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АКЦЕНТЫ НОМЕРА

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В утвержденных стратегических документах Российской Федерации прямо или косвенно определяются направления развития экономики и общественного производства, важным аспектом в которых является повышение качества жизни населения

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Статья исследует кросс-отраслевые показатели и методики управления в жилищно-коммунальном хозяйстве, акцентируя внимание на их значимости для повышения энергоэффективности и оптимизации ресурсов

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Многообразие видов резервирования привело к созданию десятков различных моделей, учитывающих конкретную специфику систем Лю Чун, Фомин Никита Игоревич, Сяо Шотин В данной работе представлен подробный организационно-технологический анализ ускоренных процессов строительства гражданских многоэтажных зданий в Китае, с акцентом на использование технологий предварительного изготовления для решения задач стремительной урбанизации и растущего спроса на жилье Переход к новому технологическому укладу, предполагающему широкое использование цифровых технологий в производстве и сфере услуг, кардинально меняет процесс труда, социально-трудовые отношения и характер занятости

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2.1.14 Life cycle management of construction objects (technical sciences).

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Assessment of the competitive environment in the public utilities sector

The state of the competitive environment in the field of public utilities is one of the key factors determining the efficiency of the housing and communal infrastructure. Increased competition in this area can have a significant impact on the quality of services provided, their accessibility to the population, as well as on the modernization and development of public utilities.

Currently, the public utilities sector is characterized by a high degree of monopolization, insufficient level of private investment and low innovation activity. This is due to a number of factors, including the difficulty of entering the market for new players, the lack of effective public-private partnership mechanisms, the lack of transparency of tariff formation, and the lack of development of the service quality control system. In addition, the high deterioration of municipal infrastructure and insufficient funding for its modernization create additional barriers to the development of competition.

To solve these problems, it is necessary to implement a set of measures aimed at developing competition in the field of public utilities. This may include encouraging the transfer of public infrastructure facilities for concession or lease, as well as creating favorable conditions for the participation of small and medium-sized businesses in the provision of public services. In addition, it is important to ensure transparency in the functioning of the industry, improve tariff regulation and introduce modern digital technologies.

The implementation of such measures will increase the efficiency of the public utilities sector, improve the quality and accessibility of public services for the population, and create prerequisites for attracting private investment in infrastructure modernization. This, in turn, will contribute to the development of competition and increase the competitiveness of the industry as a whole. Public authorities should play an important role in this process by implementing a comprehensive policy of supporting and stimulating competition in the public utilities sector.

Keywords: *competitive environment, public utilities, housing and communal infrastructure, monopoly, concessions, modernization of public-private partnership, quality of services*

The state of competition in the field of public infrastructure is one of the key factors determining the effectiveness of the functioning of the municipal economy (public utilities — PU) and the quality of public services provided to the population. Despite the measures taken in recent years to develop a competitive environment in this industry, the situation with the level of competition remains complex and ambiguous.

The purpose of this article is to conduct a comprehensive assessment of the state of competition in the field of modernization of municipal infrastructure in the Russian Federation. To achieve this goal, the following tasks were solved:

1. The concept of PU and what applies to it is considered.
2. Analysis of the regulatory framework governing the development of competition in the agricultural sector.
3. Assessment of the state of the competitive environment in the modernization of municipal infrastructure.
4. Identification of the main barriers to entry in to the municipal infrastructure markets.
5. Identification of key issues that hinder

the development of competition in the field of modernization of municipal infrastructure in the agricultural KXsector.

6. Development of recommendations for improving the competitive environment in the municipal sector.

Regulatory and legal regulation of competition development in the field of municipal infrastructure is carried out on the basis of a number of federal laws^{1, 2, 3, 4}.

These regulatory legal acts provide for a number of measures aimed at developing a competitive environment in the modernization of municipal infrastructure in the agricultural sector, including:

- ensuring equal access to public infrastructure facilities;
- introduction of competitive procedures in the selection of organizations for the modernization of municipal infrastructure;
- creating conditions for the participation of small and medium-sized businesses in the provision of services for the modernization of municipal infrastructure^{1, 2, 3, 4}.

A public utility is a set of facilities and systems that provide the population and organizations with

1 On the General Principles of Organization of Local Self-Government in the Russian Federation : Federal Law of 06.10.2003 No. 131-FL.

2 On Heat Supply : Federal Law of 27.07.2010 No. 190-FL.

3 On Water Supply and Sanitation : Federal Law of 07.12.2011 No. 416-FL.

4 On the contract system in the sphere of procurement of goods, works, services to meet state and municipal needs : Federal Law of 05.04.2013 No. 44-FL.

Table 1. Share of organizations that occupy a dominant position in the modernization of municipal infrastructure in 2023. Compiled by the author^{4, 5}

Utilities segment	Share of organizations, with the dominant position, %
Water supply and sanitation	32.4
Heat supply	41.9
Electricity supply	52.7
Gas supply	61.2

basic public services necessary for a comfortable life and activity. There are seven main elements in the public utilities system:

1. Water supply and sanitation.
2. Heat supply.
3. Power supply.
4. Gas supply.
5. Improvement of house territories.
6. Removal and disposal of solid household waste.
7. Operation of the housing stock.

To provide high-quality and affordable public services, timely modernization of public infrastructure is required, which includes:

- updating and replacing worn-out networks;
- introduction of energy-efficient technologies;
- digitalization of municipal infrastructure;
- application of innovative materials and technologies.

Table 1 shows an analysis of the state of the competitive environment in the field of modernization of municipal infrastructure for 2023, which shows that most of the agricultural markets are characterized by a high level of concentration. Analysis of the presented data shows that the most concentrated segments are electricity and gas supply, where more than half of the market is controlled by organizations with a dominant position. In the heat supply sector, the share of such organizations is also high and amounts to almost 42 %. The situation is relatively better in the water supply and sanitation sector, where the share of organizations with a dominant position is just over 32 %.

The high market concentration in the key segments of KH is due to the following factors [1]:

- high capital intensity of municipal infrastructure modernization projects;
- significant investment and technological barriers to entry for new players;
- uncompetitive market participants due to the lack of high-tech equipment;
- historical structure of the industry.

The limited number of players in the utility markets leads to a decrease in incentives to increase efficiency, introduce innovations, and improve the quality of services provided to the end user.

The limited number of organizations is due to the fact that there are a number of barriers presented in Table 2, that prevent

Table 2. Barriers that prevent new organizations from entering the market to participate in the modernization of municipal infrastructure. Compiled by the author [2]

Barrier	Description
High capital intensity	Construction and modernization of water supply, sanitation, and heat supply facilities require significant financial investments, which significantly limits the ability of new players to enter these markets
Technological connectivity	Most of the KH networks and structures are unified technological complexes, which makes it difficult to split them up and create conditions for competition
Administrative barriers	Procedures for obtaining technical specifications, building permits, and licensing activities in the agricultural sector are often complex and opaque, which reduces the attractiveness of the market for new entrants
Imperfection of the regulatory framework	Imperfection of legislation in terms of regulating competitive relations, distribution of powers between authorities, and tariff formation creates additional risks for investors

► *Table 3. The main problems hindering the development of a competitive environment in the field of modernization of municipal infrastructure. Compiled by the author [4, 5]*

Problem	Description
Description Maintaining the dominant position of joint-stock companies with 100 % municipal participation	Often, joint-stock companies, having administrative advantages, displace private organizations from the market, which reduces the motivation of the latter to improve the efficiency and quality of services provided
Insufficient transparency of procedures for selecting organizations for CI modernization	Often, the selection of organizations for the repair of CI is carried out according to non-transparent schemes, using fictitious competitive mechanisms, which limits the opportunities for new players to enter the market
Imperfection of the system of tariff regulation in the field of CU	The current methods of setting utility tariffs do not fully take into account the competitive factor, which reduces the economic incentives for organizations to improve efficiency

new organizations from entering the market to participate in the modernization of public infrastructure.

In accordance with the National Plan for the Development of Competition in the Russian Federation for 2018–2020⁶, it was proposed to reduce the number of state/municipal unitary enterprises (hereinafter referred to as state unitary Enterprises). Municipalities, in turn, solved this problem in a different way, by going through the process of corporatization (100 % of the shares remain with the municipality), while retaining all the assets and working personnel of the organization. Thus, it was possible to preserve the key role of already joint-stock companies in the modernization and operation of AI facilities and at the same time gain greater managerial and financial flexibility [3].

Examples of such organizations include:

- Mosvodokanal JSC, formerly Mosvodokanal State Unitary Enterprise of the City of Moscow;
- JSC “T Plus” — a leading energy company specializing in heat supply and modernization of heat supply systems formerly SUE “Volga Territorial Generating Company”;
- JSC “Teploset of Saint Petersburg” — is responsible for the heat supply systems of the former State Unitary Enterprise “Fuel and Energy Complex of Saint Petersburg”.

In the course of our work, we can identify the following problems that hinder the development of a competitive environment in the field of modernization of municipal infrastructure (Table 3).

In order to develop competition in the field of public utilities and improve the efficiency of the functioning of public infrastructure, it is necessary to consider such a comprehensive direction as promoting the development of private initiative and competition in the provision of services for the modernization of public infrastructure, including measures to encourage the transfer of public infrastructure facilities to concession, lease, as well as entrepreneurship in the provision of public utilities.

The implementation of this activity should include a number of key elements:

1. A clear definition of the requirements for concessionaires, selection criteria and conditions for concluding concession agreements is an important element in creating favorable conditions for the transfer of public infrastructure facilities to the concession. Requirements for concessionaires should include their

financial stability and solvency, including the availability of sufficient own funds and the ability to attract investment, as well as a positive credit history and the absence of overdue obligations. Equally important are the technical and managerial competencies of concessionaires, including experience in implementing similar infrastructure projects and the availability of qualified personnel and an effective management system. The requirements should also take into account the business reputation and reliability of concessionaires, the absence of facts of violation of the law and unfair behavior, as well as the presence of positive feedback from previous partners and customers. The criteria for selecting concessionaires should be as objective and transparent as possible, taking into account financial, economic, technical and reputational aspects, such as the proposed size of the concession fee or investment, the timing and quality of planned reconstruction and modernization of facilities, tariff policy and availability of services for the population, as well as the financial model of the project and sources of financing. The terms of entering into concession agreements should clearly regulate the rights, obligations and responsibilities of the parties, as well as mechanisms for regulating relations in the project implementation process, including the terms of validity of the agreement, the procedure for transferring objects to the concession and returning them, requirements for the volume and quality of services provided, mechanisms for changing tariffs and distributing risks, as well as application of penalties [6, 7].

2. Ensuring equal access of potential investors to information about the objects and conditions of the concession is an important condition for creating favorable conditions for the transfer of municipal infrastructure facilities to the concession. It implies that all essential information about the objects planned for transfer to the concession, their technical condition, main characteristics, as well as the conditions and requirements for concession agreements should be made public and available to all interested investors on an equal basis. To do this, it is necessary to create a unified register or database for objects planned to be transferred to the concession, with a detailed description of their characteristics and condition. In addition, the terms and requirements for concession agreements, including terms, investment volumes, tariff policies, risk allocation and liability of the parties, should be clearly regulated and publicly available. Holding open and competitive

concession tenders, where potential investors have equal access to all necessary information, will ensure transparency and objectivity of the selection procedures for concessionaires. This, in turn, will help attract more private investors and promote competition in the implementation of public-private partnership projects in the field of municipal infrastructure [6, 7].

3. The application of open and competitive concession bidding procedures is also a key element in creating favorable conditions for the transfer of public infrastructure facilities to the concession. This implies that the selection process for concessionaires should be as transparent as possible and based on equal access for all potential investors to participate in competitive procedures. To do this, it is necessary to provide broad information about the objects planned to be transferred to the concession, as well as about the conditions and requirements for concession agreements. Conducting open competitive procedures, in which investors have the opportunity to submit applications and proposals on equal terms, will allow identifying the most effective and competent concessionaires based on objective selection criteria. Such criteria should take into account not only the financial, but also the technical, managerial and reputational characteristics of the participants. An open and competitive bidding process will also ensure fair pricing for concessionary properties and help attract more private investment in the modernization of municipal infrastructure. In addition, transparent competitive procedures will increase public confidence in the concession projects being implemented and will contribute to the development of public-private partnerships in this area [8].

4. The provision of tax benefits to concessionaires, such as exemption from property tax in relation to objects transferred to the concession, the application of a reduced income tax rate, as well as the provision of an investment tax credit, is an important mechanism for stimulating the transfer of municipal infrastructure objects to the concession. These tax support measures can reduce the financial burden on concessionaires and thereby increase their interest in participating in concession projects. Exemption from property tax on objects transferred to the concession allows concessionaires to allocate the released funds for their modernization and development. The application of a reduced income tax rate also increases the economic efficiency of concession projects, making them more attractive to private investors. The provision of an investment tax credit encourages concessionaires to invest in the reconstruction and construction of municipal infrastructure facilities. The integrated application of these tax benefits and preferences will reduce the financial risks and costs of concessionaires, which, in turn, will help attract more private investment in the modernization of municipal infrastructure [8].

5. Providing the possibility of setting economically reasonable tariffs for concessionaires, it implies that the tariffs set for concessionaires should take into account the real costs of operating, repairing and upgrading facilities, as well as provide them with the opportunity to make economically reasonable profits. To do this, it is necessary to develop transparent and objective methods for calculating tariffs that will take into account all the necessary items of expenses of concessionaires, including energy costs, staff remuneration, maintenance and repair of facilities, as well as tax payments and planned profitability. In addition, it is important to ensure that tariffs can be regularly indexed in accordance with changes in the cost of resources and the level of inflation. This will help maintain the financial stability of concession projects and

maintain their investment attractiveness in the long term. The establishment of economically reasonable tariffs will help attract more private investors to participate in the modernization of municipal infrastructure under concession conditions.

6. Application the mechanism of tariff indexation taking into account inflation and cost changes. This mechanism assumes that the tariffs set for concessionaires will be regularly reviewed and indexed in accordance with changes in the main economic factors. First of all, this concerns the growth of prices for energy resources, materials, labor remuneration and other items of expenditure related to the operation and modernization of municipal infrastructure facilities. In addition, tariffs should be indexed to reflect the overall level of inflation in the economy. Such linking of tariffs to actual costs and economic dynamics will ensure the financial stability of concession projects and maintain their investment attractiveness in the long term. Regular tariff indexation, which takes into account rising costs and inflationary processes, gives concessionaires confidence in the ability to cover their costs and make the necessary profit, which encourages them to participate in the modernization of public infrastructure on the terms of public-private partnership [7, 9].

The implementation of the proposed measures will contribute to the development of a competitive environment in the field of modernization of municipal infrastructure, improving the efficiency of public utilities, improving the quality and availability of public services [10].

The conducted research has shown that the state of competition in the field of modernization of municipal infrastructure in the Russian Federation is characterized by a high degree of concentration of most utility markets, the presence of significant barriers to entry for new players, and imperfection of regulatory and tariff policies.

The main problems hindering the development of competition in the public utilities sector are: the preservation of the dominant position of former state unitary enterprises/municipal units, and now joint-stock companies, the lack of transparency in the procedures for selecting organizations providing services for the modernization of energy supply systems, the imperfection of the tariff regulation system, and the insufficient development of infrastructure for the implementation of energy service contracts [11, 12].

To overcome these problems and create conditions for the development of a competitive environment in the field of modernization of municipal infrastructure, it is proposed to implement a set of measures to encourage the transfer of municipal infrastructure facilities to concession, lease, as well as create conditions for small and medium-sized businesses in the provision of public services.

The implementation of the proposed measures will contribute to improving the efficiency of public utilities, improving the quality and accessibility of public services for the population [13–15].

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Оценка состояния конкурентной среды в сфере коммунального хозяйства

Состояние конкурентной среды в сфере коммунального хозяйства является одним из ключевых факторов, определяющих эффективность функционирования жилищно-коммунальной инфраструктуры. Повышение конкуренции в этой сфере способно оказать существенное влияние на качество предоставляемых услуг, их доступность для населения, а также на модернизацию и развитие коммунальных систем.

В настоящее время отрасль коммунального хозяйства характеризуется высокой степенью монополизации, недостаточным уровнем частных инвестиций и низкой инновационной активностью. Это обусловлено рядом факторов, в том числе сложностью входа на рынок для новых игроков, отсутствием эффективных механизмов государственно-частного партнерства, непрозрачностью тарифообразования и неразвитостью системы контроля качества услуг. Кроме того, высокая изношенность коммунальной инфраструктуры и недостаточное финансирование ее модернизации создают дополнительные барьеры для развития конкуренции.

Для решения этих проблем необходимо реализовать комплекс мер, направленных на развитие конкуренции в сфере коммунального хозяйства. Это может включать в себя стимулирование передачи объектов коммунальной инфраструктуры в концессию, аренду, а также создание благоприятных условий для участия субъектов малого и среднего предпринимательства в оказании коммунальных услуг. Кроме того, важно обеспечить прозрачность функционирования отрасли, совершенствование тарифного регулирования и внедрение современных цифровых технологий.

Внедрение таких мер позволит повысить эффективность работы коммунального комплекса, улучшить качество и доступность коммунальных услуг для населения, а также создать предпосылки для привлечения частных инвестиций в модернизацию инфраструктуры. Это, в свою очередь, будет способствовать развитию конкуренции и повышению конкурентоспособности отрасли в целом. Важную роль в этом процессе должны сыграть органы государственной власти, реализуя комплексную политику поддержки и стимулирования конкуренции в сфере коммунального хозяйства.

Ключевые слова: конкурентная среда, коммунальное хозяйство, жилищно-коммунальная инфраструктура, монополия, концессии, модернизация государственно-частного партнерства, качество услуг

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Comfortable living environment as a priority for regional development

In recent years, the number of urban population in the total population of the Russian Federation, as well as in the whole world, has been increasing, together with the global trend of population aging, this determines the formation of a comfortable living environment as a priority for the development of regions and individual territories of the Russian Federation. To complete the study, attention is paid to the experience of taking into account the needs of low-mobility groups of the population in international practice, using the example of different countries. The study identified factors, trends and key trends that have a direct or indirect impact on the formation of a request for a comfortable living environment in the modern realities of the Russian Federation, taking into account the needs of low-mobility groups of the population, including the elderly. The research is based on the principle of consistency, which involves considering the object of research as a complex system consisting of many interrelated elements. The object of the study is a comfortable living environment in the cities of the Russian Federation, and the subject is the tools for creating a comfortable living environment in the cities of the Russian Federation. The methodological basis of the research consists of various methods of scientific cognition, such as content analysis, factor analysis, statistical data analysis, methods of systematization, grouping, generalization, as well as graphical data visualization techniques. The paper decomposes the process of forming a comfortable living environment, taking into account the needs of low-mobility groups of the population through the tools of graphical notation. The analysis of the decomposition of the process made it possible to identify the shortcomings of the process of forming a comfortable living environment in its existing form and determine the directions of further research in order to develop it.

Keywords: comfortable living environment, trends, low-mobility population groups, context diagram, graphical notation IDEFO

INTRODUCTION

The approved strategic documents of the Russian Federation directly or indirectly define the directions of economic development and social production, an important aspect of which is to improve the quality of life of the population. According to the Decree of the President of the Russian Federation "The national development goals of the Russian Federation for the period up to 2030 and for the future up to 2036"¹ improving the quality of life is designated as the national development goal of the country, which is essentially impossible without creating a comfortable living environment. Therefore, the importance of creating comfortable and safe living conditions for the population is especially emphasized, which is relevant in a situation when both the total urban population in the country and the population over working age, which is more sensitive to the level of comfort of the living environment, is increasing (Fig. 1).

The problems of modern society, including those caused by the aging of the population, are reflected in the documents of world organizations (WHO, UN), as well as in the strategic development documents of many countries². For example, the Strategy of Scientific and Technological Development of the Russian Federation (Decree of the President of

the Russian Federation)³ presents major challenges at the current stage of the country's development, including those caused by demographic changes, increased life expectancy and changes in people's lifestyle, which leads to an aging population. This creates a number of social problems in modern post-industrial society. Solving these problems requires an integrated approach, including social, economic and urban planning spheres, i.e. creating conditions that make life in the urban environment comfortable, safe and convenient for all its inhabitants, including with the aim of integrating the elderly population into society, which, together with the increasing level of urbanization in the Russian Federation, determines the desire to create a comfortable living environment as a priority for the development of the regions. The need to develop strategic directions for the formation of a comfortable living environment, taking into account the needs of elderly people, was considered earlier in [1]. At the same time, the process of forming a request for a comfortable living environment, and the very system of forming a comfortable living environment in modern Russian cities, is of interest for the current study.

RESEARCH METHODS AND PRINCIPLES

The research is based on the principle of consistency, based on the consideration of the object of

1

On the National Development Goals of the Russian Federation for the period up to 2030 and for the future up to 2036 : Decree of the President of the Russian Federation dated 05.07.2024 No. 309. URL: <http://kremlin.ru/events/president/news/73986> (accessed: 05.10.2024).

2

National programmes for age-friendly cities and communities : a guide. Geneva : World Health Organization, 2023. License: CC BY-NC-SA 3.0 IGO.

3

The Strategy of Scientific and Technological Development of the Russian Federation : Decree of the President of the Russian Federation dated 02.28.2024 No. 145. URL: <http://www.kremlin.ru/acts/bank/50358> (accessed: 05.02.2024).

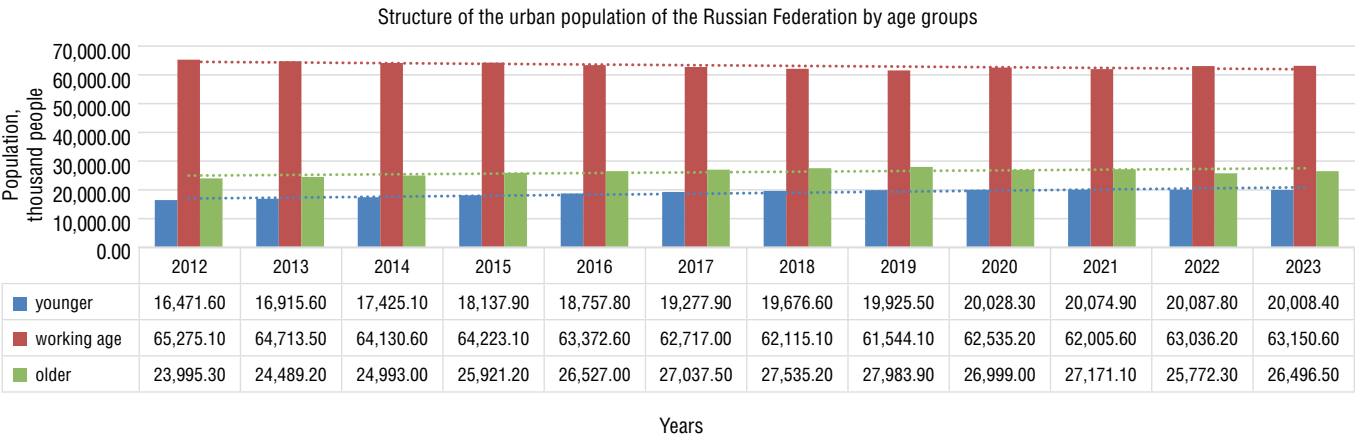


Fig. 1. Structure of the urban population group in the Russian Federation by age groups⁴

research in the form of a complex system, as a set of cause-effect and functional relationships. The methodological basis of the research is a set of methods of scientific cognition: content analysis, factor analysis, analysis of statistical data, methods of systematization, grouping, generalization, as well as graphical methods of data visualization. Data analysis allows you to mentally decompose the subject into its component parts, therefore, in order to study in more detail, the system of forming a comfortable living environment in the city, the tools of the Ishikawa causal diagram are actively used. In addition, the graphical notation of the IDEF0 family has been applied, which allows visualizing the formation of a comfortable living environment in the form of a process for its further analysis and determining the directions of further research in order to develop it.

The object of the study is a comfortable living environment in the cities of the Russian Federation.

The subject of the study is the tools for creating a comfortable living environment in the cities of the Russian Federation.

DISCUSSION

In Fig. 2 the key trends of modernity are highlighted, which, in our opinion, have an impact on the creation of a comfortable urban environment.

Trend No. 1. The formation of a comfortable living environment occurs primarily through the creation of comfortable living and working conditions, therefore, the increment of a high-quality fund of residential real estate in conjunction with the development of infrastructure has a direct impact on the level of comfort of the living environment.

The paper [2] analyzes the situation in the Netherlands, where the state strategy is aimed at maintaining elderly people in their usual place of residence, at separating places of residence and caring for them and replacing the institutional lifestyle with a non-institutional one.

Trend No. 2. The increase in the number of elderly people indicates an increase in the number of people with limited mobility (LMGP), because according to regulatory sources⁵, people with temporary disabilities, pregnant women, the elderly, people with strollers, etc., also belong to the category of people with limited mobility, in addition to the disabled. This means that a comfortable living environment should take into account the needs of the LMGP. The organization of living conditions for the elderly requires special attention, which affects the development of alternative forms of living environment that make it possible for them to integrate into the economy and socialization. This thesis is confirmed in the publication of Thai researchers [3]: the provision of public amenities and social services that promote healthy aging in an urban environment ensures that older people will feel comfortable aging in their homes, since a favorable living environment for older people should support their social activity. This study showed that landscaping, interest clubs for the elderly, medical and social care services, as well as social activity services played an important role in the social status and health status of elderly people, therefore, developers and authorities should take this into account when creating a comfortable urban living environment.

Trend No. 3. This trend is based on the principles of sustainable development, i.e. there is a desire to create environmentally

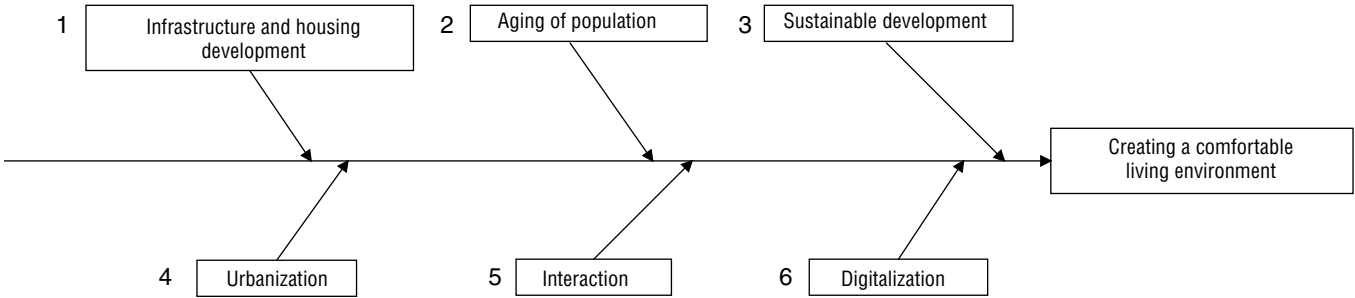


Fig. 2. Key trends affecting the formation of a comfortable living environment (made by the author)

4 The population of the Russian Federation by gender and age, Federal State Statistics Service. URL: <https://rosstat.gov.ru/compendium/document/13284> (accessed: 02.21.2024).

5 SP 59.13330.2020. SNiP 35-01-2001. Accessibility of buildings and structures for low-mobility groups of the population. URL: <https://minstroyrf.gov.ru/docs/117294/> (accessed: 05.02.2024).

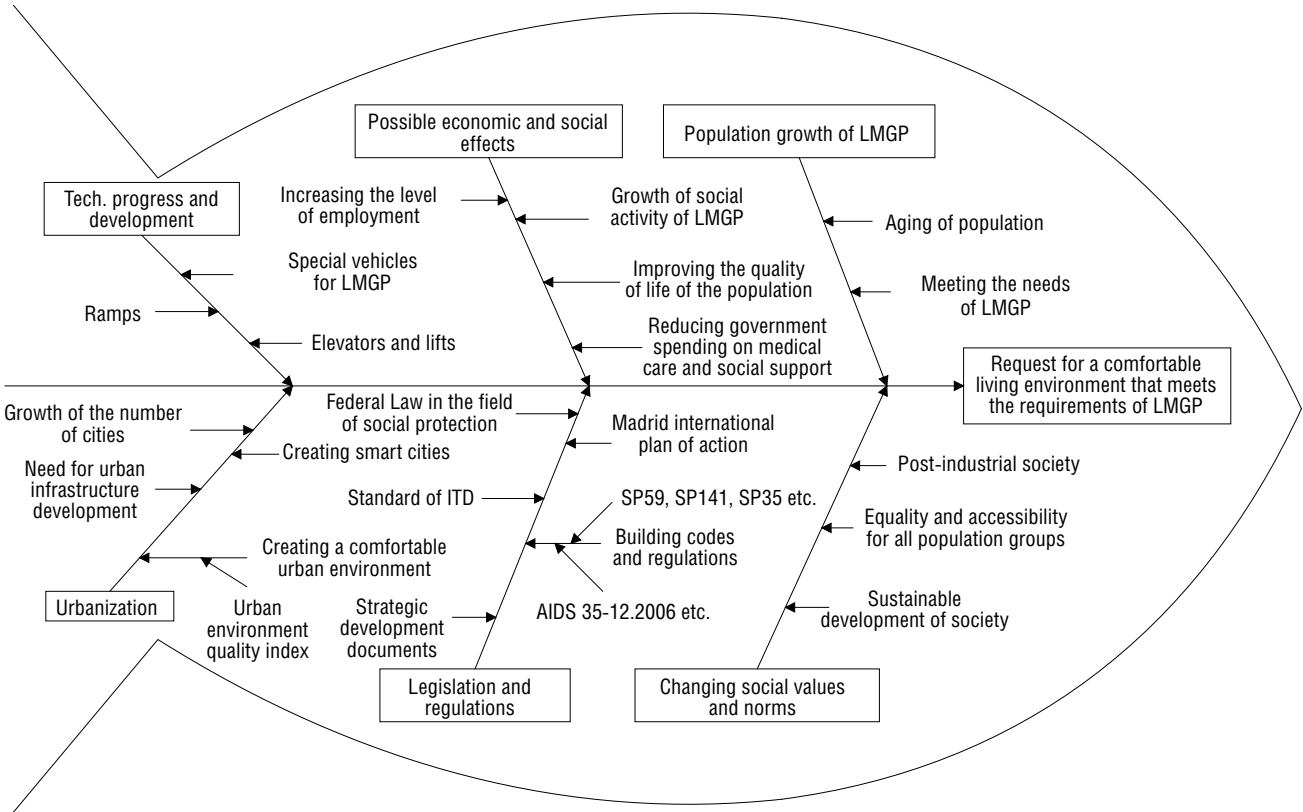


Fig. 3. Ishikawa diagram “Forming a request for a comfortable living environment that takes into account the needs of LMGP” (made by the author)

friendly urban spaces, reduce energy consumption and apply innovations to improve the quality of life of citizens.

