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Architectural, Construction, Environmental and Digital Technologies for Future Cities

Experience and Challenges from Russian Cities

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Preface

This book offers an overview of Russian and international experience in developing the concept of future cities and its practical implementation. The concept of future cities is associated with several important trends. The first trend is the sustainable development of the urban environment and the implementation of eco-friendly technologies and materials in civil construction and industrial and power plants. The harmonious coexistence of the citizens with all forms of nature in the urban habitat becomes a great value. The second trend is the individualization of the aesthetical and architectural image of the future cities. The city's unique flavor based on the blending of the historical legacy and architectural traditions is now as important as the utility of the environment. The third trend is the digitalization of the urban environment with the use of state-of-the-art sensors, information and communication technologies, and data science. The efficiency of operations and services achieved by the extensive use of complex IoT networks becomes a value as well. The last trend is the adaptation of the urban and social environment for individual demands of a community and a person. Individual comfort and safety are now more important than ever before. By addressing these trends, the volume discusses local and international plans, practices, and technologies aimed at the development and implementation of future cities.

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Contents

Application of the Experience of the "Exemplary Facades" of the XIX Century in Order to Harmonize Modern Cottage Buildings

E. Yu. Ageeva, A. A. Oskirko, and Yu. V. Abrosimova

Abstract The authors of the article consider methodological approaches to solving a complex set of problems of creating a full-fledged aesthetic environment that plays a significant role in the formation of a harmonious image of modern cottage development which is most often faceless and monotonous. The article also deals with improving the quality of the visual environment of new suburban settlements and villages. The novelty of the authors' approach is in understanding the process of forming the architectural space of modern cottage settlements as a system of an aesthetic, visual impact, the interaction of urban and rural ecological environment which also includes socio-economic influence. These factors form the physical space of the settlement in which the compositional solution of facades, fences and the preservation of the individual characteristics of buildings are essential. The development of a modern standard of facades for each newly designed rural cottage is solved by the authors on the basis of the classic experience. The authors resort to solutions from the Albums of facades applied for detached houses in 1809–1812. The use of decorative elements presented in the Album is able to provide a picturesque and variable solution of the facades of modern cottages.

Keywords Low-rise buildings · Architecture · Exemplary facades · Facade composition · Consumer qualities of the environment

1 Introduction

The development of standards for the formation of the visual environment of newly built cottage settlements is associated with solving a set of tasks in order to create its individual unique appearance. Apart from the fact that in Russian suburbs there are numerous monotonous cottage settlements with a large number of repetitive identical houses , the problem is aggravated by the absence of stylistic unity in all that huge

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mass of individual residential houses whose development has been going on for decades. In the total volume of housing stock in Russian regions, their share is up to 50%, including summer houses.

The suburbs of Nizhny Novgorod are no exception as the development of individual housing construction around the city was developed in an extremely peculiar way: the construction went chaotically depending on the time of obtaining a certain land plot for a cottage settlement. If in the cottage settlements built up by a large developer, one can observe monotonous solutions of individual residential buildings, townhouses with absolutely the same facades, then in the settlements where individual land plots are sold, negative compositional contrasts appear, often contradicting all the rules of architectural harmony. The huge volumes of construction of cottage settlements with standard residential buildings is becoming a disaster. Such buildings lack the imagery of facade compositions, the harmony of urban planning solutions, the visual range is scarce, there is no authenticity which is so important for people. It is natural that such settlements give the impression of a "ghetto".

The entire solution of the facades is carried out in a utilitarian way, the main thing being the accuracy of the external finishing of the facade that is considered to be quite sufficient. The current situation is such that since the houses are willingly bought, the developers do not intend to invest in harmony and beauty, and as a result, the architectural and spatial environment of the vast majority of suburban cottage settlements has been emasculated. Of course, the comfort of housing and the availability of infrastructure are of particular importance, yet, the aesthetic issues have been completely neglected.

Therefore, research and proposal of methods which can help improve facade solutions and which are based on architectural heritage are of great significance.

The object of research is modern suburban cottage development. The purpose of the research is the achievement of harmonization of modern suburban cottage development using the architectural-compositional experience of "exemplary facades" of the nineteenth century. The purpose involves solution of the following tasks: collection and analysis of documentary-photographic information of the suburban cottage development of the villages Krutaya and Cheremisskoye of Kstovsky district of the Nizhny Novgorod region. There is also conducting the survey among residents of the above mentioned settlements concerning the satisfaction level of the existing houses and the degree of preference for the style of proposed façade solutions. This includes formulation of proposals and recommendations concerning improvement of the visual environment of suburban cottage development of the villages Krutaya and Cheremisskoye of Kstovsky district of the Nizhny Novgorod region; development of the façade solutions catalogue for the suburban cottages on the basis of the "exemplary projects" of the nineteenth century.

Methodology of rehabilitation techniques of façade solutions of the existing suburban development on the basis of architectural heritage is closely linked to the problem of comfortable living environment.

This methodology is closely linked to the problem of comfortable living environment. Aesthetic visual degree of comfort is a major part of a person's daily life. The correlation of the main human psychological necessities and their daily spatial environment is disclosed in the scientific works of John R. Gold, Tommy Garling, Reginald G. Golledge and others. The realization of visual comfort factors is very essential for rethinking of design and improvement of Russian cities, towns, settlements from the point of view of the inhabitants’ needs.

