result of the environmental monitoring of the territory of the subject of

¹ Strategy for the sustainable development of rural territories of the Russian Federation for the period up to 2030 : approved by the Government of the Russian Federation on February 2, 2015. No. 151-p. URL: http://www.consultant.ru/document/cons_doc_LAW_174933/2844094b7ba6e57e91fd5bb036ee91d9f6727238 (Accessed: May 10, 2022).

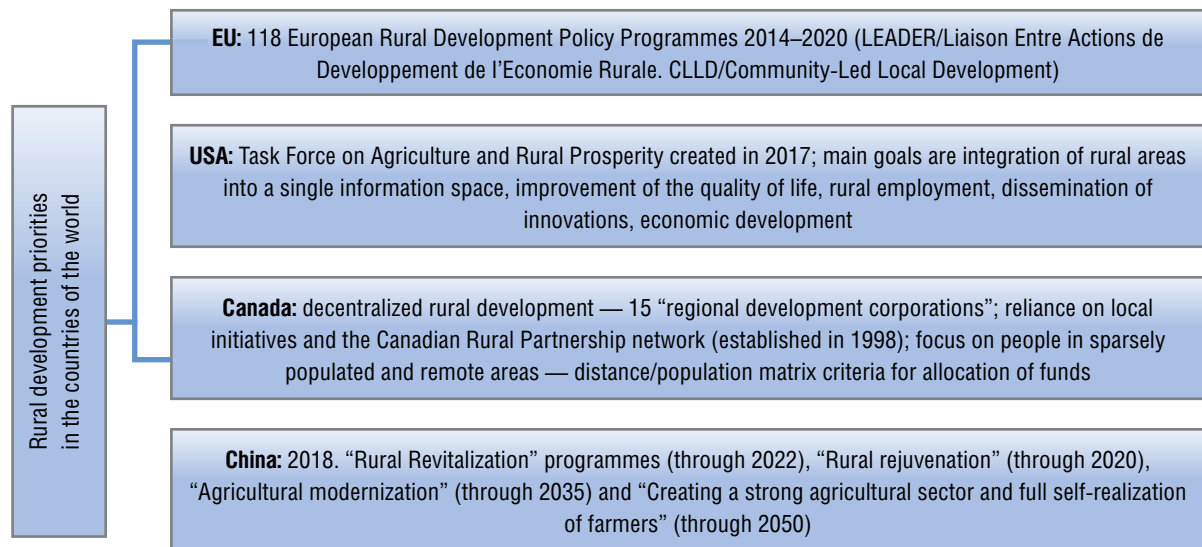


Fig. 1. Priority areas of rural development: the global experience [2]. *The left vertical line:* Priority areas of rural development worldwide; *the top horizontal line:* **EU:** 118 programmes of rural development in Europe for 2014–2022 (LEADER/Liaison Entre Actions de Développement de l'Économie rurale, CLLD/Community-Led Local Development); *the middle horizontal line:* **Canada:** decentralized development of rural territories — 15 regional development corporations; support through local incentives and Canadian Rural Partnership (est. 1998); principal attention is focused on the dwellers of remote and scarcely populated areas, a matrix criterion for the distribution of funds being the “distance/population density”; *the bottom horizontal line:* **China:** 2018 — Countryside Revival programme (through 2022), Countryside Rejuvenation programme (through 2020), Agricultural Modernization programme (through 2035), and Strong Agricultural Sector Creation and Self-Fulfillment for Farmers programme (through 2050)

Russian Federation integrated into the database in the ArcGIS ESRI environment DB;

- the land use layout for the RF subject integrated into the ArcGIS ESRI environment DB;
- information and simulation modeling, development and changes in the rural areas of the subject of Russian Federation.

The processes involving environment-friendly initiatives in production, decision-making optimization in urban planning policy, and monitoring of land are closely linked and require the development of a simulation model to improve the agricultural land usability [4]. The preparatory stage of designing a simulation model needed to improve the agricultural land suitability includes the steps shown in Fig. 2.

Hence, rural areas should be analyzed using the system of comprehensive assessment [5].

The implementation of all of the above steps allows to develop a simulation model to improve the agricultural land suitability (see Fig. 3).

Cartographic methods of visualization, applied to development processes and analysis of territories on the basis of GIS technologies, are an effective tool used by various target groups of specialists in the field of urban planning and regional management. The implementation and demonstration of the results of a comprehensive assessment of the territory in the ArcGIS ESRI environment allows to optimize the decision-making process by systematizing all incoming information and land monitoring data.

It is necessary to identify the main branches of agriculture and the degree of influence of the agricultural priority of land on their development following the comprehensive assessment of the territory of the RF subject. The key sectoral specializations of the agro-industrial complex are:

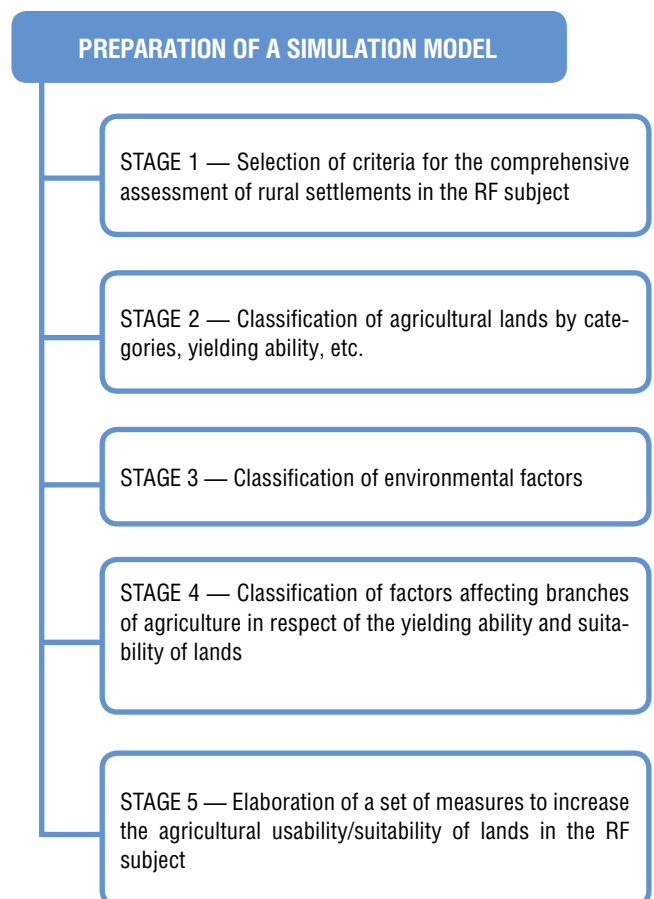


Fig. 2. Preparation of a simulation model

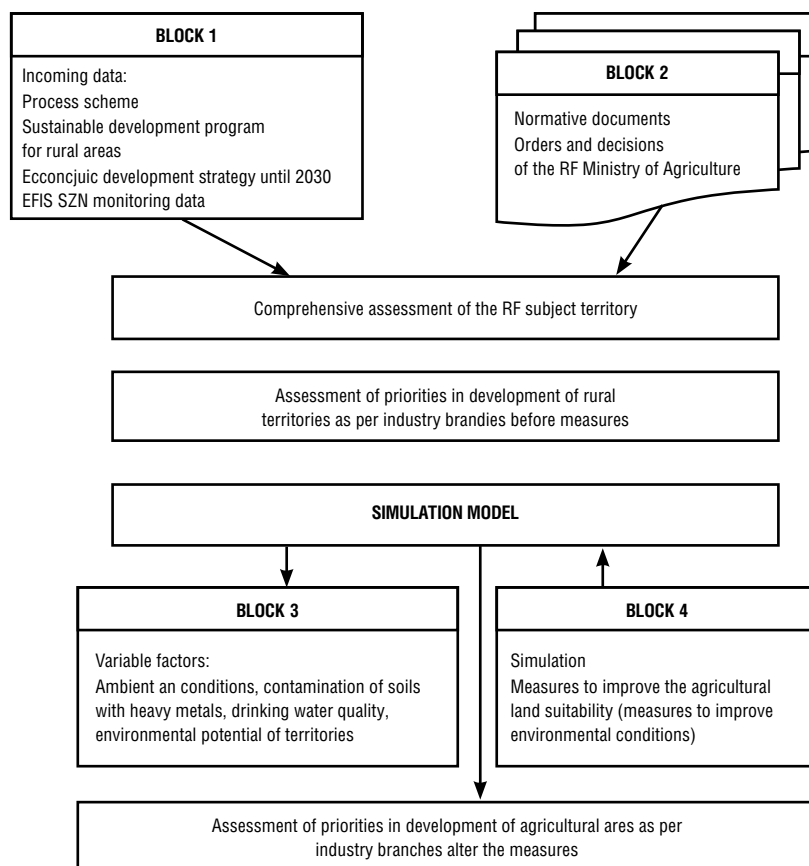


Fig. 3. Simulation of the agricultural land suitability enhancement in the RF subject

- animal breeding;
- crop farming;
- agricultural produce processing (enterprises and manufacturing facilities);
- machine building.

Therefore, crop farming and, indirectly, animal breeding have the greatest influence on the specialization and the agro-industrial complex of the territory. This means that it is reasonable to use the case of crop production and improvement of the agricultural land suitability in the subject of the Russian Federation to demonstrate the operation of the model under consideration and its implementation. Here we use the case of the Rostov Region, one of the leading agrarian regions in the country.

First of all, all stages of preparation for the simulation process are performed (see Fig. 2). The process of preparation is shown stagewise.

Stage 1. Selection of criteria for the comprehensive development assessment of rural settlements in an RF subject.

For this purpose, the factors, presented in Table 1 below, are employed to conduct a comprehensive assessment of the territory.

F7. The integral indicator of natural factors. The integral assessment of an area using natural factors encompasses two indicators: the ecological potential of natural landscapes and the sustainability of ecosystems.

F8. The integral indicator of the anthropogenic load is determined by summing up the impact on the natural and man-made environment (transport, production, agriculture, etc.).

Table 1. Comprehensive assessment factors

Identification	Factor	Numeric value, points
F1	Crop farming branches	0...1
F2	Animal breeding branches	0...1
F3	Agro-climatic resources	0...1
F4	Ploughland yielding capacity	0...1
F5	Agricultural stress	0...1
F6	Degradation of soils	0...1
F7	Integral indicator of natural factors	0...1
F8	Integral indicator of the anthropogenic load	0...1
F9	Atmosphere air pollution	0...1
F10	Pollution pf soils with heavy metals	0...1
F11	Drinking water quality	0...1
F12	Environmental potential	0...1

F12. The environmental potential includes the following parameters:

- air temperature;
- relative humidity;
- condensation processes in the atmosphere;
- heat supply.

Factors F9 to F12 are variable; when included in the simulation model, they allow to clearly demonstrate changes in the suitability of agricultural land. Each factor is scored from 0 to 1. The results of the comprehensive assessment of a territory are the basis for determining the agricultural (hereinafter — A/C) priority of territories.

Stage 2. Classification of agricultural lands (broken down into categories on the basis of the yielding capacity).

According to Article 22 of the Land Code, agricultural lands are the lands for the agricultural production, agricultural research and training activities, accommodation of the corresponding production infrastructure, or designated for these purposes (Table 2)² [7].

Stage 3. Classification of environmental factors.

The main pollution factors affecting the environment in the Rostov Region are:

- condition of the atmosphere air;
- pollution of soils with heavy metals;
- quality of drinking water.

Stage 4. Classification of factors affecting the branches of agriculture in terms of the productivity of land, its suitability for agricultural use.

The main factors of anthropogenic impact on soils are (Table 3):

- salinification;
- erosion;
- desertification;
- pollution, land disturbance during construction;
- mining;
- storage of wastes;

Table 2. Classification of A/C lands on the basis of the yielding capacity [6]

Group	Land type
Productive lands	Ploughlands
	Hay-making lands, including natural ones, improved, seeded with crop rotations of perennial grasses
	Pastures
	Fallow lands, which are not inarable, and other lands unsuitable for agricultural production
	Land occupied by perennial plantings (orchards, vineyards, etc.)
	Lands enclosed by water bodies used for the production of marketable products
	Land occupied by forests and shrub vegetation, which can be used to obtain marketable products
Non-productive lands	Land occupied by farm roads
	Land occupied by utilities, as well as linear and other structures not related to the agricultural production
	Lands occupied by trees and shrub vegetation intended to protect lands from the impact of negative (harmful) natural, anthropogenic and technogenic phenomena, protective forest belts
	Land occupied by enclosed bodies of water not used in the manufacturing of commercial products
	Fallow lands, which are inarable and other lands unsuitable for agricultural production
Lands occupied by buildings and structures	Land occupied by buildings, structures and facilities used for production, storage and primary processing of agricultural products
	Land occupied by other structures used in the process of agricultural production (sheds, drinkers, structures of reclamation systems, warehouses of solid mineral fertilizers, meliorative agents, etc.)

Table 3. Anthropogenic factors divided into groups

Group	Type of land	Description
Main factors	Soils, topography, water bodies, buildings, plants, animals, etc.	Static
Process factors	Plowing of soil, corrosion of metals, moving plants and animals, etc.	Dynamic
Phenomena	Air, water, soil pollution, radio waves, electric current, etc.	Variable

² The Russian Federation Land Code dd. October 25, 2001 No. 136-FZ (ver. dd. December 25, 2018) (with consequent amendments and additions, valid as of January 01, 2019): The RF Official Gazette. 2001; Oct. 29(44):4147.

- alienation of land for the purposes of industrial and municipal construction [7, 8].

Stage 5. Elaboration of a set of measures to improve the suitability of land for agricultural uses in the subject of the Russian Federation.

A set of environmental measures were developed and presented in Table 4 to improve the agricultural suitability of areas, which are rated as low priority ones as a result of assessment.

The result of a set of measures in the low rating areas is a rise in the indicators and, consequently, a higher priority rating of the territory for agricultural development (Table 4). This process is a simulation of an increase in the agricultural priority of the territory, and the measures are presented according to the above stated environmental factors with an assessment of their efficiency^{3, 4, 5} [9, 10].

After a comprehensive assessment of the territory of the Rostov region, the calculation of the agricultural specialization priority is made in respect of the crop production.

By compiling a matrix of the agricultural priority, significance coefficients are determined for each F1–F12 factor in respect of crop production, and then the calculation is made.

For this purpose, importance coefficients are determined (varying from 0 to 1) for each factor and entered into Table 5. It should be noted that the survey was conducted among a group of 5 experts with the help of the questionnaires developed for this particular task.

The A/C priority rating is calculated using the target function formula (1), by multiplying the matrix by the results of a comprehensive assessment.

$$P^j = \sum Q_i \cdot R_i^j, \quad (1)$$

where P is the value indicator (utilization priority) for j -th type of A/C specialization; Q is i -th relative value ratio of the territory;

R is the importance coefficient of the i -th factor for j -th type of A/C specialization.

The result of the calculation is a priority map of agricultural specialization, or crop production, implemented in ArcGIS ESRI (Fig. 4, a).

A set of environmental measures is needed to increase the arable land's suitability in the areas featuring low priority ratings. The simulation model is implemented and the recalculation of the P indicator is made anew as a result of environmental measures⁶ [11, 12].

After the implementation of a set of environmental measures and the recalculation of the rating of agricultural priority lands, the land use map, showing the crop production, looks like the one shown in Fig. 4, b.

The comprehensive land assessment and agricultural priority maps of the Rostov region, demonstrating the soil fitness for the crop production, the priority districts are: Egorlyksky, Tsimlyansky, Zernogradsky, Kagalnitsky, and Myasnikovsky. After the implementation of a set of environmental measures and the recalculation of the rating, the list is supplemented by the following districts: Sholokhovsky, Verkhnedonsky, Kasharsky, Salsky, Proletarsky, Tselinsky, Zimovnikovsky. Hence, the analysis of the maps shows that the suitability of land grows not only in the south-west of the region, but also in its southern and northern parts. Using such a parameter as the agricultural suitability of the territory, geographic information systems can clearly demonstrate future changes to be caused by the reduction in the anthropogenic load and implementation of environmental protection measures.

The proposed simulation model is universal and can be applied to the territory of any subject of the Russian Federation in the current conditions of natural and man-made environment and landscapes [13–15]. This model can find the most suitable sites and territories for AIC enterprises and the arrangement of

Table 4. Results of implementation of a set of environmental measures

Factor	Measures
Air pollution	Creation of sanitary protection zones, sewage treatment plants, introduction of lower emissivity technologies, treatment of emissions
Soil pollution	Development of systems for the recycling of industrial waste into secondary material resources; replacement of toxic waste with non-toxic waste; replacement of unrecyclable waste with recyclable waste
Water pollution	Development of different types of drainless engineering systems and water recycling procedures on the basis of wastewater treatment methods
Environmental potential	Removal of industrial enterprises from large cities and construction of new ones in sparsely populated areas with lands unsuitable for agricultural purposes; optimal location of industrial enterprises, taking into account the topography of the area and prevailing winds

Table 5. Priority matrix (selection of importance coefficients for factors F1–F12)

Branch	Factor											
	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
Crop farming	1	0.5	1	1	1	1	1	1	0.5	1	0	1

3 Key measures for environment protection. URL: <http://ecologylib.ru/books/item/f00/s00/z0000000/st014.shtml>

4 Basic processes of engineering protection of environment. URL: <http://msd.com.ua/processy-inzhenernoj-zashchity-okruzhayushhej-sredy/>

5 Guidelines on comprehensive assessment and functional zoning during district planning. URL: <http://russianreality.net/2014base/zastroyschik2/rukovodstvo19.htm>

6 State of Environment and its Impact on Human Health. Official web portal of the Rostov Region Government. URL: <http://www.donland.ru/Default.aspx?Pageid=80952>

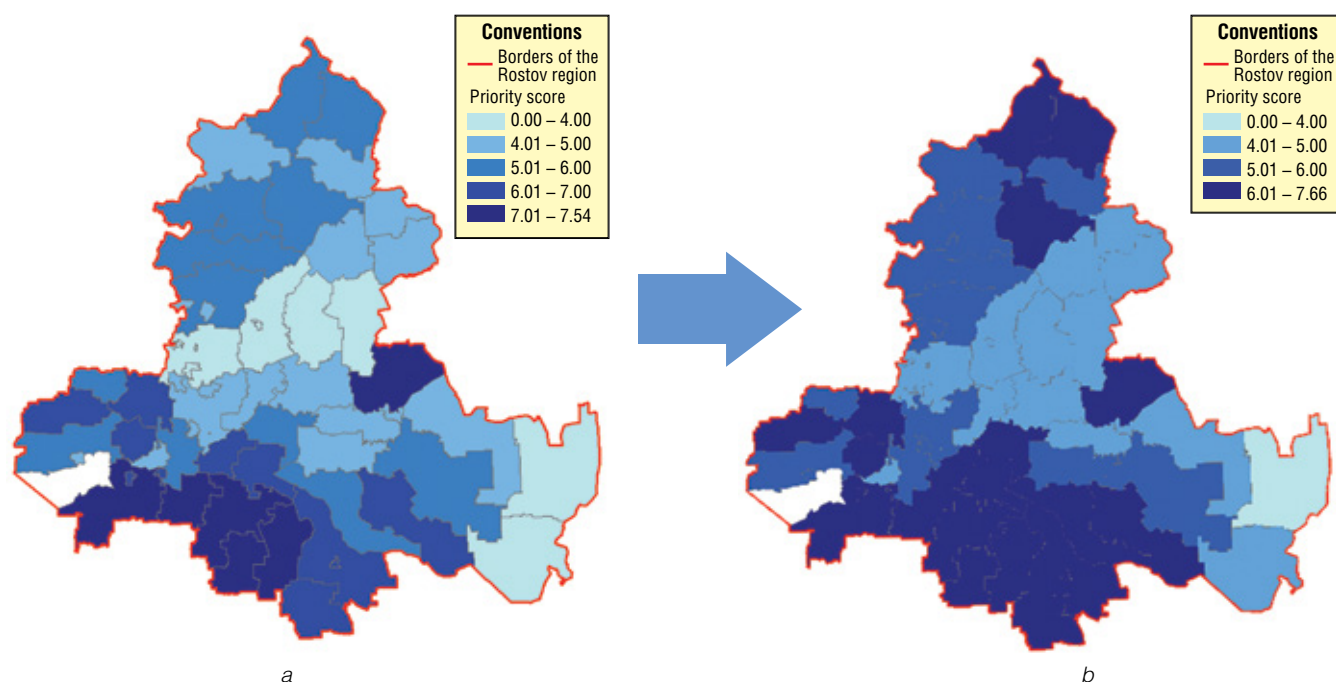


Fig. 4. A/C land priority rating for the purpose of crop farming in the Rostov Region: a — before the measures are taken; b — after the measures are taken

functional zones. The calculation of the rating of agricultural priority lands allows for:

- the targeted regulation of the use of territories according to their functions and suitability;
- the establishment of the optimal regime of land use for each area;
- the evaluation of the effectiveness of environmental measures and their composition according to the pre-set purposes;
- the determination of the sequence of land development, taking into account complexities and environmental conditions;
- the expansion of the developed land, taking into account the concept of sustainable development, without damaging the environment and reducing environmental risks.