Trend No. 4. In addition to the process of urbanization, i.e., the growth and development of cities, and, consequently, the growth of the urban population, the trend of “competition for people in modern cities” identified in an earlier study [4] should be attributed to influencing the development strategies of municipalities, since a direct relationship between the level of urban quality has been mathematically proven the environment and the population of the city.

Trend No. 5. Interaction of the population, executive authorities and business to create a comfortable living environment in cities, i.e. the development of partnership between participants in the system of creating a comfortable living environment. Similar prerequisites can be traced in the research of Japanese scientists, because the problem of population aging in Japan is very acute. The study [5] focuses on the importance of the active participation of all stakeholders and local enterprises and business structures in the urban planning process. The main task is to create conditions optimal for improving the well-being of elderly people, providing them with the opportunity to lead an active and safe life in society.

Trend No. 6. Digitalization of the economy contributes to the creation of modern so-called “smart” cities.

All of the above trends represent important aspects of the development of urban planning and the urban environment in the regions of the Russian Federation, aimed at creating modern, sustainable and convenient cities that improve the quality of life of

the population and the level of comfort of living for all categories of citizens, as well as contributing to the implementation of the state policy of people saving in the Russian Federation.

The development of the living environment, namely: the formation of a comfortable living environment occurs in accordance with the fundamental economic law of supply and demand. The demand formed by the population, i.e. the consumer of construction products, entails the development, and as a result, an increase in the level of comfort of the elements of the living environment.

The Ishikawa causal diagram⁶ presented in Fig. 3 reflects the factors that, in our opinion, influence the consumer's request for the formation of a comfortable living environment that takes into account the needs of LMGP. It includes such elements as possible economic and social effects from increasing the comfort level of the living environment, population growth, which belongs to the LMGP category, changes in social values and norms in the system of worldviews, legislative and regulatory acts in the field of urban planning and social protection of the population, as well as technological progress and urbanization.

The harmonious development of urban settlements takes into account both social, economic, environmental and cultural aspects. It is important to note the mechanism of integrated territorial development (ITD), which has been actively developing in recent years, which is designed to ensure the fulfillment of the law of supply and demand in the formation of a comfortable living environment⁷. The ITD of the city is an important and modern way to

6 Ishikawa Cause-and-Effect Diagram. URL: <https://up-pro.ru/encyclopedia/diagramma-isikavy/> (accessed: 04.17.2024).

7 The Russian Federation. Laws. Amendments to the Urban Planning Code of the Russian Federation and Certain Legislative Acts of the Russian Federation in order to ensure the integrated development of Territories : Federal Law No. 494-FL : adopted by the State Duma on 12.12.2020 : approved by the Federation Council on 12.25.2020. URL: <https://docs.cntd.ru/document/573249809> (date of application: 04.15.2024).

create a comfortable living environment for its residents, since modern citizens live outside their apartments, they tend to live in residential complexes whose services are able to meet the full range of their needs. Therefore, an important question remains how much the ITD takes into account the requests of both elderly people and other people with limited mobility. In view of this, the key element in the formation of a comfortable living environment, in our opinion, is to take into account the needs and wishes of local residents. This can be achieved through surveys, public hearings, the creation of public councils and the use of other feedback tools. The publication [6] defines the importance of sociological research in assessing the quality and development of the living environment, in this context it is interesting to consider the experience of a Hong Kong company specializing in real estate development. They conducted a survey among the elderly and those who care for them to find out their opinion about the services provided. The study was conducted by a specialized marketing company using questionnaires and subsequent focus groups, which allowed them to take into account the wishes of local residents in their further work [7].

Graphical notations of the IDEF (Integrated DEFINition) family are excellent for visualizing the process⁸. For functional modeling, the subtype of this family, IDEF0, is applicable, it will allow you to create a conceptual model of a system for creating a comfortable

living environment, since the constituent elements of this subtype of graphical notation correspond to the classical set of constituent elements of any system, i.e. there are inputs and outputs of the system.

At the first stage of creating a graphical notation of the IDEF0 family, the state is defined as a participant in the process, from whose point of view the entire process of creating a comfortable living environment is considered, taking into account the needs of LMGP.

The second stage defines the purpose of the diagram — an analysis of the process of forming a comfortable living environment, taking into account the needs of LMGP and determining possible directions for its development.

Fig. 4 shows a zero-level contextual diagram reflecting the system of creating a comfortable living environment taking into account the needs of LMGP.

In the centre there is a functional block (A0), which represents the system as a whole in a context diagram. Adjacent to the functional block are arrows reflecting “input”, “output”, “control” and “mechanisms”. The entry arrows reflect the source documents, conditions, and resources. The control arrows introduce various rules and restrictions into the system and have a controlling effect. The arrows of the mechanism reflect immutable resources, without

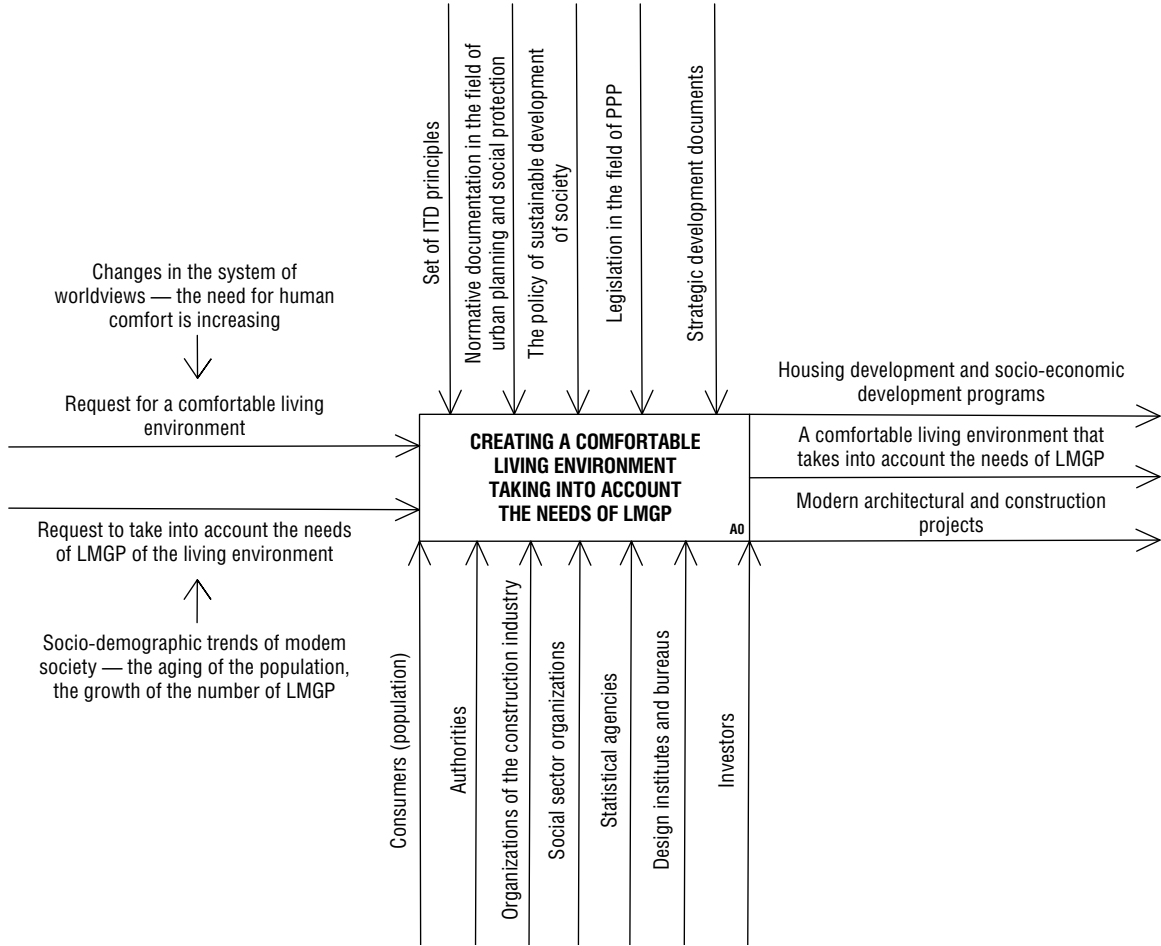


Fig. 4. Contextual diagram of the system for creating a comfortable living environment in the graphical notation of the IDEF0 family (made by the author)

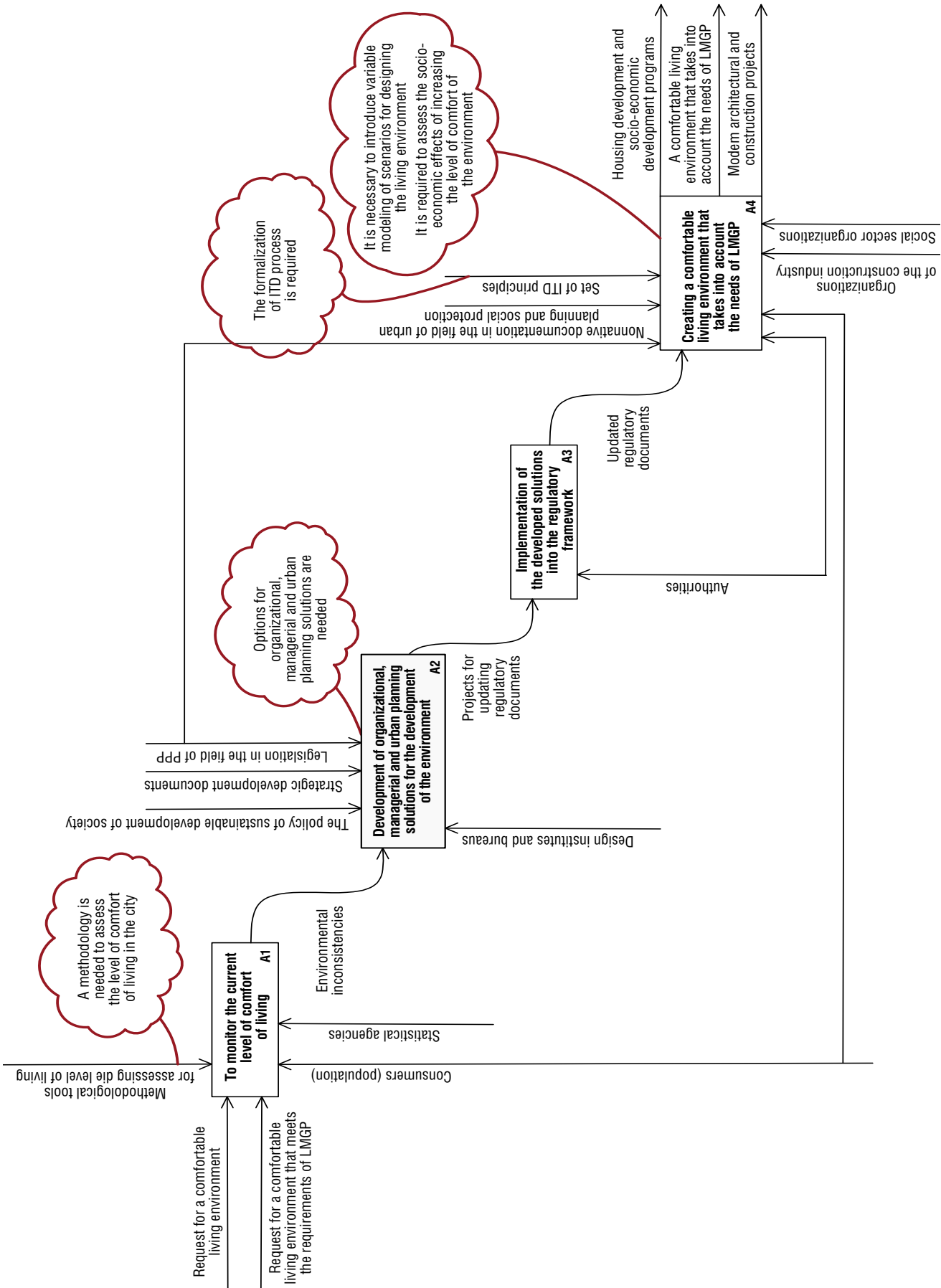


Fig. 5. Decomposition of the system for creating a comfortable living environment taking into account the needs of LMGP (made by the author)

which the process cannot be completed. The exit arrows essentially reflect the outcome of the process, outgoing documents, and resources. Thus, the system of forming a comfortable living environment was graphically visualized in a generalized format using the example of constructing a context diagram in the graphical notation of the IDEF0 family.

MAIN RESULTS

When drawing up graphical notations, the level of detail of the process can be increased. Fig. 5 shows the decomposition of the process shown in Fig. 4. The secondary or child diagram contains a number of functional blocks (A1, A2, A3, A4) that display the main subfunctions of the original functional block (A0) on the context diagram.

The analysis of the decomposition of the process made it possible to identify the shortcomings of the process of forming a comfortable living environment in its existing form and determine the directions of further research in order to develop it:

1. To monitor the current level of comfort of the living environment (A1), a methodology is needed to assess the level of comfort of the living environment in the city, taking into account the opinion of the population and the needs of the LMGP.

2. The analysis of functional block A2 revealed the need to develop options for organizational, managerial and urban planning solutions that allow developing alternative forms of living environment for the purpose of socialization and integration of LMGP and in particular elderly people into modern post-industrial society.

3. The analysis of the A4 functional block revealed the following areas of work:

- the formalization of the decision-making procedure and the implementation of the integrated development of the territory will allow the introduction of options for organizational, managerial and urban planning decisions at the legislative level;
- the introduction of the practice of variable modeling of the living environment, in particular, into the practice of integrated development of urban settlements territories, will allow choosing the best design solutions from the point of view of infrastructure balance, which allows taking into account the needs of LMGP;
- the activities of developers are aimed at making a profit from their activities, therefore, assessing the socio-economic effects of increasing the comfort level of the living environment is an integral part of the economic development of the regions and allows developers to engage in the implementation of investment and construction projects with an increased

level of comfort, taking into account the needs of LMGP in the region.

CONCLUSION

Creating comfortable living conditions in modern Russian cities is an urgent problem of regional development, requiring the collective work of all participants in this process from the population to public authorities. The areas of work identified with the help of graphical notation tools pose new challenges to the scientific community for further research in the field of creating a comfortable living environment in Russian cities, which will contribute to the collective response of modern society to the great challenge for the scientific and technological development of the country as a whole associated with demographic aging of the population. This is the only way to create comfortable living conditions in Russian cities that contribute to improving the quality of life and well-being for all citizens.

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Комфортная среда проживания как приоритет развития регионов

В последние годы численность городского населения в общей численности населения страны в Российской Федерации, как и в целом в мире, увеличивается. В совокупности с общемировой тенденцией старения населения это определяет формирование комфортной среды проживания как приоритет развития регионов и отдельных территорий Российской Федерации. Для полноты исследования уделяется внимание опыту учета потребностей маломобильных групп населения в международной практике, на примере разных

стран. В ходе проведенного исследования были выявлены факторы, тенденции и ключевые тренды, оказывающие непосредственное или косвенное влияние на формирование запроса на комфортную среду проживания в современных реалиях Российской Федерации с учетом потребностей маломобильных групп населения, включая людей пожилого возраста. Исследование опирается на принцип системности, который предполагает рассмотрение объекта исследования в виде сложной системы, состоящей из множества взаимосвязанных элементов. Объектом исследования выступает комфортная среда проживания в городах Российской Федерации, а предметом — инструменты формирования комфортной среды проживания в городах Российской Фе-

дерации. Методологическую основу исследования составляют различные методы научного познания, такие как контент-анализ, факторный анализ, анализ статистических данных, методы систематизации, группировки, обобщения, а также графические приемы визуализации данных. В статье выполнена декомпозиция процесса формирования комфортной среды проживания с учетом потребностей маломобильных групп населения посредством инструментария графической нотации. Анализ декомпозиции процесса позволил выявить недостатки процесса формирования комфортной среды проживания в существующем виде и определить направления дальнейших исследований в целях его развития.

Ключевые слова: комфортная среда проживания, тренды, маломобильные группы населения, контекстная диаграмма, графическая нотация IDEFO

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Development of warehouse infrastructure serving the process of construction of real estate objects in the housing market

The paper considers the main directions and rates of development of the construction production of residential real estate and the commissioning of residential facilities. In addition, an analysis of statistical data was carried out that reflect the dynamics of such development in Russia. Also, the paper considers the issue of the effectiveness of the implementation in practice of the main methods of constructing multi-storey buildings, taking into account the modern development of construction production and the requirements of the housing market. The role of warehouse real estate in the general production process of the construction of real estate is also determined. The construction of such real estate is inherently linked to the level of development of the industrial and social infrastructure of the region in which the construction of structures is carried out. These facilities are part of the maintenance processes, on which the development of the main production processes for the construction of multi-storey buildings in the housing market largely depends directly. The obtained statistics on housing commissioning allows to predict an increase in the growth rate of construction, which largely determines the choice of construction methods under the influence of environmental factors that lead to various changes in the course of development of production processes. To date, several fairly large developers have formed in the real estate market, which, on the one hand, have large financial capabilities, on the other hand, introduce large volumes of housing. The construction of a monolithic apartment building, in some cases, may be less economically efficient than the construction of similar areas already made of panels or blocks. Based on this forecast, it is necessary to analyze how modern warehouse infrastructure will be ready for possible changes in the field of apartment construction.

Keywords: development, real estate, warehousing, industrialization, logistics, warehouse infrastructure, supporting industry

INTRODUCTION

The development of construction production is associated with the need to address complex challenges. This requires considering the main trends in housing market growth, the specific features of the construction of real estate structures, and the need to develop appropriate measures to support a positive trend in the pace of commissioning high-rise buildings into the housing market.

The activities of enterprises within the construction sector in the housing market are largely determined by the extent to which essential production processes are supported by various buildings and structures, which ensure the stable operation of diverse supporting production processes. Additionally, the development of warehousing infrastructure significantly influences the utilization level of the organizational and technological potential of construction organizations, while also considering the mobility and uncertainty conditions of construction production.

MATERIALS AND METHODS

The research methods applied in this study include theoretical analysis and empirical investigation, followed by the generalization and systematization of obtained data. In addition, the primary scientific approaches used were: "dialectical", "systematic", "dynamic", "variant", "balance" and "modelling". The object of the study comprises facilities

and structures within warehousing infrastructure, focusing on their impact on the rate of housing commissioning for high-rise buildings, the stability of production process development, and the activities of construction organizations.

The empirical basis of the study includes statistical and other informational sources, materials characterizing the production and economic activities of developers, expert evaluations, legislative acts, and other regulatory documents in the construction sector.

RESULTS

Current trends in the construction industry indicate an increase in the growth rate of residential real estate construction. Market demand for new housing is being met by developers, resulting in an accelerated annual increase in the square footage of commissioned housing over the past several years. This is evidenced by statistical data (Fig. 1)¹.

This figure shows that the commissioned square footage of individual residential homes in Russia is steadily increasing, while the square footage of apartment buildings remains relatively stable, with a slight recession. The dynamics of these developmental trends can be described by the following equations:

$$Y = 114 \cdot x^2 - 463,410 \cdot x + 468,269,752; \quad (1)$$

$$Y = 351 \cdot x^2 - 1,415,819 \cdot x + 1,427,781,558, \quad (2)$$

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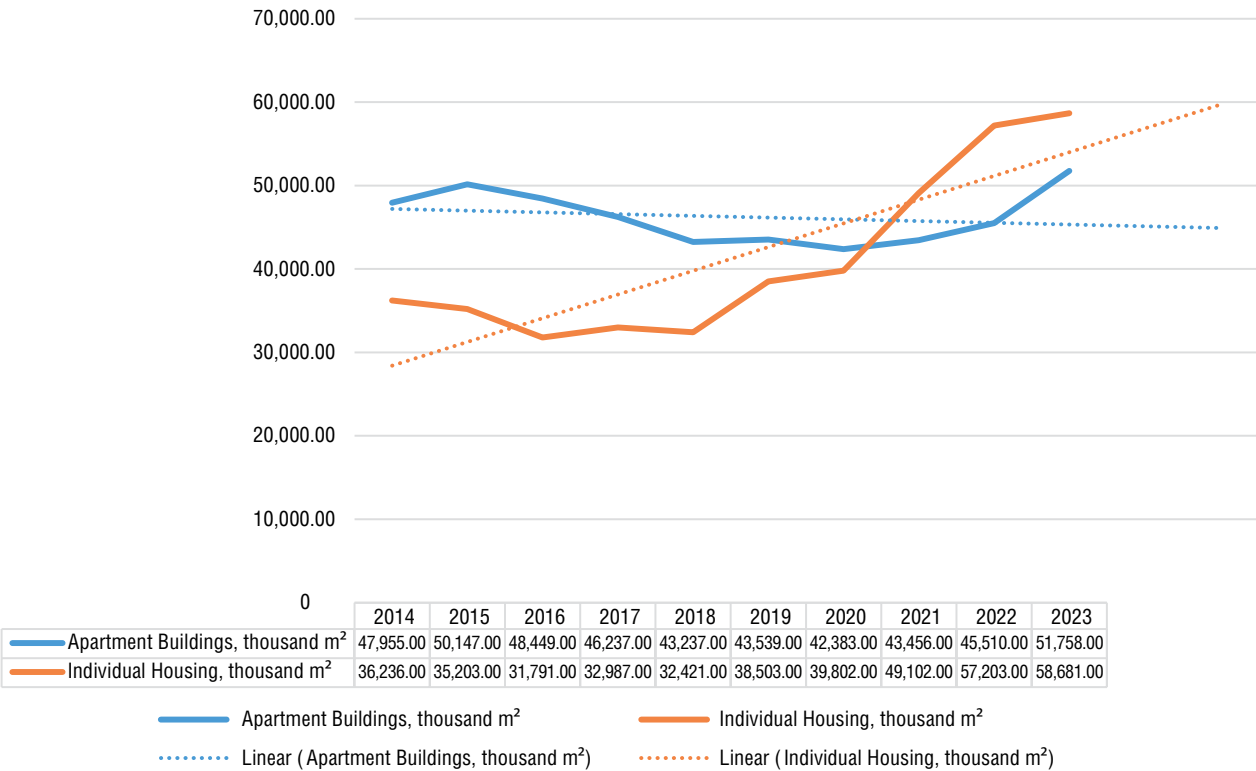


Fig. 1. Dynamics of residential real estate commissioning in Russia by year¹

where equation (1) describes the trend in the development of multi-apartment housing construction, while Equation (2) pertains to individual housing. These equations enable the forecasting of the ongoing trend of growth in the volumes of individual housing construction, alongside a further decline in multi-apartment construction, which will create a significant disparity in growth rates by the end of 2024.

Despite the predominance of individual housing construction across the country as a whole, the situation may vary significantly depending on the region. This conclusion can be drawn by analyzing the statistics for the city of Moscow (Fig. 2).

The trends for the first and second types of housing can be described by Equations 3 and 4:

$$Y = 15.05 \cdot x^2 - 60,333.70x + 60,455,990;$$

(3)

$$Y = -13.18 \cdot x^2 + 53,359.38x - 54,005,378,$$

(4)

where equation (3) describes the trend in the construction of multi-apartment buildings, while equation (4) pertains to individual housing. These equations enable the forecast that the area of individual housing completions will remain at the same level, whereas multi-apartment construction shows a tendency to increase. Thus, it is evident that in Moscow, the primary square footage of residential real estate is provided by the construction of multi-apartment buildings. This is primarily due to the high population density and land costs in Moscow.

The heterogeneity of housing construction conditions across different regions of the country presents certain necessary requirements for the objects and facilities that support production processes, particularly for warehousing infrastructure [1]. The construction of large multi-apartment buildings requires significant investments not only in labor and machinery but also in substantial volumes of

various materials, ranging from construction materials for load-bearing and enclosing structures to various network components and equipment. It is also worth noting that this heterogeneity may apply not only to residential real estate but also to industrial or commercial properties [2, 3].

Improving the efficiency of core production by enhancing the performance metrics of supporting industries is one of the main approaches to mitigating risks for both specific projects and the industry as a whole [4, 5]. To enhance the effectiveness of management, organization, and coordination of cargo transportation, it is crucial to accurately identify the existing characteristics and types of warehouses that define the role of warehousing infrastructure in logistics systems [6–8].

To address this, a classification of warehouse real estate has been developed, taking into account its diversity based on various parameters and criteria, which is presented in Table.

Examine each parameter of this classification in detail.

Purpose of the Warehouse. This parameter aims to determine the intended use of the facility. For instance, warehouses at manufacturing enterprises are primarily designed for storing finished products before they are dispatched further along the production chain or directly to consumers [9]. These warehouses are located at industrial facilities. Customs warehouses, on the other hand, also serve as transshipment points for finished products; however, their location is not tied to a specific manufacturing process and, in the case of bonded warehouses, they possess a special economic status. Trade and logistics complexes must be capable of accommodating a wide variety of goods, which requires greater versatility compared to warehouses associated with production, where the majority of products tend to be standardized. Specialized warehouses, unlike others, may be equipped with additional specialized

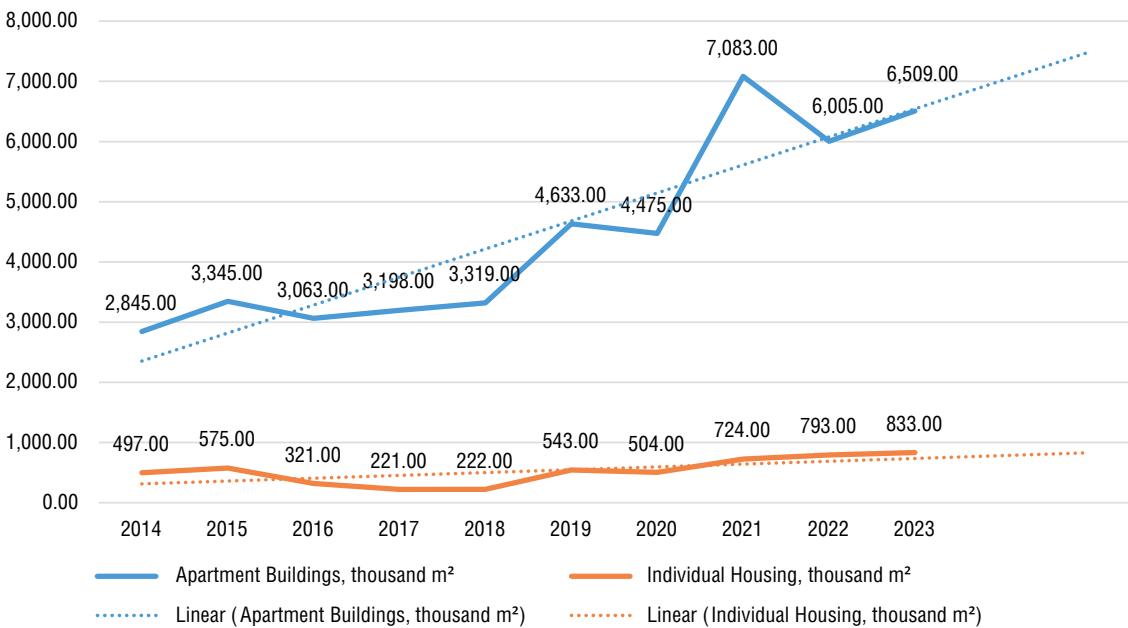


Fig. 2. Dynamics of residential real estate commissioning in city of Moscow by year¹

engineering systems of varying complexity, which will create the conditions required for the stored cargo [10].

Storage Duration. This parameter allows for the determination of the duration for which goods will be stored at the warehouse. This, in turn, influences the necessary equipment that will be used at the facility and subsequently affects the cost of both the real estate itself and the storage of items within it. Stored cargo can be conditionally divided into three categories:

- 1) Short-term Storage.** The storage period for goods does not exceed several weeks, indicating that a large volume of cargo will pass through this warehouse. Such warehouses can be highly mechanized or even automated to enhance productivity and throughput;
- 2) Medium-term Storage.** The storage duration ranges from several weeks to six months. This type of warehouse is more of a hybrid, combining elements of both long-term and short-term storage. Such warehouses may feature different sections designated for fast-moving goods as well as for items stored for longer periods, which introduces new requirements for layout, equipment, and accounting systems [11];
- 3) Long-term Storage.** Warehouses designed for the long-term storage of various goods experience a slow turnover of products, which reduces the need for automation and shifts the focus to

product preservation. This necessitates the maintenance of specific storage conditions, creation of an appropriate microclimate, and periodic inspections of goods to ensure compliance with storage conditions.