The interdisciplinarity of this issue has determined a wide range of tasks that scientists research considering the analysis of the compositional solution and the use of various style decorative solutions for building facades. It finds reflection in the works of E. A. Ashchepkov, S. Ya. Zabello, A. N. Grech, A. L. Punin, N. F. Khomutetskiy, L. M. Lisovsky, E. H. Kirichenko, T. P. Kazhdan, E. A. Beletskaya, N. L. Krasheninnikova, I. V. Ern and others. The problem of the formation of the social field of suburban development, the issues of authenticity and reading of the architectural text were disclosed only in a few works of modern scientists (V. L. Glazychev, Z. I. Pastukhova, etc.), and in practice these issues in relation to suburban individual development have not been studied thoroughly enough.

The methodology for studying textual artifacts of culture, architecture and art is also represented in the works of philosophers: these are K. Levi-Strauss, R. Barth, M. Heidegger, J. Habermas, in the domestic scientific research—G. G. Shpet, A. F. Losev, Yu. M. Lotman, yet, there are practically no approaches to real application of these results in architectural environment of suburban cottage development. The general principles of the environmental approach, aesthetics are studied by Yu. B. Borev, L. A. Zelenov, T. V. Karakova, etc., the analysis of the natural and visual ecology of the urban environment is also widely represented in scientific works of D. Gibson, L. Ronchi, V. A. Filin, etc. However, there are no concrete proposals, solid theoretical background concerning using architectural heritage in modern suburban cottage development even in these scientific works.

2 Methods and Materials

The research of visual environment was conducted on the basis of the structural-semiotic approach, methodology of rehabilitation techniques of façade solutions based on architectural heritage. The authors also resorted to the morphological analysis of buildings and graphic-analytical method of systematization of the material. A survey was conducted and its results were systematized.

The field studies were conducted with the help of visual analysis, photographing of architectural objects, aerial photography.

The following software products were used for the data processing: ArchiCAD and Revit (for BIM modelling of objects), Microsoft Excel, Filemaker Pro (for the data processing of the questionnaire and polls).

3 Theory

Using the methodology of rehabilitation techniques of facade solutions based on architectural heritage, the authors pay special attention to the exterior of the buildings constituting the suburban development.

The authors of this article consider modern approaches to the picturesque solution of the facade composition of a residential building and underline that they reveal the material essence of the structure by artistic means, by the presence of artistic expressiveness. To achieve artistic expressiveness the architect uses the whole range of compositional means—tectonics, proportions, scale, rhythm, proportionality, light, color, and the very texture of the material which is underlined by the historian of architecture, V. I. Pilyavsky [1, p. 8]. Through the use of these tools, the architect creates an image. The entire structure of the material organization and the applied artistic means create the architectural image of an individual dwelling house.

The structure of a residential building is formed by window openings, balconies, bay windows, terraces, entrance groups and other elements and details, which are considered in detail in the encyclopedia of Anthony White and Bruce Robertson [2]. All of them are of a typological nature and are the basis for the formation of an architectural image. The artistic task of achieving expressiveness, creating a harmonious image of a residential building is solved on this initial basis namely. At the same time, a residential building, having all the typological features, will look ugly, monotonous, if the aesthetic problem is not solved. And in the matter of solving an architectural image, one can turn to the experience of the past. In our opinion, the harmonious residential development of the era of classicism in Russia serves as an excellent example for modern architects, which is convincingly proved by the authors of the book "Exemplary residential projects of Russian cities of the XVIII–XIX centuries" [3].

Classicistic compositions, decorative elements of the solution of facades are distinguished by sculpturality, regularity, symmetry. "In a shaky and changing material world," writes Professor V. Vlasov, "this can give a feeling of stability and self-confidence. Following a small set of rules, tested techniques, the canon of proportions, a small number of typical details, elements, you can achieve a simple and clear harmony" [4, V. 3, p. 661]. The architecture of classicism combined the functional, constructive and artistic aspects in the composition of the order system. Subsequently, it was the order elements that formed the basis for the development of "exemplary facades" for residential buildings in Russian cities of the eighteenth-nineteenth centuries. These are various types of rustication, horizontal belts, cornices, decoration of window openings, the use of pilasters, pediments [5].

The analysis showed that the use of the simplest decorative elements of the "exemplary facades" of the nineteenth century gives a completely different impression to a residential building, creates the sought-after imagery that was lost in the stormy stream of inexpensive mass development. And already in the Albums of "exemplary facades" [6] we observe the evolution of the treatment of order elements of the decoration of facades, we see that order decorative elements, which in the past used to be an obligatory element of the building structure become just a decor, a detail of the decoration of the facade. It enables us today to use them creatively realizing at the same time that decorative elements of facades in the classical style are perceived now in a different way, differ from the strict order systems of the past. And new technologies and modern building materials make it possible to build residential dwellings of any proportions with various decorations quickly, with minimum labour intensity and financial investment.

Today, in the mass development of cottage settlements in Russia, there are no aesthetic criteria, no one evaluates the visual impression of the resulting development of the territory; only the owners using the means available to them try to give individuality to the appearance of the house. As a result, we get a low aesthetic quality building of suburban settlements.

As one of the ways to solve this problem, the authors propose that architects should use the experience of “exemplary facades” of the nineteenth century. The range of solutions for the entire variety of design problems of a modern cottage can be expanded by use of order elements and order compositions. Even the minimum use of order details and elements gives the building harmony, orderliness, imagery [7]. The issue of using the elements of the order system is similar to referring to the archetype. The socio-cultural structure of an architectural form is the embodiment of the spiritual aspects of human community [8]. Like any technology, the architectural form and image are built on a unified and normative elementary basis, and the system of using the heritage of “exemplary facades” presents such opportunity.