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Методология повышения сельскохозяйственной пригодности земель для устойчивого развития территории

Концепция долгосрочного социально-экономического развития Российской Федерации предопределяет обеспечение устойчивого развития сельских территорий, а также повышение уровня жизни сельского населения. Оптимизировать эти процессы в рамках грамотной градостроительной политики можно путем создания геоинформационной системы их поддержки. Геоинформационные системы позволяют обеспечить устойчивое развитие территории за счет использования инструментов моделирования при планировании комплекса природоохранных мероприятий, а также мер по улучшению сельскохозяйственной пригодности земель. В статье описан процесс интеграции данных для проведения комплексной оценки территории Ростовской области, описана методология проведения данного исследования и выведены ключевые факторы, обеспечивающие показатели сельскохозяйственной пригодности земель. Представлен подготовительный этап сбора информации для создания имитационной модели. Обоснование решений по планированию развития сельских территорий также осуществляется с помощью подробной классификации земель и антропогенных факторов, влияющих на устойчивость всей ландшафтной системы субъекта Российской Федерации. Для расчета сельскохозяйственной пригодности территории используется метод объективной функции и применения матрицы приоритетов. Разработан комплекс природоохранных мероприятий, основанный на уровнях и видах ущерба и загрязнения территории субъекта Российской Федерации. Представленный комплекс мер является стандартным, но включает оценку их эффективности. Результатом исследования являются карты Ростовской области по параметру сельскохозяйственной пригодности территории для развития растениеводства до и после проведения корректирующих мероприятий. Заключение содержит выводы о перспективах использования имитационной модели, ее многогранности и преимуществах.

Ключевые слова: устойчивое развитие, сельские поселения, имитационное моделирование, экологическая устойчивость, пригодность земель, агропромышленный комплекс, периферийные зоны, территориальное планирование

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Using the microbial Anammox community to treat wastewater in cities and settlements

Anammox bacteria, discovered in the late 20th century, had a stimulating influence on the development of new wastewater treatment technologies. Processes, involving this type of bacteria, can occur both at urban treatment facilities and industrial enterprises, depending on the degree of contamination of incoming wastewater. In this article, the authors compare various technologies offered on the market for various purposes. The Anammox community of microorganisms is interesting because of its potential ability to purify wastewater saturated with nitrogen compounds, but poor in organic matter. Classical methods of removing biogenic elements cannot effectively treat this type of wastewater. The authors have revealed that in nature Anammox bacteria play a significant role in the nitrogen cycle as well as in the process of thorough biological wastewater treatment and removal of nitrogen compounds. Various patterns of the Anammox process are considered; they differ from one another in oxygen conditions and items of equipment. They are also recommended for the treatment of wastewater featuring different concentrations of contaminants at the inlet to the treatment plant. As a result, potentially effective development areas have been identified. The authors have proven that the quality of wastewater treatment can meet standard requirements if Anammox bacteria are used.

Keywords: *Anammox bacteria, Anammox process, denitrification, nitrification, MVK-Anammox, Sharon-Anammox, Demon, Deamox*

INTRODUCTION

Today, the task is to intensify processes to ensure their energy efficiency and improve the quality of wastewater treatment at wastewater treatment plants. If we address the treatment of domestic wastewater, the main indicators that determine the quality of wastewater treatment are the biological oxygen demand (BOD), chemical oxygen demand (COD), suspended solids and biogenic elements (nitrogen and phosphorus).

Particular attention is paid to technologies employed to remove biogenic elements, whose excessive content at the outlet from the reservoir causes eutrophication and the death of fish.

Historically, before it was identified that aerobic, anaerobic and anoxic microorganisms, including recently discovered Anammox bacteria, play the most important role in the life cycle of the nitrogen molecule, description of the natural nitrogen cycle had had certain assumptions. A certain role belongs to nitrogen fixers, which are both aerobic and anaerobic. The Anammox community is most important for the nitrogen cycle; it is particularly developed in the oceanic waters, the vital activity of which, along with denitrifying bacteria, saturates the atmosphere air with molecular nitrogen.

First of all, the newly discovered Anammox bacteria can be studied by specialists in applied biotechnology because of the strong potential of a new biological method of wastewater treatment. Before the discovery of Anammox processes, nitrogen-containing substances were removed from effluents using multistage patterns of sequential nitrification-denitrification.

It is obvious that currently used biological wastewater treatment solutions cannot be called perfect. Both nitrification (the aerobic oxidation of ammonium

nitrogen to nitrite and nitrate) and denitrification (the process of reducing nitrate nitrogen to molecular nitrogen under anaerobic conditions) involve high operating costs. This is due to the high cost of aeration of activated nitrifying sludge, as well as the cost of external sources of organic substrate needed to ensure effective denitrification. Processes, involving nitrification and denitrification, demonstrate a consistently effective treatment quality if the effluent is slightly polluted with nitrogen, but rich in organic matter.

Such methods are optimal for the treatment of domestic wastewater, but it is problematic for the wastewater with a varying ratio of the concentration of total nitrogen and organic pollutants. Experience has shown that the economic effect of traditional denitrification processes is low [2].

MATERIALS AND METHODS

The ANAMMOX (ANAerobic AMMonium OXidation) process entails the anaerobic oxidation of ammonium by nitrite to form nitrogen. This process is carried out by Anammox bacteria (Fig. 1).

In the anaerobic microbial community, Anammox bacteria are known as planktonomycetes, which use nitrite and ammonium in oxidative processes, resulting in the release of pure nitrogen molecules. Anammox bacterial cells tend to aggregate and create sarcinogenic microcolonial agglomerates.

The cellular structure of bacteria is more or less similar, but insignificant variations have been revealed. The cells are similar in shape to cocci, and they also have incised forms; the diameter rarely exceeds 1 micron. The largest cells are found in *Candidatus Anammoxoglobus propionicus* [1].

Like all planktonomycetes, Anammox bacteria are divided into several groups, in which particular



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Fig. 1. *Anammox bacteria*

biochemical processes occur. The first one is parifoplasma, which is located between the outer membrane and the first inner one. The second site is located below; it is the riboplasm, which is limited by the second inner membrane. And, finally, there is a unique cellular organelle, or Anammoxoma, surrounded by a double-layer membrane. It occupies about 70 % of the cell volume and is responsible for catabolism [3, 4].

The Anammox process enjoys the increasing attention of scientists from all over the world. The main task of research is to determine the composition of communities of microorganisms, to understand their relationships and to develop the flow chart of the Anammox process.

RESULTS

What is the complexity of research? All Anammox bacteria are characterized by the low growth rate (11 days) and, accordingly, in the future, the operating mode of these bioreactors is slow.

They all function as part of communities. These communities consist of diverse though closely related microorganisms. Their connections are still being investigated by scientists from different countries [5].

The traditional flow chart of the Anammox process is well-known. At the first stage of the process, ammonium is converted to

nitrite. Later, molecular nitrogen is formed. The classical flow chart combines two processes: partial nitrification (nitridation) and the AMX process.

The Anammox technology is both economically and environmentally superior to the standard methods:

- lack of demand for organic matter, reduced demand for oxygen, which leads to a 2–3-fold reduction in energy consumption;
- nitrous oxide is not formed during intermediate reactions and, as a result, it has a lower greenhouse effect [6].

More than 100 pilot plants use current Anammox technologies worldwide. They differ in the type of hydraulics, the biomass and the type of loading, if any. Varieties of process charts are shown in Fig. 2 [7].

Let's consider the features of several technologies.

1. The Mosvodokanal Anammox process.

The Anammox-type technology was developed by Mosvodokanal together with the Russian Academy of Sciences for the treatment of return flows, that is, those flows that enter the aeration tank after the sludge treatment stage (for biological treatment purposes). Traditional methods cannot cope with this task due to the lack of organic matter.

The Anammox bioreactor operates as a "carousel" reactor, that is, it is a hydraulically mixed reactor that entails simultaneous mixing and displacement. The temperature in the reactor is maintained in the range of 30–37 °C.

The Mosvodokanal — Anammox technology is distinguished from other types by the presence of.

A reactor, or an additional oxidizer, needed for the removal of organic residues, and the reactor acting as the crusher of activated sludge (Fig. 3) [9–11].

2. The SHARON Anammox.

This process has two stages:

1) SHARON (Single reactor High activity Ammonia Removal Over Nitrite), or a single-stage reactor with highly active ammonia oxidation of nitrites;

2) ANAMMOX, or a reactor for the anaerobic oxidation of ammonium.

Due to the presence of two reactors, the task is to control the growth of solely ammonium-oxidizing bacteria in the Sharon-reactor and to suppress nitrite-oxidizing bacteria.

At the first stage, some ammonium is converted into nitrite in the presence of oxygen. The process does not need any biomass retention. This means that the activated sludge immediately

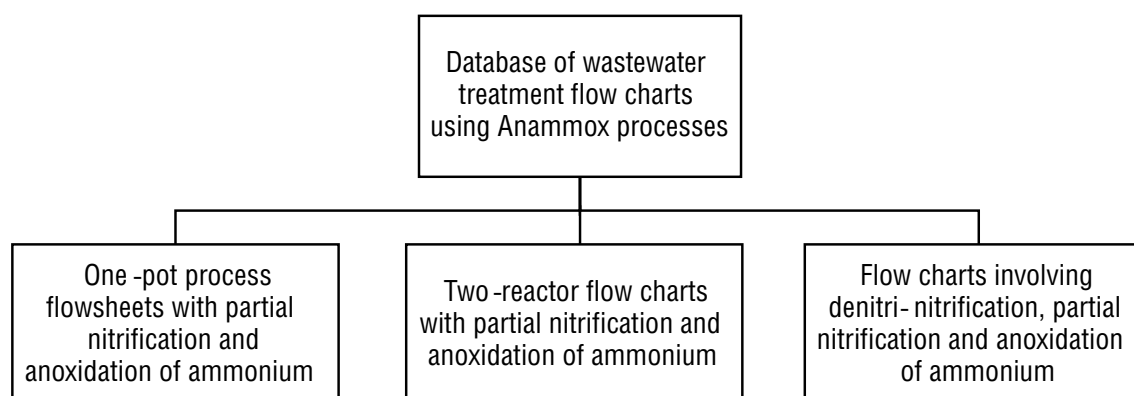


Fig. 2. Wastewater treatment flow charts involving Anammox processes [8]

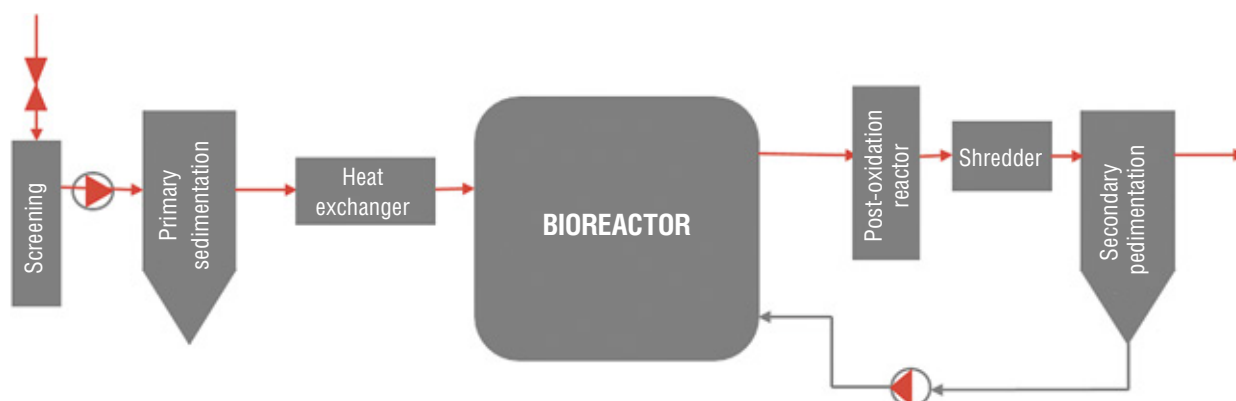


Fig. 3. The Mosvodokanal Anammox – process

contacts nitrogen and flows out of the reactor. In this case, the age of the sludge is about eight days.

At the second stage, the resulting mixture of nitrite and ammonium enters the anaerobic reactor, where it is converted into molecular nitrogen (Fig. 4) [12, 13].

3. The Demon Technology.

The Demon, also known as the Deammonification System, is implemented in the SBR reactor (Fig. 5). Batch processing is carried out by batch feeding of untreated waste water, controlling aeration and agitation, to simultaneously carry out the partial nitrification

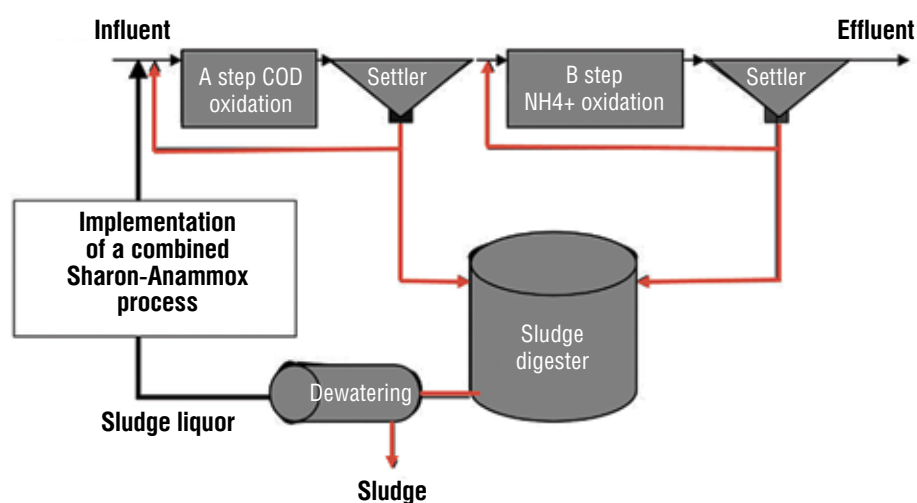


Fig. 4. SHARON-Anammox

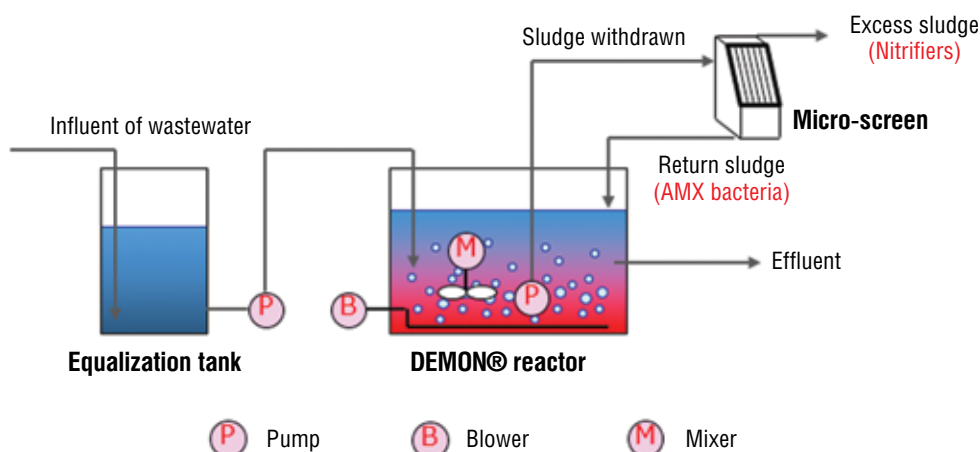


Fig. 5. The Demon Technology

▶ and AMX reaction in the same reactor. The amount of sludge increases when bacteria perform the nitrogen treatment; however, the balance between the metabolism of nitrifying bacteria and AMX bacteria is maintained by selectively removing nitrifying bacteria from the reservoir using a microscreen. Sludge separation is required to retain slow-growing AMX bacteria in the system.

In the long term, this process ensures the process stability [14, 15].

4. The Deamox Technology.

This technology encompasses processes of partial denitrification and Anammox.

The process needs an anaerobic reactor due to the low content of the organic substrate. Further, the flow of wastewater is divided into two streams. The first one enters the nitrifier reactor, the mixing chamber, and the second one enters the mixing chamber.

The combined wastewater stream enters the anaerobic post-treatment reactor having Anammox cultures. The anaerobic reactor consists of SBR-reactors, designed to receive waste water, mix and remove purified water (without aeration).

In conditions of the insufficient amount of an organic substrate and the presence of a significant amount of ammonium nitrogen in the absence of oxygen, the process of partial denitrification leads to the reduction of nitrates to nitrites.

The mode of operation of the SBR-reactors assumes intensive granulation using the initial removal of unstable flocs of activated sludge. The bioreactor is saturated with the Anammox culture after the granulation of heterotrophic denitrifying activated sludge [16–18].

The process of formation of nitrite from nitrate occurs both under autotrophic and heterotrophic conditions, i.e. with the presence of auto-hetero-trophic bacteria, which complicate the process (Fig. 6).

CONCLUSION

The paper considers the influence of Anammox bacteria on the biological removal of biogenic elements, namely nitrogen compounds, as well as its general effect on the nitrogen cycle in nature. The strengths of this process are revealed. As a result, the main directions for the future development of this area have been identified.

1. Increasing the stability of the Anammox process.

Due to the incompleteness of research, not all Anammox bacteria-related factors are taken into account. Hence, the technology operation is unstable. This can disturb the ecological balance in the water bodies. Also, Anammox bacteria are sensitive to some environmental factors, such as temperature, pH, etc., which can also aggravate the instability of operation [18].

2. Treatment at low temperatures.

Currently, much attention is paid to the study of the behaviour of Anammox bacteria at low temperatures, because it is important to track this process in the countries with cold climates, including Russia. Several attempts have been made to design different circuits at low temperatures. These studies are currently being carried out at the Scientific and Educational Center for Water Supply and Sanitation. The system shows more stable performance at a temperature of about 15 °C. The research at lower temperatures continues [19, 20].