Cost or Durability of the Building. This parameter is responsible for determining the timelines and costs associated with the construction of the facility. Depending on the warehouse's purpose and the duration of goods storage, the construction of the warehouse complex may require varying levels of effort and resources. Warehouses can be conditionally divided into three categories:

- 1) Quick-erect Warehouses.** Such warehouse properties typically have a shorter lifespan compared to permanent warehouses. They are constructed from metal frames and simply covered with profile sheets, with the advantages being quick construction and low material costs. A characteristic feature of these warehouses is the lack of complex engineering systems, and sometimes even basic ones. They may not be connected to water supply systems, lack electrification, and may not be heated. The minimal protection of stored goods from environmental factors is the primary purpose of such structures [12];
- 2) Permanent Warehouses.** These structures are built for long-term operation, and the complexity and cost of the equipment used

Classification of Warehouse Real Estate

Parameter	Category	Description
Purpose of the Warehouse	1) Warehouses at Manufacturing Enterprises; 2) Customs Warehouses (including Bonded Warehousing); 3) Trade and Logistics Complexes; 4) Specialized Warehouses (Medical, Grocery, etc.)	Depending on their purpose, warehouses can be used for storing raw materials and finished products, temporary customs storage, or for commercial purposes
Storage Duration	1) Short-term (up to 1 month); 2) Medium-term (from 1 month to 6 months); 3) Long-term (over 6 months)	Classification by the Duration of Goods Storage in Warehouses, Influencing Equipment Type and Preservation Requirements for Products
Cost (Building durability)	1) Quick-erect Warehouses (Frame, Modular); 2) Permanent Warehouses (Concrete, Brick); 3) Temporary or Mobile Structures	Level of Durability and Construction Cost: Quick-erect, Permanent, or Temporary Warehouses

for careful preservation of the stored products can vary significantly based on the type of goods. Permanent warehouses typically feature solid reinforced concrete foundations, walls with high thermal resistance, sophisticated ventilation and heating systems, and connections to all necessary engineering networks. Additionally, such warehouses may include facilities for staff comfort, office spaces, and designated areas for meals. Each warehouse has its own unique configuration;

3) Temporary Warehouses. Similar to quick-erect warehouses, temporary warehouses can be constructed from relatively inexpensive materials. The main feature of this type of warehouse is the ability for rapid assembly and, if necessary, equally quick disassembly of the structure.

Resources. Depending on the type of warehouse, different resources may be utilized. For example, large permanent warehouses require more materials and financial resources for construction and maintenance due to their size, while highly automated warehouses demand greater investment in information resources. Let's explore these resources in detail:

1) Labour Resources. Depending on the complexity and durability of the constructed facility, various amounts of labor may be required for its construction;

2) Material Resources. Different materials and equipment may be used in warehouse construction. For example, wall construction can consist of a combination of brick and gas-silicate blocks, sandwich panels of varying thicknesses, or simply profile sheets attached to the frame of the structure. The materials used for construction are selected based on the storage conditions and intended purpose of the warehouse [13];

3) Technical Resources. In addition to engineering networks, warehouses may be equipped with various mechanisms, such as forklifts, manipulators, and automated systems. The presence of such mechanisms enhances warehouse productivity and facilitates staff work; however, their use may not always be practical. Additionally, their implementation imposes extra requirements on the internal layout of the warehouse, which can affect its technical and economic performance;

4) Management Resources. Depending on the volume of stored products, the size, and purpose of the warehouse, management practices may vary significantly;

5) Financial Resources. The cost of maintaining a warehouse can vary widely based on its purpose. Choosing the most suitable category of warehouse for storing products can significantly reduce storage costs, thereby optimizing the entire production process;

6) Informational Resources. Digitalization and automated accounting of stored goods significantly enhance the productivity of workers involved in sorting items within the warehouse. Various digital systems may be used for this purpose, which require maintenance, updates, and upgrades [14].

Such a classification of facilities will facilitate a better understanding of the diverse forms that comprise warehouse infrastructure, which, in turn, will help optimize the operation of supporting production processes, improve manageability, and enhance control.

CONCLUSION

Based on the results of the conducted analysis, several trends have been identified, leading to the following key conclusions:

1. The primary trends in the development of the multi-apartment housing market in Russia and Moscow have been identified,

which must be considered when implementing technologies and flow-based organizational forms in material production across all types of production processes.

2. The objects and facilities supporting the construction processes of multi-apartment buildings define the sophistication of warehouse infrastructure, which significantly influences the stability of housing market trends and the core processes of multi-apartment construction and construction organization activities.

3. It has been established that the formation of warehouse infrastructure is affected by the method of real estate construction, the construction area, and the degree of influence from external and internal environmental factors and risks, which need to be identified and accounted for in future research.

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Девелопмент складской инфраструктуры обслуживающего процесса возведения объектов недвижимости на рынке жилья

В статье рассмотрены основные направления и темпы развития строительного производства жилой недвижимости и ввода жилых объектов. Кроме того, был проведен анализ статистических данных, которые отражают динамику такого развития в России. Также в статье рассмотрен вопрос эффективности реализации на практике основных способов возведения многоэтажных зданий с учетом современного развития строительного производства и требований рынка жилья. Также определяется роль складской недвижимости в общем производственном процессе возведения объектов недвижимости. Строительство таких объектов недвижимости неотъемлемо связано с уровнем развития производственной и социальной инфраструктуры региона, в котором производится возведение сооружений. Эти объекты являются частью обслуживающих процессов, от которых во многом зависит развитие основных производственных процессов возведения многоэтажных зданий на рынке жилья. Полученная статистика по вводу жилья позволяет прогнозировать увеличение темпов роста строительства, что во многом определяет выбор способов строительства в условиях влияния факторов внешней среды, которые приводят к различным изменениям хода развития производственных процессов. На сегодняшний день на рынке недвижимости сформировалось несколько достаточно крупных застройщиков, которые, с одной стороны, обладают крупными финансовыми возможностями, с другой стороны, вводят большие объемы жилья. Возведение монолитного многоквартирного дома, в ряде случаев, может быть менее экономически эффективно, чем возведение аналогичных площадей уже из панелей или блоков.

Однако отсутствие альтернативы по доступной цене, либо по причинам высокой дистанцированности, не оставляет выбора застройщику. Недополучаемая прибыль из-за менее эффективного способа строительного производства может побудить таких крупных игроков к созданию собственных мощностей по производству крупноблочных и панельных элементов зданий. Основываясь на данном прогнозе, необходимо проанализировать, насколько современная складская инфраструктура будет готова к возможным изменениям в сфере многоквартирного строительства.

Ключевые слова: девелопмент, недвижимость, складирование, индустриализация, логистика, складская инфраструктура, обслуживающее производство

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Application of complex analysis provisions in order to assess the efficiency of residential renovation projects

Implementation of the municipal program of residential development renovation in Moscow is a large-scale and long-term directive socio-economic policy aimed at sustainable renovation of the existing outdated housing stock and wave resettlement of citizens into newly constructed residential buildings. This program is implemented to provide citizens with comfortable and safe housing create new centers of attraction and create conditions for the renovation of residential development in the districts under consideration. The municipal program of residential development renovation includes three stages of wave resettlement, namely: 1st stage — 2020–2024; 2nd stage — 2025–2028; 3rd stage — 2029–2032. During the program realization, it is planned to carry out demolition of 5,175 residential buildings, which are in a high state of physical and moral deterioration, as well as to develop more than 650 starting sites for construction of new residential buildings.

The first phase for the implementation of individual projects under this program is the determination of the starting site — the selection of a land plot for the construction of a new residential building. As the practical experience of the program shows, the peculiarities and restrictions imposed by the surrounding development, parameters and physical characteristics of the land plot and other initial parameters can have a negative impact on the efficiency of project implementation: insufficient analysis conducted at the stage of concept and land plot selection can significantly increase the risks of the project and have a negative impact on the economic efficiency and timing of the project, which in the conditions of the need to comply with the plan for the introduction of a new residential building. In order to solve this problem, we propose to consider the feasibility of applying the provisions of complex analysis in the process of implementation of residential renovation projects in the city of Moscow in order to determine the probable risks in advance and develop mechanisms to minimize them.

Keywords: residential development renovation programme, integrated territorial development, complex analysis, improvement of the interaction mechanism, Moscow City Renovation Programme

The basis for the preparation of the principles of improving the efficiency of construction project execution is the need to conduct a deep and comprehensive analysis of the project: its strengths and weaknesses, construction conditions, likely risks and other aspects that need to be taken into account in order to develop and apply the most optimal mechanisms to improve the overall efficiency of the project. The main task of applying a comprehensive analysis of the project is to consider the main and most significant parameters of the project to identify and determine the basic efficiency of the project, which will allow to form a number of necessary measures to reduce the likely risks in the implementation of the project, taking into account the characteristics of the project (surrounding development, the peculiarities of interaction between the main participants in the process of project implementation, limit parameters and so on)¹.

The application of a comprehensive analysis in relation to the implementation of projects under the municipal residential renovation programme will also allow assessing the list of the most important parameters². As part of the implementation of the residential development renovation program,

the efficiency indicators of the projects under consideration are assessed, the main ones being: cost and time indicators of project implementation, which should ensure timely wave resettlement of citizens. It should be noted that, taking into account the peculiarities of the implementation of the residential development renovation program, the most important is the time indicator — the project implementation period. This fact is related to the planned wave resettlement of citizens, which makes it necessary to comply with the declared and calculated time indicators³ [1, 2].

Also, one of the most important performance indicators of the project implemented under the residential development renovation program is the indicator of social significance, which can be characterized by the following parameters⁴:

1. Remoteness of the new house under construction from the house to be resettled (in case the resettlement of citizens takes place in a new residential house built at a remote location, if it is impossible to build a residential house on the land plot of the house to be resettled).
2. Provision with social infrastructure (proximity of polyclinics, city hospitals, schools, kindergartens and other objects of social infrastructure).

1

Approval of the Basic Requirements to Improvement of the Residential Development Territory during the Implementation of the Program for Renovation of the Residential Stock in the City of Moscow : Government Decree No. 515-PP.

2

Approval of the Requirements for Improved Finishing of Equivalent Residential Premises Provided in Replacement of Residential Premises in Multifamily Buildings : Government Resolution No. 516-PP

3

Consideration of Public Opinion on Housing Renovation Project in Moscow : Decree of the Government No. 245-PP.

4

Approving the Addressed List of Neighbourhoods (Territories) : Government Decree No. 708-PP.

3. Transport accessibility: distance from the nearest metro stations, public transport stops, public parking lots [1, 2].

The social indicator is one of the most important, as it can have a significant impact on the attitude of citizens to the implemented program of residential development renovation, shows the significance of the residential building to be constructed on the selected site and the provision of social infrastructure to the citizens relocated from the demolished residential buildings⁵ [1]. The social indicator can be assessed by analyzing the adjacent development in terms of, among other things, the availability and number of social infrastructure facilities relative to the number of relocated citizens — additional load on the existing social infrastructure facilities; assessment of the accessibility of these facilities for citizens. This assessment should be carried out at the stage of project conceptualization, taking into account the possible number of resettled citizens depending on the expected capacity of the projected residential building.

A set of methods of project assessment based on its initial parameters, determined in the framework of pre-project analysis, allows to sufficiently determine its effectiveness and choose the most optimal strategy for project implementation. It is fair to evaluate the initial parameters of the object and determine its efficiency using the method of complex analysis, which subsequently allows to form a factor space for building an economic and mathematical model [3].

The main objective of the comprehensive analysis is to determine the initial efficiency of the project based on the assessment

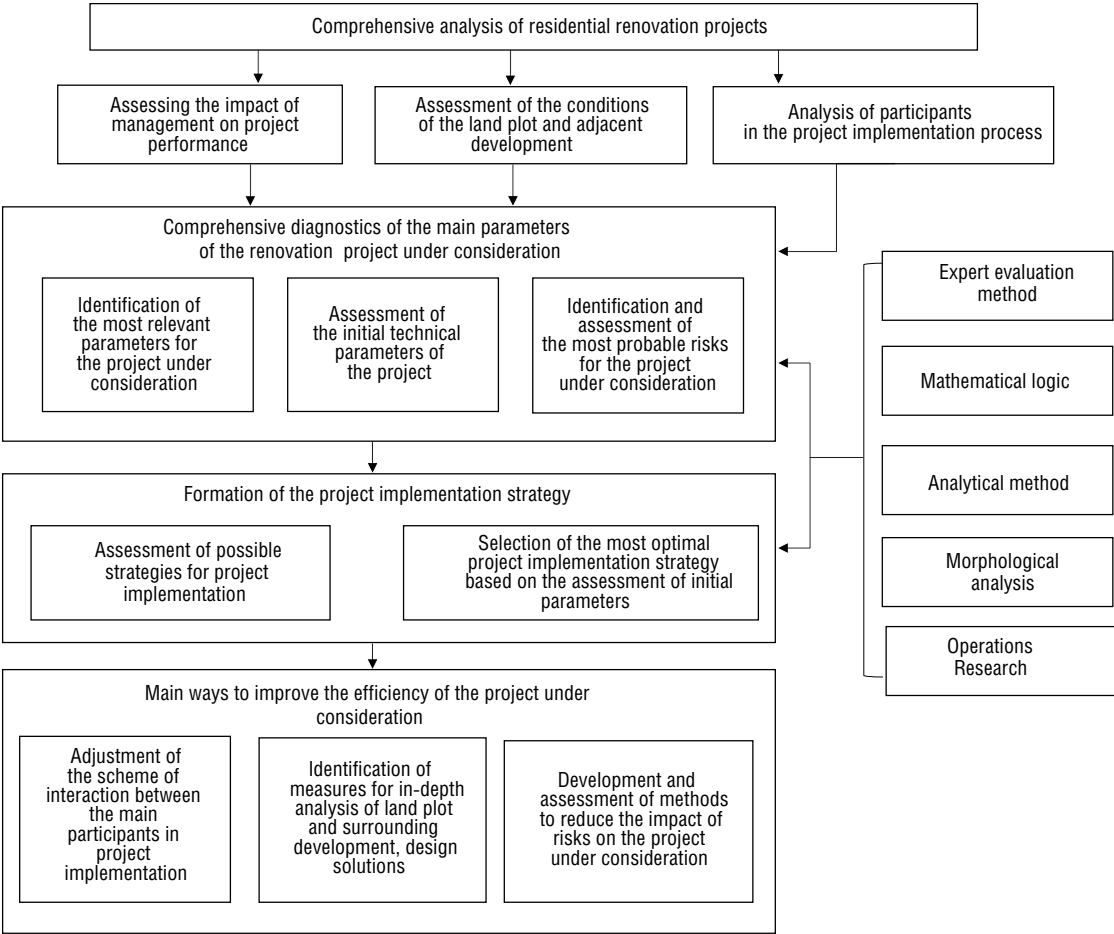
of initial parameters and conditions for its implementation. When considering a large portfolio of ongoing projects within the framework of the residential development renovation programme, which do not have sufficient efficiency, it can be concluded that the efficiency of the programme, expressed primarily in the timing of wave resettlement, will be at an insufficient level for its successful implementation [1]. Thus, the development of a method of integrated project appraisal is practically significant.

It is proposed to conduct project performance evaluation according to a set of actual indicators and baseline data in accordance with the provisions of comprehensive analysis. Comprehensive analysis of project effectiveness is carried out using such methods:

- expert evaluation method;
- principles of mathematical logic;
- analytical method;
- morphological analysis;
- method of research of the operations carried out in the process of project realization.

The mentioned methods of conducting a comprehensive analysis of project efficiency allow to sufficiently assess such basic blocks of parameters as:

- assessment of the conditions of the considered land plot and surrounding development;



Scheme of comprehensive analysis

- assessment and analysis of the limit parameters of the projected residential building and possible related restrictions;
- assessment of possible and most probable risks associated with the implementation of the project under consideration in order to determine them and develop solutions to minimize them;
- assessment of the impact of management peculiarities in the project realization;
- analysis of the main participants and methods of their interaction in the implementation of the project.

It should be noted that only a comprehensive analysis, consisting of various methods of analysis allows conducting a full-fledged and multifaceted assessment of the initial parameters of the project under consideration by a list of criteria that form the overall assessment of project efficiency and allow to form further methods for its improvement [4–6].

In the following, the comprehensive analysis of the project under consideration will allow to form a list of the most significant parameters for the residential renovation project under consideration with the help of certain evaluation methods at each stage of the analysis. In turn, the selected parameters will help to form a multi-criteria evaluation of the project in order to apply an economic-mathematical model to select the most optimal strategy for the project implementation based on the comprehensive analysis with the use of these evaluation methods.

It should be noted that an isolated diagnosis (evaluation) of the project without taking into account how the project implementation is managed, its initial parameters, data on the surrounding development, probable encumbrances, risks and other data can only partially conduct a comprehensive assessment of the project efficiency and will not allow to form the most optimal strategy for project implementation with the achievement of the highest efficiency. Only taking into account the set of data can develop a project implementation strategy and select areas for reforming the initial parameters (management structure, technical parameters) of the project [3, 7].

Taking into account the provisions described above, it seems possible to form a model for the evaluation of projects implemented under the residential renovation programme in the following form Figure.

The results of the morphological analysis can be used to assess the effectiveness of management in the implementation of the project at various stages, which will allow to choose the most effective scheme of interaction between the main participants of the process, as well as to propose methods of reforming the current management structures [7, 8].

The application of the above complex assessment of the project efficiency will allow to determine the directions for reforming the basic (initial) model of the project, including: management features, the system of interaction of the main participants of the process, to determine the main and most likely risks in the implementation of the project under consideration and to propose a strategy

for the project implementation, taking into account its initial parameters to achieve the highest efficiency [9, 10].

The result of the comprehensive analysis of the project is to obtain the necessary data to assess its initial parameters, the final cost of the finished construction object, as well as its other components, including an assessment of the most likely risks in the implementation of the project, possible encumbrances, and subjects of object management. The results obtained in the course of complex analysis allow us to conclude that a deeper complex analysis at the pre-project stages of project implementation and land plot selection will allow us to identify the most likely risks that may arise at further stages of project implementation, as well as to develop mechanisms to minimize them in advance. Thus, the application of complex analysis provisions in the implementation of the residential development renovation programme, taking into account the previously described features, is expedient and practically significant in order to optimize the project implementation process and improve its efficiency.

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Применение положений комплексного анализа с целью проведения оценки эффективности реализации проектов реновации жилой застройки

Реализация муниципальной программы реновации жилой застройки на территории города Москвы представлена масштабной и долгосрочной директивной социально-экономической политикой, направленной устойчивое обновление существующего

устаревшего жилого фонда и волновое переселение граждан во вновь возведенные жилые дома. Данная программа реализуется с целью обеспечить граждан комфортным и безопасным жильем, создать новые центры притяжения и создать условия для обновления жилой застройки в рассматриваемых районах города. Муниципальная программа реновации жилой застройки включает в себя три этапа волнового переселения, а именно: 1-й этап — 2020–2024 гг.; 2-й — 2025–2028 гг.; 3-й — 2029–2032 гг. За время реализации программы планируется осуществить снос 5175 жилых домов, находящихся в высокой

степени физического и морального износа, а также произвести освоение более 650 стартовых площадок для строительства новых жилых домов.

Первичным этапом для реализации отдельных проектов в рамках указанной программы является определение стартовой площадки — выбора земельного участка для строительства нового жилого дома. Как показывает практический опыт реализации программы, неучтенные особенности и ограничения, накладываемые окружающей застройкой, параметры и физические характеристики земельного участка и иные исходные параметры могут оказать негативное влияние на эффективность реализации проектов: недостаточный анализ, проводимый на этапе концепции и выбора земельного участка, может существенно повысить риски проекта и оказать негативное влияние на экономическую эффективность и сроки реализации проекта, что в условиях необходимости соблюдения плана по вводу новых жилых домов, обеспечения волнового переселения является одной из важнейших задач. Для решения данной задачи предлагается рассмотреть обоснование целесообразности применения положений комплексного анализа при реализации проектов реновации жилой застройки в городе Москве с целью заблаговременного детерминирования вероятных рисков и разработки механизмов по их минимизации.

Ключевые слова: программа реновации жилой застройки, комплексное развитие территорий, комплексный анализ, программа реновации города Москвы

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Analysis of the symbiosis of factoring and chargeback in outsourcing of construction processes and real estate management

One of the main factors influencing the final cost of construction is compliance with deadlines, as well as the quality of work performed or services provided. Existing mechanisms that guarantee payment or quality of work performed or services rendered become ineffective and protect the interests of only one of the parties involved in the construction process, while the second becomes more vulnerable. The exponentially growing volume of accounts receivable in the construction industry requires new management approaches. The particular importance for the development of the construction industry in the Russian Federation is consideration of interests of all parties involved in construction processes and real estate management. The purpose of this paper is to analyze the possibility of simultaneous use of tools as factoring and chargeback in outsourcing construction processes in terms of improving the effectiveness of financial risk management for the customer and contractor. The relevance of the topic is related to the growth of accounts receivable in the construction sector of the Russian Federation and the lack of relevant research on the use of factoring and chargeback symbiosis in outsourcing construction processes. Up-to-date statistics were collected and the dynamics of changes in the volume of accounts receivable by industry in construction and real estate management were modeled, and based on the research conducted, a comparative characteristic of use of factoring and chargeback was carried out. It is a reasonable conclusion that the mechanisms under consideration perform different functions and are aimed at achieving different goals, while contributing to financial recovery and reducing cash gaps of companies, and the symbiosis of their application is able to reduce the volume of accounts receivable in the construction and real estate management industry as a whole.

Keywords: outsourcing, chargeback, factor, factoring, construction processes

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According to research conducted by the Federal State Statistics Service of the Russian Federation (Rosstat) from January 2020 to December 2023, the size of accounts receivable of domestic companies in the construction or real estate management sectors, remains consistently high, and in some cases showed continued growth in exponential progression.

The amount of accounts receivable of the companies from January 2020 to December 2023:

- 1) in the sector of management of maintenance of the residential fund — decreased from 122,278,661.00 rubles to 111,248,284.00 rubles, but still remains at a high level (Fig. 1);
- 2) in the non-residential fund maintenance management sector — increased several times from 42,127,674.00 rubles to 246,658,682.00 rubles (Fig. 1);
- 3) in the construction sector, an explosion of growth was recorded — from 3,410,087,984.00 rubles to 8,388,597,131.00 rubles (Fig. 2).

To calculate the total amount of accounts receivable, Rosstat used the methodology, where the indicators of debts on settlements with buyers and customers for goods, works and services were taken, including debts secured by promissory notes; debts on settlements with subsidiaries; debts on unearned advances; overpayments of taxes and fees to the budget; debts of accountable persons and employees who were given amounts and loans; debts on government orders, as well as fines, penalties and forfeitures recognized by the debtor or Statistical data for the Russian Federation are given without information on the Donetsk

People's Republic (DPR), Luhansk People's Republic (LPR), Zaporizhia and Kherson regions [2].

Modelling the accounts receivable schedule in the construction industry, the authors used Rosstat data on the classification of the following types of economic activities (Fig. 2):

- development of: construction projects, dismantling and demolition of a building;
- preparation of: construction site, including its clearing, for development and extraction of minerals, except for oil and gas sites, exploratory drilling;
- construction: residential and non-residential buildings, engineering structures and communications for water supply and water disposal, gas supply, utility facilities for electricity and telecommunications, roads and highways, railroads and subways, bridges and tunnels, local and intercity power transmission and communication lines, power plants, water, port and hydraulic engineering structures, other engineering structures;
- works: underwater, including diving, dredging and shore protection, specialized construction, earthworks, electrical installation, sanitary engineering, installation of heating and air conditioning systems, construction and finishing works, plastering, carpentry and joinery, interior finishing of buildings (including ceilings, partitions, etc.), flooring and wall cladding, painting and glass works, specialized, waterproofing, scaffolding installation, piling and foundation construction,

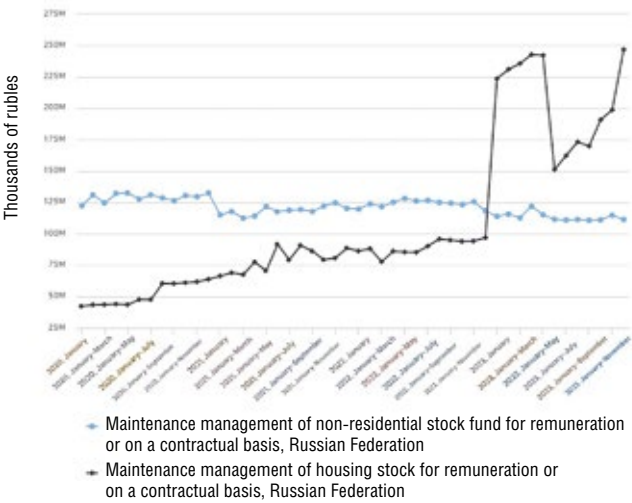


Fig. 1. Accounts receivable schedule from 2020–2023 in maintenance management [1]

concrete and reinforced concrete, installation of steel building structures, stone and brick, assembly and installation of prefabricated structures, other construction and assembly finishing, finishing and specialized, including those not included in other groupings.

The diversity of economic activities that make up construction processes, as well as the growth of accounts receivable in all of the above-mentioned industries, clearly gives an impetus to the search for new types of financial guarantees for all participants of construction processes.

As examples of such guarantees and financial security, let us consider the symbiosis of factoring and chargeback and the creation of a “two-way road” in the financial interaction of participants of construction processes and real estate management.

The origin of the term factoring is formed from the English word “factor” — “intermediary, commercial agent”. In Russian law, factoring refers to the process of financing under the assignment of a monetary claim, the subjects of the factoring agreement are the client, financial agent (factor) and debtor [4].

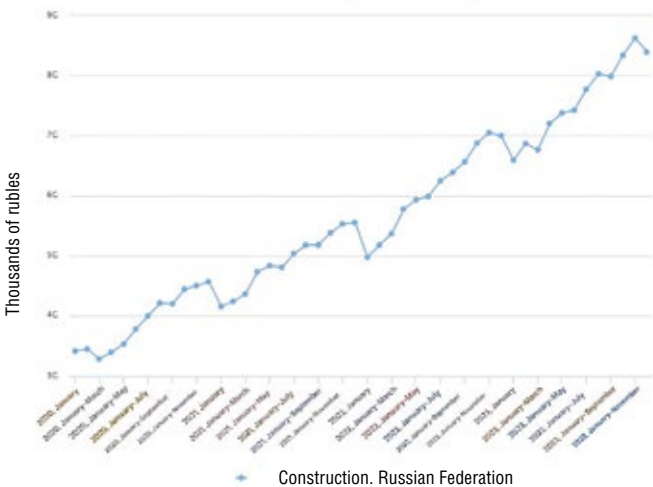


Fig. 2. Accounts receivable schedule from 2020–2023 in construction [3]

The factoring mechanism allows to shorten the financial cycle, gives stability to the working capital, because it allows to receive payment immediately after rendering the service, without the condition of deferred payment, which the participants could have agreed on, which reduces cash gaps of the performers, as well as increases the amount of working capital.

There are the following types of factoring according to the distribution of the degree of risks between the participants — recourse and non-recourse [5]. In recourse factoring it is assumed that the risk of non-payment falls on the supplier and if the buyer has not fulfilled its obligations, the factoring company (factor) has the right to demand the return of funds from the supplier. Non-regressive factoring is the one where the risks of non-payment are assumed by the financial agent and in this case the debt recovery from the buyer will be handled by the factor. Factors propose the use of factoring in outsourcing of construction processes in the development, construction and production of works [6].

Trade and manufacturing companies are considered to be the main consumers of the factoring market, but it is also gaining popularity in the construction industry [7]. According to research for 2023, the largest market for factors is Europe, where factoring volume amounted to 2,555 trillion euros, with countries such as France, England, Germany, Italy and Spain being the flagships in this territory. The Asia-Pacific region (China, Thailand, Japan and Singapore) takes the next position, where the volume of factoring services amounted to EUR 942 billion. In the Americas, the volume amounted to EUR 237 billion. The share of factoring in the BRICS member countries — Russia, India, Brazil, UAE, South Africa, Egypt, Iran and Ethiopia (China and Brazil in this study were included in the Asia-Pacific region, so in the calculation as part of BRICS was excluded from the study) amounted to \$ 944,361 billion, where the turnover of Russia amounted to \$ 333 billion [8, 9]. The increase in the use of factoring has a positive impact on world trade, and conservative calculations made by foreign researchers have shown that an increase in the share of factoring by 10 % would lead to an increase in trade volume by 1 %. In addition, that factoring is positively correlated with credit, they complement rather than replace each other [10].

In the world practice, popularization and increasing the level of confidence in factoring is carried out by creating a rating of companies providing it. Forbes magazine published a rating of the best in 2024 network factoring companies according to various parameters, such as the best company for freight brokers or the flexibility of tariffs, or the best for transportation companies, etc. [11]. Examples of global network factoring companies represented in the Russian market are: Raiffeisen Factor Bank AG, UniCredit Group, Societe Generale [12].

In the Russian Federation, the Association of Factoring Companies (AFC), a professional public association of factoring market participants in the Russian Federation, is engaged in popularization and rating of factoring companies' volume and reliability, one of the goals of which is to expand the factoring market volume and reduce the risks of factoring business.

According to AFC's research, the number of active clients in the construction industry for the first half of 2024 was 488, whose number increased by 15 % in 12 months (Fig. 3).

The growth of the quantity of active participants of factoring is connected with its popularization and creation of ratings among factors, as well as due to the advantages of factoring in comparison with credit and overdraft in terms of flexibility of terms, financing limits, order of security, repayment and others (Table).