This principle of following the pattern always existed in folk architecture, and was fundamental in provincial architecture. However, the main sign of the vitality of construction based on patterns was characterized by the absence of a mere reproduction of a pattern or its mechanical replica; the canon and pattern only served as a support and stimulus for creativity. One of the basic fundamentals of classicism is imitation of the graceful, and imitation, the desire to build on the pattern is one of the features of provincial architecture. The appeal to proportions, classical forms and samples at the same time was of a creative nature. The classical techniques used in the scheme acquired an individual and peculiar interpretation, determined both by the skill of the builders and by the natural environment and regional characteristics [9]. All this gives us the right to use the heritage of “exemplary facades” artistically, creating certain variations on the theme of classicism, and most importantly, giving harmony and imagery to the same residential individual houses. It is especially significant because a common feature to all variants of the developed “model projects” has always been the limited use of decorative details and use of the same finishing materials for the walls of the main facade.

4 Results and Discussion

4.1 Justification or Prehistory

The scientific initiative group of NNGASU, created in June 2020, proposed a variable design for decorating the existing facades of the new cottage development in the Kstovsky district of the Nizhny Novgorod region, the villages of Krutaya, Cheremisskoye. The developer Ltd Zhilishchny Otvet has built more than 1500 identical residential 2-storey individual houses in these territories. The author of the concept is E. Yu. Ageeva, Doctor of Philosophy, Professor of the Department of Architecture at NNGASU. The proposed developments were included in the draft of the developed program document “Strategy for improving the visual environment of modern cottage settlements”.

The main goal of the variable designs for decorating existing facades is to improve the functional and aesthetic qualities of the aforementioned settlements, rational use of material resources, availability and low labor intensity of the proposed solutions. The proposed options for decorating existing facades imply obtaining the maximum socio-cultural effect which improves the quality of construction thanks to the decorative elements of “exemplary facades”, each building acquires individuality and originality. At the same time, all facades of cottage settlements will be solved in a single style, as a result the dissonance of the homogeneity of the visual fields of residential buildings disappears, and we can observe the desired figurativeness which is typical of the artistic direction, focused on the ideals of the ancient classics. The approach proposed by the authors allows not only to create a harmonious, investment-attractive building of rapidly growing cottage settlements, but to solve the problem of authenticity, self-identification of a person through the creation of an individual unique appearance of his home. The significance of the given approach is undoubtful because the development of harmonious visual environment creates preconditions for the residents’ mental and physical comfort, influences their behavior, stimulates the development of the personality and consequently affects the social welfare of the family and the social comfort of the locality. Nowadays we can even meet the notion urban village which can characterize suburban cottage settlements [10–12]. In the Moscow region alone, there are now 1740 villages of different segments and formats. There are 112 cottage settlements in the Nizhny Novgorod region.

For the city of Nizhny Novgorod, the Nizhny Novgorod region, the problem of improving the aesthetic properties of individual residential buildings is more important than ever.

4.2 *Experiment*

The result of this work is a catalog of proposed facade solutions based on the existing development of the village of Krutaya, Cheremisskoe, including 32 options. The analysis of the existing buildings of the village Cheremisskoye (in the following streets: Yuzhnaya 1, Yuzhnaya 2, Yazhnaya 3, Zelenogorskaya) was conducted. The authors clearly show the current state of the development, which concerns more than one thousand five hundred identical residential homes (Figs. 1 and 2).

The album presents 32 developed variants of various levels of complexity: ranging from the minimal use of decorative order details to full adherence to the order architecture.

The survey among the homeowners (the village Cheremisskoye) was conducted on the basis of the results of the research. 67 respondents participated in the survey.

Fig. 1 Residential development of the village Cheremisskoye (Kstovsky district of Nizhegorodsky region), 2020. The photo is taken by the authors

Fig. 2 The main facade of the house in the village Cheremisskoye (Kstovsky district of Nizhegorodsky region), 2021. The photo is taken by the authors with permission of the homeowner

They were offered a developed author's album with 32 variants of the facade solutions based on the architectural order heritage of the "exemplary facades" of the XIX century. According to the results of the survey the overwhelming majority (87% or 57 respondents) expressed the wish to choose the facades from the offered album with the variants. A part of the respondents (10% or 7 people) would like to see the facade solution in the high tech style or "in a modern style". The rest of the respondents (3% or 2 people) did not consider it necessary to improve the exterior of their home.

4.3 Final Results

The obtained options for decorating the facades of residential buildings, even with a minimum of decorative elements of "exemplary facades", acquire a different quality (Figs. 3, 4, 5 and 6). According to this catalog, the owner of a residential building can choose the facade solutions that he likes, suitable in terms of the volume of investments. And even options that require minimum investment will create the necessary harmony of the building. Even the variants requiring minimal investment will attach the necessary individuality and attractiveness to the main facade of the house (Fig. 7).

The urban planning task—creation of the ensemble in already existing development—was also taking into consideration. Despite the diversity of facade compositions, the use of order elements creates a unified visual field. Sticking to a set of rules, using even a small list of typical elements of the exemplary facades we receive a multifunctional solution of the task. It leads to a maximum improvement of the

Fig. 3 Variant 1 of the residential facade in the village Cheremisskoye Kstovsky district Nizhegorodsky region with a décor from the album of exemplary facades

Fig. 4 Variant 2 of the residential facade in the village Cheremisskoye Kstovsky district Nizhegorodsky region with a décor from the album of exemplary facades

Fig. 5 Variant 3 of the residential facade in the village Cheremisskoye Kstovsky district Nizhegorodsky region with a décor from the album of exemplary facades

visual environment of the suburban settlements, increasing investment attractiveness. A good-looking dwelling infuses a sense of pride and contributes to a positive attitude of the residents to their neighborhood and the main thing, according to Tommy Gerling, is forming a positive attitude of residents to their place of living [13].