3. Purification of low nitrogen concentrations.

4. Treatment in membrane reactors.

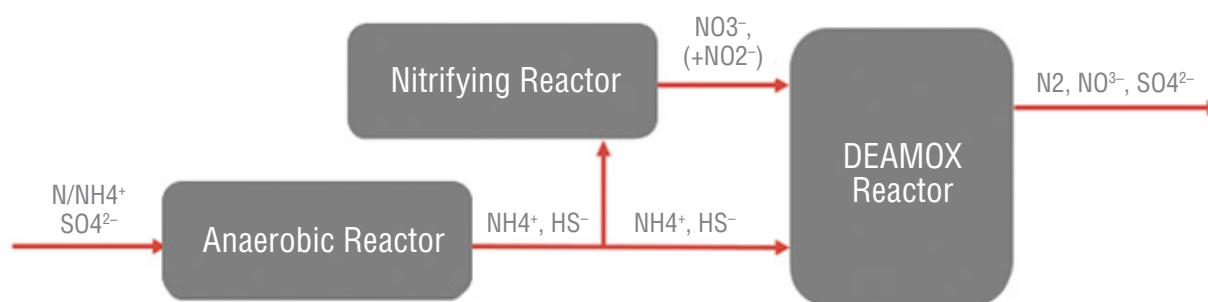


Fig. 6. The Deamox Technology

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Очистка сточных вод городов и населенных пунктов с применением бактериального сообщества Анаммокс

Открытие в конце XX века анаммокс-бактерий вызвало достаточно большой прогресс в разработке новых технологий очистки сточных вод. Процессы с участием данного вида бактерий могут протекать как на очистных сооружениях городов и поселков, так и на промышленных предприятиях в зависимости от степени загрязнения поступающих сточных вод. Данная статья посвящена сравнению различных технологий, которые сегодня предлагаются на рынке для различных целей. Сообщество микроорганизмов Анаммокс интересно перспективностью очистки сточных вод, насыщенных соединениями азота, но бедных органическими веществами, именно с такими сточными водами не справляются классические методы удаления биогенных элементов. Выявлено, что анаммокс-бактерии играют значительную роль в круговороте азота в природе, а также в процессе глубокой биологической очистки сточных вод от соединений азота. Рассмотрены различные технологические схемы анаммокс-процесса, которые различаются кислородными условиями, набором сооружений, а также рекомендуются для очистки сточных вод с разными концентрациями загрязнений в сточных водах на входе в очистные сооружения. В результате были выявлены перспективные направления развития в этой области. Показано, что качество очистки сточных вод, которое может быть получено использованием изученных бактерий, может соответствовать нормативным показателям.

Ключевые слова: анаммокс-бактерии, анаммокс-процесс, денитрификация, нитрификация, MBK-Анаммокс, Шарон-Анаммокс, Демон, Деамокс

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Implementation of a simple additive weighting method to choose a thermal insulation material for buildings

Using insulation materials is a solution to reduce energy consumption in buildings and structures. Insulation materials are chosen on the basis of economic and technical criteria, such as the energy-saving effect, construction conditions, climatic conditions, durability, price, etc. At present, there are many different methods related to multi-criterial decision-making; one of them is the Simple Additive Weighting (SAW) method. This paper explains how to apply SAW to solve sequence problems in choosing an insulation material.

Keywords: multi criterial analysis, SAW method, thermal insulation material, mineral wool, expanded polystyrene (EPS), extruded polystyrene (XPS)



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INTRODUCTION

Today energy efficiency is key to sustainable development not only in Vietnam, but also around the world. Its mission is to combat climate change in the conditions of depleting global fossil oil resources^{1, 2, 3}. Using insulation materials to make buildings and constructions is one of the solutions to reduce energy consumption by air-conditioning and ventilation systems and improve the quality of life inside buildings [1, 2].

The choice of an insulation material affects the insulation capacity, the quality and durability of the structure of exterior building walls. Multi-criterial decision making (MCDM) deals with decisions involving the choice of the best alternative among several potential options to select an insulation material with account taken of the following factors: the energy-saving effect, construction conditions, climatic conditions, the durability and cost of construction.

The authors introduce the Simple Additive Weighting (SAW) method to make a decision on the insulation material used to repair exterior walls of buildings in tropical countries (Vietnam, Indonesia, Thailand, Myanmar, ...). The next section of the paper is arranged as follows: Part II, Literature Review surveys research papers about insulation materials and some popular multi-criterial decision-making methods; Part III, Methodology, presents the SAW method; Part IV, Numeric Example applies the SAW method to select insulation materials; and Conclusion is the final part.

LITERATURE REVIEW

Insulation materials have been widely used in Europe and Russia for the purpose of reducing heat loss and saving energy in buildings. Some basic categories

of insulation include bulk insulation — vermiculite, perlite and expanded clay gravel, mineral wool (basalt fiber or glass wool), eco-wool, insulation, including foamed polymers (polyfoam, urea formaldehyde foam insulation, expanded polystyrene, extruded polystyrene, and polyurethane foam) [3–6]. The technical strengths and weaknesses of different types of materials are presented by several authors (K.S. Kravchenko, T.I. Ilyasov, G.R. Gafurova and A.G. Dalabaeva). However, in their research works, the method used to evaluate and select insulation materials, if the selected alternatives meet the pre-set criteria, such as insulation efficiency, durability, construction conditions, climatic conditions and material prices, is not provided. In these works, mineral wool, expanded polystyrene (EPS) and extruded polystyrene (XPS) have the following noticeable advantages: low thermal conductivity, durability, fire resistance, efficiency, environmental friendliness, and ease of installation.

However, to choose insulation materials with account taken of constraints such as insulation efficiency, durability, construction conditions, climatic conditions, material price, MCDM is used to choose the best alternative among several potential options. Currently, there are many methods to solve this problem, including the method of simple additive weighting (SAW); the TOPSIS method; electre I and electre II methods, etc. [7–13]. The SAW (Simple Additive Weighting) method is one of the best-known and widely used methods of multi-criterial decision making.

METHODOLOGY

In general, the process of finding the best thermal insulation material can be divided into the following steps:

- analysis of materials according to the criteria;
- standardization of the criteria;

¹ QCVN 09:2017/BXD. Building structures utilized energy efficiency. Hanoi, 2017.

² Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings. Official Journal of the European Communities. 2003; 65-70.

³ On Energy Saving and on Increasing Energy Efficiency and on Amendments to Certain Legislative Acts of the Russian Federation : Federal Law No. 261-FZ of November 23, 2009.

- determining the criteria weight;
- determining the rating of materials by multiplying the criteria values by weights.

The applied method for determining the integral dimensionless index based on the modified SAW method can be divided into the following stages.

Step 1: selecting initial comparison criteria (it is necessary to make sure that the criteria are not duplicated).

Step 2: setting functional comparison goals (maximum or minimum values).

Step 3: defining the direction of each criterion and translating the criteria not corresponding to the direction of the functional goal (using the reciprocal of the number).

Step 4: determining the value of dimensionless criteria using the following formula:

$$P_{ij} = \frac{C_{ij}}{\sum_{j=1}^n C_{ij}} \cdot 100, \quad (1)$$

where P_{ij} is the dimensionless value of criterion i of option j ; C_{ij} is the value of criterion i of option j ; n is the number of options, $j = 1, 2, \dots, n$.

Step 5: determining the importance of each criterion in the comparison.

The use of the Warkentin square matrix and the evaluation of criteria on a scale, the use of the e_{ij} coefficient means the importance of BK_j criterion according to the rules:

- the level is not important when $BK_i \ll BK_j$

$$L_{ij} = 1;$$

- the level is less important when $BK_i < BK_j$

$$L_{ij} = 2;$$

- the importance levels are equal when $BK_i = BK_j$

$$L_{ij} = 3;$$

- the level of importance when $BK_i > BK_j$

$$L_{ij} = 4;$$

- the level is very important when $BK_i \gg BK_j$

$$L_{ij} = 5.$$

Given that:

$$L_{ij} = L_{ji} = 3, \text{ for which } i = j;$$

$$L_{ij} = L_{ji} = 5, \text{ for which } i \neq j.$$

The weight coefficient of each criterion is identified and the results are controlled using formulas (2)–(4).

$$W_i = \frac{L_{ij}}{\sum L_{ij}}, \quad (2)$$

$$3m^2 = \sum L_{ij}, \quad (3)$$

$$\sum W_i = 1, \quad (4)$$

where W_i is the weight coefficient of criterion i for all criteria; L_{ij} is the level of importance of criterion i of option j ; m is the number of initial criteria for comparison.

Step 6: determining the dimensionless value for each option using formula (5):

$$V_j = \sum_{i=1}^m P_{ij} W_i, \quad (5)$$

where V_j is the dimensionless value of option j ; P_{ij} is the dimensionless value of criterion i of option j ; W_i is the weight coefficient of criterion i in all criteria.

Step 7: analyzing and rating the options by the dimensionless values.

A NUMERIC EXAMPLE

The economic and technical criteria, presented in Table 1, are used to calculate and analyze the heat transfer process through the external wall structure into the buildings and to conduct experiments to assess the suitability of three types of materials (extruded polystyrene, expanded polystyrene and mineral wool) to the climate conditions in the Hanoi area. The criteria in Table 1 are used as input

Table 1. Economic and technical criteria

Criterion	Units	Option number 1 (XPS)	Option number 2 (EPS)	Option number 3 (Mineral wool)
Coefficient of thermal conductivity λ	W/(m·C)	0.029	0.041	0.038
Material layer thickness δ	m	0.02	0.02	0.025
Material density ρ	kg/m ³	33	10	80
Static load P	kg/m ²	0.66	0.2	2
Material price	rub/m ²	118	53	156
Durability	Years	70	50	40
Fire resistance	—	Abnormal	Abnormal	Perfect
Level of compliance with climate conditions	—	Perfect	Normal	Abnormal
Thermal insulation efficiency	%	59.16	49.10	58.04

data for evaluating, comparing and selecting insulation materials for exterior wall structures and constructions in Vietnam^{4,5} [14–16].

Step 1. Choice of comparison criteria

Table 2 presents the analysis and selection of 7 criteria from the entire set of criteria (Table 1), in which the properties of the criteria are not repeated.

Step 2. Determining the functional targets for comparison

The choice of maximum values is a functional purpose for comparison.

Step 3. Determining the direction of each criterion

According to Table 2, it is necessary to translate the criteria

(1, 2 and 3) that are contrary to the direction of the functional goal, using the reciprocal of the number. In addition, the value of criteria 6 and 7 are determined using the method of analysis and the rating scale. The results are shown in Table 3.

Step 4. Determining the value of dimensionless criteria

The value of dimensionless criteria is determined using formula (1), the results are shown in Table 4.

Step 5. Determine the importance of each criterion used for comparison purposes

The level of importance of the criteria is determined by experts.

1. Coefficient of thermal conductivity — very important (λ).

Table 2. Baseline options for comparison

Criterion	Units	Option number 1 (XPS)	Option number 2 (EPS)	Option number 3 (Mineral wool)
Coefficient of thermal conductivity λ	W/(m·C)	0.029	0.041	0.038
Static load P	kg/m ²	0.66	0.2	2
Material price	rub/m ²	118	53	156
Durability	Years	70	50	40
Fire resistance	—	Abnormal	Abnormal	Perfect
Level of compliance with climate conditions	—	Perfect	Normal	Abnormal
Thermal insulation efficiency	%	59.16	49.10	58.04

Table 3. Results following the translation of the criteria that are contrary to the direction of the functional goal

Criterion	Units	Option number 1 (XPS)	Option number 2 (EPS)	Option number 3 (Mineral wool)
Coefficient of thermal conductivity λ	W/(m·C)	34.483	24.390	26.316
Static load P	kg/m ²	1.515	5.000	0.500
Material price	rub/m ²	0.008	0.019	0.006
Durability	Years	70	50	40
Fire resistance	—	1	1	5
Level of compliance with climate conditions	—	5	2	1
Thermal insulation efficiency	%	59.161	49.097	58.041

Table 4. The meaning of dimensionless criteria

Criterion	Option number 1 (XPS)	Option number 2 (EPS)	Option number 3 (Mineral wool)
Coefficient of thermal conductivity λ	40.478	28.631	30.891
Static load P	21.598	71.274	7.127
Material price	24.985	56.149	18.866
Durability	43.750	31.250	25.000
Fire resistance	14.286	14.286	71.429
Level of compliance with climate conditions	62.500	25.000	12.500
Thermal insulation efficiency	35.575	29.523	34.901

4 TCVN 9258: 2012. Thermal insulation of residential buildings — Standard projects. Hanoi, 2012.

5 TCVN 4605:1988. Heat engineering — Enclosing structures — Standard projects. Hanoi, 1988.

- 2. Static load — less important (*P*).
 3. Material price — important (*Pri.*).
 4. Durability — important (*Dur.*).
 5. Fire resistance — very import (*Fir.*).
 6. Level of compliance with climate conditions — very import (*Cli.*).
 7. Thermal insulation efficiency — important (*Eff.*).

The results of the application of the Warkentin square matrix used to determine the weight factor of each criterion are shown in Table 5.

Step 6. Finding the dimensionless value

We determine the dimensionless values for each option using formula (1)–(5).

Step 7. Evaluation and rating of options

In order to select the best option, it is necessary to start by identifying the option that has the largest dimensionless value (Table 6).

Option No. 1 (XPS) has the largest dimensionless value of 35.986 and is ranked as the first one;

Option No. 2 (EPS) has a score of 32.943 and is second in the ranking;

Option No. 3 (Mineral wool) has a score of 31.071 and is ranked third.

As it can be seen from the ranking, option No. 1 is the best one, compared to options No. 2 and No. 3.

CONCLUSION

Hence, the use of expanded polystyrene (XPS) in the renovation of the facade of a building in Vietnam not only meets the climate conditions, but also proves the effectiveness of thermal insulation. It also meets the requirements of evaluation of materials in the integral system of parameters. As the studies have shown, we can say that expanded polystyrene (XPS) is the most optimal material for repairing the facade of a building and a structure in a hot and highly humid climate, characterized by long rainy seasons and heavy precipitation.

Table 5. Matrices for determining the weight factor of each criterion

Criterion	λ	P	$Pri.$	$Dur.$	$Fir.$	$Cli.$	$Eff.$	L_{ij}	W_i
λ	3	5	4	4	3	3	4	26	0.177
P	1	3	2	2	1	1	2	12	0.082
$Pri.$	2	4	3	3	2	2	3	19	0.129
$Dur.$	2	4	3	3	2	2	3	19	0.129
$Fir.$	3	5	4	4	3	3	4	26	0.177
$Cli.$	3	5	4	4	3	3	4	26	0.177
$Eff.$	2	4	3	3	2	2	3	19	0.129
Control results: $3 \cdot 7^2 = \sum L_{ij} = 147$ and $\sum W_i = 1$								147	1

Table 6. The results of determining the dimensionless value of the criterion of options

Criterion	W_i	Option number 1 (XPS)		Option number 2 (EPS)		Option number 3 (Mineral wool)	
		P_{i1}	$P_{i1}W_i$	P_{i2}	$P_{i2}W_i$	P_{i3}	$P_{i3}W_i$
λ	0.177	40.478	7.159	28.631	5.064	30.891	5.464
P	0.082	21.598	1.763	71.274	5.818	7.127	0.582
$Pri.$	0.129	24.985	3.229	56.149	7.257	18.866	2.438
$Dur.$	0.129	43.750	5.655	31.250	4.039	25.000	3.231
$Fir.$	0.177	14.286	2.527	14.286	2.527	71.429	12.634
$Cli.$	0.177	62.500	11.054	25.000	4.422	12.500	2.211
$Eff.$	0.129	35.575	4.598	29.523	3.816	34.901	4.511
			35.986		32.943		31.071

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Реализация простого аддитивного веса метода для выбора теплоизоляционного материала в зданиях

Использование теплоизоляционных материалов является решением для снижения энергопотребления в зданиях и сооружениях. При выборе теплоизоляционных материалов используются экономико-технические критерии: эффект энергосбережения, состояние конструкции, климатические условия, долговечность, цена материала и т.д. В настоящее время существует множество различных методов, связанных с многокритериальной проблемой принятия решений, одним из них является метод простого аддитивного взвешивания (SAW). В этой статье объясняется, как применять SAW для решения проблем последовательности при выборе изоляционного материала для каждой альтернативы по всем атрибутам.

Ключевые слова: многокритериальный анализ, метод SAW, теплоизоляционный материал, минеральная вата, пенополистирол (EPS), экструдированный пенополистирол (XPS)

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Asset management tools used by institutions of higher education (cases of state universities)

State universities, whose assets are dominated by buildings erected at the end of the 19th–first half of the 20th century, are facing a problem associated with significant depreciation of the property fund and an increase in the cost of its maintenance.

Professional real estate management allows to considerably extend the life cycle of real estate facilities and increase the efficiency of funds spent on its maintenance. To choose the most effective methods of managing the assets of state universities, that will ultimately rise the efficiency of the universities, it is necessary to identify current mechanisms and methods of state property management.

The article analyzes the legal organizational forms of Russian universities and the procedure of interaction between the state university and the property owner. The current mechanisms used to manage the assets of a state university are described, including various methods of disposal, use and possession of real estate facilities.

Keywords: higher education, legal forms of universities, assets of higher education institutions, real estate management



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INTRODUCTION

Educational institutions of higher education (universities, academies, institutes) are engaged in training highly qualified personnel in all major areas of socially useful activities in accordance with the needs of society and the state. In the Russian Federation, there are both state universities established by the state (state bodies acting on its behalf) and private universities founded by citizens and legal entities.

Less than 9 % of all students study at private universities. The area of the property of private universities is 4 % of the total area of all universities, while about 39 % of the property is rented. In general, the property of private universities is in a normal technical condition, less than 1 % of the property needs repair. The share of the property of state universities to be repaired goes up every year, and today it exceeds 23 %.

Starting from 2022, an increase in the number of students of Russian higher education institutions is projected, it is associated with the demographic indicators and an increase in the number of students studying within the framework of a quota for foreign

students, which will, in turn, require effective measures to bring the infrastructure of state universities into the proper condition [1].

Modernization of infrastructure will allow to achieve the best results, provided that efficient asset management mechanisms are implemented.

COMPARATIVE CHARACTERISTICS OF THE UNIVERSITIES

To better understand the choice of effective ways to manage the university assets, first of all, it is necessary to analyze the current organizational and legal forms of universities and identify the main differences.

As of the end of 2021, the higher education system of the Russian Federation encompassed 803 organizations of higher education (Table 1).

Comparative characteristics of higher education institutions in the context of their legal organizational forms are provided in Table 2.

A private education institution of higher education is founded by natural persons and/or legal entities. Their legal organizational forms include an autonomous nonprofit organization (ANO), and a private institution.