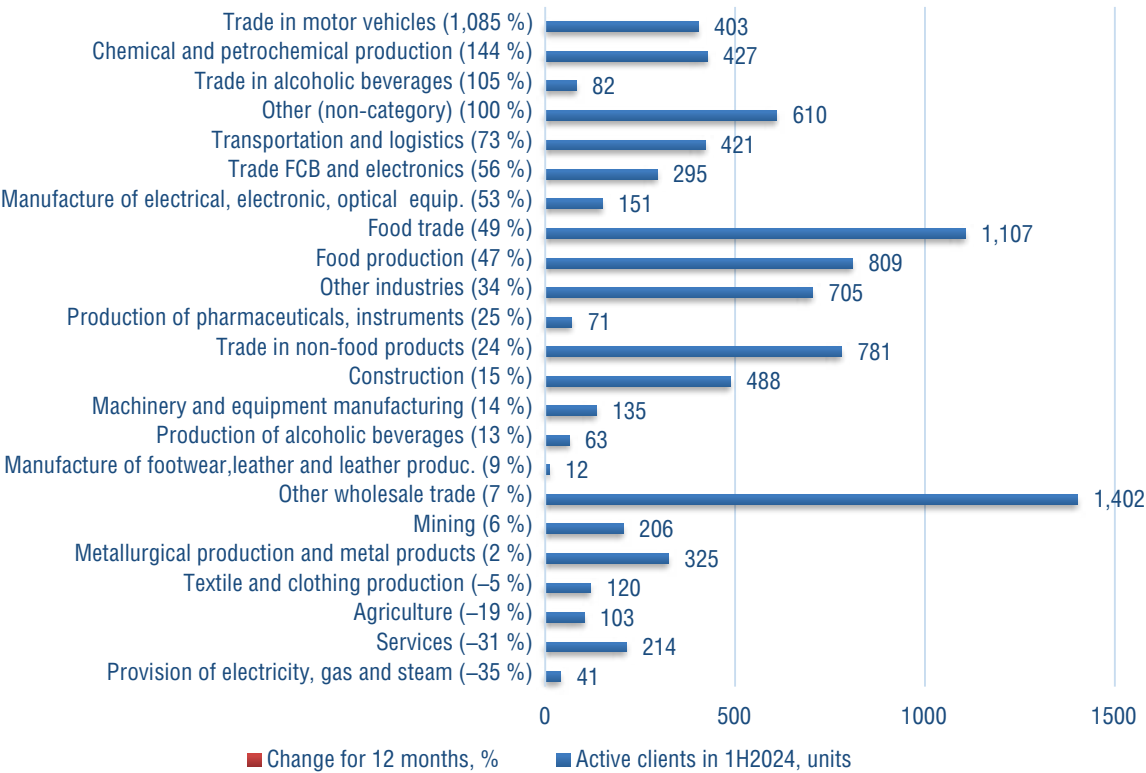


Fig. 3. Dynamics of active factoring clients in certain industries in the 1st half of 2024 in units with data on changes over 12 months in % [13]

The notion of chargeback is derived from the English word "chargeback" and translates as "return payment". It exists in the financial sector and is currently used in the interaction between an individual, a bank and an executor. Chargeback procedure refers to the contestation of the transaction by the issuing bank and acceptance-free debiting of funds from the payee and return to the payer, in other words, it is a procedure for returning funds to the client in case of improper provision of services or performance of work [15].

The essence of this procedure implies out-of-court resolution of disagreements, which saves time, eliminates legal costs, as well as the possibility of losses due to the bankruptcy of the counterparty and the inability to receive the awarded compensation. For example, in construction, if the customer discovers defects in the work performed or services rendered, he can demand compensation, similarly in the case of delivery of low-quality materials.

The comparative analysis of existing financial instruments in the form of guarantee retention, bank guarantee and chargeback

in the outsourcing of construction processes, including construction processes and real estate management has shown that chargeback has prospects, but requires correction through the prism of relationships between companies in the construction industry [16].

The considered tools of factoring and chargeback in construction processes and real estate management perform different functions and are aimed at achieving different goals, in particular, factoring procedure is suitable for outsourcing companies (contractors, executors), while chargeback is suitable for client companies, both of these tools contribute to financial recovery and increase working capital. Popularization and mutual application of the above instruments requires holding thematic forums with the participation of representatives of the construction process and subsequent amendments to the current legislation.

Symbiosis of application of factoring and chargeback instruments in outsourcing of construction processes and real estate management for the participants of these processes, as well as

Comparison of factoring with credit and overdraft [14]

	Factoring	Credit	Overdraft
Contract period	Indefinite	Fixed term	Fixed term
Funding limit	Increased as needed	Fixed amount	A certain percentage of turnover
Funding period	Actual deferral	Fixed term	Fixed term
Provisioning	Assignable monetary claims	Bail	Maintaining a certain turnover
Redemption	The day of actual payment by the buyer	Fixed day	Fixed day
Services	Receivables management, reduction of non-payment risk	–	–
Control	–	Targeted use	Penalty for not selecting a limit
Balance structure	Not recognized as a credit liability	Credit obligation	Credit obligation

for the construction and real estate management industry as a whole can bring benefits in the form of obtaining additional guarantees in terms of payment, quality of work performed, reducing cash gaps and reducing the volume of receivables. Outsourcing companies with the help of factoring tool receive a guarantee of payment for work performed or services rendered, customers at the same time receive a guarantee of the quality of work performance or service rendering with the help of the tool of chargeback, in both cases the factor acts as an intermediary and guarantor, which takes the risks arising in the collaboration on itself. The symbiosis of these processes can be called a "chargeback-factor".

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Анализ применения симбиоза факторинга и чарджбека при аутсорсинге строительных процессов и управлении недвижимостью

Одними из основных факторов, влияющих на окончательную стоимость строительства, являются соблюдение сроков, а также качество выполняемых работ или оказываемых услуг. Существующие механизмы, обеспечивающие гарантию оплаты или качества выполняемых работ или оказываемых услуг, становятся неэффективными и защищают интересы только одной из сторон, участниц строительного процесса, в то время как вторая становится более уязвимой. Рост в геометрической прогрессии объема дебиторской задолженности в строительной отрасли требует новых подходов в управлении. Особую важность для развития строительной отрасли в Российской Федерации представляет учет интересов всех сторон-участников строительных процессов и управления недвижимостью. Целью настоящей статьи является анализ возможности одновременного применения при аутсорсинге строительных процессов таких инструментов, как факторинг и чарджбек, с точки зрения повышения эффективности управления финансовыми рисками для заказчика и подрядчика. Актуальность темы связана с ростом дебиторской задолженности в строительном секторе Российской Федерации и отсутствием актуальных исследований, посвященных применению при аутсорсинге строительных процессов симбиоза факторинга и чарджбека. Была собрана актуальная статистика и смоделирована динамика изменения объема дебиторской задолженности по отраслям в строительстве и управле-

нии недвижимостью, и на основании данных исследований была проведена сравнительная характеристика применения факторинга и чарджбека. Сделан обоснованный вывод о том, что рассматриваемые механизмы выполняют разные функции и направлены на достижение разных целей, при этом способствуют финансовому оздоровлению и снижению кассовых разрывов компаний, а симбиоз их применения способен снизить объем дебиторской задолженности в отрасли строительства и управления недвижимостью в целом.

Ключевые слова: аутсорсинг, чарджбек, фактор, факторинг, строительные процессы

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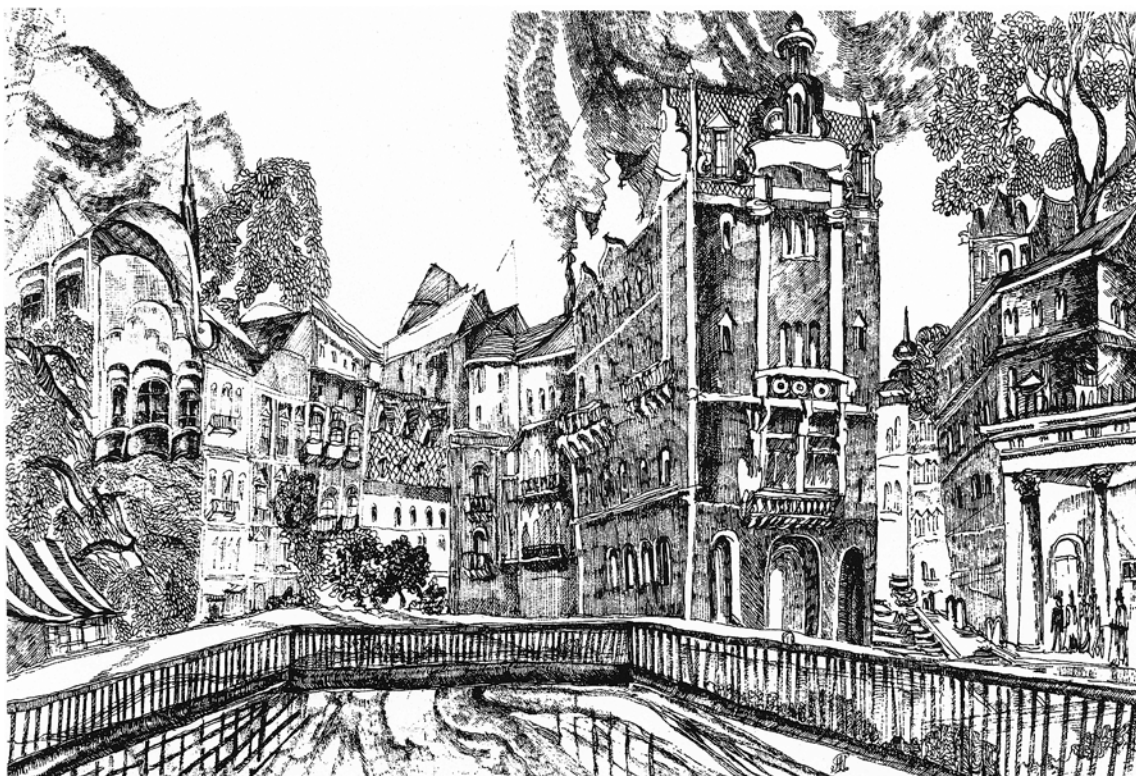
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Functioning and development of construction formations in the market of multi-storey residential buildings

In the conditions of activity of construction formations and all participants in the investment process in the market of multi-storey buildings in various regions of the country, various organizational and technological situations arise most sharply, associated with the presence of a number of new features, when the nature of their work, interaction with each other, directions of development in the housing market change, taking into account accumulated experience, potential and types of specializations. This determines the need for the formation and use of rational forms of construction organization aimed at stabilizing the entire construction industry and processes, reducing the impact of changes in the external and internal environment, and various types of risk. The research methods used in the work are theoretical analysis, empirical study with subsequent generalization and systematization of the data obtained, in addition, the main scientific approaches were used: "dialectical", "systemic", "dynamic", "variant", "balance", "modelling". The object of the analysis is the organizational and technological processes of the construction of a real estate object and the activities of enterprises in the market of multi-storey residential buildings, taking into account the features that affect the stability and sustainability of the development of production processes.

The use of various mechanisms, measures in the field of technology use, rational forms of organization of material production in the activities of enterprises will increase the stability and reliability of their work under the influence of risks and uncertainty factors of construction production.

Keywords: multi-storey residential buildings, housing market, developers, external and internal environment, features, building formations, sustainability, forms of construction organization, risks, organizational and technological mechanisms, life cycle

INTRODUCTION

The development of the construction industry, as well as the entire Russian economy as a whole, is associated with the need to solve a complex problem that reflects both global trends and internal barriers to development. This requires taking into account the main features and the need to develop mechanisms and measures to ensure the stabilization and sustainable development of enterprises in the housing market of multi-storey buildings.

The formation of such mechanisms for the development of construction enterprises is significantly influenced by a decrease in demand for construction products, as well as changes in norms and rules for the construction of buildings and structures. The need to solve this problem of forming mechanisms and measures for the stabilization and sustainable development of enterprises of the construction complex in housing markets in various regions of the country predetermined the relevance of this study.

The activity of construction organizations is largely determined by the degree of rational use of their organizational and technological potential, reliability and stability of development of all types of production processes, taking into account all types of losses, risk conditions and uncertainty, the values of which change under the influence of spatial, resource, time and cost parameters of enterprises and organizational and technological parameters of construction production, flexibility

of organizational forms of their management, as well as taking into account the conditions of mobility and uncertainty associated with the dispersal of facilities under construction [1–4].

MATERIALS AND METHODS

The research methods used in conducting research are theoretical analysis, empirical study, followed by generalization and systematization of the data obtained. In addition, the main scientific approaches were used: "dialectical", "systemic", "dynamic", "variant", "balance", "modelling". The object of the analysis is organizational and technological approaches to the development of production processes and activities of construction formations in the market of multi-storey residential buildings.

The theoretical and methodological basis of the research is the scientific publications of foreign and domestic scientists and practitioners devoted to the study of the problems of the presence and influence of the peculiarities of the functioning and development of construction formations in the market of multi-storey residential buildings, taking into account various types of their specialization and the nature of the external environment. The empirical base of the study was made up of statistical and other information sources, materials characterizing the production and economic activities of business structures of various organizational and legal forms in the Russian Federation, expert opinions, legislative acts and other regulatory documents in the construction sector.

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RESULTS

Construction companies, as well as all participants in the investment process of real estate construction in the housing market, are trying to create conditions that will ensure the maximum use of all their accumulated potential, ensure stable production and economic ties in order to maximize the interests of contractors, subcontractors and consumers of final products. This is usually achieved through the formation of rational forms of construction organization through the development of appropriate organizational and technological mechanisms and measures. At the same time, traditional forms and forms of organization and management do not lead to an increase in the efficiency of activities due to existing features and risk factors and uncertainty of construction production [5–7].

The Ministry of Construction and Housing and Communal Services of the Russian Federation annually conducts the necessary monitoring of housing situations in the territory of the country's constituent entities. In the context of the modern development of construction production in the Russian Federation, there has been a positive trend over the past few years in terms of housing commissioning [8–11].

The analysis of data on the number of floors of the housing stock carried out by developers in the Russian Federation showed that the most erected real estate objects in the housing market are multi-storey residential buildings, which use monolithic, panel construction methods to reduce construction time, the average height of such buildings exceeds 19 floors per one residential unit under construction (Fig. 1).

Modern construction production is characterized by the presence of a large number of: internal and external industrial relations and relations between participants; information flow in the field of management. At the same time, it is necessary to ensure the stability of the organization of the labour process based on the application of progressive norms and standards, which is the basis

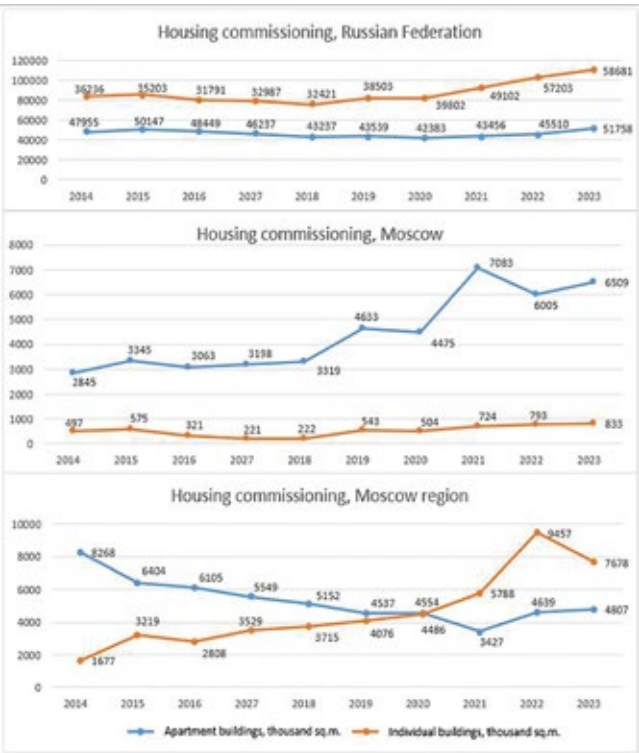


Fig. 1. Dynamics of housing commissioning in the Russian Federation, Moscow, Moscow region (by year)

for the use of flow-based forms of labour organization in processes. In addition, the concentration of all types of construction production resources on production processes makes it possible to maximize the entire accumulated potential, which requires the implementation of the basic principles of flow-based forms of organization, namely:

Types of specialization and specifics of the development of the construction system

Types of specialization	Purpose	Characteristic
Territorial (external environment)	The orientation of the construction system to the construction of real estate for various purposes in a certain territory of the region, i.e. determines the specifics of the housing market development	The type of building is determined: multi-storey, low-rise, point, block, micro-district, satellite city, etc.
Industry (external environment)	Orientation of the construction system to the specifics of real estate under construction within a specific branch of the national economy (construction) in the housing market	The type of real estate object, its spatial planning and design solutions are determined: monolithic, panel, brick, wooden, etc.
Subject (internal environment)	Orientation of the construction system to perform all types of construction and installation work when creating final products, (or in the workshop) production of fully finished products	The types of technologies and forms of organization of material production and management in the implementation of construction and installation work are determined, object flows in production processes are formed and organizational, technological and economic ties and relations between all participants in the process of constructing a real estate object are defined. The method of construction is determined: "on your own", contractual, Project Management, real estate management as an investment asset (Asset Management), etc.
Technological (internal environment)	The orientation of the construction system to perform a certain type of work or provide services at different stages of the life cycle of a real estate object and the stages of development of the production process	The types of special technologies and forms of organization of material production and management are determined when performing work by specialized formations, specialized flows are formed in production processes and specialized organizational, technological and economic ties and relations between all participants in the process of constructing a real estate object are defined. The forms of construction and management are determined: internal; external management; mixed, etc.

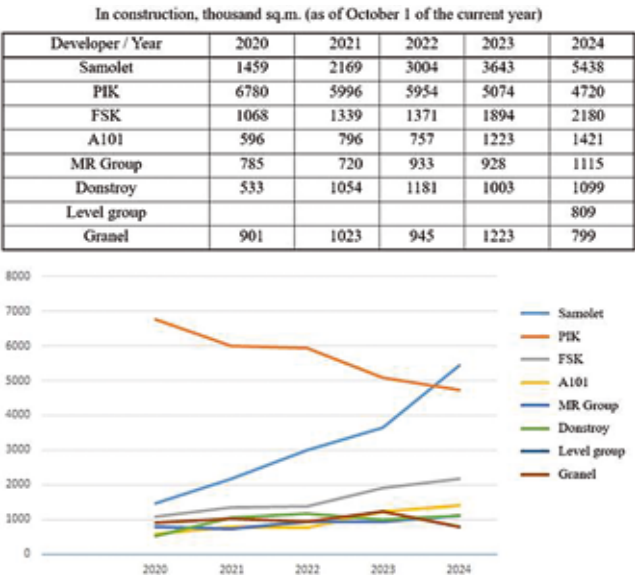


Fig. 2. Dynamics of housing commissioning by the main developers in Moscow (by year)

specialization, continuity, parallelism, rhythmicity, directness and automation [12, 13].

The following types of specializations are implemented in construction, namely: territorial, sectoral, subject, technological, detailed. The first two types of specialization. As a rule, they determine the territorial and sectoral features of the development of the multi-storey buildings market and the specifics of the territories themselves and are the external environment for construction formations of different levels. Other types of specializations determine the internal environment of their activities, which significantly affects the stability and sustainability of the development of all production processes (main, auxiliary, servicing) and the construction units themselves.

The choice of a rational option for the sustainable development of enterprises in the housing market depends on the existing features, the degree of influence of various groups of factors of the external and internal environment, types of specializations for the development of the housing market and construction production (Table).

In addition, the option chosen in this way creates all the necessary conditions for the formation of stable ties and relationships between all participants in the construction of real estate in multi-storey buildings [14, 15]. All these connections are concentrated and ensured through the main participant of this construction system, namely, the developer, who performs all the functions of managing the system based on the use of rational forms of construction organization, which contributes to an increase in the volume of final products (Fig. 2).

The dynamics of the main developers in Moscow shows that this trend takes place in modern conditions of the construction of multi-storey buildings.

CONCLUSION

Based on the results of the analysis, trends were identified that allowed us to draw the following main conclusions:

1. The main features of the functioning and development of construction production in the construction of multi-storey real estate buildings have been identified, which must be taken into account when introducing technologies and in-line forms of organizing

material production in the main, auxiliary and servicing production processes, which contributes to the establishment of stable links between all participants in these processes [16–18].

2. Developers are the main participants in the process of constructing multi-storey buildings, on which the stability and stability of these relationships and the specifics of the development of both the housing market and the entire construction system depend.

3. It has been defined that the process of forming a system of relationships between participants in the construction of multi-storey real estate in construction is influenced by the peculiarities of their construction, a large number of factors of the external and internal environment, which must be identified and taken into account in further research based on the creation of necessary organizational and technological reserves when introducing flow forms of material production in the activities of construction organizations, taking into account their depth of specialization in risk conditions [19, 20].

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Особенности функционирования и развития строительных формирований на рынке многоэтажных жилых зданий

В условиях деятельности строительных формирований и всех участников инвестиционного процесса на рынке многоэтажных зданий в различных регионах страны наиболее резко возникают различные организационно-технологические ситуации, связанные с наличием ряда новых особенностей, когда меняется характер их работы, взаимодействия между собой, направления развития на рынке жилья с учетом накопленного опыта, потенциала и видов специализаций. Это определяет необходимость формирования и использования рациональных форм организации строительства, направленных на стабилизацию всего строительного производства и процессов снижения влияния изменений внешней и внутренней среды, различных видов риска. Методами исследования, применяемыми в работе, являются теоретический анализ, эмпирическое изучение с последующим обобщением и систематизацией полученных данных, кроме того, были использованы основные научные подходы: «диалектический», «системный», «динамический», «вариантный», «балансовый», «моделирование». Объектом анализа являются организационно-технологические процессы возведения объекта недвижимости и деятельности предприятий на рынке многоэтажных жилых зданий с учетом особенностей, учет которых влияет на обеспечение стабильности и устойчивости развития производственных процессов.

Применение различных механизмов, мероприятий в области использования технологий, рациональных форм организации материального производства в деятельности предприятий позволит повысить устойчивость и надежность их работы в условиях влияния рисков и факторов неопределенности строительного производства.

Ключевые слова: многоэтажные жилые здания, рынок жилья, застройщики, внешняя и внутренняя среда, особенности, строительные формирования, устойчивость, формы организации строительства, риски, организационно-технологические механизмы, жизненный цикл

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Management of Energy Efficiency
in the Operation and Management of Real
Estate in the Housing and Communal Sphere

The paper explores cross-sector indicators and management methodologies in the housing and communal sphere, emphasizing their importance for improving energy efficiency and optimizing resources. In the context of global challenges such as climate change and the depletion of natural resources, the effective use of energy in housing and communal sphere becomes critically important. This sphere is one of the largest consumers of energy, and inefficient use of energy resources leads to high costs and negative environmental impacts. Cross-sector indicators allow for the comparison of energy-saving efficiency in housing and communal services with other sectors of the economy, facilitating the transfer of the best practices and technologies. For example, energy consumption management methods developed in industry can be adapted for heating and water supply systems in apartment buildings. The paper highlights several key stages in the management methodology: setting goals for improving energy efficiency, analyzing the current state of systems, assessing energy efficiency, and developing energy-saving measures. The use of modern monitoring technologies enables real-time tracking of resource consumption and identification of inefficiencies. An essential aspect is the need for a comprehensive approach to managing energy resources, which includes interaction with the population and local authorities. This collaboration fosters sustainable development in housing and communal services and enhances the quality of services provided. Implementing innovative solutions to improve system reliability and reduce utility costs is one of the crucial directions that ultimately relate to achieving the goal of enhancing citizens' quality of life. **Keywords:** energy efficiency, housing and communal sphere, cross-sector indicators, resource management, modern technologies, ecological aspects

In the context of global climate change and depletion of natural resources, the issues of energy saving and energy efficiency are gaining acute relevance. Energy saving is a strategic trend in the development of the economy of the Russian Federation. The most part of energy consumption is accounted for by housing and communal sphere [1]. The housing and communal sphere is a significant consumer of energy and faces challenges such as inefficient use of resources, high costs, and environmental impacts. In order to address these issues, it is necessary to implement comprehensive energy efficiency regulations. The introduction of modern energy management technologies has the potential to reduce costs and improve the quality of life for those affected by these issues. The significant functions of the energy management service are to ensure that the system meets the requirements of the relevant standard, and to implement action plans for consistent improvement of energy performance [2]. In the Russian Federation, the main document that regulates issues of energy saving and energy efficiency improvement is the Federal Law¹. Compliance with its provisions contributes to saving energy resources, ensuring energy security and reducing energy intensity in the housing and communal services industry [3]. The law establishes specific responsibilities for developers

and property owners, including in particular the obligation to ensure that buildings comply with energy efficiency standards at both the design stage and during operation. This involves the use of modern technologies and materials that help reduce energy consumption. Moreover, there are also a number of additional regulations in place, enhancing control over energy efficiency requirements compliance. Thus, the Order² introduced energy efficiency requirements for buildings and structures [4]. The coverage of the issues of determining the balance and correlation between state and market self-regulation in the energy sector is studied on the basis of analyzing the development of the legal and regulatory framework in the field of energy saving and energy efficiency improvement [5]. Cross-sector indicators are key metrics for assessing energy savings and energy efficiency in different sectors, including housing and utilities. They allow analyzing and comparing the performance of different sectors, identifying linkages and facilitating the transfer of best practices. These indicators provide opportunities for integrating approaches from other industries. This can improve resource efficiency and reduce utility costs, while also improving the quality of services. Energy management techniques from industry can be applied to heating and water supply systems in apartment buildings. By using cross-industry indicators,

1 Energy Conservation and Energy Efficiency Improvement : Federal Law No. 261-FZ dated 11/29/2009.
2 The Order of the Government of the Russian Federation dated 09/27/2021 No. 1628.

utility companies can identify deficiencies in their energy supply systems and borrow successful solutions from other industries.

Capital investments include not only the costs of construction, but also the expenses associated with design work, equipment purchase, and other assets required for the operation of the housing and communal services industry.

It is also necessary to conduct a timely assessment of the effectiveness of capital investments [6]. Effective capital expenditures management (CapEx) is critical for optimizing budget costs, reducing construction and modernization costs, and improving the quality of services. It is essential to take into account both current costs and the introduction of new technologies that help reduce operating costs.

Estimating the cost of upgrading outdated infrastructure, such as pipelines and heating systems, is an important step in determining the feasibility of the upgrade. Replacing old systems not only helps prevent leaks but also reduces water costs.

To minimize power losses in housing and communal services, it is essential to implement several effective solutions. Upgrading existing systems is one of the main methods. It is also crucial to use energy-efficient technologies that help optimize resource consumption [7]. Regular network performance audits help identify problem areas and take steps to address them. This, in turn, helps reduce costs and increase the reliability of communal services by

introducing modern technologies and regular infrastructure status' monitoring [8, 9].

Reliability indicators in housing and communal sphere are important criteria for assessing the ability of these systems to provide continuous service. These indicators can be measured through internal monitoring [10], and include the frequency of emergency outages, recovery time after failures, and user satisfaction levels. High reliability rate helps to build consumer confidence and improve an organization's reputation in the industry. Regular monitoring allows for the identification of problem areas and the implementation of measures to address them, ultimately improving the overall quality of service.

Fig. 1 illustrates the relationship between the content of relevant price categories, possible parameters, and methods for evaluating relevant indicators, as well as the timing of changes in these price categories.

These metrics allow to evaluate the extent of strain on the power grid, the electricity supply quality, the harmonic distortion level, and the effectiveness of resource utilization. By scrutinizing these metrics, we can pinpoint areas that demand particular attention when it comes to optimizing energy consumption and resource allocation. The implementation of smart metering devices becomes increasingly crucial for data collection and analysis essential for setting pricing policies and efficient energy management, as well as for the daily hourly consumption schedule leveling [11].