Fig. 6 Variant 4 of the residential facade in the village Cheremisskoye Kstovsky district Nizhegorodsky region with a décor from the album of exemplary facades

Fig. 7 Variant 5 of the residential facade in the village Cheremisskoye Kstovsky district Nizhegorodsky region with a décor from the album of exemplary facades

4.4 Discussion

Shaping the unique look of the street, creating a variety of facade solutions in a single style, the legacy of "exemplary facades" will also increase investment attractiveness. Apart from it the improvement of public areas or as architects call it design environment is of great importance as well [14]. These are sidewalks, squares, recreation areas, small architectural forms. Thus, starting with the improvement of the visual compositional characteristics of the facades, work is underway to improve the comfort of the living environment in villages, townships, settlements [15]. This is an urgent problem of creating a comfortable environment with elements of urban improvement for rural residents, which constitute 26% of the total population of the country.

Minor architectural forms influence shaping of the visual environment of a city, suburb, any residential area. Architects continue their work on the design of fencing, gates, street lighting understanding the significance of these elements in forming a comfortable environment. The importance of the emphasis of originality, uniqueness, authenticity of living environment elements was underlined by the researcher of American towns and suburbs, Jane Jacobs [16]. Even minor architectural forms give an opportunity of using elements of classical proportions and lineament.

The spatial environment of urban and rural areas is a visual environment which is constantly perceived by a person. It influences mental well-being of the inhabitants. It should be born in mind that the most significant parameters of comfort in any environment, urban, suburban or rural, according to the doctor of architecture T. V. Karakova, are “diversity of architectural objects. They constitute a harmonious ensemble; a consumer value of the environment, convenient transport and pedestrian infrastructure, availability of objects of developed service network, a wide range of these services, a high level of improvement of the territory—paving, landscaping, watering, a variety of style and colour environment” [15]. Comfort of the visual environment defines by and large the level and quality of a human’s life.

5 Conclusion

The most important task of our time is the formation of a high standard for the quality of the visual environment for each settlement in our country. The architect must take care of the emotional impact of space and volumetric form, which through perception affect a person. The development of a catalog of facade solutions based on “exemplary projects” of the nineteenth century can become the basis for the formation of an attractive, authentic image of a settlement, village and its socio-cultural space.

The original result of this research is the catalogue of proposed façade solutions on the basis of the existing construction development of the villages Krutaya, Cheremisskoye which includes 32 variants. All the variants are based on use of decorative elements of “exemplary facades” of the nineteenth century. The survey conducted among the inhabitants of the above-mentioned settlements revealed that 87% of the people would like to see the proposed classic decoration on the facades of their houses. In the catalogue the authors also proposed drawings of fences and gates, architecturally and compositionally adapted to the style features of the proposed façade solutions.

All the proposed developments were included in the project of the programme “The strategy of visual environment improvement of modern suburban cottage settlements of the Nizhny Novgorod region” developed by the authors.

The predicted results of the implementation of this approach are the improvement of the cottage settlement residents' consumer qualities. It leads to the improvement of the population's quality of life, the formation of a decent aesthetic appearance of the residential area as a place where people's daily life takes place and an increase in the investment attractiveness of such cottage settlements.

Suburban settlements are growing very rapidly now. It is caused by a special rural mortgage with a preferential rate not higher than three percent. More than four billion rubles are allocated to realize this project. Consequently, there is, unfortunately, a high probability that a number of faceless, stereotyped houses will grow. In this connection it is necessary to introduce a visual aesthetic control for such development. One of the solutions of the problem, real in terms of finance and implementation, is use of the classic order décor.

The importance of comfortable visual environment is hard to overestimate. The visual harmonious environment of a city, a suburb, a settlement, a village forms a person's attachment to their place of residence, a sense of satisfaction with life. These feelings, undoubtedly, are difficult to measure as there is a great deal of subjectivity here. Nevertheless, the classical heritage whose harmony of proportions and recognizability of elements have been tested by centuries. Only in this way we can avoid a painful visual impression of a ghetto and gain a positive attitude of a person to their home, village or city which promotes a social stability in the long run.

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Regenerating the Environment of a Small Historic Town Applying the Principles of Identity

L. V. Anisimova and Y. V. Anisimov

Abstract Dynamics of development of a small historic town ensures sustainability and efficiency of its environment. However evolution of the urban environment presupposes preservation of the identity and the uniqueness of a settlement, which are the brand, the object of investment and tourist attraction. The research is aimed at finding an innovative methodology for regeneration of historical environment and at the development of its cultural, tourist and economic potential. A method is proposed for a quantitative and qualitative assessment of the territory, which allows one to identify the zones of the greatest concentration of objects of historical and cultural heritage, traditional authentic buildings, which preserved the historic landscape, which will be attractive for tourists and residents of the town. The town's zones are places where the main volume of investments can be sent to, where it is necessary to develop craft traditions and unique production, creating competitiveness and sustainable image of the town. The use of an innovative methodology for identifying the resources of the historical and cultural potential of the town and determining the boundaries of the zone of tourist attractiveness will effectively regenerate the environment.