Table 1. Data on the number of higher education institutions in the context of legal organizational forms as of December 31, 2021

Private higher education organizations		State universities			
Autonomous nonprofit organizations	Private organizations	Interstate organizations	Autonomous organizations	Budget organizations	State organizations
216		3	57	440	1
		501*			

* excluding 86 universities of the law enforcement ministries registered as state and budget institutions

Table 2. Comparative characteristic of the higher education organizations in the context of legal organizational forms

Characteristic	Autonomous non-profit organizations <i>Article 123.24, 123.25 of the Civil Code of the Russian Federation, Article 10 of Federal Law No. 7 of January 2, 1996 "About non-profit organizations"</i>	Organizations			
		Private <i>Article 123.21, 123.23.296, 298 Civil Code of the Russian Federation, Article 9 of Federal Law No. 7 of January 12, 1996 "About non-profit organizations"</i>	Autonomous <i>Article 123.21, 123.22.296, 298 Civil Code of the Russian Federation, Federal Law No. 174 of November 3, 2006 "About autonomous organizations"</i>	Budgetary <i>Article 123.21, 123.22, 296, 298 Civil Code of the Russian Federation, Article 9.2 of Federal Law No. 7 of January 12, 1996 "About non-profit organizations"</i>	State <i>Article 123.21, 123.22, 296, 298 Civil Code of the Russian Federation, Article 161 of Budget Code of the Russian Federation</i>
Term	A unitary non-profit organization with no membership and established on the basis of property contributions from citizens and (or) legal entities <i>in order to provide services in the fields of education, health, culture, science and other areas of non-commercial activity</i>	A non-profit organization established by the owner (citizen or legal entity) <i>to perform administrative, socio-cultural or other non-commercial functions</i>	A non-profit organization created by a non-profit organization established by the Russian Federation, a constituent of the Russian Federation or a municipal entity <i>to perform works, provide services to exercise the powers of state authorities, the powers of public authorities of the federal territory, the powers of local self-government bodies in the fields of science, education, health, culture, mass media, social protection, employment, physical culture and sports, as well as in other areas in the following cases, provided for by the legislation of the Russian Federation, established by federal laws (including activities with children and youth in these areas)</i>	A non-profit organization established by the Russian Federation, a constituent of the Russian Federation or a municipal entity <i>to perform works, provide services in order to ensure the implementation of the powers provided for by the legislation of the Russian Federation, respectively, of state authorities (state bodies), public authorities of the federal territory or local self-government bodies in the fields of science, education, health, culture, social protection, population employment, physical culture and sports, as well as in other fields</i>	A state (municipal) institution <i>providing state (municipal) services, performing works and/or performing state (municipal) functions in order 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 on the basis of the budget estimates</i>
Founder	One or several	One			
	citizens and/or legal entities and/or Russian Federation, constituent entity of the Russian Federation, municipal entity	Citizen or legal entity	Russian Federation or constituent entity of the Russian Federation or municipal entity		
Property	The owner — ANO	The owner is the founder, the property is allocated with the right of operational management	The owner — the founder, property is allocated by the right of operational management		
			The land plot is provided on the right of permanent (indefinite) use		
Property disposal	Has the right to dispose of property	Without the consent of the owner, is not entitled to dispose of the property assigned to it by the owner or acquired at the expense of funds allocated by the owner	Without the consent of the owner, is not entitled to dispose of the property assigned to it by the owner or acquired at the expense of funds allocated by the owner	Without the consent of the owner, is not entitled to dispose of the most valuable movable assets assigned to it by the owner or acquired at the expense of funds allocated by the owner, as well as real estate	Without the consent of the owner has no right to dispose of property

End of the Table 2

Liabilities	Founders are not liable for ANO obligations	Is liable in cash, in case of insufficiency, the owner of the property bears subsidiary responsibility	Is liable in cash and property that it has the right to dispose of (including real estate acquired at the expense of the institution), if there is insufficiency in obligations related to causing harm to citizens, the owner of the property bears subsidiary responsibility	Is liable in cash and property that it has the right to dispose of (except for the real estate acquired at the expense of the institution), if there is insufficiency in obligations related to causing harm to citizens, the owner of the property bears subsidiary responsibility	Is liable in cash, in case of insufficiency, the owner of the property bears subsidiary responsibility
	Not liable for obligations of the founders				
Transformation	Into fund	Into ANO or fund	BI or SI	AO or SI	BI or AO
Financial security	Totally or partially financed by founders	Totally or partially financed by founder	Subsidies from the budgets of the Russian Federation budgetary system on the basis of a state assignment		Allocations from the budget system of the Russian Federation on the basis of budget estimates
Implementation of income-generating activities and disposal of funds received	Has the right to carry out entrepreneurial activities corresponding to the goals for which the ANO was created	Has the right to carry out income generating activity in accordance with the Articles of association	Has the right to carry out income generating activities only insofar as it serves to achieve the goals for which it was created, and corresponding to these goals, provided that such activities are specified in its Articles of association		Has the right to carry out income generating activity in accordance with the Articles of association
	ANO disposes of the income generated	The organization disposes of the income generated			Income is received by the budget system of the Russian Federation
The right to borrow funds, place deposits at credit institutions	Unlimited	Unlimited	Unlimited	It is not entitled to deposit funds at credit institutions, as well as to accomplish securities transactions	Is not entitled to provide and obtain credits (loans), to buy securities
Closing of major deals	Unlimited, stipulated by the Charter	Unlimited, stipulated by the Charter	Preliminary approval of the supervisory board of the institution	With the consent of the body endowed with the functions and powers of the founder	With the consent of the body endowed with the functions and powers of the founder
Bankruptcy	Possible	Not provided for (judicial practice exists)	Not provided for		
Purchases under Federal Law No. 44 dated April 5, 2013	—	—	By a subsidy for implementation of the capital investments	By subsidies of the budgetary system of the Russian Federation	All purchases
Purchases under Federal Law No. 223 dated July 18, 2011	—	—	All purchases, except for a subsidy for implementation of the capital investments	At the expense of means of a present, a grant, donations; the performer under the contract; revenue-producing activities	—

► The founders of **ANO** can be several persons (their replacement is possible), who do not have the opportunity to influence their main activity, while ANO has the greatest independence.

The founder of a **private institution** is the only person (no change is provided) who appoints the head of the institution and determines the decision-making procedure. The activity of a private institution depends on the decisions of the founder acting as a citizen or a legal entity.

A state (municipal) educational organization of higher education is founded by the Russian Federation, a constituent entity of the Russian Federation or a municipal entity. Its legal organizational forms include an autonomous institution, a budget institution, a state institution.

In addition, there are state universities established by the Russian Federation jointly with other states, for example, Interstate Educational Institution of Higher Education "Belarusian-Russian University"; Interstate Educational Institution of Higher Education "Russian-Tajik (Slavic) University"; Interstate Educational Institution of Higher Education "Kyrgyz-Russian Slavic University named after the first President of the Russian Federation B.N. Yeltsin" and others.

Any activity of state institutions depends on decisions of the founder acting on behalf of the Russian Federation/a constituent entity of the Russian Federation/a municipal entity. The **state institution** enjoys the smallest independence; it is maximally limited in the manifestation of any initiative, the income from its activity goes to the budget of the Russian Federation. The main

advantage is that the activities are funded on the basis of budget estimates. The legal organizational form of state institutions is inherent in the majority of higher education institutions of law enforcement authorities. **Budget and autonomous institutions**, unlike the state ones, enjoy more flexibility in disposing of the property and funds, and are interested in conducting income generating activities. At the same time, the status of a budget institution implies greater control on behalf of the founder compared to an autonomous institution.

GENERAL PROVISIONS ON A SET OF ASSETS

Real estate is an object of civil rights that is proprietary in essence, is firmly tied to the land and registered in accordance with the effective legislation [2].

Real property (realty, real estate) includes land plots, subsoil plots and objects that are firmly tied to the land, the relocation of which is not possible without a disproportionate damage to their function: buildings, constructions, unfinished structures, as well as air and sea vessels subject to state registration, inland navigation vessels, residential and non-residential premises, parking lots¹ (Table 3).

The right of ownership and other property rights to immovable things, restrictions on these rights, their emergence, transfer and termination are subject to state registration in the unified state register by the bodies conducting state registration of rights to real estate and transactions with it¹.

Table 3. The concept of real estate

Real estate						
Land plot	Subsoil plots	Building	Construction	Object under construction	Premises, parking lots	Air and sea vessels, inland navigation vessels
		Capital construction facilities				

Note:

A *land plot* is an immovable thing that represents a part of the earth's surface and has characteristics that allow it to be defined as an individually defined thing².

A *building* is the result of construction, which is a three-dimensional construction system having aboveground and/or underground parts, including premises, engineering support networks and engineering support systems and intended for the residence and/or activities of people, the placement of production, storage of products or keeping animals³.

A *structure* is the result of construction, which is a three-dimensional, planar or linear construction system having ground, aboveground and/or underground parts, consisting of load-bearing and, in some cases, enclosing building structures and designed to perform various types of production processes, storage of products, temporary stay of people, movement of people and cargo³.

An *object of unfinished construction* is an object whose construction or reconstruction has not been completed⁴.

An *object of capital construction* is a building, structure, construction, facilities whose construction has not been completed (objects of unfinished construction), with the exception of non-capital buildings, structures and inseparable improvements to the land plot (paving, covering, and others)⁴.

As you know, the owner of the property owns the rights to own, use and dispose of his property. The owner has the right, at his discretion, to perform any actions with respect to his property that do not contradict the law and other legal acts and do not violate the rights and legally protected interests of other persons, including alienating his property into the ownership of other persons, transferring to them, while remaining the owner, the rights of ownership, use and disposal of property, to pledge the property and encumber it in other ways, dispose of it in another way. The ownership, use and disposal of land are carried out by their owner freely, if this does not cause damage to the environment and does not violate the rights and legitimate interests of other persons.

The owner may place his property in the management of another person (trustee). The transfer of the property to the trust management does not entail the transfer of ownership to the trustee, who is obliged to manage the property for the benefit of the owner or a third party specified by him¹.

Persons who own a land plot have the right to sell it, donate it, pledge it or lease it and dispose of it in any other way, insofar as the relevant lands are not excluded from circulation or restricted in circulation on the basis of the law¹.

Proprietary rights, along with the right of ownership, are: the right of permanent (indefinite) use of a land plot and the right of operational real estate management.

1 Civil Code of the Russian Federation. URL: https://www.consultant.ru/document/cons_doc_law_5142/ (rus.).

2 Land Code of the Russian Federation. URL: http://www.consultant.ru/document/cons_doc_LAW_33773/ (rus.).

3 The Technical Regulation about Security of Buildings and Construction : Federal law of December 30, 2009. No. 384-FZ. URL: http://www.consultant.ru/document/cons_doc_LAW_95720/ (rus.).

A person to whom a land plot has been granted for permanent (indefinite) use, exercises **ownership and use** of this plot within the limits established by law, other legal acts and the act on the provision of a plot for use. At the same time, it has the right to independently use the site for the purposes for which it is provided, including the construction of buildings, structures and other immovable property on the site for these purposes. Buildings, structures, and other immovable property created by this person for himself are his property. Persons to whom land plots are provided for permanent (indefinite) use **are not entitled to dispose** of such land plots, except in cases of signing an agreement on the establishment of an easement and the transfer of a land plot for gratuitous use to a citizen in the form of an office allotment in accordance with the Land Code of the Russian Federation¹.

Institutions for which real estate is assigned the right of operational management, **own, use** this property in accordance with the purposes of their activities and the purpose of this property, **dispose of property** (buildings, structures, objects of unfinished construction) with the consent of the owner of the property¹.

The founder of a state educational organization is the Russian Federation or a subject of the Russian Federation (a municipal educational organization is a municipal entity).

The founder is the owner of the property of the institution created by him¹. The property owned by the right of ownership of the Russian Federation (federal property), and the property owned by the right of ownership of the subjects of the Russian Federation (the property of the subject of the Russian Federation) is the state property¹.

The state property is assigned to state institutions in ownership, use and the disposal by the right of operational management¹. The state land plots are provided to state institutions in permanent (indefinite) use^{1, 2}. The land plots are provided for organizations to perform their statutory objectives.

Fig. 1 illustrates the interaction between the state university with the property owner.

Distribution of number of the educational organizations of the higher education for federal executive bodies in whose jurisdiction they are is given in the Table 4^{4, 5}.

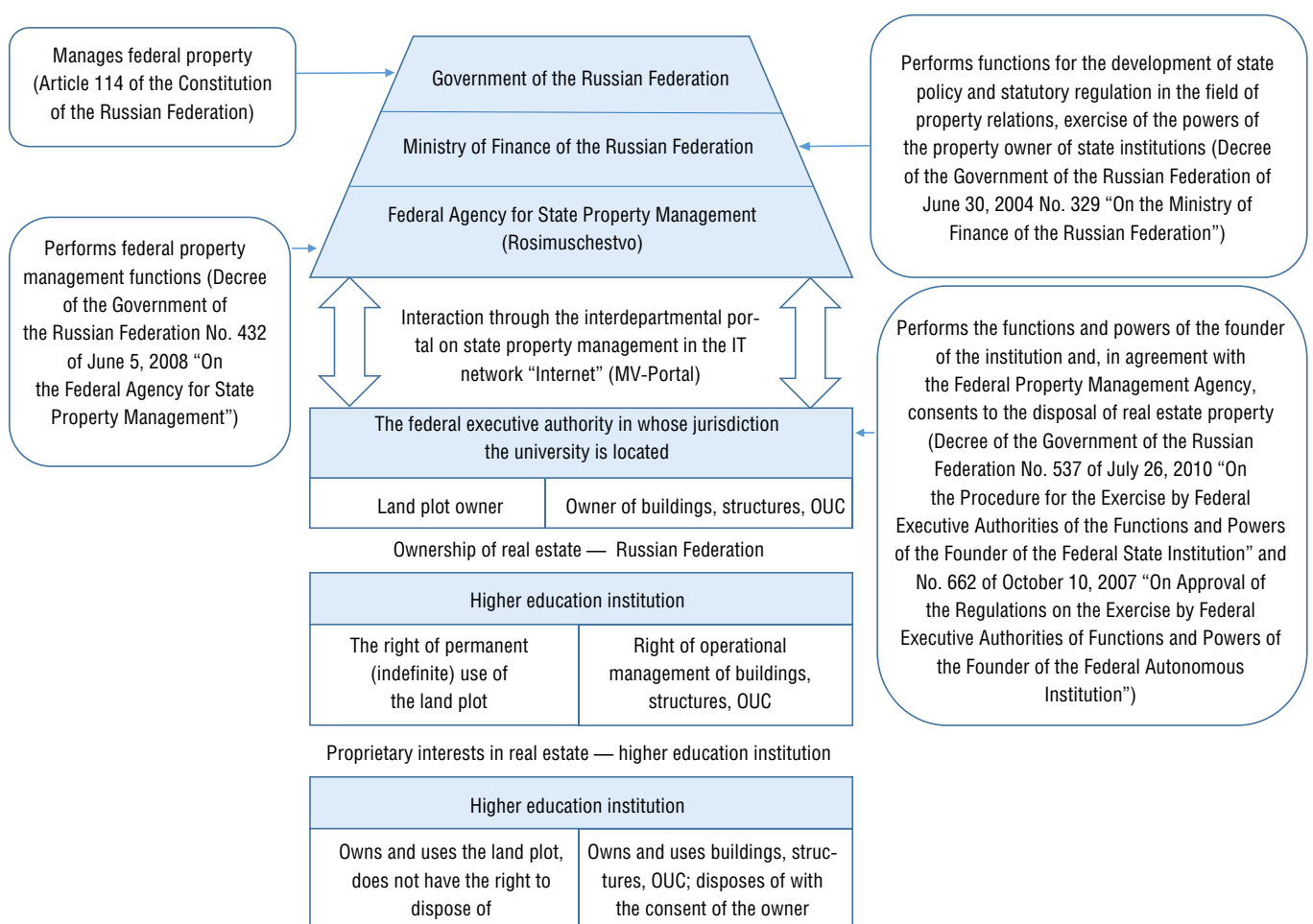


Fig. 1. Interaction between the state university and the property owner

4 Town Planning Code of the Russian Federation. URL: http://www.consultant.ru/document/cons_doc_LAW_51040/ (rus.).

5 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" and Form No. VPO-2 "Data on material 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=lv60b4apy> (rus.).

Table 4. Distribution of higher education institutions by subordination as of December 31, 2021

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 Defence, 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 constituent entities of the Russian Federation and municipalities — total	44

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" from the official site of the Ministry of Science and Higher education of the Russian Federation as of January 1, 2021 from the official site of Minobnauki. Data on law enforcement agencies — from the websites of departments and universities.

CURRENT MECHANISMS OF THE STATE UNIVERSITY ASSET MANAGEMENT

The term "Real estate management" implies goals and objectives setting, 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].

Professional real estate management allows you to significantly extend the life cycle of a real estate object and increase its value by reducing the actual physical and functional depreciation, as well as reducing damage from external depreciation [4].

The peculiarity of state real estate as an object of public law is that it represents real assets involved in economic turnover not in commercial interests, but with the aim of ensuring the vital activity of the population, achieving strategic goals of development and protection of the state, creating legal and economic mechanisms for regulating the real estate market, as well as protecting the interests of all its participants. In a market economy, the objects of state real estate act as an economic basis for building relations between the state and all market participants by means of the taxation system, rental relations, mechanisms of public-private partnership, privatization, as well as providing industrial and social infrastructure [5].

Let us reveal the term "Real Estate Management" from the point of view of the realization of the rights of disposal, use and possession of property belonging to the owner of the property.

Disposal of real estate — the ability to determine the future of the property: change ownership, condition, purpose. Existing mechanisms for the disposal of real estate: liquidation; alienation into the ownership of other persons; transfer of ownership and use rights to other persons; capital investments in the construction and reconstruction of capital construction facilities; change of purpose and redevelopment (Table 5).

The use of mechanisms for the effective disposal of real estate will reduce unnecessary costs for the maintenance of property — the liquidation of dilapidated and alienation into the ownership of other persons of excessive, unused or misused property, as well as to involve the property in economic turnover — the transfer of ownership and use rights to other persons; the implementation of capital investments in the construction and reconstruction of capital construction facilities; change of purpose and implementation of replanning.

The disposal mechanisms are applied only with the consent of the owner of the property acting through the federal executive authority, in whose jurisdiction the university is located. At the same time, an autonomous institution, unlike a budgetary and state institution, has the right to dispose at its own discretion of real estate that was acquired at the expense of the institution's funds or received as a donation. According to the Civil Code of the Russian Federation, state institutions do not have the right to dispose of land plots, but in fact state universities can initiate measures to dispose of land plots by the owner.