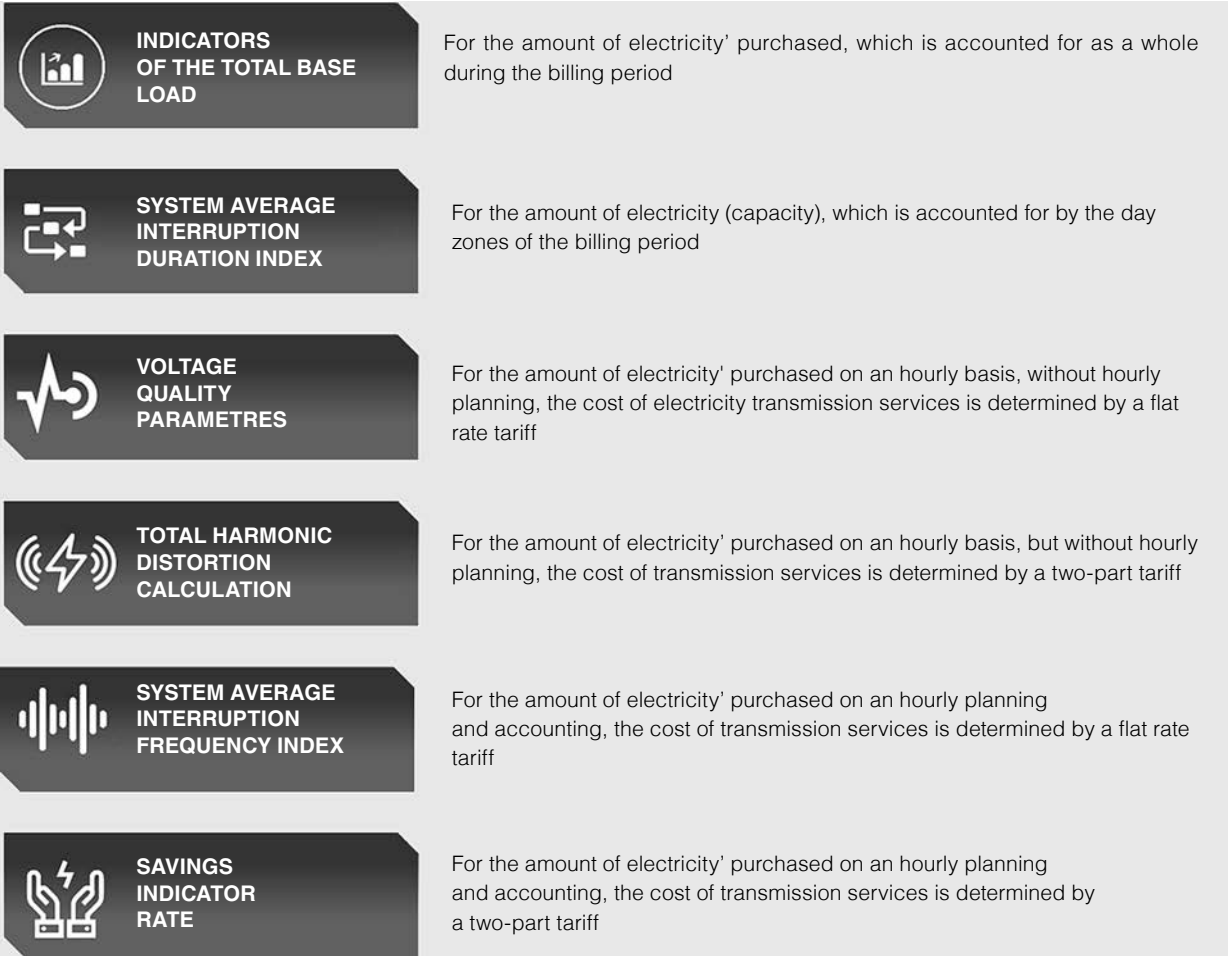


Fig. 1. Anchor indicators for the price categories defining. Source: compiled by the authors

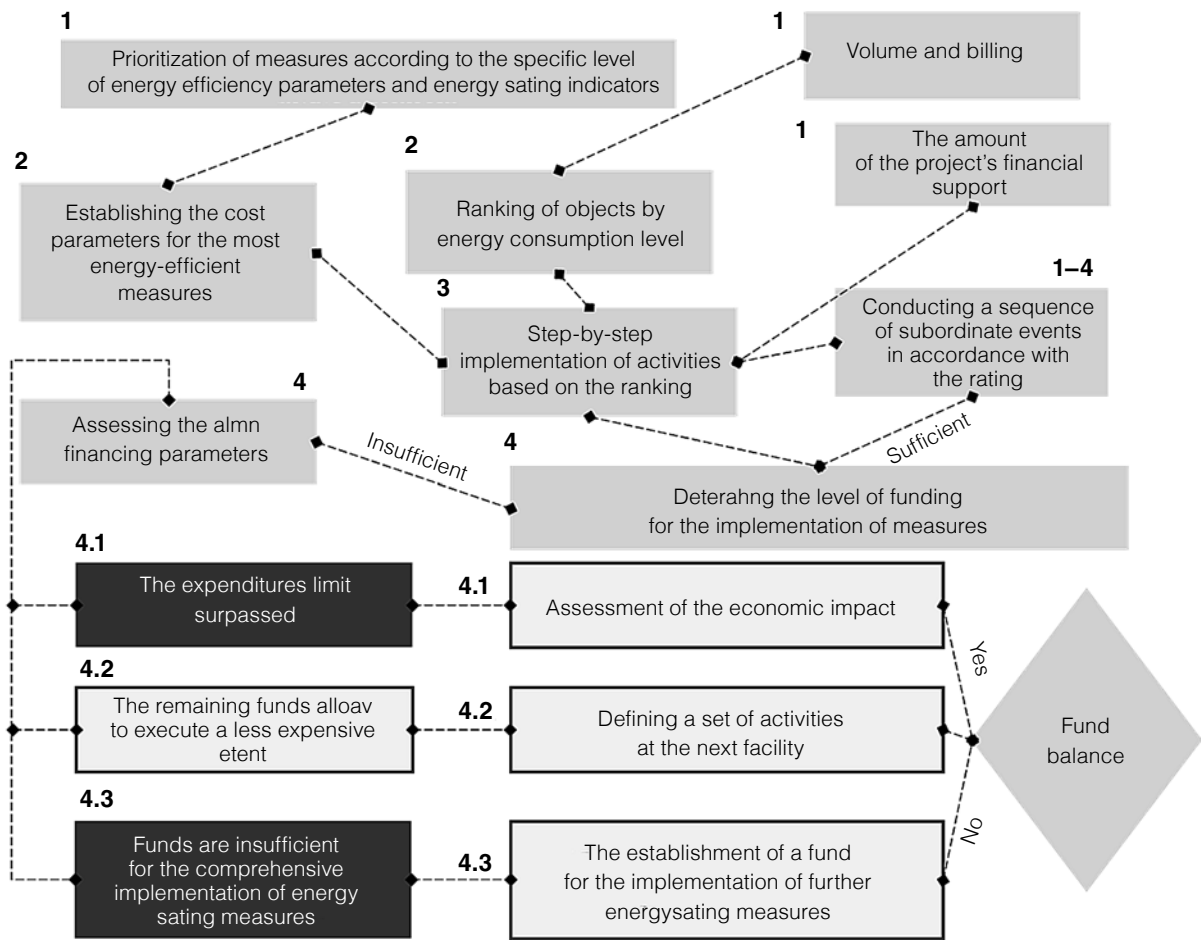


Fig. 2. The structure of the assessment of the initiatives 'economic efficiency. Source: compiled by the authors

Environmental aspects of management are becoming increasingly relevant in the context of sustainable development. Incorporating environmental criteria into the decision-making process can reduce the negative impact on the environment. This may include the use of renewable energy sources, waste recycling and the introduction of technologies to reduce pollutant emissions.

The quality of voltage in power grids also plays an important role in ensuring the reliability of electricity supply to consumers, which can in one way or another influence its quality [12]. Voltage quality measurement methods include monitoring of voltage, frequency and harmonic distortion. Regular monitoring of these indicators allows to detect deviations and take measures to eliminate them, which is important for stable operation of electrical equipment and user satisfaction. Effective power loss management, reliability monitoring, environmental considerations and voltage quality control contribute to the efficiency of the utilities sector by reducing costs and improving service quality, which has a positive impact on the lives of citizens and the environment. Thus, the reconstruction of heat supply systems implies an increase in the efficiency of fuel utilization, contributes to the increase of heat capacity and to the purchase of electricity [13].

The methodology of energy efficiency management in the housing and communal sphere is designed to optimize resources, reduce costs and enhance service quality. It comprises several critical stages.

The first step is to set specific and measurable targets for energy efficiency improvements, taking into account the views

of residents and authorities. It is also important to develop strategies for infrastructure modernization and technology deployment. The next step is to analyze the current state of the systems, which identifies the strengths and weaknesses of the resources. Energy audits help identify inefficient areas for optimization.

At the stage of assessing energy efficiency, a range of methods for analyzing energy consumption are employed, encompassing the use of specialized software and the implementation of comparative analysis. These findings serve as a foundation for identifying critical areas that require immediate attention in terms of implementing energy-saving initiatives.

The key step is to analyze the financial situation, which includes assessing the current costs and forecasting the benefits of implementing energy saving technologies, as well as considering different financing scenarios.

The economic impact of energy-saving measures is characterized by a multitude of indirect effects arising from alterations in the fundamental process of energy consumption. These modifications affect auxiliary processes that are not inherently linked to energy consumption, but rather have their own financial aspects [14].

Based on the analysis, a range of energy-saving measures are being developed, encompassing the modernization of heating systems, the implementation of automation for optimized consumption, regular audits of facilities, and the professional development of staff. These initiatives not only contribute to reducing energy expenses but also enhance the overall quality of services provided.

Modern monitoring technologies, such as sensors and automated metering, allow you to track the status of networks and resource consumption in real time. Building Management Systems (BMS) help to optimize the operation of engineering systems.

Energy conservation planning includes prioritization, action plan development, technology implementation and staff training. Effective planning prevents delays and cost overruns. Monitoring results involves regular collection of data on resource consumption after measures have been implemented. This can be done through automated accounting systems or periodic audits [15].

Determining the level of adequacy of funds involves assessing the required investments, including the housing and utilities organizations' own funds and external sources of funding. It is important to conduct a detailed budget analysis for successful implementation of initiatives.

Thus, the management of rationing and energy efficiency in the housing and utilities sector is a complex process that requires a careful approach at all stages, from setting goals to monitoring results, which contributes to increasing resource efficiency and improving the quality of life of citizens.

The use of a hierarchical structure in the assessment of economic efficiency contributes to a more accurate definition of energy saving and energy efficiency strategies (Fig. 2).

The hierarchical structure in the assessment of the cost-effectiveness of measures aimed at improving energy saving and energy efficiency in the housing and communal sector is a critical element, as it ensures prioritization of measures based on cost analysis and expected results, as well as ranking of facilities by energy consumption level to identify the most vulnerable elements for improvement. In addition, this structure allows for the verification of the main financing parameters against expenditure limits, which helps to prevent overspending, as well as the assessment of the economic impact of the implemented solutions, which in turn contributes to a more informed allocation of resources. It is also important to take into account the volume and tariffication of payments, which affect the financial sustainability of projects and their attractiveness to investors, thus forming a comprehensive package of resources. for investors, thus forming a comprehensive approach to energy management and cost optimization in this area.

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Вопросы управления энергоэффективностью при управлении и эксплуатации объектов недвижимости в жилищно-коммунальной сфере

Статья исследует кросс-отраслевые показатели и методики управления в жилищно-коммунальном хозяйстве, акцентируя внимание на их значимости для повышения энергоэффективности и оптимизации ресурсов.

В условиях глобальных вызовов, таких как изменение климата и истощение природных ресурсов, эффективное использование энергии в жилищно-коммунальном хозяйстве становится критически важным.

Отрасль жилищно-коммунального хозяйства является одним из крупнейших потребителей энергии, и неэффективное ис-

пользование энергетических ресурсов приводит к высоким затратам и негативным экологическим последствиям.

Кросс-отраслевые показатели позволяют сравнивать эффективность энергосбережения в жилищно-коммунальном хозяйстве с другими секторами экономики, что способствует переносу лучших практик и технологий. Например, методы управления энергозатратами из промышленности могут быть адаптированы для систем теплоснабжения и водоснабжения многоквартирных домов. В статье выделяется несколько ключевых этапов методики управления: постановка целей по повышению энергоэффективности, анализ текущего состояния систем, оценка энергетической эффективности и разработка мероприятий по энергосбережению.

Использование современных технологий мониторинга позволяет в реальном времени отслеживать потребление ресурсов и выявлять неэффективные участки. Важным ас-

пектом является необходимость комплексного подхода к управлению энергоресурсами, который включает взаимодействие с населением и местными властями. Это сотрудничество способствует созданию устойчивого развития жилищно-коммунального хозяйства и улучшению качества предоставляемых услуг. Внедрение инновационных решений для повышения надежности систем и снижения затрат на коммунальные услуги является одним из важнейших направлений, что в конечном итоге связано с достижением цели повышения уровня жизни граждан.

Ключевые слова: энергоэффективность, жилищно-коммунальное хозяйство, кросс-отраслевые показатели, управление ресурсами, современные технологии, экологические аспекты

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Prospects of application of educational–
technological task in the formation of information
models of university campuses

This paper is a continuation of a series of publications devoted to the intermediate results and prospects of digital and regulatory-technical transformation in the construction industry of our country and its impact on individual tasks of the investment and construction cycle arising from the creation of modern university campuses. The programme of creating a network of university campuses, is one of the main drivers of scientific and technological development and personnel training in the Russian Federation at present. In this regard, in previous publications in the development of this topic, the author proposed and substantiated the need to introduce into the system of construction documentation of the Campus Programme, educational-technological conditions as a new type of engineering parameters-measures of the material-spatial environment and Educational-technological task as a new type of document, which can be part of the design task or an annex to it, as well as part of the subsequent contract for the provision of services for the management or technical operation of the campus. When applied, the Educational-Technological Assignment (hereinafter referred to as ETA) becomes the only available comprehensive tool for forming qualitative and quantitative functional-technological and operational parameters of campus facilities, in accordance with the adopted target model of the educational organization, defined in its development programme. In this paper, the author proposes the algorithms for the formation of ETA, describes the need and possibility of its integration with the technology of information modelling and directly with information models of capital construction objects. This is determined by the fact that in view of the current legal requirements, the information model is designed to cover and unite all stages of the life cycle of a capital construction object.

Keywords: *design task, normative-technical documents, functional-technological requirements, educational-technological task, registers of requirements, parametric normalization, Classifier of construction information*



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INTRODUCTION

In the introduction, let us recall what we managed to establish regarding the ETA in the previous publication. ETA is a document containing a set of basic requirements established by normative documents, certain educational and technological conditions and the target model of the educational organization. The approach to the development of ETA is built from the “realized function”, i.e. from the type, scale, features and parameters of educational or research processes. ETA can be oriented to separate buildings and groups with different functional-technological content, within the framework of new construction, reconstruction, major repairs [1]. ETA by the customer's decision can become a part (appendix) of the design task, because it is formed on the basis of synthesis:

- parameters of the material and spatial environment;
- characteristics of the realized educational process or research and scientific-production activity;
- applied educational and research technologies;
- peculiarities of educational and research infrastructure;
- functions necessary for transformation of the educational environment for modern tasks and advanced development [2].

ETA is based on the following principles: increasing the functional flexibility of the university environment; increasing the organizational and technological sustainability of the university during the operation period; increasing integrated security and resource

conservation; ensuring the predictability of the personnel policy of the operation system, etc.

**REQUIREMENT REGISTRIES
AND PARAMETERS IN THE STRUCTURE
OF THE ETA**

As it has already been mentioned, ETA is formed on the basis of synthesis of the parameters of material and spatial environment, realized educational process, research and production activities, applied educational and research technologies, educational and research infrastructure. In the previous publication, the author gave an approximate structure of the ETA, which, in his opinion, would optimally contribute to the solution of the tasks set before it. Taking into account the fact that in most cases the ETA will be a part of the design task, its structure should reflect mainly those issues that are insufficiently disclosed or absent in the standard version of the task. This refers to the “Form of the developer's or technical customer's task for the design of a capital construction facility, the construction, reconstruction, capital repair of which is carried out with the involvement of funds from the budgetary system of the Russian Federation” [3]. These are the issues of functional zoning of buildings, floors, premises, organization of student flows, safety and comfort issues, created automated and high-tech workplaces, ensuring functional efficiency, requirements for microclimate, requirements determined by the specifics of manufactured products, rendered services, implementation of technological navigation, possible expansion of infrastructure, requirements

► for microclimate by rooms and zones, formed operational parameters and much more.

But it is not only inefficient, but sometimes even impossible to enter, correct, or read these data and information in text form or in the form of explications. This means unnecessary processes, additional losses, reduced accuracy, avoidance of automation, etc. The digital and normative-technical transformations developing in the construction industry today equip us with such tools as the information model with its data, digital twins, registers of requirements, parametric method of standardization. These are the tools of tomorrow. In this regard, and based on the developments in the field of integration of registers of requirements and parameters described in previous publications [4], the author proposes to classify and combine all qualitative requirements and calculable parameters that determine functional, architectural, construction, engineering, technical and other properties of capital construction objects of university campuses into a single system with common algorithms of formation and development. In such a system, the parameters should be formed taking into account a variety of flexibly customizable properties and criteria. The formed system in digital format will be able to contain data on functional processes in campus buildings, their parameters and properties, necessary flexibility and so on. As such a digital system, it is proposed to consider the Combinatorial Matrix. The prototype of the Combinatorial Matrix was developed by the author together with N.V. Kashirina.

The approach to the development of ETA based on the application of the Combinatorial Matrix is more universal, because the method of parametric normalization is taken as a basis. This method allows to provide uniform standards and parameters for all participants of the construction process, to guarantee uniformity in the work of all parties, more accurately predict the results and control the construction processes [5]. In this regard, the registers of requirements can include both mandatory requirements of regulatory documents and requirements proposed by developers, which are supposed to be justified. This will ensure the achievement of adaptability and sustainability of ETA.

The application of the register principle and parametric normalization in the basis of the ETA allows it to become a modern, effective tool for describing the complex material and spatial environment of the university. It is equally applicable both at the stage of preparation of the task for the design of a new construction object and in preparation for major repair or reconstruction.

COMBINATORIAL MATRIX

Combinatorial matrix can be defined as a complex integrative tool. When applying the matrix, it is necessary to start from the required function and characteristics of the room, or to be more precise, of the space, because at the pre-project stage "rooms" as an architectural volume do not exist yet, and then adjust its properties to the required tasks. Combinatorial matrix can contain different types of requirements: mandatory, voluntary, recommended from normative and technical documents and regulations, design or operation manuals, as well as appropriate educational and technological conditions. The main criteria for selecting the requirements is compliance with the stated characteristics and functions of spaces and technical equipment of campus facilities. In this respect, the matrix corresponds to the basic provisions of the register principle [6].

The proposed structure of the matrix can have several levels of rationing when using the parametric method. The upper level is the goals of rationing, they are defined by laws and should realize the corresponding socially important tasks. Applied to universities, this is

the realization of the Standard of innovative educational environment (campuses) [7]. The next level of the hierarchy is functional requirements. These are architectural and construction, engineering, functional-technical, functional-technological and operational requirements, zoning requirements, selected taking into account the functions of the designed object. In the conditions of creating an innovative educational environment, the goal to be achieved by complying with specific regulatory requirements comes to the fore. Only in this case, instead of the goal there will be functions, because on the campus site it is necessary to create such material and spatial conditions so that they would allow to solve the tasks of another order — the tasks of scientific and technological development. Therefore, variability, flexibility of requirements and parameters depending on the requested functions is necessary. Typical solutions for the construction of buildings of higher education institutions, mostly do not meet the modern demands of the educational environment. This is a consequence of the transition to Education 3.0 [8], the transformation of universities, the introduction of new educational technologies in the educational process, the use of high technologies and so on.

In the hierarchy of the combinatorial matrix the problem of parameter formation for each room is progressively solved. At the beginning, the level of education is determined (bachelor's, specialist, master's, postgraduate). Then, the type of training: frontal, non-frontal, collective, group, individual training. After that, types of classes: coursework, project activities, student research work, startup-incubator, joint projects with industrial partners, advanced training, accelerated professional training [9], etc. For each room, sets of functional requirements are taken into account, provided at the design stage and maintained at the operation stage in connection with the relevant codes of the Classifier of Construction Information (CCI) [10], (if available). The proposed list takes into account new types of training that meet the modern demands of the educational process. For all types of training, the matrix takes into account differences in the scale and number of practical tasks that a student or young scientist performs as part of his/her educational or research activities. This is reflected in the diversity and specific requirements for the spaces of campus facilities (in particular, teaching, research and other specialized laboratories).

In the Combinatorial Matrix, each level of education corresponds to the type of learning and function to be realized in the material-spatial environment. The rooms are labeled by type in accordance with CP 118.13330.2022. "Code of Rules. Public buildings and structures" [11] and in accordance with the codes of CCI.

A fragment of the matrix considering the type of training and function can look as follows:

- 1. Function: EDUCATION:
 - 1.1. Level: Bachelor's degree/specialization.
 - 1.1.1. Type: Basic disciplines.
 - 1.1.1.1. CSI code.
 - 1.1.1.1.1. Room type.

An excerpt of a transcript of the CII codes, linked to room types, is as follows:

- IBAEI Teaching spacel
- IBAE010I Lecture halll
- IBAE020IUniversal classroomsl
- IBAE030IUniversal classrooml
- IBAE040ISpecialized training rooml
- IBAE060IComputer labl

A selection of normative and individual requirements to ensure the effective implementation of the educational or scientific process are attached to the rooms in the matrix. The requirements are selected in such a way that the room can become multifunctional

and modelable for changing tasks of the scientific and educational process [12]. For example, in order to take into account, the modern demands of distance and combined education, the combinatorial matrix takes into account the functions of the educational process, which involve live broadcasts of laboratory experiments, the possibility of conducting webinars and classes in AR, VR environments.

Thus, the combinatorial matrix allows to establish, assign and bind the necessary register of requirements and parameters-measures to each space or room of each campus object. The formed requirements and parameters are to be systematized and placed in the ETA, which in turn can reasonably become an annex to the design task.

INTEGRATION OF ETA WITH THE INFORMATION MODEL

Information model (IM) is a set of electronically presented documents, graphical and textual data on the construction object, placed in the common data environment and representing a reliable source of information on the object at all or some stages of its life cycle [13]. The listed materials and data begin to be formed at the very initial stages of the life cycle, in particular, while identifying functional and technological requirements, which then become the basis for design solutions. In the process of digital transformation of the construction industry, there is a need to supplement the information model with new, additional data and information. For example, about construction manufacturing technologies, material properties, and performance characteristics. In the last two years, the task of creating digital registers of requirements and their integration with the information model has become more and more frequent.

While researching this task, the author, together with the student of NRU MGSU A.T. Asanova, conducted a selective comparison of digital tools open for use, with the help of which this integration can be realized to a greater or lesser extent. For this purpose, normative-technical, functional, operational and other requirements to the building, its elements, structures, engineering systems were systematized and analyzed, as well as parameters that are usually present in design solutions and materials in text, graphic or explication format.

The study of the possibility of integrating these requirements and parameters into the information model was carried out by the example of Revit Autodesk and Microsoft Excel programmes. Excel

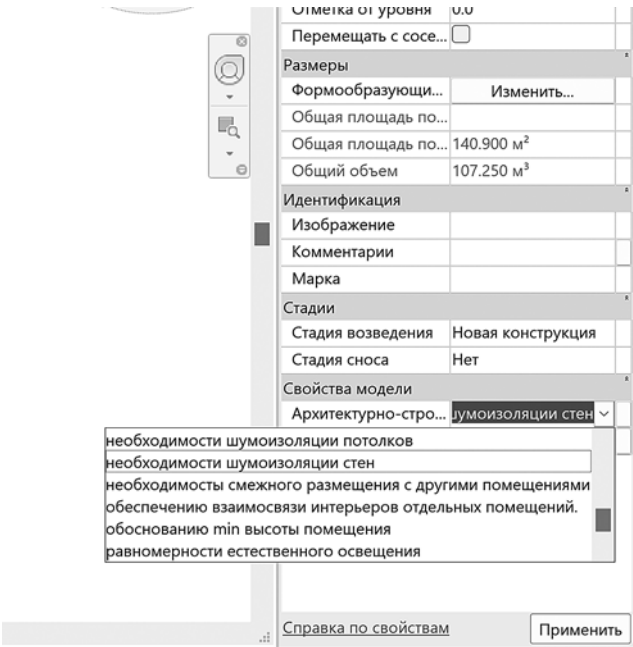


Fig. 1. Requirement formulations placed in the information model materials

contained a list of architectural and construction requirements for structures that needed to be entered into the information model in the Revit programme. Several auxiliary programmes with which this could be accomplished were also examined. The first was Speckle, which is an open platform for data exchange between different programmes, design and collaboration in a 3D environment; the second was DiRoots, which is a less popular programme, but has more agile options for importing data from Excel to Revit. DiRoots is a utility programme for Revit; the third — Dynamo extension, built into Revit environment, allows adding lists, for example, to model properties (Fig. 1).

By applying the Dynamo extension, the model can be a representation of even the smallest volume, such as a single room. In this way, certain requirements will be linked to a specific element, structure or equipment. This solution has the greatest development prospects,

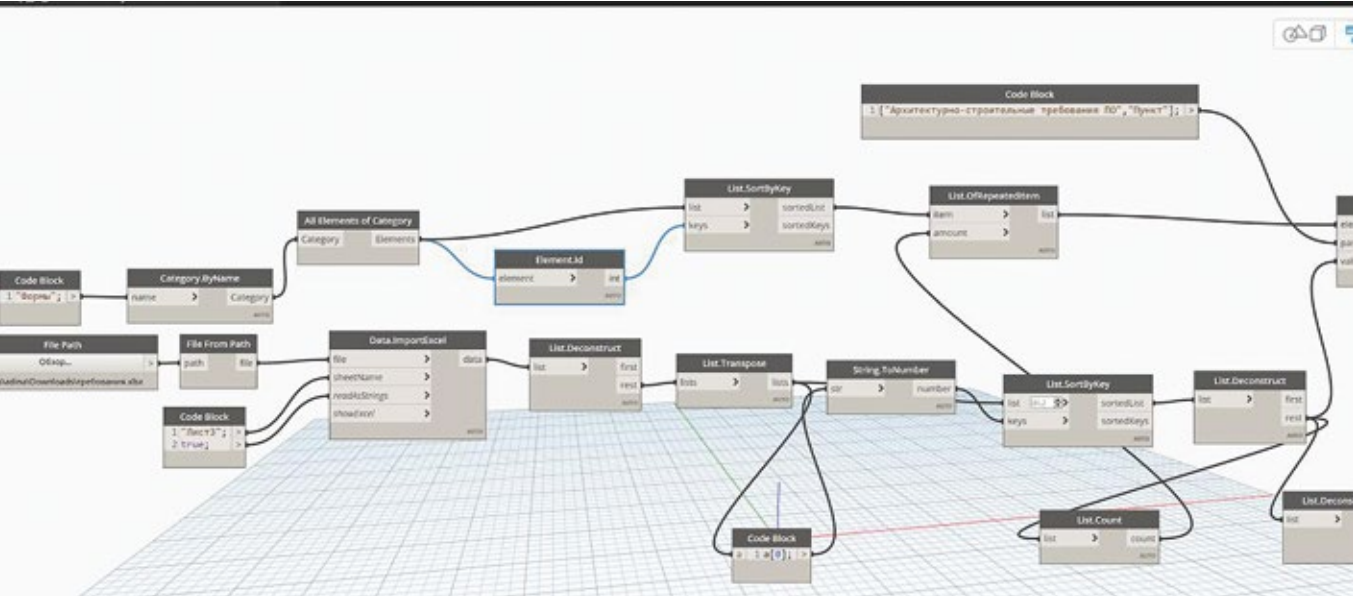


Fig. 2. Code fragment for Dynamo

▶ because in this case, the requirements from Excel can be integrated with various elements of the information model, guided by the Rules of formation and maintenance of the information model of the capital construction object [14]. Initially setting the necessary settings and conditions implemented in the information model, it is possible to significantly simplify the design tasks. It should be noted that in Speckle and DiRoots, importing data from Excel is almost automatic. Whereas Dynamo is an application for visual programming, therefore, it is necessary to generate programme code in it first. The code fragment is shown in Fig. 2. It shows the programme code for importing lists from Excel to the properties of elements, structures, equipment.

The logic of the Dynamo programme implies the use of id [15] for the elements to be changed. These id's need to be uploaded from Revit to Excel before starting to write programme code. This preparation is necessary so that the row ids from the Excel spreadsheet data match the element ids from Revit and integrate in the right order. This task is to establish a match between the element id and the Excel spreadsheet data. This condition imposes certain inconveniences in writing code for Dynamo. From the above analysis results we can conclude that with the help of ETA, it is possible not only to realize the pre-design and design stage of the life cycle of university facilities at a more modern, efficient and safe level, but also to significantly improve the formation and maintenance of their information models.

CONCLUSIONS

University campuses, by definition, should have unique characteristics that differ significantly from standard requirements. They represent an organized set of multifunctional objects performing educational, research, innovation, social, and service functions, united by infrastructural issues of development. The ETA proposed for consideration is one of the few tools with the help of which the formation of a system of initial data for design and operation can be carried out. The educational and technological conditions contained in it reflect the system of interrelationships between the characteristics of various types of educational, scientific or auxiliary activities and the corresponding or required parameters of the created or preserved material and spatial environment of campus facilities. The author reasonably assumes that the ETA tool can be further developed through the creation of a register of requirements in the form of data cards in "xml, as well as combining the requirements tied to the relevant spaces and technical equipment of the campus to determine the functional zones of premises or cross classification.

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Перспективы применения образовательно-технологического задания при формировании информационных моделей университетских кампусов

Данная статья является продолжением серии публикаций, посвященных промежуточным результатам и перспективам цифровой и нормативно-технической трансформации в строительной отрасли нашей страны и ее влиянию на отдельные задачи инвестиционно-строительного цикла, воз-

никающие при создании современных университетских кампусов. Программа создания сети университетских кампусов является одним из основных драйверов научно-технологического развития и подготовки кадров в Российской Федерации в настоящее время. В связи с этим в предыдущих публикациях в развитие данной темы автор предлагал и обосновывал необходимость введения в систему строительной документации Кампусной программы, образовательно-технологических условий как нового типа инженерных параметров-измерителей материально-пространственной среды и образовательно-технологического задания (ОТЗ) как нового типа документа, который может являться частью за-

дания на проектирование или приложением к нему, а также частью последующего договора на оказание услуг по управлению или технической эксплуатации объектов капитального строительства. При применении ОТЗ становится единственным доступным комплексным инструментом формирования качественных и количественных функционально-технологических и эксплуатационных параметров объектов кампуса в соответствии с принимаемой целевой моделью образовательной организации, определенной в ее программе развития. В настоящей статье автор предлагает алгоритмы формирования ОТЗ, описывает необходимость и возможность его интеграции с технологией информационного моделирования и непосредственно информационными моделями объектов капитального строительства. Это определяется тем, что ввиду действующих требований законодательства информационная модель призвана охватывать и объединять все этапы жизненного цикла объекта капитального строительства.

Ключевые слова: задание на проектирование, нормативно-технические документы, функционально-технологические требования, образовательно-технологическое задание, реестры требований, параметрическое нормирование, Классификатор строительной информации

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Determination of the level of redundancy of the complex construction flow of the cluster-territory of the existing city development

Among the methods of increasing reliability envisaged in the design, a special place is occupied by the use of redundancy. Redundancy is additional means (or capabilities) beyond the minimum required to perform a given function. Reservation is a method of increasing reliability by introducing redundancy. The special place assigned to this method is explained by the fact that redundancy most fully solves the problem of obtaining the required reliability with relatively unreliable elements. Depending on the type of redundancy used, the following types of redundancy are distinguished: structural — providing for the use of redundant elements; in the structure of the object (nodes, blocks similar to those available); temporary — providing for the use of excess time; functional — providing for the use of the ability of elements to perform additional functions; informational — providing for the use of the ability to perceive additional information coming to the object; load — providing for the use of the ability to perceive an additional load. One of the main ways to increase the reliability of systems is structural redundancy, which provides for the inclusion of additional facilities in the system. Structural redundancy differs in a number of ways: the reserve is switched on permanently or the reserve element is switched on as needed (replacement reservation, unloaded reserve); individual or group redundancy; the transition to the reserve element occurs instantly or it takes a finite time to switch; the system of health monitoring and reserve management is absolutely reliable or has ultimate reliability, etc. The variety of types of redundancy has led to the creation of dozens of different models that take into account the specific specifics of the systems.