Keywords Small historic town · Evolution of the urban environment · Identity · Brand · Tourist attraction · Sustainable image · Tourist attraction area

1 Introduction

Small historical towns and settlements, which make up 50% of all the historical settlements in Russia have significant potential for tourism development. Being the bearers of an authentic culture they reveal richness of cultural and historical character of the country. However, the outflow of the population, the lack of jobs and underdeveloped infrastructure slow down the dynamics of the development of small

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towns. The urgency of solving the problems of shrinking towns was discussed at the All-Russian Forum "Development of small towns and historic settlements" in October 23–24, 2019 [1]. It was mentioned that natural and recreational potential of small towns, national and cultural diversity of Russian territories as well as state support for the tourist industry create favorable prerequisites and conditions for the sustainable development of small towns. Inbound and domestic tourism in Russia is among the most important sectors of the economy and accelerator of social and economic development of small Russian towns.

A significant number of studies of the historical urban environment are focused on the issues of drawing up historical and architectural reference plans, the boundaries of protection of the cultural heritage areas and urban planning regulations that provide professional assessment of the quality of the preserved environment [2, 3]. These studies are focused on determining the status of the architectural structure and planning permission requirements for the new construction within the boundaries of the heritage protection area. The research methods are focused on the assessment of the existing state of urban environment in general. At the same time, a lot of limitations caused by the requirements to preserve the valuable historical and cultural heritage, hinder the introduction of technical and technological innovations, providing the modern level of comfort and service and, accordingly, the tourist attractiveness of the place. The other group of research [4–7] is aimed to study the processes of regeneration of the historical urban environment. The understanding of the urban environment first of all as human perception of spatial and temporal structures is outlined by K. Lynch in his book "City Image" [7, 8]. Research that continues to study the image of the city based on social media analysis has shown that the frequency of mentions on Instagram is associated with an architectural and tourist attraction, and the analysis of the location mentions on Twitter is more to do with its daily relevance [9].

E. A. Akhmedova and T. F. Volkova note that slowing down the active processes of regeneration of the environment is caused by the lack of a well-developed urban regeneration strategy. T. V. Babylonskaya offered a methodology for urban environment regeneration, based on the three main approaches: symbiotic, vector and multi-level. Taken together they make it possible to study the historical environment comprehensively [5].

The works of D. Jacobs and W. White are devoted to the methods for preserving the identity of a city architectural environment. In the 60s of the twentieth century they proposed "Placemaking" methodology (Places in The Making) which enabled to take into account the opinions of the communities in the development of regeneration projects and, accordingly, their participation in the process of city development [10, 11].

The works of M. V. Nashchokina are devoted to the study of the issues of preserving the architectural heritage and creating tourist attractiveness of small historical towns. In the works it is rightly noted that preservation of physical parameters of the buildings "is just impossible without the residents being interested in it, as well as without at least partial preservation of their lifestyle" [12].

The unique combination of the historical landscape and traditional buildings constructed by hands give a special value to such complex, forming an urban "branding". Creating a brand of the urban environment depends on the way the city is perceived from the outside and the way the residents themselves see it [13, 14]. Of interest are research methods associated with revealing the criteria of place identity [15, 16]. Based on the data of these studies, the authors developed methodology for assessing the fragments of environment of a historical town in which symbols of the identity of the place are preserved. The purpose of this study is the approbation of a comprehensive methodology for quantitative and high-quality assessment of the historical environment. The objectives of the study are: to identify the zones of the greatest concentration of objects of the historic urban environment and the preserved historical landscape requiring regeneration; determination of remarkable places for citizens and tourists; the boundaries of the tourist attractive zone for the most effective investment.

2 Materials and Methods

The article is devoted to the presentation of the methodology for the quantitative and qualitative assessment of fragments of the environment of a small town, which has retained the features of the identity and the uniqueness of the place. The fragments of the environment define the boundaries of the investment-attractive area, highlighting the uniqueness of the place where objects of tourist infrastructure and services can be concentrated. Let's denote the fragment as TAA (Tourist Attraction Area). The scientific novelty of the research is in a systematic approach to the problem of site analysis. The urban environment is seen as an adaptive system capable of developing with maintaining its identity. The methodology has been tested and reported at conferences of different levels, by the examples of several small historical towns of Vologda Oblast being in the list of "Small Towns and Historical Settlements of Russia" as unique objects of history and culture. According to the Order of the Ministry of Culture of the Russian Federation and the Ministry of Regional Affairs of the Russian Federation dated July 29, 2010 No. 418/339 [17] forty-one settlement received the status of a historical settlement of federal significance, since they suffered least of all from later rebuildings and reconstructions thus preserved the historical landscape unchanged. Among them are such settlements as Belozersk, Totma, Veliky Ustyug. The purpose of the research is to determine the features of the identity of each of them for the further development of the cluster organization of tourist services.

Belozersk is a small town founded in 862. In 2020 its population was 8580. The town is located on the bank of Lake Beloye, which is a part of the Mariinsky Water System. It has numerous canals and canal locks of the nineteenth century. The town has cultural heritage sites of both federal and regional significance. Among them is a fortification rampart surrounding Belozersk ancient settlement, located in the center of the town. The most valuable buildings include cathedrals, churches and merchant houses.

Totma town was founded in 1137. In 2020 its population was 9784. The town is located on the steep bank of the Sukhona River, which flows through the Northern Dvina into the White Sea. The most valuable historical buildings of the town are: the Spaso-Sumorin Monastery, many cathedrals and merchant houses. The landscape of the Sukhona river embankment is unique.

Veliky Ustyug was founded in 1147. The town is located on the left bank of the Sukhona in its confluence with the Yug River. The most valuable historical buildings are the former Archangel Michael Monastery, founded in 1212, the Cathedral Square and numerous merchant houses.