For the alienation of property into the ownership of other persons, in addition to the consent of the founder, the consent of the receiving party is required. When renting out real estate, the owner of the property assesses the feasibility of approving

Table 5. Real estate disposal mechanisms

<i>Liquidation (demolition) and write-off of shabby and dangerous structures, constructions, objects under construction</i>	
Liquidation (demolition)	Demolition of a capital construction facility is the liquidation of a capital construction facility by destroying it (with the exception of destruction due to natural phenomena or illegal actions of third parties), deconstruction and/or dismantling of a capital construction facility, including its parts ⁴
Write-off	Demolition of a capital construction facility involves the writing off property. The writing off federal property is understood as a set of actions related to the recognition of federal property unsuitable for further use for its intended purpose and/or disposal due to the complete or partial loss of consumer properties, including physical or moral deterioration, or being out of possession, use and disposal due to perish or destruction, and also with the impossibility of establishing its location. The regulation on the specifics of the write-off of federal property, approved by the Decision of the Government of the Russian Federation dated October 14, 2010 No. 834 "On the particulars of writing off federal property"
<i>Alienation of excessive, unused or misused real estate into the ownership of other persons</i>	
The owner of the property has the right to withdraw excessive, unused or misused property assigned to the institution or acquired by the institution at the expense of funds allocated to it by the owner for the acquisition of this property ¹ . The owner of the land plot has the right to withdraw the land plot due to non-use of the land plot for its intended purpose or use of the land plot in violation of the legislation of the Russian Federation, as well as in case of refusal of the land user (a person who owns and uses the land plot on the right of permanent (indefinite) use or on the right of gratuitous use) from the right to the land plot belonging to him ² . The withdrawal of real estate property by the owner may be carried out for the purpose of its transfer to	
The state treasury of the Russian Federation	The funds of the relevant budget and other state property not assigned to state enterprises and institutions constitute the state treasury of the Russian Federation ¹ . The property of the state treasury is managed by the Federal Agency for state property management, whose powers include ensuring the effective state property management. A citizen or a legal entity may renounce ownership of the property belonging to him by announcing this or by performing other actions that definitely indicate his removal from possession, use and disposal of property without the intention to retain any rights to this property ¹ . The transfer of property to the state treasury of the Russian Federation is carried out simultaneously with the termination of the operational management right of the state university to property. Such a transfer, which does not imply further assignment of property to another organization, can be made only with the consent of the Federal Agency for state property management, which will bear the burden of maintaining such property
Other state organization (assigning by the right of operational management/ economic control)	The list of documents required for making decisions on the issues of securing (lawful seizure) of immovable property objects is established by the Federal Agency for State Property Management. The corresponding list is indicated in the letter of the Federal Agency for State Property Management dated January 31, 2020 No. VY-08/2882 "On the Procedure for Disposing of Federal Property". A prerequisite for securing (lawful seizure) of real estate property is the availability of consent (waiver of the right) of the state university and Federal Executive Authorities, under whose jurisdiction the university is located, for the lawful seizure of immovable property, as well as the consent of the state organization and the Federal Executive Authorities under whose jurisdiction the organization is located, for the consolidation of real estate property
Into the ownership of another public legal entity (from federal ownership into the ownership of the constituent entities of the Russian Federation or municipal entities)	The list of documents required for a decision making on the property transfer from federal ownership to the ownership of a constituent entity of the Russian Federation or municipal property is established by Decree of the Government of the Russian Federation No. 374 of June 13, 2006. Proposals of the constituent entity of the Russian Federation and municipal entity on the transfer of property from federal ownership to the property of the constituent entity of the Russian Federation and municipal property are submitted to the Federal Agency for State Property Management by the authorized executive body of state power of the constituent entity of the Russian Federation and the authorized body of local self-government, respectively. The transfer of federal property to the ownership of a constituent entity of the Russian Federation or municipal property is possible in respect of property that can be and is intended to be used for the purposes of the locality in which the university is located. For example, provided that it is possible to use the property in the implementation of the Housing Renovation Program in Moscow, approved by the Decree of the Government of Moscow dated August 1, 2017 No. 497-PP
In the ownership of another public legal entity to provide power grid organizations with regards to engineering and utility facilities	The procedure for the transfer of engineering and utility facilities, lists of documents necessary for making a decision on the transfer of property, are established by the constituent entity of the Russian Federation and/or municipalities on the territory of which engineering and utility facilities are located. For example, the procedure for the acceptance of engineering and utility facilities into the ownership of the city of Moscow was approved by the Decree of the Government of Moscow dated August 22, 2020 No. 660-PP. The transfer of federal property to the ownership of a constituent entity of the Russian Federation or municipal ownership for provision to power grid organizations is possible in relation to engineering and utility facilities, in the receipt of which the relevant power grid organization is interested
To the Unified Institute for Housing Development in order to promote the development of housing construction	The procedure for preparing proposals and making decisions on the use of land plots and other objects of real estate owned by the federal government for housing construction, for the construction of facilities intended for the production of building materials, products, structures for housing construction, the creation of parks, industrial parks, technology parks, business incubators and other development of territories, regulated by Federal Law No. 161 of July 24, 2008 "On Assistance to the development of housing construction". Preparation of proposals on the use of land plots and real estate objects is carried out by the Unified Institute for Housing Development, the decision on the use is made by the Government commission on housing construction development and evaluating the effective use of land plots owned by the Russian Federation, established by Decree of the Government of the Russian Federation dated August 22, 2008 No. 632

Non-profit organization as the Russian Federation property contribution	The rules for the transfer of federal property by the Federal Agency for State Property Management to Non-Profit Organizations as a property contribution of the Russian Federation were approved by Decree of the Government of the Russian Federation No. 1200 dated November 6, 2015. The decision on the transfer of property is made by the Government of the Russian Federation, the basis for the preparation of a draft decision of the Government of the Russian Federation on the transfer of property to a non-profit organization is an order or instruction from the President of the Russian Federation, an order from the Prime Minister of the Russian Federation, the First Deputy Prime Minister of the Russian Federation or the Deputy Prime Minister of the Russian Federation	
Religious organization	The procedure for the gratuitous transfer to the ownership or gratuitous use of religious organizations of religious property under federal ownership, property of the constituents of the Russian Federation or municipal property is regulated by Federal Law No. 327 of November 30, 2010 “On the transfer to religious organizations of religious property under state or municipal ownership”. The decision on the transfer of property to religious organizations is made by the Federal Agency for State Property Management	
To the Unified Institute for Housing Development in order to transfer to a housing construction cooperative (land plot only)	The procedure for the transfer of land plots is regulated by Federal Law No. 161 of July 24, 2008 “About assistance to development of housing construction”. The categories of citizens who can be accepted as members of cooperatives and their eligibility are approved by Decree of the Government of the Russian Federation No. 108 dated February 9, 2012. The rules for forming lists of citizens eligible to be accepted as members of a cooperative are approved by federal state bodies, governing bodies of federal state educational organizations. The standard charter of the housing and construction cooperative was approved by the Decree of the Government of the Russian Federation No. 558 dated June 6, 2012. The land plots of the Unified Institute for Housing Development are transferred for free use to cooperatives established in order to provide housing for citizens — employees of federal state educational institutions of higher education and employees of federal executive authorities, for the construction of multi-apartment buildings, residential buildings, including individual housing construction, and the construction of engineering infrastructure facilities within the boundaries of these land plots. Upon completion of construction, the Unified Institute for Housing Development carries out the gratuitous transfer of the formed land plots of the Unified Institute for Housing Development occupied by residential buildings, including facilities of individual housing construction, to the ownership of citizens, members of the cooperative; land plots intended for the placement of engineering infrastructure facilities or occupied by them, to the cooperative ownership; land plots on which apartment buildings and other objects of real estate property that are part of such houses are located in the common shared ownership of the owners of premises in apartment buildings	
Sale (limited)	The paid alienation of state-owned property into the ownership of individuals and/or legal entities is called the privatization of state property. This area is regulated by Federal Law No. 178 dated December 21, 2001 “On Privatization of State and Municipal Property”. At the same time, Article 102 of Federal Law No. 273 of December 29, 2012 “On Education in the Russian Federation” provides that state and municipal educational organizations, assigned to them on the right of operational management or being at their own disposal facilities (buildings, structures, constructions) of educational, industrial, social infrastructure, including residential premises, located in buildings of educational, industrial, social, cultural purposes, dormitories, as well as clinical bases, those that are under the operational management of educational organizations or belong to them by another right are not subject to privatization	
Donation (limited)	According to the donation agreement, one party (the donor) transfers or undertakes to transfer the thing to the other party (the donee) for free ¹ . A legal entity to which a thing belongs on the right of operational management has the right to donate it with the consent of the owner, unless otherwise provided by law ¹ . The conclusion of gift agreements (donation) of real estate, where the state institution acts as a donor (benefactor), is not provided for, while the state university can act as a donee (benefactor) — gratuitously	
Exchange (limited)	Under the exchange agreement, each of the parties undertakes to transfer one product to the ownership of the other party in exchange for the other. The conclusion of a contract for the exchange of real estate property for a state institution is not provided for, but in fact this mechanism can be applied when transferring property between state organizations and state bodies (transfer of one real estate object subject to the transfer of another equivalent real estate object)	
Transfer of ownership and use of real estate rights to other persons		
Lease (limited for the land plots)	Under the lease agreement, the lessor undertakes to provide the lessee with property for a fee for temporary possession and use or for temporary use ¹	The conclusion of lease agreements and gratuitous use agreements in respect of real estate of state universities is carried out based on the results of tenders or auctions for the right to conclude these agreements, except for the cases established by Article 17 of Federal Law No. 135 of July 26, 2006 “On Protection of Competition”. Information about the holding of tenders or auctions is posted on the official website of the Russian Federation on the Internet for posting information about the bidding — www.torgi.gov.ru . At the same time, in addition to the general exceptions relating to all state institutions, special cases are highlighted relating to the conclusion of lease agreements and gratuitous use agreements by state universities with: medical organizations; catering organizations; physical culture and sports organizations; for research and development or practical training of students; with economic societies established by universities
Free use (limited for the land plots)	Under the contract of gratuitous use, one party undertakes to transfer or transfers the thing for gratuitous temporary use to the other party, and the latter undertakes to return the same thing in the condition in which it received it, taking into account normal wear and tear or in the condition stipulated by the contract ¹ . A land plot can be transferred for free use to a citizen in the form of an office allotment, for state universities the possibility of providing office allotments is not provided for	

Continue of the Table 5

Establishment of an easement	Conclusion of an agreement on the establishment of an easement in respect of a land plot. Easement — the right of limited use of someone else's land. An easement may be established to ensure passage and passage through a neighboring land plot, construction, reconstruction and/or operation of linear objects that do not interfere with the use of the land plot in accordance with the permitted use, as well as other needs of the owner of real estate that cannot be provided without the establishment of an easement
Transfer to trust management (limited)	Under the contract of trust management of property, one party (the founder of the management) transfers the property to the other party (the trustee) for a certain period of time into trust management, and the other party undertakes to manage this property in the interests of the founder of the management or the person indicated by him (the beneficiary). The transfer of property to trust management does not entail the transfer of ownership of it to the trustee ¹ . Property under operational management cannot be transferred to trust management ¹
Transfer to pledge (limited)	Under an agreement on the pledge of real estate property (mortgage agreement), one party — the mortgagee, who is a creditor under an obligation secured by a mortgage, has the right to obtain satisfaction of its monetary claims against the debtor under this obligation from the value of the mortgaged real estate property of the other party — the pledgor, primary to other creditors of the pledgor, with exceptions, established by federal law. This area is regulated by Federal Law No. 102 of July 16, 1998 "On mortgage (pledge of real estate)". According to article 6 of the above-mentioned Federal Law, the mortgage of property (pledge of real estate), the privatization of which is prohibited, is not allowed
<i>Capital investments in the reconstruction of capital construction facilities, the implementation of which involves buildings, structures, construction-in-progress, as well as in the construction of facilities within the boundaries of land plots</i>	
The objects created or acquired as a result of capital investments are assigned to state universities on the right of operational management with a subsequent increase in the cost of fixed assets in operational management	
At the federal budget expense	Enrollment of facilities in targeted investment programs. Budgetary allocations for capital investments in state property of the Russian Federation are provided in the form of budgetary investments in accordance with Article 79 of the Budget Code of the Russian Federation or by providing subsidies to budgetary and autonomous institutions in accordance with Article 78.2 of the Budget Code of the Russian Federation
At the university expense	Enrollment of facilities in the University's development program with funding from the University's income-generating activities
By raising non-budget funds through the closing of an investment agreement, a concession agreement or an agreement on a public-private partnership	As a result of the implementation of the investment agreement, part of the created facility becomes state property, the remaining part is provided to the Investor on the right of ownership or on the terms of a long-term lease (for up to 49 years). The procedure for the federal executive authorities decision making on giving consent to the conclusion of transactions to attract investments in respect of federally owned real estate facilities is regulated by Decree of the Government of the Russian Federation No. 505 of August 10, 2007. Decree of the Government of the Russian Federation No. 234 of April 3, 2008 "On Ensuring Housing and Other Construction on Federally Owned Land Plots" prohibits the approval of transactions and auctions to attract investments in respect of land plots and real estate facilities provided to federal state institutions and located within the boundaries of settlements or within their borders. Under the concession agreement, the Investor carries out the construction and/or reconstruction of the property at his own expense and subsequently uses it for a certain period, after which all the property is returned to the state. The procedure for the preparation, conclusion and execution of concession agreements is regulated by Federal Law No. 115 of July 21, 2005 "On Concession Agreements". Under the public-private partnership agreement, the Investor carries out the construction and/or reconstruction of the property at his own expense and subsequently operates or technically maintains it for a certain period, after which the facility is returned to state ownership or may remain with the Investor if the Investor's costs for the creation of the facility exceeded 50 % of the total costs, taking into account the cost of transferred property. The procedure for the preparation, conclusion and execution of public-private partnership agreements is regulated by Federal Law No. 224 of July 13, 2015 "On Public-Private Partnership, Municipal-Private Partnership in the Russian Federation and Amendments to Certain Legislative Acts of the Russian Federation". The conclusion of an investment agreement is subject to agreement with the Federal Executive Authorities and the Federal Agency on Property Management, and if the property value exceeds 150 million rubles and the volume of capital investments exceeds 500 million rubles, also with the Ministry of Finance of the Russian Federation and the Government of the Russian Federation. The concession agreement and the public-private partnership agreement are concluded on the basis of a decision of the Government of the Russian Federation in coordination with the FEA and the Ministry of Economic Development of the Russian Federation

Due to donations	Implementation of the capital investments in construction and reconstruction of capital construction projects according to the contract of donation
<i>Change of purpose and implementation of replanning</i>	
Change of purpose of the building, construction, premise, implementation of re-planning and reorganization of the room	In accordance with Federal Law No. 218 of July 13, 2015 "On State Registration of Real Estate", additional information about the real estate object is entered into the real estate cadastre — the purpose of the building (non-residential, residential, apartment building, residential building, garden house, garage), if the real estate property is a building; the purpose of the building, if the real estate property is a structure; and the purpose of the premises (residential, non-residential), if the real estate property is a premise. The redevelopment of a premise is a change in its configuration, requiring a change in the technical passport of the premise. The reconstruction of a premise is the installation, replacement or transfer of engineering networks, sanitary, electrical or other equipment that require changes to the technical passport of the premise
Land plot change of purpose	The purpose of the land plot is stated in the category of land, territorial zone, types of permitted use of the land plot. The Government of the Russian Federation shall change the categories of lands for their intended purpose (lands of settlements; agricultural lands; lands of industry, energy, transport, communications, radio broadcasting, television, computer science...) with respect to lands that are federally owned. Lands of settlements are recognized as lands used and intended for the construction and development of settlements. The composition of the lands of settlements may include land plots assigned in accordance with town-planning regulations to various territorial zones (residential; social and business; industrial; engineering and transport infrastructures; recreational; agricultural use; special purpose; military facilities; other territorial zones). The rules of land use and development of the territory establish town-planning regulations for each territorial zone individually, taking into account the peculiarities of its location and development, as well as the possibility of territorial combination of various types of land use (residential, public-business, industrial, recreational and other types of land use). Town-planning regulations are mandatory for all owners of land plots, land users, landowners and tenants of land plots, regardless of the forms of ownership and other rights to land plots. These persons may use land plots in accordance with any type of permitted use provided for by the town-planning regulations for each territorial zone. In relation to the land plot, the types of permitted use (one or more) are established: basic, auxiliary, conditionally permitted. The rightholder of the land plot chooses the main or auxiliary type of permitted use. Permission may also be obtained for a conditionally permitted type of permitted use. Changing the type of permitted use of a land plot and assigning a land plot to a certain territorial zone is carried out by making appropriate changes to the Rules of Land Use and Development of the territory. For example, the Rules of Land Use and Development of the city of Moscow were approved by the Decree of the Government of Moscow dated March 28, 2017 No. 120-PP, and the Procedure for sending and considering proposals to amend the rules of land use and development of the city of Moscow was approved by the Decree of the Government of Moscow dated May 17, 2018 No. 457-PP

such a decision in terms of compliance with the objectives of the university's activities (education and science) and the formation of the necessary infrastructure to ensure it. In order to carry out the construction and reconstruction of capital construction facilities, it is necessary first of all to ensure the allocation of funding.

The existing mechanisms for the use and ownership of real estate are structured in Table 6.

The use of real estate is an opportunity to use (exploit) property with the extraction of beneficial properties. Existing mechanisms for the use of real estate: capital repairs, operation, methods of effective use of property.

Ownership of real estate is the possibility of actual possession, which imposes on the owner of the property the obligations to account for the property and registration of rights; to comply with the order of disposal and use of property; to pay taxes.

The mechanisms of use and ownership do not require coordination with the owner of the property and are limited only to the objectives of the activity and the purpose of the property.

With a long-term absence of repair and construction work, the life cycle is reduced and the period of existence of buildings is shortened. Without timely repair work, the operation of buildings leads to excessive consumption of energy resources, hence an increase in the cost of housing and communal services and an

increase in the cost of emergency recovery works [7]. The costs of building operation amount to more than 75 % of the total cost of the building's life cycle (design/construction/operation/disposal), in this regard, the use of effective mechanisms for the use of real estate leads to a reduction in unnecessary costs for the maintenance of property and the extension of the service life of buildings due to effective operation and capital repairs, which in general will reduce the total cost of ownership of the building [8, 9].

Ownership, in turn, imposes obligations on the owner of the property to account for property and register rights, to comply with the order of disposal and use of property and to pay taxes, if they are not fulfilled, restrictions will arise in the use of mechanisms for the distribution and use of property.

The management mechanisms of the asset complex of the state University are structured in Fig. 2.

The development of methods for the effective use of property is one of the stages of creating a comprehensive mechanism for effective management of the asset complex of state universities. Such methods include: increasing the occupancy of classrooms; transferring classes to the territory of industrial partners; reducing excessive space; opening access to sports and service facilities of the university for city residents and visitors; increasing income from the use of property.