Keywords: resource reservation, intensity of specialized flow, complex construction flow, cost of maintenance of reserve resources, the principle of choosing the optimality criterion

The level of resource reservation (power type) is determined by the additional intensity that should ensure the performance of a given amount of work in the estimated time with a given reliability [1, 2]. To determine this level, taking into account the optimality criterion, the following sequence can be proposed:

1. Statistical data on the intensity of private flows in the studied investment and construction project of the real estate object are collected and analyzed.

2. The average statistical values of the alternating intensities of partial flows — i , as well as their variances σ^2 and average deviations — σ are calculated.

3. The earliest dates for the entry into operation of the main specialized flows of the complex flow are found. These deadlines are found as a result of analyzing the linear or network construction schedule of the entire facility as a whole. If the found average value of the intensity of the final specialized flow I_{sf} does not allow the completion of the construction of the facility as a whole within a specified period, then a corresponding increase in intensity should be ensured by attracting reserve resources [3–5].

4. The optimal level of reliability $P_t^{rel} \rightarrow P_{opt}^{rel}$ is determined for the corresponding specialized flow, which makes it possible to complete the construction of the facility as a whole in the optimal time period T_{opt} .

5. The average shift intensity of the final specialized flow I_{sf} is calculated, the value of which is determined, in addition to the many factors affecting it by the intensity of the preceding factors, also specialized flows interconnected by a single system

of parameters of the construction flow, I_{sf} is necessary to comply with the construction period T_{opt} , which ensures the commissioning of the entire facility within the estimated time, according to the formula [6]:

$$I_{sf} = q_c^{sh} = \frac{Q_c (r = 0.5)}{(T_{opt}^{sf} - T_{depl}^{sf})}, \quad (1)$$

where T_{opt}^{sf} — construction period; T_{depl}^{sf} — the deployment period of the specialized (final) flow.

6. The required shift intensity is calculated I_{sf} according to the formula:

$$I_{sf}^r = q_r^{sh} = \frac{Q_c (P_t^{rel} = P_{opt}^{rel})}{(T_{opt}^{sf} - T_{depl}^{sf})}. \quad (2)$$

7. The necessary increase in the volume of work is determined Q^r :

$$Q^r = Q_c (P_t^{rel} = P_{opt}^{rel}) - Q_{ft} (P_t^{rel} < P_{opt}^{rel}), \quad (3)$$

where $Q_{ft} (P_t^{rel} < P_{opt}^{rel})$ — amount of work that will be completed on time T_{opt} at an intensity I_{sf} .

8. There is a deadline for which the volume $Q (P_t^{rel} = P_{opt}^{rel})$ will be completed at an intensity I_{sf} and $P_t^{rel} < P_{opt}^{rel}$ by the formula [7]:

$$T_f = \frac{Q_c (P_t^{rel} = P_{opt}^{rel})}{I_{sf}}. \quad (4)$$

9. The excess of the expected period over the optimal period $T_{opt} (P_{opt}^{rel} = T_{opt})$ is determined as a result of low reliability $P_t^{rel} < P_{opt}^{rel}$ by the formula [8]:

$$\Delta T = T_{ft} (P_t^{rel} < P_{opt}^{rel}) - T_{opt} (P_t^{rel} = P_{opt}^{rel}), \quad (5)$$

where $\Delta T = \tau$ working or $d\tau$ calendar days.

10. Losses (C_{loss}) are calculated from the delay in commissioning of an object or complex of objects

as a result of exceeding the construction period for the final construction flow by dt days [9, 10].

11. The cost of maintaining the reserve resources $C_{r,r}$ should not exceed the value C_{loss} in accordance with the condition.

The following general recommendations can be made regarding the nature and conditions of the allocation of reserve resources [11, 12]:

- along with the collection and analysis of statistical data on the intensity of private flows, the level of unproductive time losses characteristic of each of them is also revealed;
- average values of total intra-shift losses (X) and the probability of whole shift $P(X_{cd})$ losses of working time in private flows are calculated. In each private flow, the amount of critical downtime X_{cd} is determined, taking into account the degree of loading of the main machine or the flow crew (of this private flow);
- REL (organizational and technological reliability) of private flows is calculated using the formula:

$$P_j^{rel} = e^{-\Phi X_{cd}}, \quad (6)$$

in individual flows, the degree of influence of various factors causing unproductive time losses is assessed and significantly influencing risk factors are identified [13];

- reserve resources are selected to neutralize the factors that significantly affect P_j^{rel} of private flows;
- measures are being developed to use reserve means of mechanization of machines or crews outside the flow or in the flow, depending on the technological content of this particular flow. This means that if a private thread is working flawlessly, backup resources are not idle outside of it (for example, on backup objects or in parallel threads). Thus, a significant part of the cost of maintaining reserve resources is repaid [14];
- the cost of maintaining all reserve resources $C_{sfr,r}$ of each specialized flow is calculated, where such resources are used. Then from $C_{sfr,r}$ the value of the economic effect C_{use} obtained as a result of the use of reserve resources and during periods of uptime of the flow is subtracted. Then the actual cost of maintaining reserve resources for the entire period of operation of the specialized flow will be:

$$C_{r,r}^f = C_{r,r}^{sf} - C_{use}, \quad (7)$$

- P_j^{rel} of private flows is calculated, taking into account redundancy. To do this, new values of X_{cd} , $P(X_{cd})$, X_r are defined;
- condition $T = P_j^{rel}$ is checked for the final specialized flow as part of a complex one.

Thus, the assignment of the type of reserve resources and their distribution to specialized flows are made on the basis of an analysis of the REL of private flows, an assessment of the degree of influence of various factors causing unproductive time losses. Reserve resources are being selected to neutralize risk factors that significantly affect the reliability of private flows.

The presented basic principles for determining the level of redundancy assume:

1. The method of backup grips.

2. The main method of increasing the REL of the construction complex flow should be recognized as economically justified resource reservation. The main requirement for the optimality of reserving resources (such as capacity) is that the cost of maintaining these resources does not exceed the amount of the economic effect

of increasing REL and reducing construction time. As a criterion for the optimality of the level of resource reservation during the construction of a complex of facilities, a minimum of total costs can be selected. The REL level, which allows the construction to be completed in the optimal time, is proposed to be considered optimal. Increasing REL with the help of reserve resources by maintaining the actual flow rate at a given level with the necessary probability [15].

3. The type of reserve resource is determined by destabilizing factors specific to this particular flow, since downtime due to the lack of a front of work cannot be used as reserve resources.

4. The use of reserve resources to increase P_j^{rel} of a complex construction flow can be justified only if it satisfies some criterion of optimality.

5. The requirements for the optimality of resource reservation, based on the optimality criterion, can be formulated as follows: the problem of the construction flow, which is insufficiently developed, is taken into account, while the issues of resource reservation are also included. It can be assumed that in the process of developing research on this very important problem, various methods of economic justification for reserving resources will be proposed. One of the possible methods of economic justification of resource reservation is proposed in order to increase the efficiency of the integrated construction flow, which allows taking into account the specifics of the urban construction complex.

In general, the principle of choosing the optimality criterion for reserving resources can be characterized as follows: there is a dependence between the reliability P_j^{rel} and the construction period T (Fig. 1).

But although with an increase in REL, the construction period decreases, and the economic effect of putting the facility into operation at an earlier date increases, this happens to a certain limit, after which a further increase in reliability becomes unprofitable. It follows from this that there is some optimum, after which a further reduction in the construction period of an object or group of objects becomes unprofitable.

Let's prove this position on a concrete example of the restoration of the housing stock of Mariupol (DPR).

Therefore, if we design a complex construction flow for a given construction period, then it is advisable to take the optimal period as such. Then, if the REL of the flow is such that the construction period T_r is longer than the optimal period, then it is necessary to increase reliability by so much that the construction period is equal to the optimal one — T_{opt} ($P_j^{rel} = P_s^{rel}$).

C_r , ths RUB/200

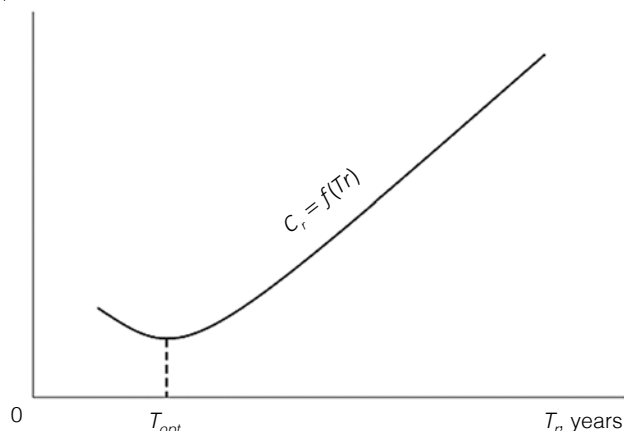


Fig. 1. Graph of the dependence of the total cost C_r on the duration of construction T_r

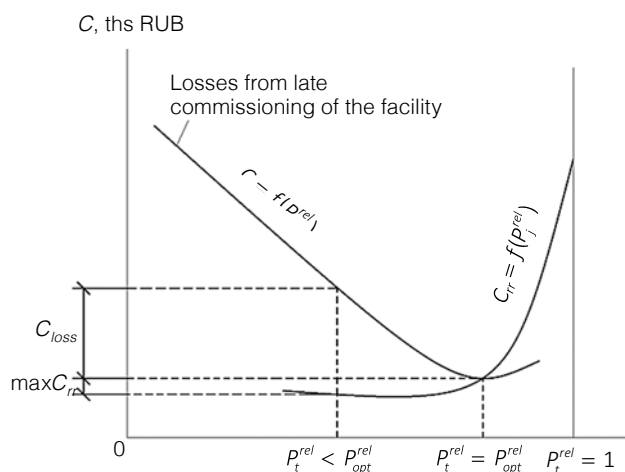


Fig. 2. The fundamental relationship between reliability, the cost of maintaining reserves and the magnitude of the economic effect

The minimum of total costs is taken as the criterion for the optimality of the construction period, and the dependence between the amount of total costs C_r and the duration of construction T_r is established. The nature of this dependence is shown in Fig. 2. A delay in the entry of the final object by τ working days will cause a delay in the commissioning of the entire complex by $\alpha\tau$ calendar days, where:

$$\alpha = \frac{\tau_k}{\tau_{\text{work}}} = \frac{365}{\tau_{\text{work}}}, \quad (8)$$

is a coefficient equal to the ratio of the number of calendar days per year to the number of working days of the year.

Therefore, in this case, it is possible to compare the reliability of the final specialized flow for the restoration of housing stock with the criterion for the entire range of costs.

Certain costs are required to increase the REL of the complex flow. At the same time, of course, with increasing reliability, the cost of maintaining it at the required level increases, and the construction period decreases.

At the same time, with increasing reliability, losses from late commissioning decrease. Given the inverse relationship between the reliability P_t^{rel} and the duration of construction T_r , the cost function $C = f(r)$ will be the inverse of the one shown in Fig. 2.

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Определение уровня резервирования комплексного строительного потока кластер-территории сложившейся застройки города

Среди методов повышения надежности, предусматриваемых при проектировании, особое место занимает использование избыточности. Избыточность — дополнительные средства (или возможности) сверх минимально необходимых для выполнения заданной функции. Резервирование — это метод повышения надежности путем введения избыточности. Особое место, отводимое этому методу, объясняется тем, что резервирование

наиболее полно позволяет решить задачу получения требуемой надежности при относительно малонадежных элементах. В зависимости от вида используемой избыточности различают следующие виды резервирования: структурное — предусматривающее использование избыточных элементов; временное — предусматривающее использование избыточного времени; функциональное — предусматривающее использование способности элементов выполнять дополнительные функции; информационное — предусматривающее использование способности к восприятию дополнительной информации, поступающей на объект; нагрузочное — предусматривающее использование способности к восприятию дополнительной нагрузки. Одним из основных

способов повышения надежности систем является структурное резервирование, которое предусматривает включение в состав системы дополнительных объектов. Структурное резервирование различается по ряду признаков: резерв включен постоянно или резервный элемент включается по мере необходимости (резервирование замещением, ненагруженный резерв); индивидуальное или групповое резервирование; переход на резервный элемент происходит мгновенно или требуется конечное время на переключение; система контроля работоспособности и управления резервом абсолютно надежна или имеет конечную надежность и т.д. Многообразие видов резервирования привело к созданию десятков различных моделей, учитывающих конкретную специфику систем.

Ключевые слова: резервирование ресурсов, интенсивность специализированного потока, комплексный строительный поток, стоимость содержания резервных ресурсов, принцип выбора критерия оптимальности

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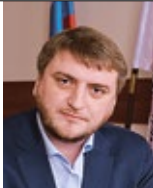


Прага. Посольство Российской Федерации в Чехии. Акварель, тушь-перо. Л.И. Павлова

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Organizational and technological analysis of high-speed construction of civilian high-rise buildings in China

This paper presents a comprehensive organizational and technological analysis of accelerated construction processes for civilian high-rise buildings in China, focusing on the adoption of prefabricated construction techniques to address the country's rapid urbanization and surging housing demands. The study systematically identifies and evaluates essential organizational and technological innovations through an extensive comparative analysis and rigorous statistical data processing, which significantly expedite construction timelines while maintaining uncompromising safety and quality standards. It emphasizes strategic improvements in management processes, integration of modern technologies and materials, and enhanced coordination among project stakeholders to optimize efficiency and delivery speed. Prefabricated reinforced concrete frame structures are highlighted as a key solution for reducing on-site construction time and labor costs, providing a practical response to urgent housing needs in rapidly growing urban areas. Furthermore, the paper introduces an evaluation framework using the Analytic Hierarchy Process (AHP) to assess and prioritize the impact factors of prefabricated buildings, enabling more informed decision-making in project management. This integrated approach addresses both the practical challenges of rapid construction and contributes to theoretical advancements by offering insights applicable to similar urban development scenarios worldwide. The findings are anticipated to influence future construction practices, fostering more sustainable and efficient strategies to meet global urbanization challenges effectively.

Keywords: rapid construction, construction technology, prefabricated structures, high-rise buildings, economic efficiency

INTRODUCTION

As China faces accelerated urbanization, the demand for efficient high-rise construction has surged. This paper explores rapid construction methods that support the rapid erection of high-rise buildings while ensuring safety and structural integrity. The study focuses on prefabricated construction techniques, which could revolutionize building processes by reducing construction times and labor costs. A comprehensive organizational and technological model tailored for rapid high-rise construction in China is proposed, enhancing efficiency and economic feasibility.

SELECTING A MODEL FOR RAPID CONSTRUCTION

To further explore the factors influencing the rapid construction of civil high-rise buildings in China, it is necessary to identify a model suitable for rapid construction. A comparison and generalization of common building types, designs, and functions is presented below (Table 1).

The use of prefabricated constructions, particularly precast reinforced concrete frame structures, enhances the speed and efficiency of constructing high-rise buildings in rapidly growing cities. Concrete's ductility and adaptability support complex structural designs while maintaining high-quality control during assembly, accelerating the construction process [1]. Chosen for its rapid construction capabilities, this structure also ensures building stability and durability, thereby

boosting construction speed and economic efficiency.

FACTORS AFFECTING THE IMPACT OF RAPID CONSTRUCTION

The establishment of a prefabricated building impact factor evaluation system (Fig. 1) is based on the cooperation of multiple prefabricated building-related enterprises [2]. Therefore, it is necessary to make a comprehensive evaluation of the elements involved and the complete process in the prefabricated building industry. In this chapter, the analysis of the hierarchy method (AHP) will be used to calculate the weights of the indicators and Kendall's concordance coefficient (*W*) to check the consistency.

Based on the research of other scholars on construction industrialization, housing industrialization, and prefabricated buildings, this paper examines some evaluation indicators of factors affecting the rapid construction of prefabricated buildings, and some of them are shown in Fig. 2.

The questionnaire was sent to 18 experts from research institutes, construction companies, design agencies, and other organizations. A rating scale from 1 to 5 points (1 — completely irrelevant, 5 — very important) was used to test the importance of the indicator system.

AHP is a widely used method for multi-criteria decision analysis [11]. In the study of the rapid construction of prefabricated buildings, the AHP model can help us to systematically evaluate the importance of different influencing factors.

Table 1. Classification of building types

Category		Types	Suitability for rapid construction
Types of buildings		Skyscraper	Due to the complexity of the design, usually not suitable for fast-track construction
		High-rise buildings	The use of prefabricated structures can partially enable fast-track construction
Types of construc- tions	By material	Reinforced concrete construction	Prefabricated reinforced concrete elements can speed up construction
		Metal construction	Assembly speed is achieved due to the factory readiness of components
		Wooden construction	Particularly suitable for the rapid construction of small or low-rise buildings
	By load	Frame construction	Suitable for prefabricated structures to speed up construction
		Shear wall construction	The use of prefabricated wall elements makes it possible to significantly speed up the construction process
		Frame-sliding wall construction	The use of prefabrication technology optimizes construction speed and cost efficiency
	By method of construction	Prefabricated construction	Ideal for rapid construction, which reduces time on-site
		Monolithic construction	This takes more time but ensures overall structural integrity
Types of functions		Housing function	Prefabricated dwellings can be built very soon
		Commercial function	Prefabricated construction can speed up the construction of commercial buildings

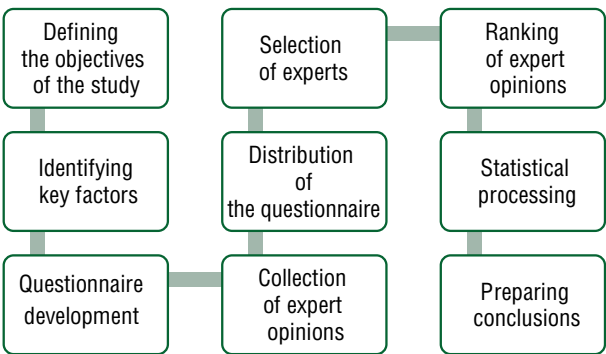


Fig. 1. Factor assessment process for the speed construction

Table 2. Weight of level criteria

Number	Stage	Quantity of factors	Weight
1	Design stage	4	0.1739
2	Production stage	3	0.1304
3	Transport stage	3	0.1304
4	Construction phase	5	0.2174
5	Project management stage	5	0.2174
6	External factors	3	0.1304

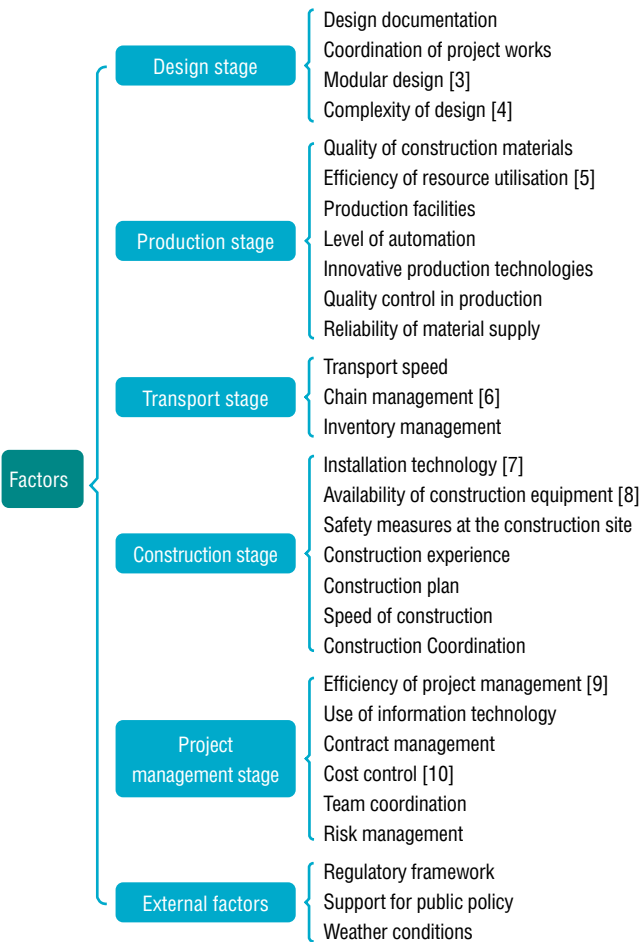


Fig. 2. Evaluation factors [3–10]

► The construction of the AHP model based on the survey data is described in detail below (Table 2).

Among the various phases of a prefabricated building project, the construction stage and the project management stage have the greatest weight (Table 3). Therefore, strengthening the management and optimizing these two stages can be the key to improving the overall efficiency of the project.

The formula for calculating the complex weight is as follows:

$$W_{complex} = W_{stage} \cdot W_{factor},$$

(1)

where $W_{complex}$ — the composite weight of a sub-factor;

W_{stage} — the weight of the stage to which the sub-factor belongs;

W_{factor} — the weight of a factor within its stage.

The calculation results are shown in Fig. 3.

In prefabricated buildings, construction and project management are critical for quick erection due to their high weighting factor. Modular construction significantly enhances construction efficiency. Moreover, efficient resource management and supply chain optimization during manufacturing underscore the complex nature of prefabrication project management and the need for an integrated approach to achieve success.

Kendall's coefficient of concordance (W) (Fig. 4) can be used to check the consistency of expert opinions [12]. If the value of W is high, it indicates a high consistency of opinions.

Based on the above data, the calculated $W = 0.713$ indicates that the experts were more consistent in their assessments of the importance of the factors.

IMPROVEMENTS FOR SPEEDY CONSTRUCTION

The BEI (Building Efficiency Index) was created to evaluate the criteria for rapid construction:

$$BEI = \frac{TP \cdot QC \cdot 100}{TD},$$

(2)

where TP (Target Performance) is calculated based on the ratio of actual project completion time to planned target time, expressed as a percentage;

QC (Quality Coefficient) — a rating of the quality of a completed project, usually between 0 and 1, where 1 means no defects, 0.8 minor defects, and a lower value serious quality problem;

TD (Time Deviation) — the ratio of actual project completion time to the industry average.

For this purpose, set thresholds (Fig. 5).

Example: suppose a project has a target completion time of 30 days, an actual completion time of 30 days, a project quality score of 0.9 (minor defects), and an industry average completion time of 40 days:

$$TP = \frac{30}{30} \cdot 100 \% = 100 \%, QC = 0.9; TD = \frac{30}{40} \approx 0.75;$$

$$BEI = \frac{100 \cdot 0.9 \cdot 100 \%}{0.75} = 120.$$

Thus, the project is a rapid construction project.

The following specific measures can be applied to optimize the efficiency and quality of prefabricated building construction:

1. Assembly technology for frame columns:
- location selection and node design: Locate frame column

Table 3. Weight of level sub-criteria

Number	Factors	Quantity of factors	Weight
1. Design stage			
1.1	Design documents	4	0.0471
1.2	Coordination of project works	3	0.0324
1.3	Modular design	5	0.0610
1.4	Complexity of design	4	0.0334
2. Production stage			
2.1	Quality of construction materials	5	0.164
2.2	Efficiency of resource utilisation	5	0.164
2.3	Production facilities	3	0.079
2.4	Level of automation	4	0.108
2.5	Innovative production technologies	3	0.079
2.6	Quality control in production	4	0.108
2.7	Reliability of material supply	5	0.299
3. Transport stage			
3.1	Transport speed	3	0.296
3.2	Chain management	4	0.370
3.3	Inventory management	4	0.334
4. Construction stage			
4.1	Installation technology	5	0.176
4.2	Availability of construction equipment	4	0.149
4.3	Safety measures at the construction site	4	0.149
4.4	Construction experience	5	0.176
4.5	Construction plan	4	0.149
4.6	Speed of construction	5	0.176
4.7	Construction coordination	4	0.176
5. Management stage			
5.1	Efficiency of project management	4	0.164
5.2	Use of information technology	3	0.123
5.3	Contract management	4	0.164
5.4	Cost control	5	0.215
5.5	Team Coordination	5	0.215
5.6	Risk management	5	0.215
6. External factors			
6.1	Regulatory framework	5	0.451
6.2	Support for public policy	3	0.274
6.3	Weather conditions	3	0.274

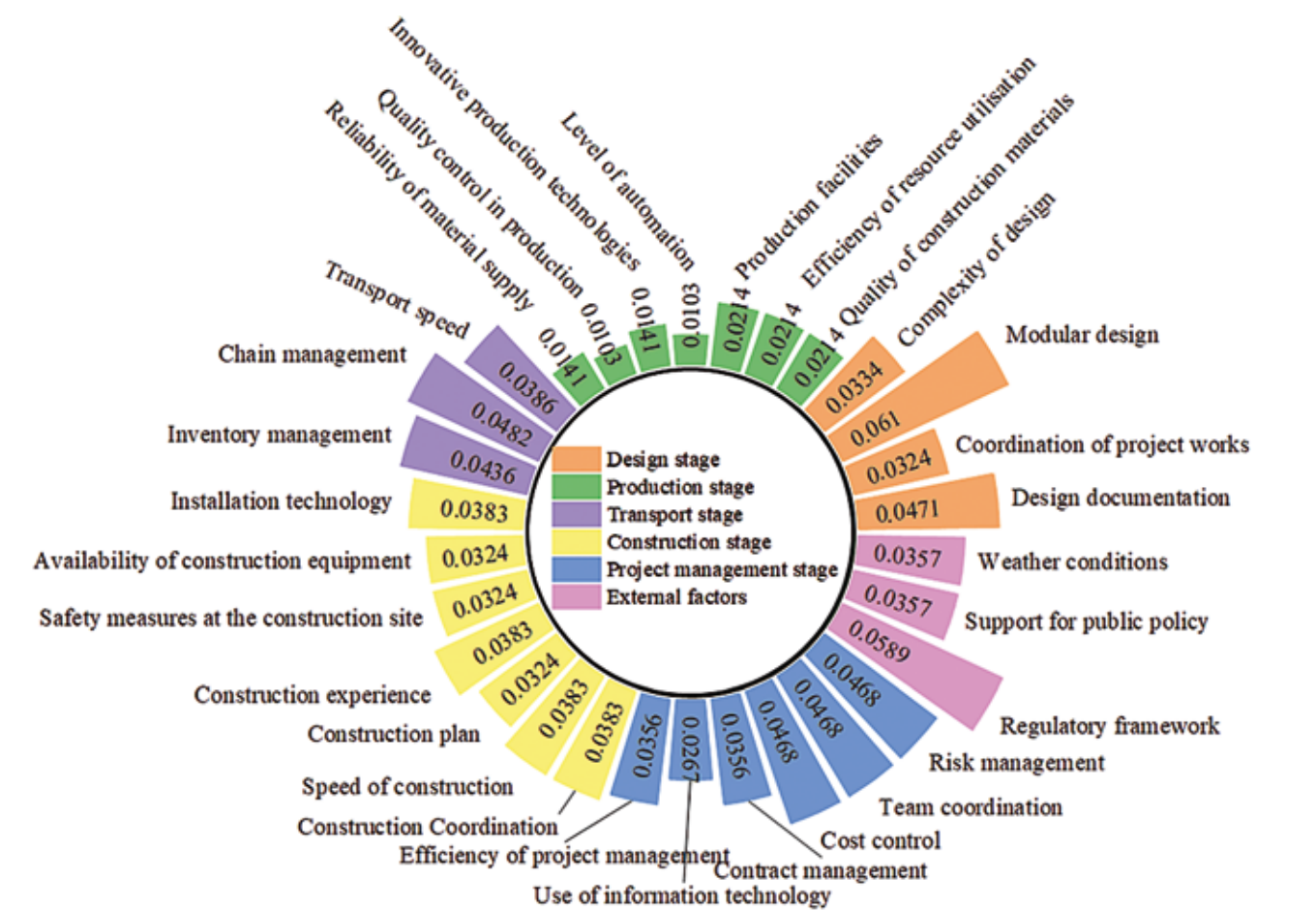


Fig. 3. Complex weights of factors

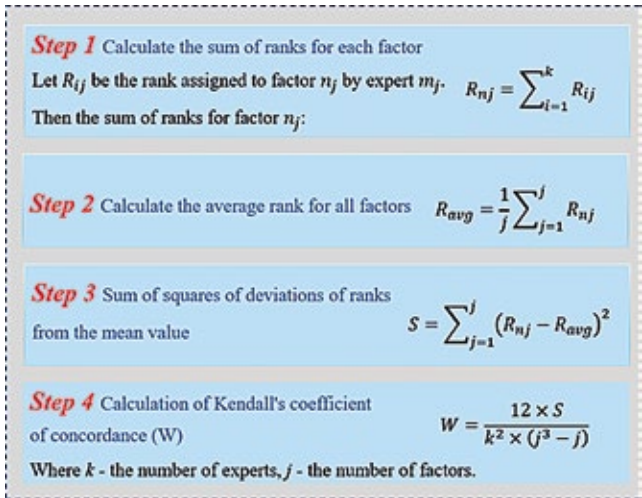


Fig. 4. Algorithm for calculating Kendall's concordance coefficient

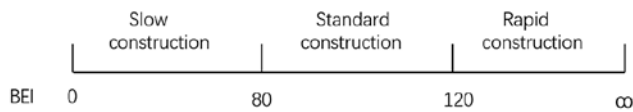


Fig. 5. Scheme of construction speed thresholds

assembly nodes in areas with lower bending moments to reduce stress in the structure (Fig. 6). Development of standardized mounting nodes and use of prefabrication to increase the early load-carrying capacity of the nodes, which speeds up construction and reduces costs [13];

- auxiliary support measures [14]: Optimization of the auxiliary support system at the construction site, reduction of dependence on temporary support structures, and increase of installation efficiency.