In 1977 in order to determine the size of the fragments of a town or city having certain specific features, Pierre Merlin developed a quantitative method of study. He describes the study carried out at the University of North Carolina to determine the size of the urban conurbation in Greensboro (1960). For the assessment of the state of territory a point-based system is used. It is based on the arithmetic calculations, dividing the territory into fragments of equal size and entering 15 variables [18]. To determine the variables important in the search for symbols of town identity, the authors applied the research method by R. Bruce Hull, Mark Lamb, and others. In the course of sociological surveys of the residents of Charleston, SC (USA), who suffered from hurricane Hugo in 1989. The researchers identified the special significance features of the uniqueness of the city before the tragedy [15].

The diversity of the urban environment and a large number of historical strata, among which not all the buildings are of historical and cultural value, create conditions for the conflict of interests between property developers and the bodies protecting the cultural heritage. Preservation of objects of historical and cultural significance is prescribed by law. However in a town there are buildings that reflect the identity of the place and possess distinctive character without being under the protected status. In the process of urban environment regeneration in the excitement of renewal the traditional manor buildings having a low density coefficient are replaced by a new, standard disharmonious housing and inexpressive environment. All that result in the loss of the uniqueness. Our methodology is developed to identify the areas of a town that retained their originality and uniqueness hence are investment attractive. The renovation of the environment should foresee re-equipment of old buildings and their adaptation for tourist purposes.

2.1 Methodology for the Quantitative Assessment of Tourist-Attractive Areas of a Town

Based on the above mentioned methods our methodology combines quantitative criteria for assessing the boundaries of the TAA territory and qualitative criteria articulated by the users as the values of special significance. The quantitative indicators of TAA boundaries are based on land price and density of built-up site. The street and road network is being assessed by the presence of various categories of roads and the level of their improvement. Historical buildings are assessed according to the presence of the objects of historical and cultural significance, their density and the presence of historic environmental buildings. The service sector is being assessed by the density of hotels, restaurants, cafes, shops.

Let us consider obtaining analytical data by the example of Belozersk (Fig. 1). The urban fabric was divided into a grid with the size unit of 300 × 300 m, corresponding to the average value of the four historical quarters.

Each unit was assigned a number from zero to three, depending on the indicators of density of objects or on the land price. The land cadastral valuation identified the most relevant for investments areas of the town, which currently are not high priced. Due to the restrictions on new construction, the areas in the central part of the town where historical and cultural heritage objects are concentrated, are not provided with engineering networks, thus have a low cadastral value (Fig. 1a). The transport and pedestrian infrastructure study identified the density of the road network and the most actively connected pedestrian areas. Pedestrian activity is an indicator not only of the level of amenity, but also of the concentration of the basic services that are popular with residents (Fig. 1b, c). This is confirmed by the analysis chart 1e, which indicates the location of the main services—shops, social facilities, hotels, pharmacies, museums, educational establishments and functional churches (Fig. 1e). The level of density of the objects of historical and cultural significance and the preserved historic environmental buildings enabled us to estimate the resource potential of place of interest (Fig. 1d). Concentration of service sectors in the certain areas of the town showed an excessive number or, on the contrary, lack of certain facilities in the town (Fig. 1e). The data were summarized and plotted on the town plan. Thus, an integrated chart which indicates the TAA boundaries of Belozersk was formed. It included the area assessed 12–14 points in the central part of the town, the location of which covers the area of the highest concentration of the preserved places of interest and historic environmental buildings. Holidays and festivals are held in this area. Here are the main town streets and landscaped pedestrian areas. Areas assessed 8–9 points are adjacent to the busy town streets, embankment and the canal. Areas assessed 5–7 points are of latent potential since they are surrounded by areas assessed 8–9 points.

It should be mentioned that not all of the studied cities have the same compact TAA as Belozersk. For example, Totma and Veliky Ustyug are characterized by location of TAA objects far from the walking distance, namely the remoteness of Spaso-Sumorin Monastery in Totma and the Votchina (Residence) of Ded Moroz in Veliky Ustyug (Fig. 2).

As a result of the large number of losses of historical environment elements in the central part of Totma, the tourist-attractive area has acquired a rather loose character. Sugar refinery of I. A. Kholodilov, merchant of the First Guild, was completely demolished. The building was dated 1815 and located in block 36, within the limits of contemporary Lenina, Trudovaya, Sovetskaya and Gushchina streets. The blacksmith