Table 6. The use of real estate mechanisms

<i>Major repairs of buildings and constructions</i>	
Major repair of capital construction facilities — replacement and/or restoration of building structures of capital construction facilities or elements of such structures, with the exception of load-bearing building structures, replacement and/or restoration of engineering infrastructure and engineering infrastructure networks of capital construction facilities or their elements, as well as replacement of individual elements of load-bearing building structures for similar or other elements that improve the performance of such structures and/or the restoration of these elements ⁴ . Major repairs include the removal of all worn-out elements, restoration or replacement with more durable and cost-effective ones that improve operational performance, while economically feasible modernization can be carried out, including improving the layout, increasing the number and quality of services, equipping with missing types of engineering equipment, landscaping	
At the federal budget expenses	In accordance with Article 78.1. of the Budget Code of the Russian Federation, the budgets of the budgetary system of the Russian Federation provide subsidies to budgetary and autonomous institutions for financial support of their performance of state (municipal) tasks, calculated with allowances made for the standard costs for the provision of state (municipal) services to individuals and/or legal entities and standard costs for the maintenance of state (municipal) property. Subsidies may also be provided to budgetary and autonomous institutions for other purposes. The Order of the Ministry of Finance of the Russian Federation dated December 13, 2017 No. 226n approved the list of codes of targeted subsidies provided to federal budget institutions and federal autonomous institutions in accordance with the second period of paragraph 1 of Article 78.1 and Article 78.2 of the Budget Code of the Russian Federation, including subsidies for the implementation of measures for the major repairs of real estate, including restoration, with the exception of reconstruction with elements of restoration (code 02–01), subsidies for the purpose of performing engineering surveys, preparation of project documentation for the repair of real estate facilities, as well as conducting a state examination of the specified project documentation and the results of the specified engineering surveys (code 02–10)
At the expense of the university funds	Adding facilities to the university's development program with funding from the university's income-generating activities
Due to donations	Implementation of major repairs of capital construction facilities in accordance with the donation agreement
<i>Operation of buildings and constructions</i>	
In accordance with "SP 255.1325800.2016. A set of rules. Buildings and structures. Operating rules. Basic provisions" operation of buildings (structures) is a set of measures for the maintenance, servicing and repair of buildings (structures), ensuring their safe functioning and sanitary condition in accordance with their functional purpose	
Operational control	The parameters of the technical and sanitary condition of the building (structure) compliance control with the parameters that ensure the safety and design operating criteria of the building, structure. Operational control over the technical status of buildings and structures is carried out through regular inspections, control checks and monitoring of the status of building bases, building structures, engineering infrastructure and engineering support networks
Routine maintenance	Maintenance of proper technical status of buildings (structures) in terms of stability, reliability parameters, as well as serviceability of building structures, engineering infrastructure, engineering support networks, their elements in accordance with the requirements of technical regulations, design documentation
Routine repair	It is carried out in order to restore the serviceability or operability of structures and engineering infrastructure, as well as to maintain operational parameters; it consists in systematic and timely work to protect the parts of buildings and equipment from premature wear and eliminate possible minor damages and malfunctions
Emergency and dispatch office service	Carries out day-to-day control over the engineering infrastructure of buildings (structures) operation and utilities quality control, registration and control of the execution of requests related to the operation of buildings (structures), and takes operational measures to ensure the safety of citizens in case of emergency situations or the risk of their occurrence
Sanitary maintenance	A set of measures to maintain the condition of real estate facilities in accordance with the sanitary and epidemiological requirements established for such facilities in order to ensure work safety, living and recreation conditions for people [6]
Utilities	Utilities include cold and hot water, electricity, gas, thermal energy, as well as sewage and wastewater disposal. The provision of utility resources is carried out on the basis of contracts with utility providing organizations
Security	Security of real estate facilities is carried out by providing security services to ensure access and on-site modes and property protection

<i>Efficient property use methods</i>	
<i>Property accounting and rights registration</i>	
State cadastral registration and state registration of the rights	The right of ownership and other property rights to immovable things, restrictions on these rights, their occurrence, transfer and termination are subject to state registration in the unified state register of real estate by the bodies performing state registration of rights to real estate and transactions with it ¹ . State registration of real estate is regulated by Federal Law No. 218-FZ of July 13, 2015 "About State Registration of Real estate". State registration of real estate includes state cadastral registration and state registration of rights. State cadastral registration is the entry into the EGRN of information about real estate object that confirm the existence of such a real estate object with characteristics that allow it to be defined as an individually defined thing, or confirm the termination of its existence. State registration of rights — making an entry in the EGRN about the right to real estate property, information about which is entered in the EGRN. In accordance with the Decree of the Government of the Russian Federation No. 457 dated June 1, 2009 "About the Federal Service for State Registration, Cadastre and Cartography", state cadastral registration, state registration of rights, maintenance of the Unified State Register of Property Rights and Transactions are carried out by the Federal Service for State Registration, Cadastre and Cartography and its territorial bodies
Accounting of property in the federal property register	In respect of federal property along with the state registration of real estate it is also registered in the register of federal property. Accounting of federal property is accompanied by the assignment of the registry number of federal property, the register is maintained in electronic form in the subsystem "Automated system of accounting of federal property" of the federal state information and analytical system "Unified system of State Property Management". Accounting of federal property and maintenance of the register of federal Property is carried out by the Federal Agency for State Property Management and its territorial bodies
Inventory of property	Within the framework of accounting, inventory is understood as checking the availability of an organization's property and the state of its financial obligations on a certain date by comparing actual data with accounting data. At the same time, the procedure and rules for conducting an inventory are regulated by the Order of the Ministry of Finance of the Russian Federation No. 49 dated June 13, 1995 "On approval of Methodological Guidelines for the inventory of property and financial obligations". In accordance with the Order of the Ministry of State Property of the Russian Federation dated October 12, 1998 No. 1289-r "On conducting an inventory of federal real estate objects", the main goals and objectives of the inventory of federal real estate objects are: identification of the actual presence of inventory objects, their characteristics and comparison of the latter with accounting data; determination of the technical condition of inventory objects and possibilities of their further operation; organization of the actual accounting of federal real estate objects; bringing accounting data in line with the actual parameters of inventory objects; identification of owners and users of inventory objects; identification of inefficiently used, unused or misused inventory objects, as well as violations in their use; determination of measures aimed at improving the efficiency of the use of federal real estate objects; creation of an information array of federal data property. Thus, the inventory of real estate should be understood as a complete check of the availability of real estate, its actual condition on a certain date by comparing the actual data with accounting data, the Unified State Register of Real Estate and the Federal Property Register
Compliance with the order of property disposal and use	Compliance with the order of property disposal consists in coordinating transactions on property disposal with the owner of the property. Compliance with the order of property use consists in monitoring the property use in accordance with the objectives of the activity and the purpose of the property — in relation to buildings and structures; in accordance with the objectives established by the act on the provision of land for use and permitted use — in relation to the land plot
Tax payment	The owner bears the burden of maintaining the property belonging to him, unless otherwise provided by law or contract ¹ . All the expenses of the owner for the maintenance of the property can be divided into permanent, conditionally-permanent and variable. Conditionally fixed and variable costs can be reduced due to actions carried out within the framework of the operation of buildings and structures, and fixed costs are an unchangeable amount. Permanent expenses include taxes: corporate property tax and land tax

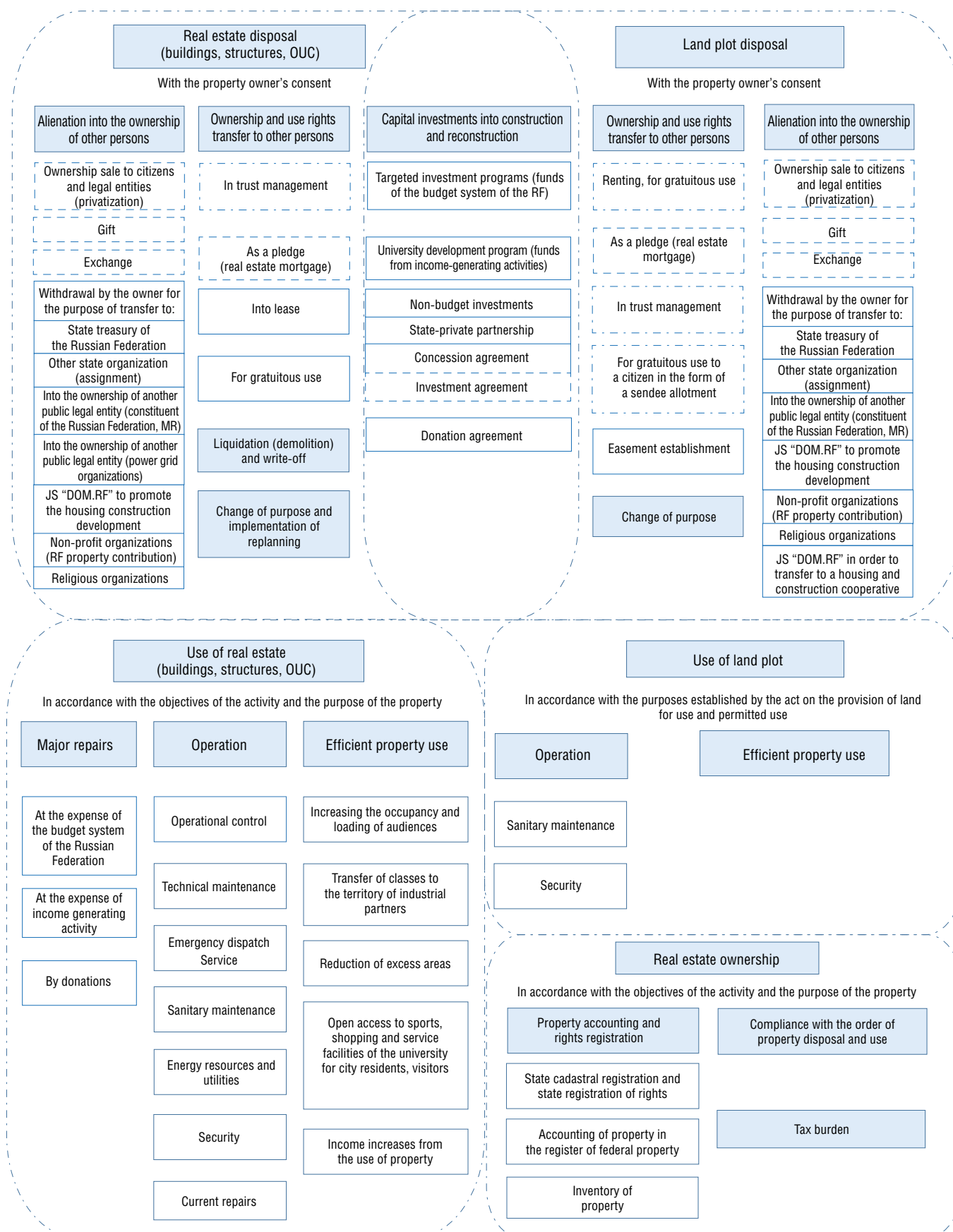


Fig. 2. The existing mechanisms of management of a property complex of the state university

► CONCLUSION

The analysis of legal organizational forms of universities and the procedure of interaction between a state university and the owner of the property allowed us to identify the current mechanisms used to manage the assets of a state university, which are associated with the realization of the rights of disposal, use and possession belonging to the owner of the property.

The use of mechanisms for managing the asset complex should take into account the tasks that education faces. The priority tasks in the field of transport education until 2035 are defined as follows⁶:

- digitalization of education, the introduction of a "digital university" model that provides management of an educational organization based on big data using platform solutions;
- implementation of educational programs for the "professions of the future";
- introduction of distance education technologies;
- expanding use of virtual simulators, virtual and augmented reality tools;
- dual and project-oriented training, development of educational programs together with the customers of targeted training, correlation of educational programs with the implementation of real projects commissioned by business partners;
- creation of business incubators and acceleration programs on the basis of educational organizations that support the entrepreneurial activity of students.

The implementation of digitalization plans, the introduction of a distance education format using virtual simulators, interaction with industrial partners, will affect the efficiency of the management of the asset complex.

For technical higher education institutions, the introduction of practice-oriented educational standards with the use of modern equipment in the training process on the territory of existing production facilities, as well as a mechanism for creating educational

and industrial formations on the principle of "University-Production" in the real sector of the economy, with the provision of advantages and benefits to attract major industrial partners, will allow to free the areas occupied by outdated educational equipment, while increasing the efficiency of 1 student per 1 sq. m the area of the asset complex, without requiring investments in updating the educational and laboratory facilities.

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Механизмы управления имущественным комплексом образовательных организаций высшего образования (на примере государственных университетов)

Государственные университеты, в имущественном комплексе которых преобладают здания постройки конца XIX — первой половины XX века, сталкиваются с проблемой, связанной со значительным износом имущественного фонда и увеличением доли расходов университета на его содержание.

Профессиональное управление недвижимостью позволяет значительно продлить жизненный цикл объекта недвижимости и повысить эффективность расходования средств на его содержание. Для выбора наиболее эффективных методов управления имущественным комплексом государственных университетов, которые в конечном итоге позволят повысить результативность деятельности университетов, необходимо определить существующие механизмы и методы управления государственным имуществом.

В статье проанализированы организационно-правовые формы университетов России и порядок взаимодействия государственного университета с собственником имущества. Описаны существующие механизмы управления имущественным комплексом государственного университета, вклю-

чающие различные способы распоряжения, пользования и владения объектами недвижимого имущества.

Ключевые слова: высшее образование, организационно-правовые формы университетов, имущественный комплекс вузов, управление недвижимым имуществом

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Л.И. Павлова. Москва. Дом Васнецова. Рисунок, тушь, перо.

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The engineering services industry: the state of affairs, problems, and prospects

The article examines the current state of affairs in the Russian services industry and presents the properties of services that distinguish them from tangible assets. It is noteworthy that over the past 30 years, the share of services, provided to the population, has almost doubled. The authors have clustered services into groups and singled out the services provided to the business community. The authors have identified the main features and functions of engineering services that include complex, construction, operational, international, and computer ones. The object of engineering services is the intellectual process of solving creative (engineering) tasks, related to the design and arrangement of production processes, rather than products, design or production. Despite the fact that the share of domestic companies in the Russian engineering and construction markets is currently 67 %, this indicator is projected to decrease in the future. Among the main problems, hindering the development of the engineering services market in Russia, are: 1) the weak institutionalization of engineering services; 2) the insufficient number of highly qualified personnel; 3) underdevelopment of integrated engineering services; 4) insufficient attention to cost engineering; 5) insufficient measures of state support for the engineering industry. To solve the above problems, the authors have proposed measures to stimulate the development of the engineering services market. The Krasnoyarsk Metro project serves as an example of effective engineering, as a result of which budget savings amounted to about 30 %.

Keywords: *engineering, engineering services, human resources, integrated engineering, support measures, project cost management*

The activity of society is composed of various spheres that are closely interrelated. Changes, taking place in one sphere, have effect on the other ones, and transformation processes are also underway. Constant changes in the mode of life of society, as well as the faster research and engineering progress affect the behavior of the population. Given a change in the nature of labour activities, its mechanization and automation, the population has more free time. The growth rate of society's wealth increases the financial capabilities of its citizens and triggers the development of the service industry. This trend is particularly pronounced in urban areas [1].

The service industry is an economic sphere where goods are produced, and its positive effect is manifested by the manufacturing process. From the point of view of economics, a service is a commodity or a benefit in the form of labour, consultation, management art, etc., in contrast to a material commodity [2]. Also, a service is understood as a socio-cultural phenomenon (of non-material nature): a service is designated to satisfy spiritual, intellectual, ethical needs and support the normal life of a consumer, including his/her health, spiritual, physical, and professional development of an individual¹.

Services inherently have a number of specific properties that distinguish them from tangible assets. In the research literature, the main properties of services include intangibility, non-preservation, impermanence of quality, inseparability of a service from its provider, the unity between the consumer and the object of the service, the individual

character, etc. Despite the fact that the service industry does not produce material goods, it establishes fundamental conditions for their production. Analysis of GDP statistics shows that the share of services, provided to the population, has been increasing in the total gross national product of Russia at a significant pace in recent years. In 1990, it was 32.6 %, in 2002 — 48.4 %, in 2008 — 55.3 %, in 2016 — 61.5 % [3]. If the degree of development of the service industry depended on the success of material production in the past, now, on the contrary, material production depends on the service industry [4].

Depending on the types of services, the service industry is most often divided into two blocks:

- 1) production of tangible services (transport, trade, housing and consumer services, etc.);
- 2) production of intangible services (management, activities of the army and security agencies, education, healthcare, science, art, show business, social services, marketing, auditing, lending, insurance, etc.).

Groups of services were made on the basis of the all-Russian classifier (Fig. 1)². Besides, it is necessary to distinguish services provided to the business community, which are understood as services of legal entities and individual entrepreneurs engaged in the activities in the field of services provided to other organizations and individual entrepreneurs³. In practice, business services are designated as professional services. The classification of professional services provided to the business community is presented in Table.

1 GOST R 50646-2012. Services to the population. Terms and definitions. URL: <http://docs.cntd.ru/document/1200102288> (rus.).

2 OK 002-93. The All-Russian classifier of services to the population : approved Resolution of the State Standard of Russia dated June 28, 1993 No. 163 (ed. dated October 17, 2013). URL: https://www.consultant.ru/document/cons_doc_LAW_39420/ (rus.).

3 GOST R 57488-2017. Services for business. Classification and general requirements. Moscow, Standartinform Publ., 2017; 8. (rus.).

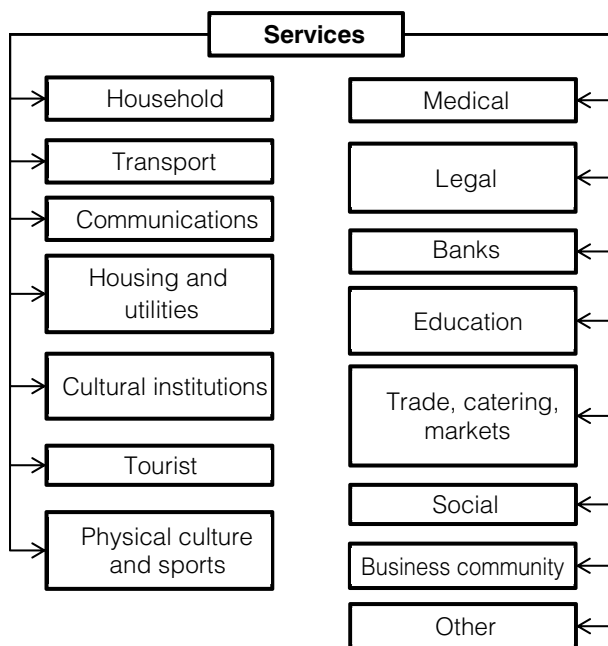


Fig. 1. Groups of services provided to the general public

Engineering services should be singled out as a separate group. The content of the concept of “engineering” is continuously expanding and absorbing the areas that are increasingly far from classical engineering. In general, engineering is understood as engineering consulting activity, the essence of which is the solution of engineering tasks related to the development or improvement of products, systems and (or) processes⁴. The subject of engineering is not a product (the final result of production), its design or production, but the intellectual process of solving creative (engineering) tasks related to the design and organization of production processes (work, services). For the first time, engineering is mentioned in the Treaty on the Eurasian Economic Union (clause 2, section 1 of Annex No. 18 to the Treaty)⁵.

Engineering has the following features.

1. This is a type of intellectual activity that involves, among other things, solving creative tasks. However, most often the task of engineering is reduced not so much to inventing (creating) new objects, processes, systems, as to the creative compilation of the best practices that allows solving a specific business task using minimal resources, given that the risk of failure is minimal, as well. This is the attractiveness of engineering for the business community: a guaranteed reduction in the costs of implementing and launching a business process, even taking into account the costs of engineering services.

2. This is not just design, construction, calculation and graphic works. The scope of engineering is ultimately the creation of a new item of intellectual property, as well as information. Engineering is a superstructure over engineering (design) activities, allowing to bring the results of engineering activities closer to implementation, shorten the path from an idea to its practical implementation. At the same time, from the consumer's point of view, engineering does not create new information, rather, it reduces the uncertainty (entropy) associated with the implementation of the designer's plan.

3. The centre of the engineering activity is not in the field of design, construction, software development, but in the field of organization of design, construction, and software development. At the same time, the scope of engineering always includes “design”, but not the design of objects, systems and processes transferred to the customer. It is the design of engineering processes and systems necessary for the implementation of the customer requirements.

4. This is not a separate special field of activity, but a special combination of well-known activities that allows to obtain a new, synergetic result infeasible as a result of a simple sequence of separate isolated processes of research, design, organization and comprehensive support, development and industrial implementation of an object (system, process).

5. It is impossible to talk about a separate professional activity in the field of engineering due to the fact that this activity includes the knowledge of engineering disciplines (theory of mechanisms and machines, theory of reliability, technology, system engineering), management disciplines (project management, quality management, ecology and safety, human resources management), legal and economic disciplines. Hence, engineering tasks can only

Classification of types of services provided to the business

Groups of professional services	List of types of services provided to the business community
Technical services	Design services, engineering and architectural services, construction works (services), transport services, technical consulting services, communication services, including telecommunication services
Specialized services	Accounting services, banking, financial, auditing, insurance, legal, consulting, marketing (advertising and public relations services), real estate services, services concerning the development and implementation of information technology products, research and analysis services, examination services
Distribution services	Logistics and transportation services, including courier, trade services, agency services
Services accompanying the production of products (goods) of certain types	Maintenance and repair of equipment, instruments, equipment, machines, vehicles, installation, examination and diagnostics, technical testing
Business support services	Rental and leasing services, recruitment services, security services, consulting services, cleaning and maintenance of buildings and territories, catering services for staff, transportation services for staff, social services for staff (provision of medical services, provision of sports, educational services, supply, recreational services), publishing and printing services, services associated with exhibitions and fairs

4 GOST R 57306-2016. Engineering. Terminology and basic concepts in the field of engineering. Moscow, Standartinform Publ., 2016; 15. (rus.).