2. Installation technology for frame beams. Assembly of frame girder assemblies outside of beam and column assemblies: the assembly of frame beam assemblies in the area outside the beam and column assemblies allows them to be installed together with whole prefabricated frame columns, thus simplifying the construction process and increasing the speed of the overall assembly [15].

3. Installation technology of floor slabs. The application of the overlap method of a one-piece slab maximally simplifies the installation of supports at the construction site, expands the working surface when erecting lower floors, and increases the efficiency of construction [16]. According to the optimized structure separation plan for the prefabricated frame structure, the proposed construction process is as follows (Fig. 7):

- delivery of prefabricated samples to the site — assembly of frame column assemblies;
- installation of columns and prefabricated columns and beam

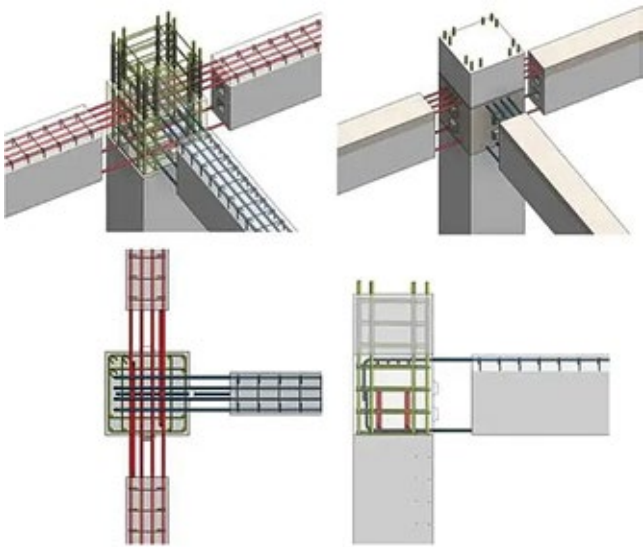


Fig. 6. Column and beam joint assembly diagrams¹

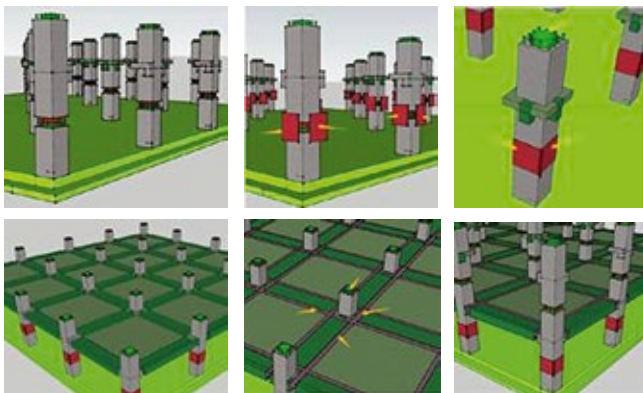


Fig. 7. Schematic diagram of the concrete frame structure assembly process [17]

- assemblies, use of steel sleeves to connect longitudinal reinforcement;
- connection of reinforcement and erection of laterally supported and laterally restrained frame column assemblies using standardized formwork systems;
 - placement of concrete mix inside and outside the frame columns at nodes, with the concrete at the nodes poured 300 to 500 mm below the node to ensure safe spacing between the old and new concrete at the core of the column;
 - installation of beams, slabs, and their support systems: First, the beam support system and its connection with columns are installed, and then the suspended slab support system is installed after the support system is installed, the prefabricated slabs are installed, and finally the reinforcement of countersunk floor beams is tied;
 - pouring concrete mix in the beam and countersunk floor beam assembly units;
 - under the auxiliary support of the assembly nodes, the frame columns of the next level are erected.

CONCLUSION

This study presents a comprehensive organizational and technological analysis of high-speed construction methods for civilian high-rise buildings in the context of accelerated urbanization in China. Particular attention was given to the adoption of prefabricated construction technologies, which have demonstrated effectiveness in reducing construction time and labor costs while maintaining rigorous safety and quality standards.¹

Furthermore, the in-depth analysis of the frame column, frame girder, and slab assembly technologies and the optimization of the overall construction process have made the construction of prefabricated reinforced concrete frame structures faster and safer. Frame column assembly technology has accelerated the construction process by optimizing the arrangement of nodes, and frame beam assembly technology has simplified the construction process by installing assembly nodes outside the node areas. The slab assembly technology improved construction efficiency by utilizing a whole-slab scheme and a self-supporting beam and slab system.

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Организационно-технологический анализ скоростного возведения гражданских высотных зданий в Китае

В данной работе представлен подробный организационно-технологический анализ ускоренных процессов строительства гражданских многоэтажных зданий в Китае с акцентом на использование технологий предварительного изготовления для решения задач стремительной урбанизации и растущего спроса на жилье. Исследование выявляет ключевые организационные и технологические инновации с помощью сравнительного анализа и статистической обработки данных. Эти инновации значительно сокращают сроки строительства, обеспечивая при этом строгие стандарты безопасности и высокого качества. В работе подчеркивается важность стратегического улучшения управленческих процессов, внедрения современных технологий и материалов, а также укрепления координации между участниками проектов. Это позволяет значительно повысить эффективность и скорость реализации проектов строительства высотных зданий. Особое внимание уделено предварительно армированным бетонным каркасным конструкциям, которые существенно сокращают время строительства на месте и трудозатраты, предлагая жизнеспособное решение для удовлетворения неотложных жилищных потребностей в условиях стремительно растущих городских районов. Дополнительно предлагается система оценки факторов влияния на предварительно изготовленные конструкции, основанная на методе аналитической иерархии (АНП). Эта система позволяет проводить приоритизацию факторов и принимать более обоснованные управленческие решения. Данный интегрированный подход не только решает практические задачи ускоренного строительства, но и вносит вклад в теоретическую базу гражданского строительства. Исследование предоставляет практические рекомендации, которые могут быть применимы в аналогичных условиях развития городов в глобальном масштабе. Результаты работы призваны повлиять на будущие строительные практики, способствуя формированию устойчивых и эффективных стратегий для решения актуальных вызовов урбанизации.

Ключевые слова: скорое возведение, технология строительства, сборные конструкции, высотные здания, экономическая эффективность

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Methodology for assessing labour resources and employment of the region taking into account digital challenges

The paper is aimed at developing a methodology for assessing labour resources and employment of the region, which allows to determine the degree of balance of changes in the labour resources of the region in the conditions of development of the digital economy and new forms of employment for the subsequent development of measures to reduce economic losses caused by the asymmetric development of the labour market and employment. The developed algorithms for implementing the methodology and assessing risks affecting labour resources can be used by regional structures that manage the region's economy in the process of developing and making decisions on its sustainable development. To achieve the purpose of this study, methods of morphological analysis were used to identify key features of the labour resources, contributing to its socio-economic and innovative development. It is suggested to apply statistical analysis to explore the dependence of the region's digital development on changes in the external environment caused by risk events, and to identify the role of digitalization of the region's manpower for ensuring sustainable economic development. In addition, widely accepted methods for data collection and comparative analysis (such as the analogy method, content analysis and expert analysis), along with the modelling method, are used. New forms of labour and employment emerged due to the development of information and communication technologies are outside the limits of national regulation. Existing approaches and methods for analyzing labour resources and estimating unemployment at the national and regional levels no longer provide a real picture, as an individual's geographic location no longer directly determines their work or employment in a particular region. This highlights the relevance of research on the methodology for analyzing regional labour resources and employment, taking into account new forms of employment and the risks associated with the replacement of human labour by robots and human intelligence by artificial intelligence. The research was supported by a grant from the Russian Science Foundation No 24-28-00848, URL: <https://rscf.ru/project/24-28-00848/>

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The transition to a new technological order, based on the wide use of digital technologies in production and services, radically changes the labour process, social and labour relations and the nature of employment.

The emergence of new forms of employment leads to the following challenges for the economy of regions and the country as a whole:

- exclusion of employees with non-standard employment from the scope of the social protection system. For instance, without access to corporate medical facilities, medical examinations and with no guarantees of a steady income, such citizens turn to public health facilities when problems arise. As a result, the burden of providing them with social protection falls on the shoulders of the state, and in particular, regions and municipalities;
- loss of income for the pension and health insurance systems, since the self-employed people are exempt from mandatory insurance contributions and make them on a voluntary basis. A serious imbalance in the pension system arises as a result of the violation of the basic principle of the current pension insurance system, namely the principle of intergenerational solidarity ("each subsequent generation feeds the previous one");
- the spread of platform-based employment, along with work performed remotely on behalf of employers from different regions or countries, leaves open the question of which

region receives added value (at basic prices) generated by labour — a key factor in determining both GRP and GDP. This creates an imbalance between budget revenues and expenditures. Regional taxes and shares of federal taxes are allocated to the budget of the employer's region, while the region itself bears no social burden, such as the need to provide free healthcare, education, transportation infrastructure for personal vehicles or the expenses for maintaining public order. On the other hand, regions that are donors of remote workforce bear the entire social burden and corresponding budget expenditures, without receiving any economic dividends in the form of taxes. If the employer is located abroad, the problem is further exacerbated by the virtual drain of intellectual resources [1–6].

The following types of imbalances in regional development are identified, caused by the asymmetric development of the labour market and non-standard forms of employment:

- qualification (the imbalance between the current supply and demand for employees with specific professions or skills);
- virtual migration (the imbalance of interregional/international inflow and outflow of virtual workforce);
- technological challenges, caused by the development of robotics and artificial intelligence and leading to the disappearance and emergence of new jobs;

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- socio-economic challenges (the imbalance in the income and expenditures of the Social Fund of the Russian Federation, the imbalance in the income and expenditures of regional budgets [7–9]).

It is suggested to consider the outlined imbalances as risks. They will pose a threat for regions if the imbalance or deviation from a certain reference point exceeds a certain level and leads to tangible negative socio-economic consequences. These might include: a shortage of labour with the necessary skills upon further use of digital technologies; increased unemployment, increased costs for medicine and health care, growing scarcity of funds for pensions and health care; a decrease in GRP due to the outflow of intellectual labour while maintaining regional per capita expenses, and a decrease in tax revenues.

To address these issues, a risk-based assessment of a region's labour resources and employment is proposed. This approach will promote the sustainable socio-economic and innovative development of regions in the context of digitalization and the development of non-standard forms of employment. This assessment follows a balance-sheet approach, which involves preparing a labour resource balance and adjusting it to account for the imbalances in the creation and distribution of manpower caused by digitalization and the emergence of new forms of employment [10, 11]. In this way, it is possible to determine potential economic losses associated with identified risk areas and promptly develop measures to ensure sustainable, risk-adjusted development of regions. Main provisions of the methodology are shown in Table 1.

The algorithm for applying the developed methodology for evaluating labour resources and employment in a region is as follows.

1. Identification of factors influencing the building and distributing labour resources in a region.

2. Collection of statistical data and independent research findings:

- current demographic statistics;
- data from sample surveys of enterprises and individual entrepreneurs conducted by state statistical agencies in the following areas: labour force, ongoing investment projects and expected changes in labour demand;
- data from consolidated reports of the Ministry of Internal Affairs of the Russian Federation on the number of migrant workers;
- data from administrative sources of information (the Federal Tax Service data platform on the number of self-employed individuals, the unified digital platform "Work in Russia", etc.);
- data from recruiting agencies and labour market platforms on the current labour supply and demand;
- data from independent research on platform-based employment, other non-standard forms of employment, virtual migration, self-employed individuals' actions (payment of voluntary pension and health insurance contributions, purchase of voluntary health insurance policies).

3. Drawing up a traditional balance of labour resources.

4. Labour distribution by types of employment (traditional, self-employed, platform-based, unregistered employment).

5. Establishing acceptable levels for qualification, innovation, virtual migration and socio-economic risks.

6. Analysis of the labour resource development balance by risk types (qualification, innovation, virtual migration and socio-economic risks).

7. Drawing up a forecast balance taking into account the expected workforce structure and staffing needs of a region.

Table 1. Basic provisions of the methodology for evaluating labour resources and employment in a region

Characteristics of the methodology	Description
Employment types under evaluation	Standard or traditional employment refers to working for a single employer at a fixed workplace provided by the employer, on predetermined days and hours, under a permanent or fixed-term employment contract. Non-standard employment refers to work where the employee independently determines working days, hours and the workplace location, often under short-term contracts and with an unlimited number of employers
Relevance of the methodology	Preventing economic losses of a region caused by the transformation of employment in the context of digitalization and virtual migration of manpower resources
Purpose of the methodology	Evaluating the balance in changes in a region's labour resources in the context of evolving digital economy and new forms of employment to work out measures to reduce economic losses caused by the asymmetric development of the labour market and employment
Approach to labour resource assessment	Balance-sheet
Methods applied	Morphological analysis, statistical analysis, widely accepted methods for data collection and comparative analysis (a survey, interviews, analogy method, content analysis, expert analysis), modeling method, decomposition method for developing a risk assessment algorithm

Table 2. Methodology for assessing risks affecting the development of labour resources and employment in a region [12, 13]

Risk types	Risk source	Risk assessment	Features
Qualification	Exceeding the acceptable proportion of unemployed individuals with relevant professional qualifications within the total unemployed population, by occupations	The excess number of unemployed with relevant professional qualifications, multiplied by the minimum wage or by the unit costs of retraining	Regional expenditures on unemployment benefits, social support for families (child payments), and retraining programs
Innovation	The deviation between the current and expected number of people employed by types of economic activity	Probable shortage of labour force with required skills by types of economic activity, multiplied by GRP per capita	Regional GRP losses caused by the lack of employees with the right skills
Virtual migration	Negative balance of virtual migration (negative difference between the number of individuals from other regions undertaking job assignments and those employed remotely outside the region)	Negative balance of virtual migration multiplied by the difference between GRP per capita and the average income of an intellectual emigrant	Regional GRP losses caused by the outflow of virtual intellectual labour resources
Socio-economic	The reluctance of people with precarious jobs (without employment contracts) to voluntarily make insurance contributions for pension and health care	The number of self-employed individuals who do not make voluntary insurance contributions for pension and health care, multiplied by the average per capita expenditures of the region on social support and protection	Additional expenditures of the region and state extra-budgetary funds for social support and protection of citizens

8. Measuring economic losses in a region according to identified risk types (Table 2).

9. Development of measures to ensure sustainable risk-adjusted development of a region.

The algorithms for assessing the risks outlined in Table 2 are shown in Fig. 1–4.

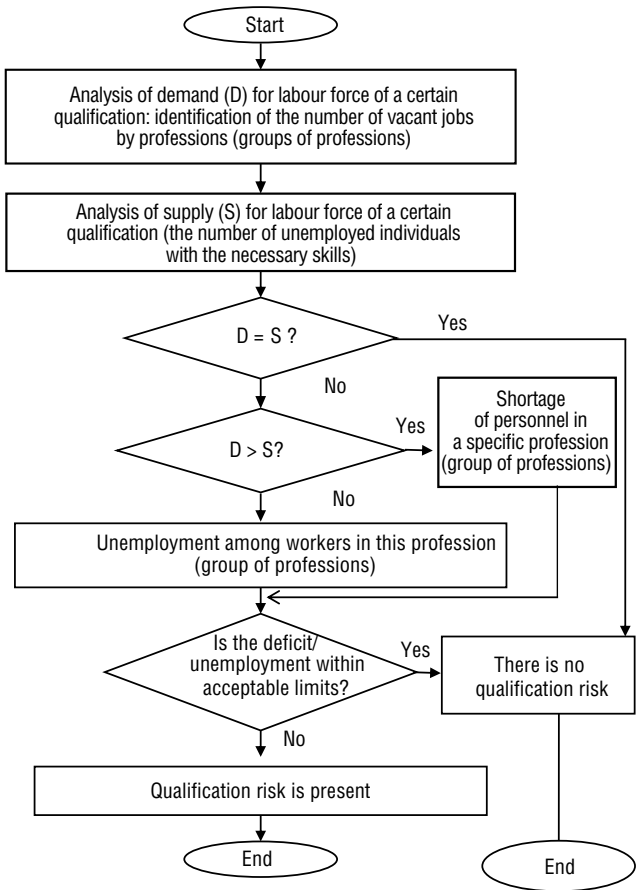


Fig. 1. The algorithm for assessing qualification-related risks

They include:

- the algorithm for assessing qualification risk;
- the algorithm for assessing socio-economic risk;
- the algorithm for assessing the risk related to virtual migration.

The algorithm for analyzing the supply and demand for labour with specific skills helps identify the stage at which qualification risk emerges. Next, the socio-economic risk is assessed as part of the proposed methodology (Fig. 2).

The socio-economic risk assessment algorithm should necessarily include the determination of the current structure of labour resources at the regional level. It is important to conduct the assessment with consideration of industry-specific employment trends. It is necessary to determine whether there is an inflow or outflow of labour by specific types of economic activity in order to determine the staffing needs in the region [14, 15].

The next stage entails assessing technological risk (Fig. 3).

The use of the developed methodology will ensure sustainable balanced development of regions in the context of digitalization,

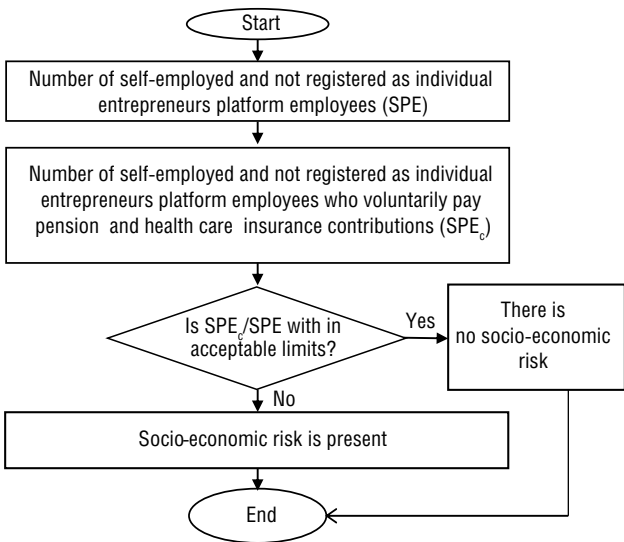


Fig. 2. The algorithm for assessing socio-economic risk

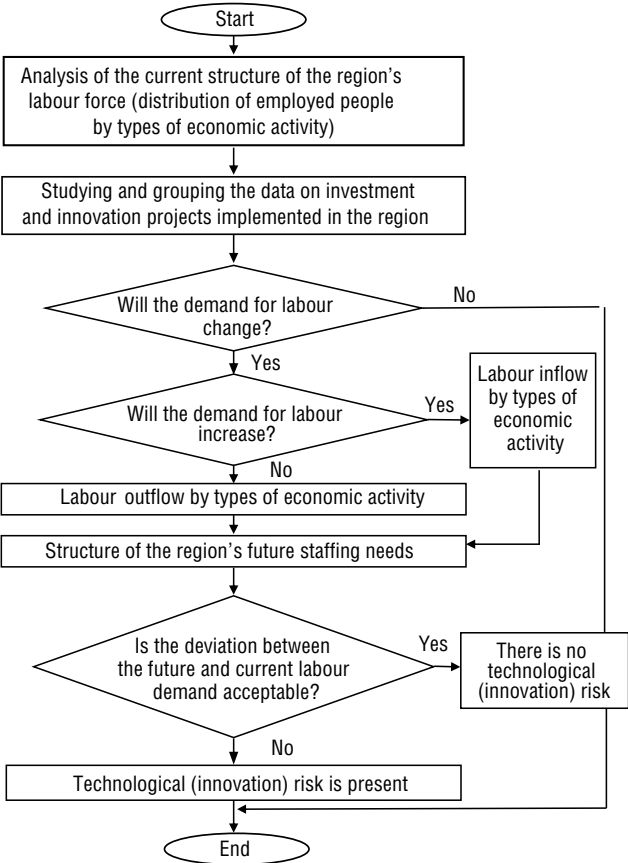


Fig. 3. The algorithm for assessing technological risk

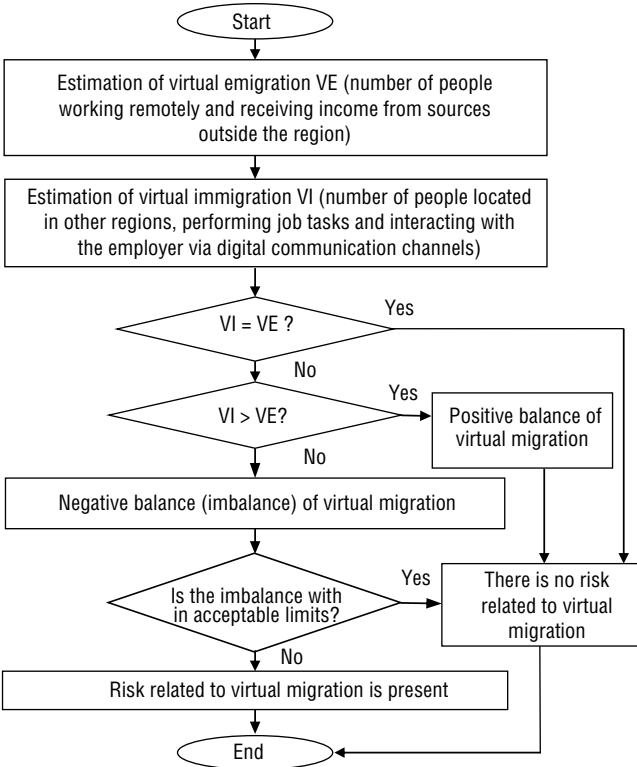


Fig. 4. The algorithm for assessing the risk of virtual migration

accompanied by a transformation of the quantity, composition and type of manpower, as well as the development of new forms of employment.

Currently, neither the world scientific community nor the authorities have developed a unified comprehensive approach to the sustainable development of the digital labour market and the regulation of migration processes in the evolving digital economy. Interregional, non-standard (flexible) labour migration driven by the rise of platform employment has been largely unexplored. This gap formed the basis of the methodology developed in this study, which was further tested with the collection and comprehensive assessment of empirical data.

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Разработка методики оценки трудовых ресурсов и занятости в регионе с учетом цифровых вызовов

Научное исследование направлено на разработку методики оценки трудовых ресурсов и занятости региона, позволяющей определить степень сбалансированности изменения трудовых ресурсов региона в условиях развития цифровой экономики и новых форм занятости для последующей выработки мероприятий по снижению экономических потерь, вызванных асимметричным развитием рынка труда и занятости. Разработанные алгоритмы реализации методики и оценки рисков, влияющих на трудовые ресурсы региона, могут быть использованы региональными структурами, обеспечивающими управление экономикой региона, в процессе разработки и принятия решений по его устойчивому развитию. Для достижения цели исследования будут использованы методы морфологического анализа для выделения ключевых характеристик трудовых ресурсов региона, способствующие социально-экономическому и инновационному развитию региона. С помощью методов статистического анализа предложено исследовать зависимость цифрового развития региона от изменений внешней среды, являющихся следствием реализации рисков событий, и выявить роль цифровизации трудовых ресурсов региона в обеспечении устойчивого экономического развития. Кроме того, предполагается использовать общепризнанные методы сбора и сравнительного анализа данных (метод аналогий, методы контентного, экспертного анализа), метод моделирования. Новые формы труда и занятости, возможные благодаря информационно-коммуникативным технологиям, оказываются за пределами национального регулирования. Прежние подходы и методы анализа трудовых ресурсов, оценки безработицы в масштабах страны и ее регионов уже не дают реальной картины, поскольку географическое местоположение человека автоматически не определяет его труд и занятость в конкретном регионе. Это делает актуальными исследования в области методологии анализа трудовых ресурсов регионов и занятости, учитывающие новые формы занятости и риски, связанные с заменой людей роботами, а человеческого интеллекта — искусственным.

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Ключевые слова: территориальное планирование, персонал организации, технологический уклад, процесс труда

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GIS HCS: Analytical Capabilities of the Open Section of the System for Educational Purposes

The paper discusses and explores the possibilities of using the open part of the GIS housing and communal services information system, the section “Analytics and reports”, as a source of large reliable data and tools for working with them. The use of such data and work tools is important and relevant in the training of future specialists, the formation of their analytical skills with information. The purpose of the study is the possibility of setting and implementing analytical tasks for educational purposes based on real reliable GIS HCS data. During the research, the main features of the system were studied and the formulation of analytical tasks for educational purposes was proposed. The sections of the system “Technical condition of apartment buildings” and “Bringing management organizations to administrative responsibility” were used. One of the tasks is solved completely using the built-in tools of the platform, the other — regression analysis — using the tools of the table processor. The built-in tools of the open part of the GIS HCS “Analytics and Reports” allow to sort data, move from aggregated data to detailed data and back, supplement tabular data with graphical models, which makes working with information simple and understandable. The lack of the ability to export data from the system makes it difficult to use third-party applications for subsequent data processing. Solving this class of analytical problems allows students to gain skills in problem formulation, solution, and interpretation of the results obtained. The considered examples of analytical tasks can be expanded by other tasks proposed directly by the students themselves. This research is of practical importance in the training of future specialists in the field of economics, management, real estate management and housing and communal services.

Keywords: GIS HCS, data analytics, educational goals, information system, housing and communal services

INTRODUCTION

Digitalization of the economy impacts all sectors of economic activity and involves the widespread implementation of comprehensive digital technologies, the development of digital platforms for integrating information exchange participants and improving the efficiency of all processes. Modern technologies facilitate the accumulation, storage, and processing of vast data sets, enabling the analysis and resolution of various analytical challenges, particularly in real estate management and housing services [1]. The rapid development of technology necessitates the training of skilled professionals, who can work with big data, use analysis tools and solve analytical problems in the applied field. Methods and technologies of training future specialists are also changing [2].

For the sphere of housing and communal services, real estate management, the state information system — GIS of housing and communal services (GIS HCS) — has been developed and implemented¹ [3–5], which unites on its platform all participants in information processes and authorities of three levels [6, 7]. The effectiveness and prospects of using such an integrating platform are considered in a number of studies [8–16]. We are exploring this platform — GIS of housing and communal services — as an open database for obtaining information analysis skills in training future specialists.

The object of this research is the state information system of housing and communal services — GIS HCS. The subject of research is the database

of the open part of the information system, the section “Analytics and reports”, for the study of the analytical capabilities of the system and its subsequent use it for educational purposes.

The purpose of this research is to explore the potential of GIS HCS tools, focusing on its technical components and analytical reports, for educational applications. The study aims to develop skills in analyzing reliable, real-world data.

The relevance of this work is determined by the need to train qualified specialists in the field of real estate management and housing and communal services, with the skills to solve analytical problems, the ability to correctly set them and interpret the results obtained. The applied nature of applying knowledge and skills to solve analytical problems using a real GIS HCS database and GIS HCS tools makes the acquired skills more important and valuable for students.

METHODS AND MATERIALS

The paper uses open information, posted in the GIS HCS, in the “Analytics and reports” section. The built-in tools of the system are used for working with information, as well as an office application, a spreadsheet software, for processing information and solving regression analysis problems.

GIS HCS has open and closed parts of its system. End users, residents of homes, can register in their personal account and receive services through the GIS HCS platform. In turn, management companies, resource supply organizations, and



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1 GIS Of Housing and Communal Services. URL: https://dom.gosuslugi.ru.(rus.).

government agencies have their own access to a certain part of the platform and information resources necessary for implementing their part of the activity in the information system. Each of these users has their own analytics tools. Leveraging the extensive data available in the GIS of housing and communal services, each of the participants of this platform has the opportunity to analyze this or that information to improve the quality-of-service delivery and increase customer satisfaction, efficient use of resources, and solve a number of specialized tasks. For example, each resident of a house registered on the platform can see their own statistics of resource consumption, utilities such as cold and hot water, electricity, and gas, as well as the amount of money actually paid for housing and communal services rendered. Based on this data, any user can predict their future resource consumption with other factors remaining constant, or analyze resource costs and find ways to save them. These are simple analytical tasks, that most users of the platform can perform if necessary. On the other hand, the resource supply organizations, management companies, also see in the dynamics of various indicators for resources, finances, user requests and their satisfaction. Based on the analysis of such indicators, resource consumption, cash receipts can be predicted, or, for example, the main reasons for not paying for certain utilities can be identified. These are all the features of the closed part of the system.

And open access information is also of some interest. The "Analytics and Reports" section contains significant amount of analytical information, presented in a convenient graphical design for the best perception, and is accompanied by tabular data. This data is valuable for teaching students analytical problem-solving skills using

real-world information. When solving analytical problems, as a rule, one can distinguish the main stages: problem formulation, selection of data and tool environment for solving the problem, the actual solution and obtaining results, and interpretation of the results obtained. We use the capabilities of the housing and utilities GIS as the source data and tool environment. We will try to set these tasks, perform them using the selected tools, and interpret the results obtained.

RESULTS

Problem Statement 1: analyzing the degree of wear and tear in MAB. It is necessary to use the GIS HCS tools, the section "Analytics and reports", "Technical condition of apartment buildings" to determine houses with a high percentage of wear and tear (more than 40 %) and in a state of emergency for one of the regions of the Russian Federation. Evaluate the dependence of the multi-apartment building (MAB) wear and tear percentage on the year of commissioning and the MAB management method by answering the following questions:

Which years of construction of buildings account for the highest percentage of wear and tear?

Does a high percentage of wear and tear always lead to an emergency condition of the MAB?

What is the MAB management method identified for emergency buildings?

GIS of housing and communal services provides immediately complete and clear information about the average percentage of MAB wear and tear for the selected region in the context of management methods (Fig. 1).