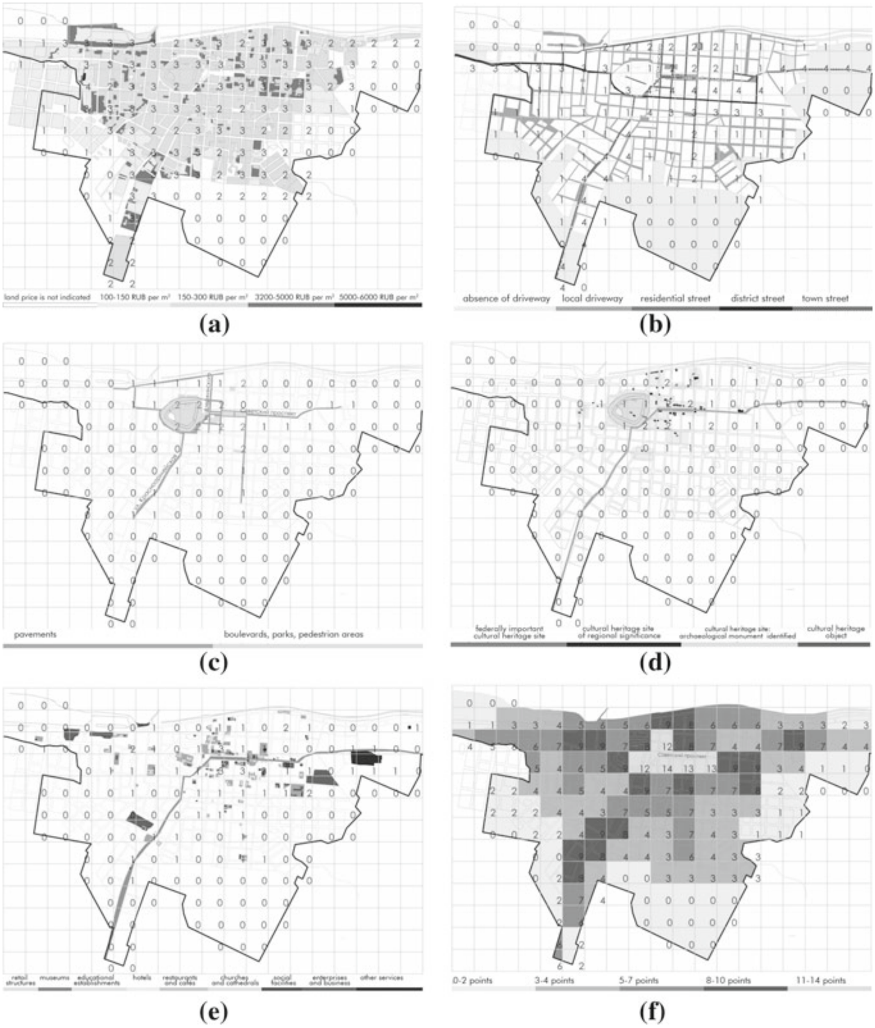

Fig. 1 Quantitative analysis of the planning structure of the town of Belozersk (Vologda Oblast). **a** Land price in rubles per 1 m^2, **b** transport infrastructure, **c** pedestrian infrastructure, **d** location of objects of historical and cultural significance, **e** location of service sector, **f** integrated chart which indicates the boundaries of the TAA. *Source* Compiled by the authors and Podsosennaya D. V

shop, located at the inflow of the Rozhdestvensky stream into the Pesya Denga river, was also lost. The salt evaporating pans were forged long time ago. The famous Totma saltworks, located at the northern boundary of the town, wharf area and the embankment as well as numerous merchants' houses, churches and cathedrals (Fig. 2e) are also being lost. In small towns the indicator of compactness of TAA is of particular importance. The connectedness of the historical environment without inclusion of modern developments increases the level of uniqueness and the identity of the town.

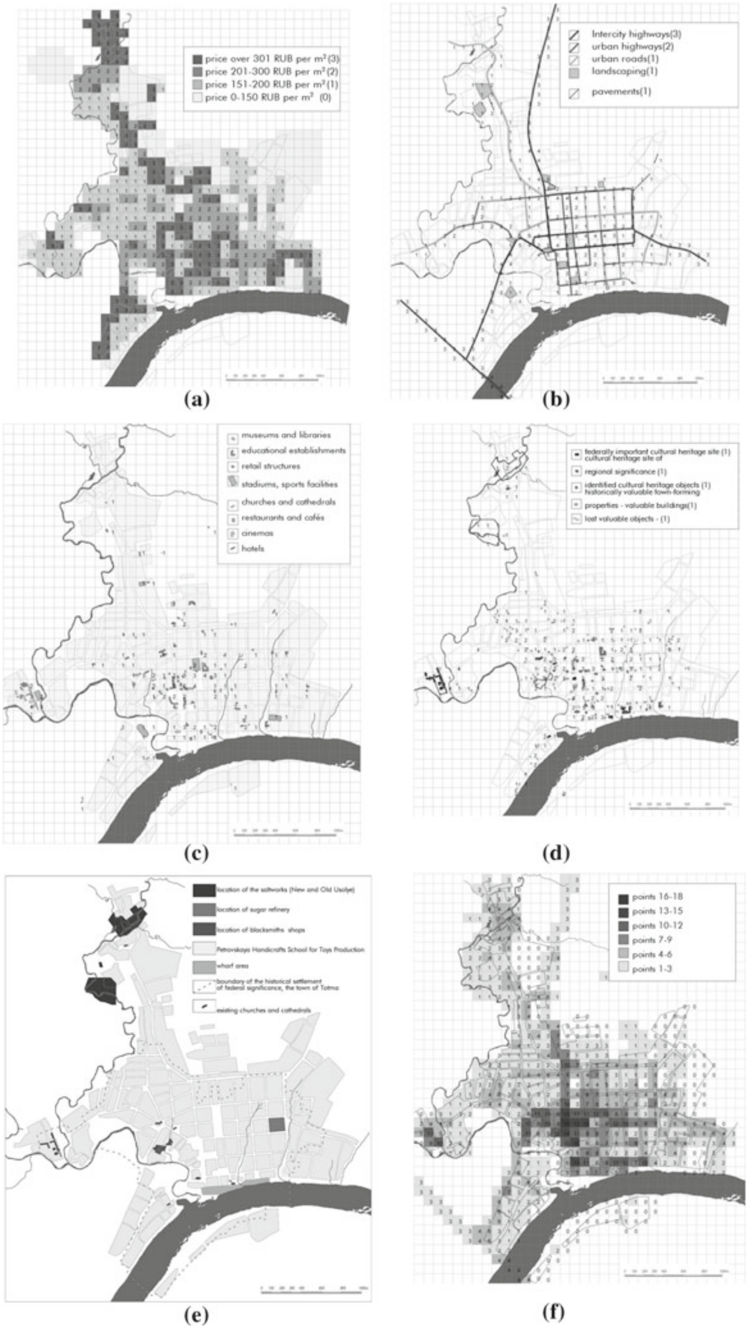

Fig. 2 Quantitative analysis of the planning structure of the town of Totma (Vologda Oblast). **a** Land price in rubles per 1 m^2, **b** transport infrastructure, **c** location of the service sector, **d** location of objects of historical and cultural significance, **e** buildings lost during the Soviet period, **f** integrated chart which indicates the boundaries of the TAA. *Source* Compiled by the authors and Al'tapova A. V

Walking tours for tourists are designed taking into account physical abilities of an average tourist, and the presence of remote places of interest requires overlapping some services and arraigning bus and walking tours. The shape of the TAA spot influences the length and the density of tourist routes and, accordingly, the development of the environment along them.