5 The Treaty on the Eurasian Economic Union : signed in Astana on May 29, 2014, ed. from October 1, 2019. URL: https://www.consultant.ru/document/cons_doc_LAW_163855/ (rus.).

► be professionally solved by teams of professionals specializing in these types of professional activities.

6. As a type of economic activity, it is primarily the provision of services. The distinctive properties of a service are the mandatory involvement of a consumer (customer) in the process of rendering and consuming services in the process of their provision.

Engineering functions can be represented in the form of a temporal logical sequence of the project life cycle (Fig. 2).

The following types of engineering are distinguished⁶.

1. Integrated engineering includes a full range of services, i.e. the justification, development and implementation of a project, including the supply of intellectual property, equipment and turnkey delivery of an object.

2. Construction engineering includes a range of services related to the construction of an industrial facility. An identical concept is engineering services in construction.

3. Operational engineering includes engineering services aimed to improve the production process at a facility in operation.

4. International engineering. A feature of this type of engineering services is the provision of services in the world market. In this case, the contract for the provision of engineering services is an international contract.

Computer engineering is a multidisciplinary, multi-scale (multi-level) and multi-stage research and engineering based on the so-called "multi-physical" knowledge and computer technologies, primarily high-tech technologies of computer engineering.

The most interesting task is to consider an independent area of engineering, engineering in the construction industry. It encompasses engineering consulting services in the process of investment and construction activities carried out by consulting engineers and (or) engineering organizations under contracts with customers and with the ultimate goal of obtaining the best results from capital investments or other costs associated with the implementation of investment and construction projects⁷. The main types of engineering services in the construction industry are shown in Fig. 3.

The engineering services market plays a significant role in the economy, since it marries science and industry. Engineering

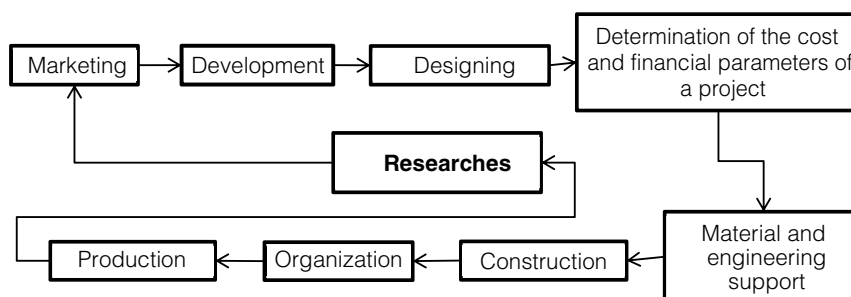


Fig. 2. Engineering functions

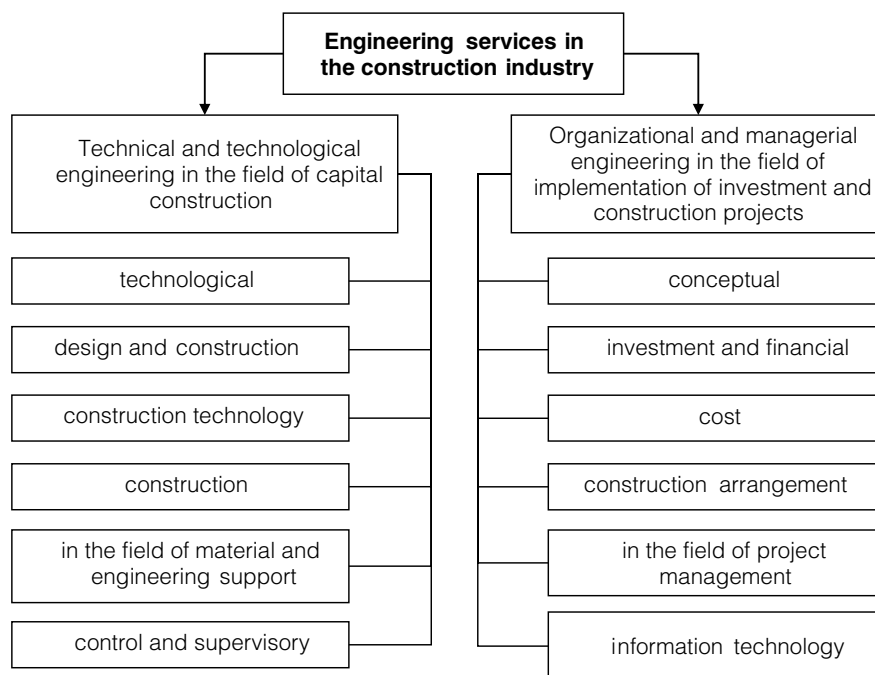


Fig. 3. Types of engineering services in the construction industry

6 Engineering. Wikipedia — free encyclopedia. URL: <https://ru.wikipedia.org/wiki/Engineering> (rus.).

7 GOST R 58179-2018. Engineering in construction. Terms and definitions. Moscow, Standartinform Publ., 2018; 17. (rus.).

companies have a multiplicative effect in the manufacturing regions due to the implementation of large-scale projects. It encompasses employment and qualification of personnel, growing tax revenues, developing territories.

The share of domestic companies in the Russian engineering and construction market in the field of transportation and processing of hydrocarbon raw materials is currently 67 %⁸. However, analysts predict a possible drop in this share to 51 in 2023. The reason for this development pattern lies in the transformation of global energy markets.

The characteristic feature of foreign engineering companies, is that they serve as managers (engineering services in the field of management account for a significant share of 20–60 %) [5]. The profitability of such companies usually ranges from 25–30 %. If we make a comparative analysis of the indicators in the USA and Russia in the field of engineering, we can see significant differences: for example, the engineering market of the USA has 142 thousand firms (both small and large) in this field, where the most developed and largest companies control mere 5 % of the entire market. If we take Russia, where large firms dominate, for example, Stroygazmontazh and Stroygazconsulting, we can see that they occupy 40 % of the market⁹. The reason for this situation is that most of the orders are large-scale capital-intensive projects of the state and state-owned companies, which are implementable only by large companies.

Hence, at present, the state of the engineering market in Russia fails to fit modern global trends, and the range of problems in this area is quite wide. It is possible to identify the main problems hindering the development of the engineering services market in Russia.

1. Weak institutionalization of the sphere of engineering services, accompanied by the imperfect regulatory and legislative framework in the field of engineering.

Currently, there are no legislative acts regulating professional engineering activities in Russia, as well as the relations arising between entities operating in the field of engineering, such as engineering companies, engineering project examination authorities, institutions that finance engineering activities, engineering funds. Back in 2017, a draft law "On engineering activities in the Russian Federation" was developed and submitted for discussion, but it has never been adopted. Therefore, the legal status of a professional engineer, the procedure of his certification, and qualification requirements are still vague today. The problem becomes particularly relevant on the eve of the Year of an Engineer in the Russian Federation in 2024.

2. An insufficient number of highly qualified personnel that have cross-disciplinary knowledge and competencies.

As noted earlier, engineering activities include various technical, management, legal and economic disciplines. Therefore, any successful operation of engineering companies requires specialists having cross-disciplinary knowledge and skills in several fields of engineering research and practice, such as design, engineering and marketing services. The present training model used to train engineering personnel in the Russian Federation can only fit a typical life cycle of technologies of traditional industries and is useless in the present-day competitive environment. In turn, the shortage of highly qualified engineering personnel reduces the competitiveness of companies operating in international engineering services markets [6].

3. The underdevelopment of complex engineering, covering all stages of the life cycle of an investment and construction project.

Despite the convenience of work with a turnkey object, integrated engineering is not widespread enough in the Russian Federation. The scale of companies, operating in the domestic market, does not allow for the comprehensive implementation and maintenance of engineering projects. The players that are active on the Russian engineering services market have a narrow focus, limited to one area of activity or a certain stage of the life cycle of an investment and construction project. As a result, the effect of engineering activities on the project as a whole is minimal, due to an increase in costs at the subsequent stages of implementation of an investment and construction project.

4. Insufficient attention is paid to cost engineering in terms of cost reduction at all stages of implementation of an investment and construction project.

Cost engineering is primarily aimed at solving the tasks of managing the cost of an investment and construction project in order to find the optimal balance between the cost, timing and usefulness/quality of assets, products, results of projects, programmes, companies, etc. Despite the fact that cost engineering is aimed at managing the cost of a project at all stages of its life cycle, its implementation without taking into account other types of engineering services, such as technical, technological, organizational and managerial ones, does not allow to take advantage of all opportunities to reduce costs.

5. Insufficient measures taken to support the engineering industry at the federal and regional levels.

In Russia, about 60 % of small engineering companies have difficulties raising debt capital [7]. High tax rates, uncertain market conditions, and the absence of a liability insurance system for engineering companies also have an adverse impact on the activities of small and medium-sized companies. There are no legally binding measures to support the engineering services, which would provide companies with guarantees in terms of taxation, state order, etc.

The authors propose the following measures to stimulate the development of the engineering services market.

1. Using an innovative approach to the professional development of the construction industry personnel.

It is advisable to draft new professional development programmes and update the current ones taking into account an interdisciplinary approach. It is necessary to develop competencies in the field of project management. New specialists, having in-depth knowledge of engineering and economics, will be in demand in the field of integrated engineering, that is, investment design, development of engineering solutions, feasibility study of design solutions, streamlined budgeting, cost control and analysis of actual costs for a construction facility.

2. Development of integrated engineering services at all stages of the life cycle of an investment and construction project.

It is necessary to employ cost engineering as the basis for any other type of construction engineering. To accelerate the propagation of integrated engineering, it is necessary to do away with the consolidation and development of monopolies in this area, and provide mechanisms ensuring interaction between small narrowly specialized companies within the framework of integrated engineering of one investment and construction project.

8 How the engineering services market is changing. Rossiyskaya Gazeta. URL: <https://rg.ru/2021/03/25/kak-menietsia-rynok-inzhiniringovyh-uslug.html> (rus.).

9 Application of engineering and reengineering of the organization. Domestic and foreign experience in the application of engineering. URL: https://vuzlit.com/1569712/primenenie_inzhiniringa_reinzhiniringa_organizatsii (rus.).

3. The issuance of a federal law regulating the development of engineering activities in the Russian Federation, accompanied by the consolidated measures of state support (within the framework of national projects).

It is necessary to keep improving the regulatory framework, governing the activities of enterprises in the field of engineering, and bring it into line with international standards, as well as the legal, economic and organizational mechanisms governing the relationship of participants in engineering activities. As measures of state support, in addition to subsidies, it is advisable to develop an "engineering menu", which would provide gratuitous budget allocations for the development of companies in the field of engineering. In addition, tax benefits should be provided to such organizations and set by the Tax Code of the Russian Federation.

4. Additional mechanisms aimed at promoting unified infrastructure to support engineering activities.

The establishment of consulting companies, licensees, engineering funds, commercial and non-profit organizations that stimulate activities in the field of engineering can be used as a tool to support engineering activities. Representatives of the professional community should be more actively involved as experts to solve a number of urgent problems in the field of engineering.

We can present the case of the Krasnoyarsk Metro project as an example of the effective implementation of integrated engineering: its construction was launched in 1995. However, in 2013, the project was put to a halt due to the lack of funding and resumed as late as in 2018. The initial cost of implementing the metro concept was 126 billion rubles. However, by using the basic principles of integrated engineering, as well as thanks to several stages of the project optimization, a decision was made to build an underground and lightweight aboveground rail line (metro line) that has the following characteristics:

- a larger length of metro lines compared to the original version;
- the main section of the line is closer to the surface to do away with deep stations to avoid time-consuming and expensive methods of construction work;
- it is proposed to place the engineering office and the office for the operational personnel in the depot;
- deep integration of the underground rail transport system in the urban network (development of the concept of RHTC, a high-speed rail transport facility). RHTC has a single network

of rail tracks. The versatility and flexibility of underground trams allow to create a system of lines that will cover the entire city, not just a strip along the metro line, and enable passengers to drive through the whole city, practically without leaving the car;

- reduction in the project implementation period to 4 years.

As a result of the measures proposed by the centre for engineering solutions of Mosproject-3 Group of Companies, the final cost of the project was reduced to 89 billion rubles using integrated engineering tools. Thus, the savings reached about 30 %. The project will be financed using the mechanism of the federal "infrastructure menu" or a budget loan.

Today, engineering services are becoming more and more popular in Russia in compliance with the development trends in the global economy and the increasing competition between industrialized countries in international markets. The development of domestic engineering services in the Russian Federation in the context of sanctions imposed by the Western countries is becoming especially relevant.

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Сфера инжиниринговых услуг: состояние, проблемы, перспективы

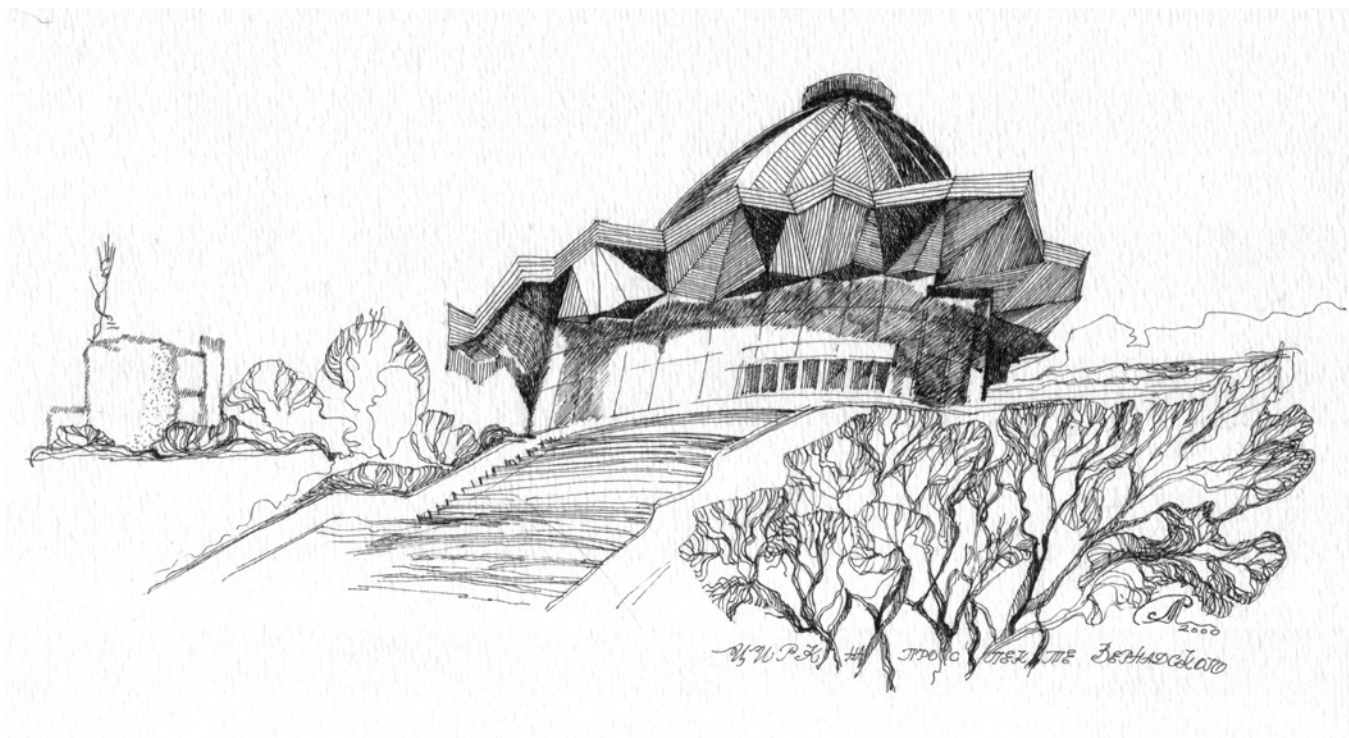
Рассмотрено современное состояние сферы услуг в России, представлены основные специфические свойства услуг, которые отличают их от материальных товаров. Отмечается, что за последние 30 лет доля услуг, оказываемых населению, выросла практически в два раза. Авторы сформировали группы оказываемых услуг, при этом отдельно выделили и раскрыли услуги, оказываемые бизнесу. В процессе анализа инжиниринговых услуг рассмотрены основные нормативные документы, регулирующие инжиниринговую деятельность. Выявлены основные особенности и функции инжиниринга, который подразделяется на: комплексный, строительный, эксплуатационный, международный, компьютерный. Отмечается, что предметом инжиниринга является не продукция, не проектирование и не производство продукции, а интеллектуальный процесс решения творческих (инженерных) задач, связанных с проектированием и организацией процессов производства продукции. Несмотря на то что доля отечественных компаний на российском рынке ин-

жиниринга и строительства составляет в настоящее время 67 % в перспективе прогнозируется снижение данного показателя. Среди основных проблем, сдерживающих развитие рынка инжиниринговых услуг в России, выделяются: 1) слабая институционализация сферы инжиниринговых услуг; 2) недостаточное количество высококвалифицированных кадров; 3) неразвитость комплексного инжиниринга; 4) недостаточное внимание к стоимостному инжинирингу; 5) недостаточные меры государственной поддержки индустрии инжиниринга. Для решения представленных выше проблем авторами предложены меры, стимулирующие развитие рынка инжиниринговых услуг. В качестве примера эффективного инжиниринга приведен проект Красноярского метрополитена, в результате корректировки которого с использованием основных принципов комплексного инжиниринга, а также благодаря нескольким стадиям оптимизации экономия бюджетных средств составила порядка 30 %.

Ключевые слова: инжиниринг, инжиниринговые услуги, кадровый потенциал, комплексный инжиниринг, меры поддержки, управление стоимостью проекта

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Л.И. Павлова. Москва. Цирк на Проспекте Вернадского. Рисунок, тушь, перо.

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2022 housing market trends in Russia

In the last two years, the housing market of Russia has been influenced by the powerful negative factors related to the COVID-19 pandemic and household income decline. In 2021 thanks to the state support and preferential mortgages the market situation improved; however in the first quarter of 2022 the powerful factor of geopolitical influence in the form of a monetary shock coupled with a financial crisis interfered with it. The relevant issue is what methods the market will use to cope with this shock and to what extent the state and the market will overcome it. In this paper, the authors review the main aspects of the Russian urban housing market development according to the 2021 results: 1) the price development in the primary and secondary markets; 2) indicators of new housing construction and commissioning; 3) the industry support from the state; 4) preferential mortgage programmes as well as the forecasted 2022 trends. This review results in a preliminary (with account taken of the unknown direction of development of the geopolitical situation) conclusion that, despite the predicted fall in GDP and real incomes in Russia, the recession of both primary and secondary housing markets will stop and by the end of 2022, the market will have gained positive momentum in terms of its turnover, while the dynamics of the nominal price level will stabilize at the level close to the inflation rate largely due to the influence of preferential mortgage programmes.

Keywords: housing market, housing construction, state support of developers, preferential mortgage, price forecast

INTRODUCTION

This paper presents [1] the main aspects of the Russian urban housing market development according to the 2021 results: 1) the price dynamics in the primary and secondary housing markets; 2) indicators of new housing construction and commissioning; 3) the industry

support from the state; 4) preferential mortgage programmes as well as the forecasted 2022 trends.

THE MARKET PRICE INDICATORS

To describe the price situation, we'll consider the data provided by professional market analysts employed with the companies united by the Russian Guild of Realtors (RGR) (Table 1 and 2) [2].