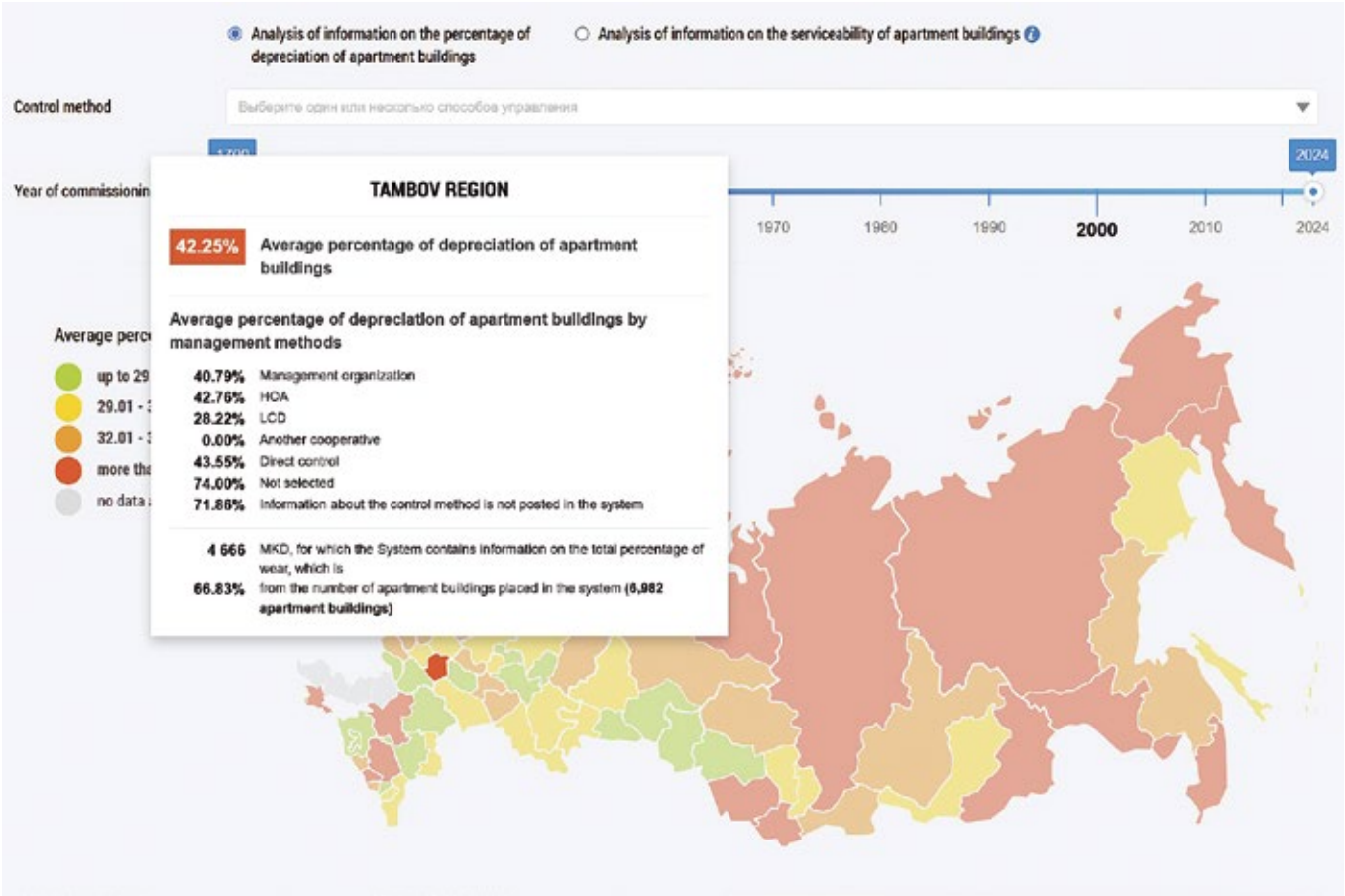


Fig. 1. GIS HCS: Analysis of information on the percentage of MAB wear and tear by management methods

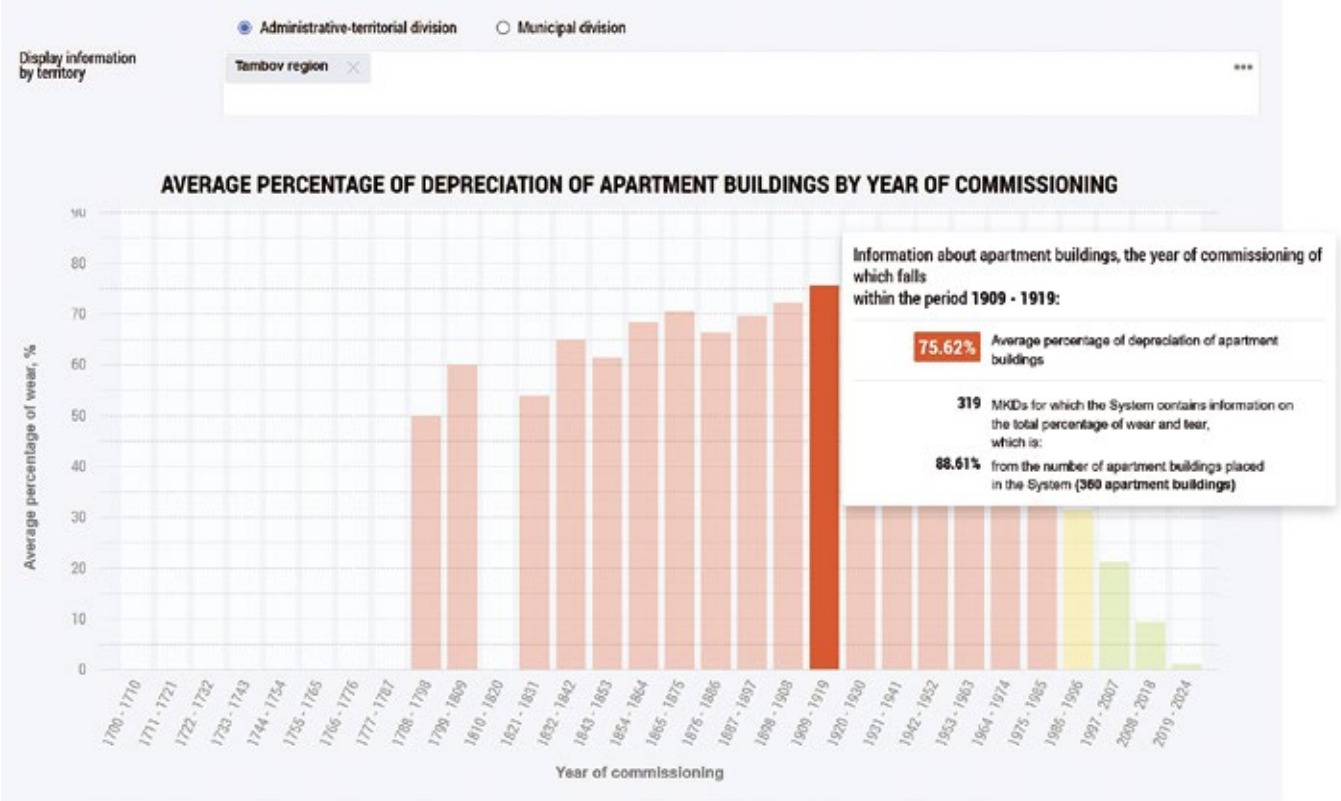


Fig. 2. GIS HCS: Average percentage of MAB wear and tear by year of commissioning

This data shows that some of the houses with a high percentage of depreciation either did not choose the management method, or the data in the system was not provided. Data on the average percentage of MAB wear and tear over the year of commissioning are also clearly presented (Fig. 2). As can be seen in Fig. 2, in this region (Tambov region), a fairly high percentage of wear and tear falls on the years of construction from 1788 to 1985, the maximum wear of 75.54 % falls on houses built in 1909–1919.

The table below in the Housing and utilities GIS provides aggregated information on apartment buildings (MAB) in this region with an indication of the average percentage of depreciation for individual districts and cities of the Tambov region (Fig. 3).

The study can be conducted for the entire Tambov Region, or for a separate district or city. For example, let's examine the areas with the highest average percentage of wear and tear. To do this, we will order the entries in descending order by the column "Average percentage of wear" (Fig. 3). The highest average percentage of MAB wear is 83.37 %, Bondarsky district. At the same time,

the method of managing such MAB is *Direct management*. By clicking the "MAB List" button, you can get detailed information. Thus, for the Bondarsky district, the maximum wear and tear of 90 % falls on one building of the 1978 year of commissioning, and another 40 buildings have 85 % wear and tear with the period of commissioning from 1962 to 1986.

Based on these data, it can be concluded that regardless of the construction period, MAB under *direct management* are in poor condition in this area and require increased attention.

We are investigating information about the MAB accident rate in this region. To do this, in the filtering parameters, specify "Analysis of information about the health of the MAB". The system provides a visual representation of data on the average percentage of MAB wear over the year of commissioning (Fig. 4) for the entire Tambov region.

Referring to the data table for detailed information on the area of interest, we observe (Fig. 5) that one building of the MAB under the *direct control* of the 2004 year of commissioning is in disrepair.

Territory	Number of apartment buildings placed in the system	MKDs for which the System contains information on general depreciation			Number of apartment buildings for which the management method is placed in the System	Management organization		
		Number of apartment buildings	%	Average percentage of wear		Number of apartment buildings	%	Average percentage of wear
Tambov region	6 982	4 666	66.83	42.25	4 534	3 387	74.70	40.79

Fig. 3. GIS HCS: MAB Depreciation Data

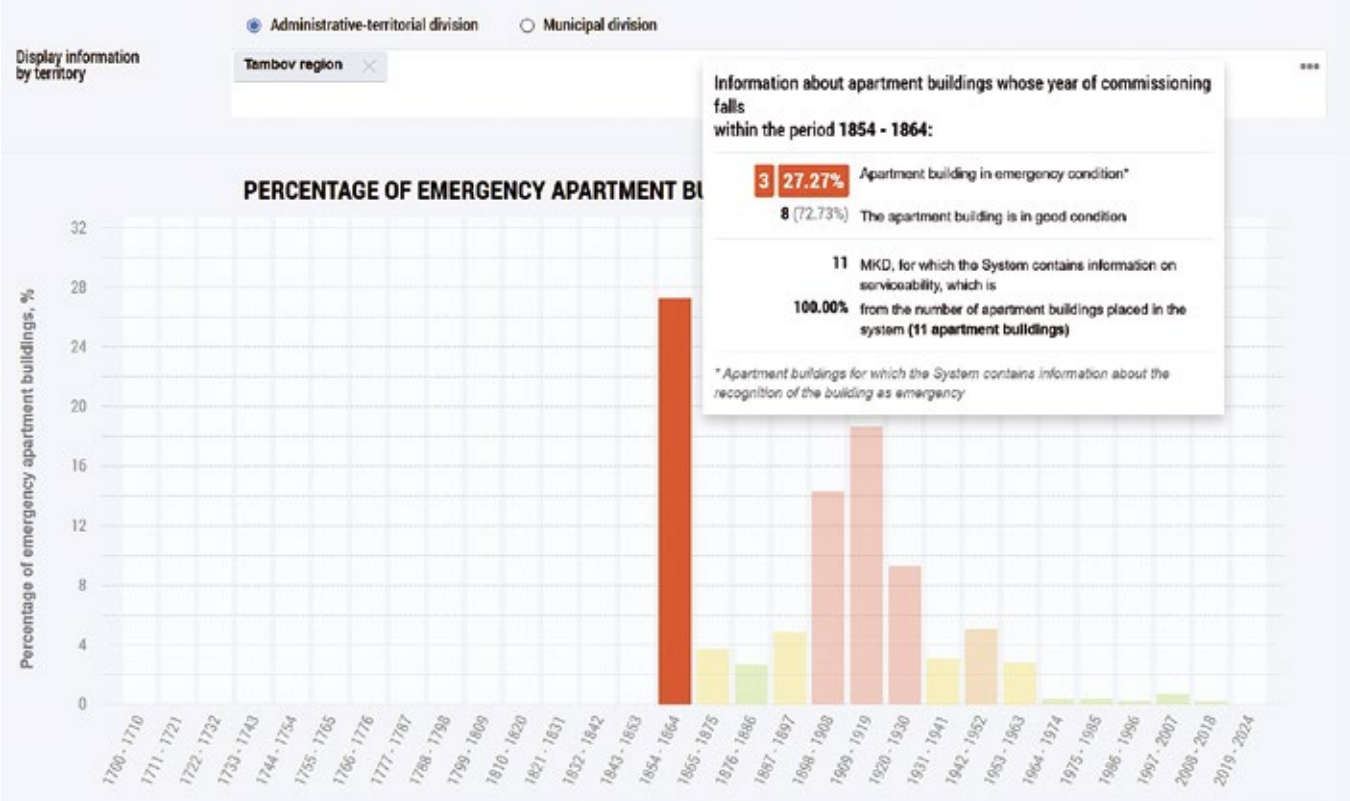


Fig. 4. GIS HCS: Percentage of MAB wear and tear by year of commissioning

This information indicates that with proper management of the MAB, regardless of the construction period and the percentage of wear and tear, the building can maintain its serviceability.

Thus, using this example, students can gain skills in analyzing real reliable information, moving from aggregated data to detailed data, use GIS HCS tools, and correctly interpret the results of the analysis.

One of the methods of analytical data processing is regression analysis and forecasting based on it. Problems of modelling [17, 18], regression analysis based on big data [19], and forecasting, including for the housing and utilities sector [20], are increasingly being developed. However, in the open part of the GIS HCS system, access to data, for example, of a dynamic nature, reflecting the dynamics of changes in indicators over time, is extremely limited, which makes it difficult to set tasks in this class for students using the system. The system also does not have the ability to export data from tables for subsequent work in third-party applications and programs. This also imposes the limitations noted in [14]. Taking into account such features of GIS HCS and wanting to give students the skills of regression analysis and forecasting based

on real data, we will use the information in the section "Bringing management organizations to administrative responsibility".

Problem statement 2: analysis of Trends in Administrative Accountability of Management Organizations Using GIS HCS Tools. It is necessary to use the GIS HCS tools, the section "Analytics and reports", "Bringing management organizations to administrative responsibility" to assess the trends in bringing management organizations to responsibility over the past three years, to conduct a regression analysis for various indicators, to assess the value of reliability and the ability to predict indicators.

To analyze information, you can use both aggregated data and detailed data for a specific federal district, for example, or more detailed data for territories in districts. GIS HCS analysis immediately provides a clear picture of the number of MAB management organizations brought to administrative responsibility in dynamics for the period from 2016 to 2024 (Fig. 6)

Let's analyze the aggregated data shown in Fig. 6. Changing the "Period of administrative responsibility" — one of the filtering parameters, we will collect numerical information for the years from 2016 to 2024 and enter it in the Excel table (Table).

Tambov region
— Bondarsky district

Address of the apartment building	State	Year of commissioning	Method of managing an apartment building	Organization carrying out activities for the management of apartment buildings
Tambov region, Bondarsky district, settlement 1st department of the state farm "Bondarsky", Sadovaya street, 6a	Emergency	2004	Direct control	—
Tambov region, Bondarsky district, Stroitelny settlement, Molodezhnaya street, 17	In good working order	1975	Direct control	—

Fig. 5. GIS HCS: Table of data on the state of MAB

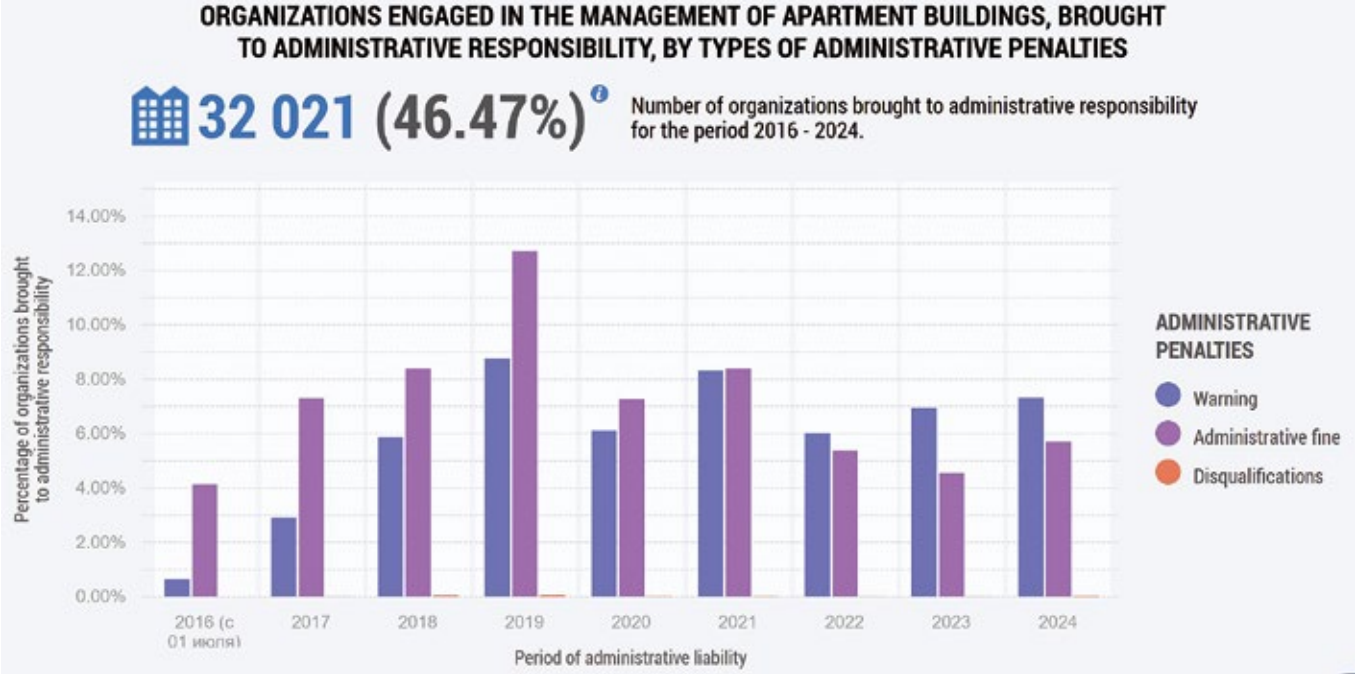


Fig. 6. GIS HCS: Organizations engaged in the management of MAB, brought to administrative responsibility, by types of administrative penalties

Organizations engaged in the management of MAB, brought to administrative responsibility, by types of administrative penalties and years

Year	Number of administrative penalty decisions	Number of managing organizations				
		Warning	Administrative fine	Disqualification	Total brought to re-sponsibility	Registered in the GIS HCS at the end of the year
2016	11.527	385	2.553	0	2.849	57.481
2017	19.063	1.712	4.413	–	5.722	58.000
2018	23.898	3.833	5.522	38	8.313	63.081
2019	49.685	5.975	8.851	49	13.043	66.834
2020	24.395	4.350	5.300	17	8.508	69.514
2021	40.441	6.236	6.452	17	10.684	73.007
2022	21.631	4.640	4.247	11	7.649	75.209
2023	20.999	5.114	3.406	9	7.209	72.024
2024	18.256	4.150	3.330	16	6.438	70.415

Numerical data show that over the past 3 years, there has been a downward trend in the number of management companies held accountable, while the number of registered organizations in the GIS HCS is slightly decreasing. We can assume that there are still better-quality, conscientious management organizations.

A graphical interpretation of the table data is shown in Fig. 7, where trend lines are added for individual indicators. When adding trend lines, we selected those mathematical dependencies for which the confidence value coefficient of determination (R^2) was the maximum. These are second-degree polynomials. An analysis of the approximation curves and the confidence value shows that it

is impossible to predict the indicator “Number of decisions on the appointment of an administrative penalty” for the future 2025 in this way, due to the small value $R^2 = 0.5505$, which is significantly less than 1.

The forecast for the indicator “Total sued” is more reliable, $R^2 = 0.785$, and suggests a slight decrease compared to the previous year. The forecast for the indicator “Registered in GIS Housing and communal services at the end of the year” (for 2024 at the current date of the year) is highly reliable, $R^2 = 0.9312$, and the forecast value will remain approximately at the same level as a year earlier.

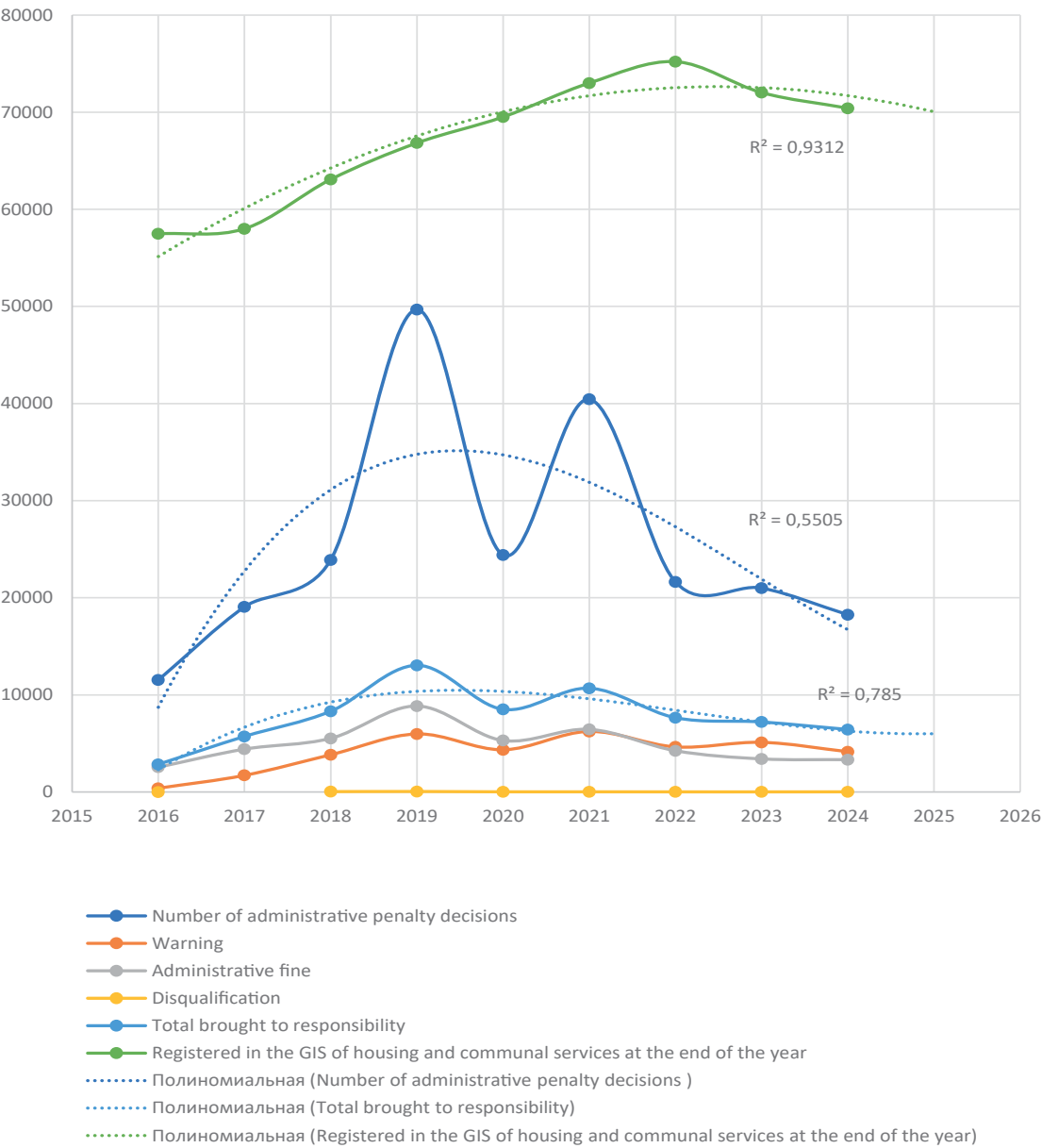


Fig. 7. Graphs of the dynamics of bringing MAB management organizations to administrative responsibility by type of responsibility

Thus, the open part of the GIS of housing and communal services allows you to solve real analytical problems and this opportunity can be used in the educational process when training future specialists.

CONCLUSION

These findings underscore the practical importance of integrating real-world data into educational processes to enhance the analytical capabilities of future professionals. The open part of GIS Housing and communal services, the section “Analytics and Reports”, has built-in tools for working with real data, the use of which for educational purposes allows students to set analysis tasks, test hypotheses, get results on a real database, and interpret the results obtained. The given examples of setting analytical tasks can be extended by other tasks proposed directly by the students

themselves. These findings underscore the practical importance of integrating real-world data into educational processes to enhance the analytical capabilities of future professionals.

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ГИС ЖКХ: аналитические возможности открытой части системы для образовательных целей

В статье рассматриваются и исследуются возможности использования открытой части информационной системы ГИС ЖКХ, раздела «Аналитика и отчеты» как источника больших достоверных данных и инструментов работы с ними. Применение таких данных и инструментов работы важно и актуально при подготовке будущих специалистов, формировании у них навыков аналитической работы с информацией. Целью исследования является возможность постановки и реализации аналитических задач для образовательных целей на базе реальных достоверных данных ГИС ЖКХ. В ходе исследования были изучены основные особенности системы и предложены постановки аналитических задач для учебных целей. Используются разделы системы «Техническое состояние многоквартирных домов» и «Привлечение управляющих организаций к административной ответственности». Одна из задач решается полностью с использованием встроенных инструментов платформы, другая — регрессионный анализ — с привлечением инструментальных средств табличного процессора. Встроенные инструменты открытой части системы ГИС ЖКХ «Аналитика и отчеты» позволяют сортировать данные, переходить от агрегированных данных к детализированным и обратно, дополняют графическими моделями табличные данные, что делает работу с информацией простой и понятной. Отсутствие возможности экспорта данных из системы затрудняет возможность использования сторонних приложений для последующей обработки данных. Решение такого класса аналитических задач позволяет обучающимся получить навыки постановки задачи, решения и интерпретации полученных результатов. Рассмотренные примеры аналитических задач могут быть расширены другими задачами, предложенными непосредственно самими обучающимися. Данное исследование имеет практическое значение при подготовке будущих специалистов в области экономики, менеджмента, управления недвижимостью и ЖКХ.

Ключевые слова: ГИС ЖКХ, аналитика данных, образовательные цели, информационная система, жилищно-коммунальное хозяйство

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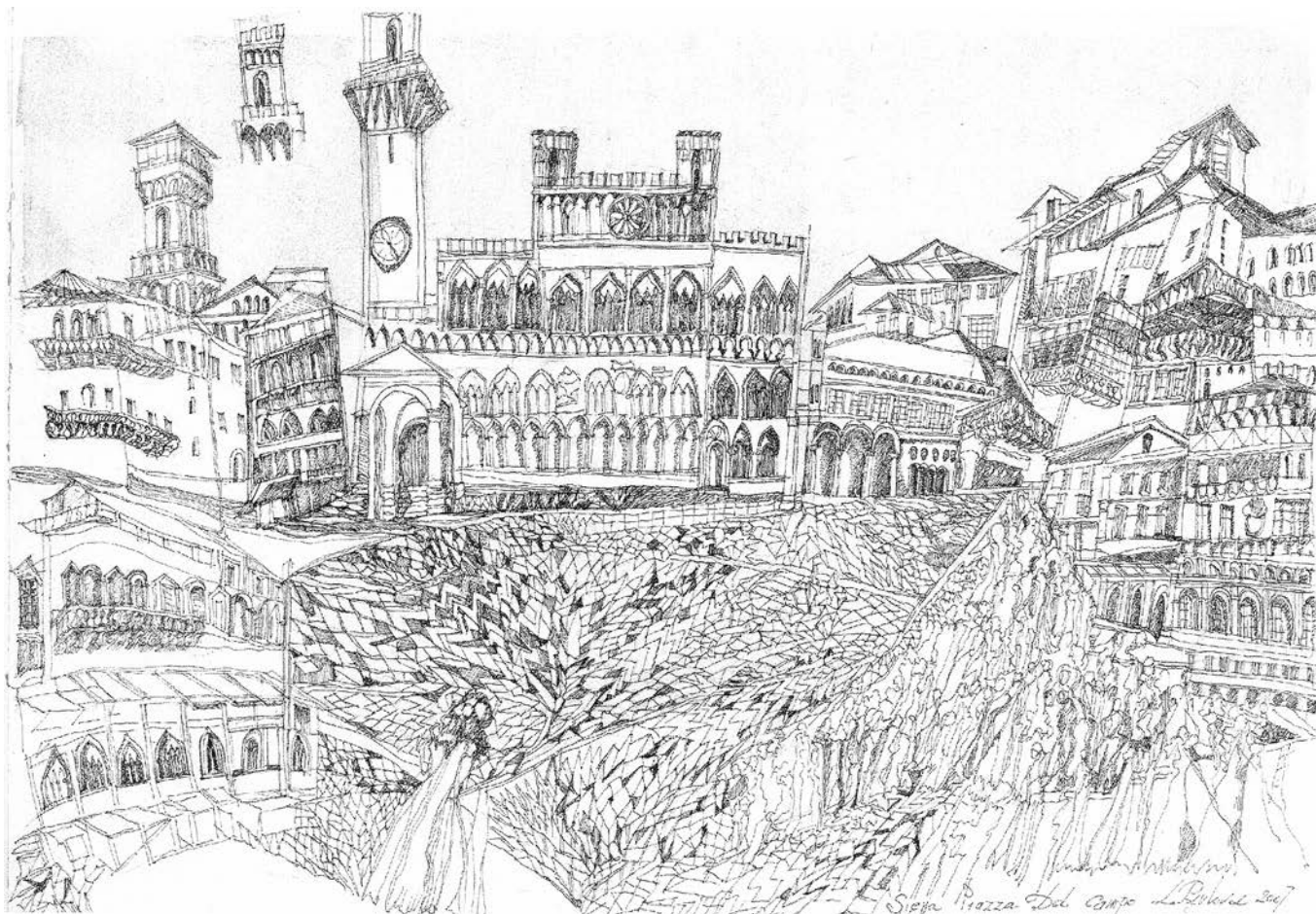
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