Table 1. Multi-apartment housing prices and their dynamics broken down by the cities of Russia, as well as secondary and primary markets in 2021¹

Federal district/city	Secondary market		Primary market		Markets price gap, %
	Average bid price, thousand rubles/sq. m	Annual growth, %	Average bid price, thousand rubles/sq. m	Annual growth, %	
Central Federal District					
Moscow	255.0	28.5	333	30.6	30.6 in favour of new buildings
Ramenskoye (Moscow region)	135.0	35.0	Not available	—	—
Sergiyev Posad (Moscow region)	106.0	35.9	Not available	—	—
Yaroslavl	75.0	26.0	75.0	22.5	Approximate equality
Voronezh	70.9	16.6	75.3	21.7	6.2 in favour of new buildings
Northwestern Federal District					
St. Petersburg	197.0	21	196.0	23	0.5 in favour of the secondary market
Kaliningrad	102.5	14.5	100.5	17.5	2.0 in favour of the secondary market
Southern Federal District					
Krasnodar	100.0–120.0	74.6	120.0–140.0	More than twice	16.7–20 in favour of new buildings
Volgograd	93.0	65.0	to 150.0	to 90	61.3 in favour of new buildings

¹ Analytical statement. Preliminary 2021 residential real estate market performance according to the experts from the Russian Guild of Realtors (RGR). 2021; 3-7.

End of the Table 1

Federal district/city	Secondary market		Primary market		Markets price gap, %
	Average bid price, thousand rubles/sq. m	Annual growth, %	Average bid price, thousand rubles/sq. m	Annual growth, %	
Volga Federal District					
Nizhny Novgorod	110.0	22.2	113.0	15.8	2.7 in favour of new buildings
Perm	75.9	24.0	84.6	17.0	11.5 in favour of new buildings
Samara	70.0	20.0–25.0	70.0	27.0	Approximate equality
Kirov	59.7	22.0	Not available	Not available	—
Ural Federal District					
Yekaterinburg	93.0	16.0	106.0	20.0	14.0 in favour of new buildings
Tyumen	93.5	23.0	91.2	16.0	2.5 in favour of the secondary market
Siberian Federal District					
Novosibirsk	91.0	20.0	98.9	14.0	8.7 in favour of new buildings
Krasnoyarsk	87.0	23.0	92.5	27.0	6.3 in favour of new buildings
Far Eastern Federal District					
Vladivostok	150.0	12.0	126.6	5.0	18.5 in favour of the secondary market
Khabarovsk	112.0	12.0	106.0	3.0	5.7 in favour of the secondary market

In 2021 the capital witnessed a record demand in the secondary market: 150,565 transactions were registered against 148 thousand a year earlier, which became the highest absolute indicator for the entire period of statistical monitoring [3, 4].

Data by cities confirm in general high price level in the Southern Federal District (Table 2).

Construction and commissioning of new housing. According to Rosstat (the Russian State Statistics Service) [5–8], 92.6 million sq. m of housing were commissioned in Russia in 2021, which is 12.7 % more than in 2020 (Table 3).

Stimul (The Incentive) federal programme has been functioning in Russia since 2016 and is an integral part of the national project (NP)

“Housing and Urban Environment”. Its main source of funding is the federal budget. Local authorities act as customers of construction works during the construction of infrastructure facilities, subject to the participation of the developer in the project of integrated development of the territory (KRT), entrusted with the project development and obtaining a positive opinion of the state examination authority [9–11].

If we consider the housing construction dynamics in the regional context, the drop in commissioning volumes was registered in 10 regions only, including Crimea and Sevastopol. The commissioning dynamics was positive almost everywhere, including all regions with a total volume of over 1 million sq. m of commissioned housing (Table 4).

Table 2. Multi-apartment housing market prices and their dynamics broken down by the cities of Russia in 2021 (secondary and primary markets are consolidated) [2]

City	Average bid price, thousand rubles/sq. m	Annual growth, %	Markets price gap, %
Sochi	250.0	100.0	3–5
Novorossiysk	150.0	57.9	No data available
Sevastopol	142.0	44.2	No data available
Ryazan	71.0	In secondary market — 40, in primary market — 36	No data available
Saratov	65.0	45.0	No data available

Table 3. Commissioning of residential buildings in Russia in 1999–2021 (the authors' calculations [5–8])

Year	Million sq. m of total area	Growth rates, %	
		Against the previous year	Against the year 2000
1999	32.0	104.2	105.6
2000	30.3	94.7	100.0
2001	31.7	104.6	104.6
2002	33.8	106.6	111.5
2003	36.4	107.7	120.1
2004	41.0	112.6	135.3
2005	43.6	106.3	143.9
2006	50.6	116.0	167.0
2007	61.2	120.9	202.0
2008	64.1	104.7	211.5
2009	59.9	93.4	197.7
2010	58.4	97.5	192.7
2011	62.3	106.6	205.6
2012	65.7	104.7	216.8
2013	70.5	107.3	232.7
2014	84.2	119.4	277.9
2015	85.3	101.3	281.5
2016	80.2	94.0	264.7
2017	79.2	98.8	261.4
2018	75.7	95.1	248.5
2019	82.0/81.0*	108.3/107.0*	270.6/267.3*
2020	82.2/77.1*	100.2/95.2*	271.3/254.5*
2021	92.6	112.7	305.6

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

The most important distinguishing feature of the market in 2021 was that the share of residential housing built by and at the expense of the population or using borrowed funds for the first time exceeded 50 % (53 %). Correspondingly, the share of multi-apartment housing, which has been steadily declining since 2016, amounted to 47 % (Table 5).

An increase in the share of commissioned residential housing has recently been caused by new factors that contribute to the registration of previously built housing [11]:

- since 2019, it has been possible to rent houses built on garden plots with their subsequent registration for permanent residence, and two years later this practice was extended due to the pandemic;

Table 4. Housing commissioning in the Russian regions in 2021 (in the order of the commissioning pace) [8]

Region	Housing commissioning pace, % by 2020
Moscow	156.8
Chechnya	135.5
Samara region*	128.7
Leningrad Region*	127.0
Krasnodar Krai*	122.6
Sverdlovsk region*	121.7
Stavropol Krai	121.0
Bashkortostan*	118.4
Orenburg region	113.9
Tatarstan*	112.4
Chelyabinsk region*	109.8
Kaliningrad region	109.2
Irkutsk region	108.9
Voronezh region	108.1
Nizhny Novgorod Region*	107.7
Dagestan	106.3
Novosibirsk region	103.1
Krasnoyarsk Krai	103.0
St. Petersburg	102.8
Saratov region	102.0
Moscow region*	101.9
Rostov region*	101.6
Belgorod region*	101.4
The Tyumen region (with autonomous areas)*	101.3
Lipetsk region	100.3

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

- in 2021, a new incentive was introduced for the registration of long-built houses, since the presidential initiative led to the approval of the law "On Amendments to the Federal Law «On Gas Supply in the Russian Federation»" of June 11, 2021 (No. 184-FZ), allowing free gas supply to the boundaries of land plots (in gasified localities).

Given the above, a more adequate indicator should be used, that is, the volume of housing under construction, to assess the real construction activity in the housing sector. This indicator is published by DOM.RF based on the data from the Unified Information System of Housing Construction [12], and it shows the activities of developers, i.e., professional building contractors. It is important that these statistical data are available not only by region, but also by city.

Table 5. The breakdown of commissioned residential buildings in the Russian Federation 2010–2021 (author' calculations [8, 7])

Year	Total, million sq. m	Multi-apartment housing construction		Individual housing construction at the expense of owners' cash/borrowed funds	
		million sq. m	Share in total commissioning, %	million sq. m	Share in total commissioning, %
2010	58.4	32.9	56.3	25.5	43.7
2011	62.3	35.5	57.0	26.8	43.0
2012	65.7	37.3	56.8	28.4	43.2
2013	70.5	39.8	56.5	30.7	43.5
2014	84.2	48.0	57.0	36.2	43.0
2015	85.3	50.1	58.7	35.2	41.3
2016	80.2	48.4	60.3	31.8	39.7
2017	79.2	46.2	58.3	33.0	41.7
2018	75.7	43.3	57.2	32.4	42.8
2019	82.0	43.5	53.0	38.5	47.0
2020	82.2	42.4	51.6	39.8	48.4
2021	92.6	43.5	47.0	49.1	53.0

According to the programme of integrated territorial development, 144 million sq. m of real estate facilities are to be built in the coming years, including 117 million sq. m of residential housing.

According to the Ministry of Construction, an integrated approach to the renewal of settlements allows to commission housing volumes comparable to 120 million sq. m, to be achieved by 2029 in accordance with the 2020 targets [13].

In 2021, the volume of multi-apartment buildings under construction increased by 2.5 % to 96.4 million sq. m, indicating that there are no prospects for a breakthrough segment growth in the short term [14].

According to the data as of the year-end 2021, the share of multi-apartment housing constructed using escrow accounts reached 76.8 % in total nationwide [15].

In general, we can talk about a significant slowdown in the pace of construction of multi-apartment housing in recent years. The moderately positive dynamics of 2021 was largely maintained due to growth in several regions.

THE STATE SUPPORT OF THE CONSTRUCTION INDUSTRY

To overcome the difficulties caused by the COVID-19 pandemic, the state has launched assistance programmes for the construction industry:

- prolongation of modified family and preferential mortgage programmes;
- shorter approval procedures in the construction industry [16];
- shorter project funding approval period [17].

Among the legal innovations are the amendments to the Urban Planning Code of the Russian Federation dated July 1, 2021 [18], according to which the "Procedure for submitting project documentation for the state examination simultaneously with the state environmental examination" is approved, and to facilitate the renovation

of the housing stock, the financial support of the resettlement of citizens from the emergency state facilities has been expanded in the subjects of the Russian Federation [19].

Besides, in accordance with Government Decree No. 1315 of August 9, 2021, due to an increase in the cost of building materials, developers are allowed to increase the contract price not more than by 30 %, pursuant to an agreement between the parties, to partially reimburse their expenses as part of the work performed under the Law on Public Procurement (No. 44-FZ) [20].

As part of his Address to the Federal Assembly of the Russian Federation delivered on April 21, 2021, the President of Russia suggested that DOM.RF be funded by subsidies from the federal budget to issue loans to developers at a minimum interest rate (3–4 % per annum) [21].

It is noteworthy that these measures did not satisfy all construction market players. For example, SGM-Most, Stroytransgaz, Avto-ban found themselves in a difficult situation. In a letter addressed to the President of the country, their executives described the state of the industry as "a crisis". The corresponding article published by RBC analyses the problems of the construction industry related to housing construction, including losses, bankruptcy of a number of companies and a reduction in the number of employees in the industry [22].

In response to this letter, the Ministry of Economic Development proposed a number of measures, including the most significant ones:

- setting the minimum level of profitability for state construction contracts in the amount of, at least, 20 % of their costs, since, according to the National Association of Builders, the estimated profit of construction projects does not exceed 4–7 %;
- to oblige state customers to make advance payments in the amount of up to 70 % of the values of construction agreements.

▶ A. Galaktionova, Head of InfraONE Research, suggests that now advance payments, provided for in state contracts, usually do not exceed 30 % of their values [23].

Following a press conference in late December 2021, the President of the Russian Federation requested to prepare "proposals to increase the contribution of big industrial companies to the construction of residential housing and social infrastructure facilities in the areas where they operate" [24].

PREFERENTIAL MORTGAGE LENDING PROGRAMMES

According to DOM.RF and the Central Bank of the Russian Federation, the total number of mortgage loans, issued in 2021, was estimated at 1,908 thousand units amounting to 5.7 trillion rubles. The total amount grew by 28 %, compared to 2020, while the number of loans increased by mere 7.2 %. As a result, the mortgage debt increased by more than 26 % over a year. As of the beginning of 2022, its value was 11.7 trillion rubles (taking into account securitized loans and acquisition of the right of claim worth 12.9 trillion rubles) [25, 26]. The weighted average mortgage rate in 2021 (7.49 %) were lower than in 2020 (7.67 %) (mainly due to the primary market), although by the year end it had grown to 7.81 % [27].

The preferential mortgage programme for new buildings was most popular in 2020, since the mid-year there was a slight increase in the interest rate (from 6.5 to 7 %) with a reduction in the maximum loan amount to 3 million rubles (for all regions without exception) against 6 million rubles earlier (12 million rubles for Moscow and the Moscow region, St. Petersburg and the Leningrad region) [28].

A change in the programme conditions on July 1, 2021 significantly reduced its potential field of application. According to the experts, only one third of the country's regions had an average cost of real estate below 3 million rubles [29].

In general, the results of 2021, especially the second half of the year, showed that the preferential mortgage programme, the most popular at the time of its launch and during the first year of

operation, was in certain decline due to the growing demand for new buildings and a rise in the cost of building materials, which led to a price increase for primary real estate [30].

On the contrary, the Family Mortgage programme became kind of a driver of the mortgage market in 2021, since its conditions remained unchanged. The interest rate (6 %) and the maximum loan amount of 6 million rubles remained the same (for Moscow and the Moscow region, St. Petersburg and the Leningrad region — 12 million rubles) [31].

According to Sberbank, under the family mortgage program, the average down payment amounted to 27.9 % of the property value in December 2021 [32]. Experts from Expert RA, Moody's, and NKR rating agency believe that this programme may become most popular among the citizens in the future [33].

The Rural Mortgage program applies to:

- rural settlements and cities with a population of up to 30 thousand people [34].

The loan is secured by the collateral, or the real estate facility being lent [35].

The following changes were made as of 2021 [36–39]:

- citizens obtained the right to build private houses on state or municipal land plots;
- maternity capital could be officially used as the first installment;
- the Yamalo-Nenets Autonomous District was assigned the status of a special territory with a maximum loan amount of 5 million rubles (as a general rule, it was 3 million rubles).

According to the research, the main customers of rural mortgages were urban residents, for example, agribusiness industry workers, rather than villagers, whose share is less than 5 % [40].

A peculiarity of the Far Eastern mortgage programme is a low interest rate (2 % per annum) with a maximum loan amount of 6 million rubles. However, de facto banks do not issue loans at such a rate [41].

In general, in 2021 preferential lending looked as follows (Table 6).

Table 6. Preferential mortgage lending 2020–2021 (calculations made by the authors [27, 42])

Loan category and programme	Loans				Total amount			
	Thousand items		%		Billion rubles		%	
	2020*	2021	2020	2021	2020*	2021	2020	2021
Mortgage loans, total	1780.0	1908	100	100	4445	5699	100	100
"Preferential mortgage" new buildings	343.9	335	19.3	17.6	1008.8	1032.0**	22.7	18.1
"Family mortgage"	85.6	131	4.8	6.9	241.7	449.5**	5.4	7.9
"Far East mortgage"	13.6	17	0.8	0.9	52.0	68.5	1.2	1.2
Preferential loans (total for 3 programs)	443.1	483	24.9	25.4	1302.5	1550.0	29.3	27.2
"Rural mortgage"	45.0	51.2	2.5	2.7	87.2	98.0	2.0	1.7
Preferential loans (total for 4 programmes, including "Rural mortgage")	488.1	534.2	27.4	28.0	1389.7	1648	31.3	28.9

* — indicators for 2020 are recalculated by the authors based on the data from the DOM.RF 2022 review;

** — calculated by the authors based on data on the average monthly disbursement within the programme in the first and second half-years of 2021

PRIMARY AND SECONDARY HOUSING MARKET TRENDS IN RUSSIA IN 2022

As the above data show, over the past two years, developers have been increasing revenues, launching new projects, taking advantage of the demand spurred by preferential mortgages in the primary market. After February 24, the situation changed: due to the "special operation" in Ukraine and subsequent sanctions against Russia, the key rate increased to 20 %, and many companies stopped supplying products to Russia. As a result, housing developers can neither bring new projects to the market, nor timely negotiate the funding terms for buildings already under construction. In the future, this may lead to a shortage of new buildings and disruptions of commissioning deadlines.

Market players [43] are forced to postpone the launch of new projects on the market, and concentrate their efforts on those already started. The obstacle is not only too expensive project funding, but also the inability to calculate the financial model of future construction projects, as well as doubts about the level of demand.

The next wave of disturbing rumours was aroused by the news about the suspension of the registration of the shared construction participation agreement. There was another reason for this phenomenon. It was a decree on a special procedure for registering transactions with residents of "unfriendly countries". After the clarifications had been issued by Rosreestr (Russian State Registration Agency), the transaction registration process resumed.

The situation changed every week in the secondary market in March from a hype at the beginning of the month to a slowdown.

By the beginning of April, the secondary housing market had almost frozen. Sellers refused to sell apartments, because buyers were stopped by expensive mortgages, only alternative deals were practically implemented. The potential demand was 40 % less than usual. The situation also threatened the market of new buildings, since many received money for their purchase or from the sale of existing housing.

The interest rate of preferential mortgages have risen from 7 to 12 % since April 1, the cost of project financing, even taking into account state support efforts, was over 15 %; building materials are also getting more expensive. The price is growing, and the willingness of people to buy expensive new residences is questionable.

Later the Bank of Russia cut the key rate twice in April: on April 8 at an extraordinary meeting of the Central Bank's Board of Directors — from 20 to 17 %, and on April 29 — to 14 %. After that, by an Order dated April 30, the Government of the Russian Federation clarified the conditions for a preferential mortgage disbursement. Now, if the borrower does not fit into the proposed limits (6 million rubles for the whole country and 12 million rubles for the metropolitan markets), the missing amount can be "bumped up at market rates". The first part will be issued at 9 % or lower, and the second — at 14–15 %. The adopted measure allows to increase the maximum available loan amount — up to 30 million rubles in the capitals and 15 million rubles in the regions until the end of 2022. Preferential mortgages are available for the purchase of housing in new buildings, the construction of a private house or the purchase of land for construction. The difference between the preferential and the market rate is reimbursed to banks by the state.

Thanks to this key measure of state support, it can be assumed that, despite the forecast of a fall in GDP and real incomes of the population, the recession of both primary and secondary housing markets in Russia will stop and by the end of the year the market

turnover will gain positive momentum while maintaining the dynamics of the nominal price level close to the inflation rate.

A more accurate forecast depends entirely on the development of geopolitical factors influencing macroeconomics and the market.

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Тенденции рынка жилья в 2022 году в России

В последние два года рынок жилья России находился под влиянием мощных негативных факторов, связанных с пандемией COVID-19 и снижением доходов населения. В 2021 г. благодаря господдержке и льготной ипотеке ситуация на рынке улучшилась, однако в первом квартале 2022 г. этому процессу помешал мощный фактор геополитического влияния в виде монетарного шока, грозящего финансовым кризисом. Актуальный вопрос: какими методами и в какой мере государство и рынок справятся с этим шоком? В данной статье авторы рассматривают основные аспекты развития рынка жилья городов России по итогам 2021 г.: 1) динамику цен на первичном и вторичном рынках; 2) показатели объемов строительства и ввода нового жилья; 3) меры государственной поддержки отрасли; 4) программы льготной ипотеки, а также прогноз тенденций на 2022 г. В результате этого обзора делается предварительный (а именно с учетом неизвестного направления развития геополитической ситуации) вывод о том, что, несмотря на прогнозируемое падение ВВП и реальных доходов населения в России, спад как первичного, так и вторичного рынка жилья прекратится и к концу 2022 г. рынок наберет положительную динамику оборота, при этом динамика номинального уровня цен стабилизируется на уровне, близком к уровню инфляции, во многом благодаря влиянию программ льготной ипотеки.

Ключевые слова: рынок жилья, жилищное строительство, господдержка застройщиков, льготная ипотека, ценовой прогноз

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