2.2 Methodology for the Qualitative Assessment of Tourist-Attractive Areas of a Town

Town identity analysis is based on mental mapping method and sociological survey of different categories of target respondents. To define the symbols of town identity based on mental mapping the respondents were asked to answer the following question by drawing a sketch: “What places of interest would you like to show your guests who visit your town for the first time?”. The survey was conducted in the three different age and social groups. The total number of respondents amounted to 376 people. The first group consisted of experts (27 specialists), working in the sphere of hospitality and tourism, the second group (297 persons) consisted of the most active town residents and the in the third group (52 persons) were teenagers and children. Work with experts was carried out by interviewing. A survey of residents of the city and adolescents took place by mental mapping. The Mental cards on which respondents themselves depicted attractions were drawn up within the TAA boundaries. Card processing took place on the principle of repeatability of the most frequently mentioned attractions. Figure 3 demonstrates the processed survey results of the second and third group of the respondents. Teenagers and children most often mentioned Belozersk fortification rampart, the cathedrals surrounded by it and the bank of Lake Beloye (Fig. 3a). The opinion of the most active adult residents of Belozersk (83 persons) coincided with that of the teenagers and children, however their assessment was much more detailed (Fig. 3b). In their opinion the most attractive places of the town are: Belozersk fortification rampart—according to the opinion of

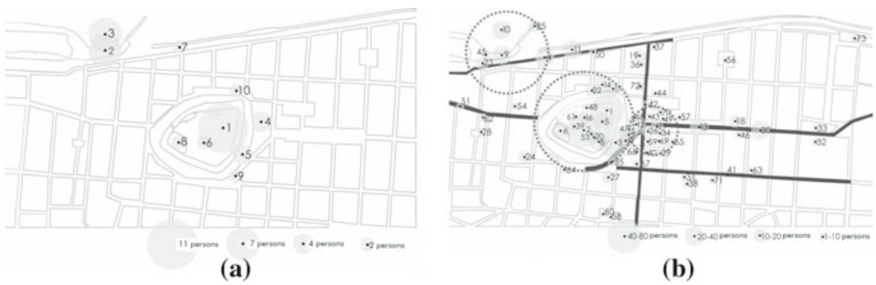

Fig. 3 Results of the mental mapping of Belozersk town centre: **a** results of the mental maps of group 3 (teenagers and children), **b** results of the mental maps of group 2 (the most active residents of Belozersk). *Source* Compiled by the authors and Podsosennaya D. V

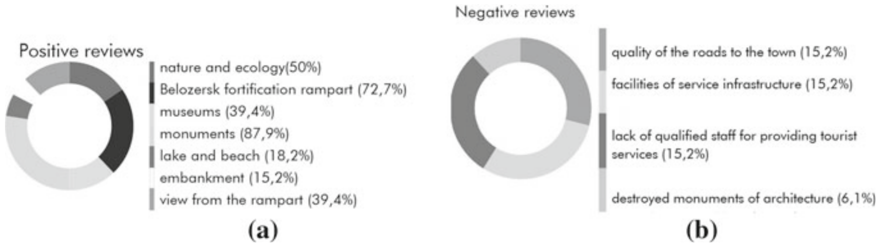

Fig. 4 Elements of the urban environment that form the identity of Belozersk. **a** Elements of the environment forming the identity of the town, **b** elements of the environment negatively affecting tourist attractiveness. *Source* Compiled by the authors and Podsosennaya D. V

91.1% of the respondents, the Transfiguration Cathedral—72.1% of the respondents, bridge across the defensive ditch—58.2%. Embankment of Lake Beloye—49.4%, historic building of the college—44.3%, ponds within the fortification rampart—43%, small form Boat—39.2%, Russian log house museum—32.9%, beach on the lake—31.6%, and Lake Beloye—31.6%.

After correlating these data with the opinion of the experts in the sphere of tourism and conducting the analysis of tourist websites, where not only unique objects that form the core of the identity of a town are noted, but also disadvantages, negatively affecting the tourist attractiveness and the reputation of the town, we can come to the following conclusion. The main elements currently forming the town's identity according to the surveys of experts and tourists (for Belozersk) are natural resources, unique architectural monuments and the places of interest related to the significant historical events (Fig. 4a). These are the so-called objectively existing in the minds of the citizens and guests of the town advantages of the urban environment. Architects, service providers, government representatives and town residents can add them artificially cultivated positive associations that should be formed. In small towns, the ecology in which is in a fairly good condition, agro- and gastronomic brands are also an important part of the identity. Processing the local raw materials or agricultural products with the use of traditional technologies is nowadays gaining popularity among the residents of large and major cities. On the one hand, this is the sphere of the local population employment, on the other hand, it is a unique and competitive souvenir product for tourists. 87.9% of the surveyed respondents regard as architectural monuments not only those historical buildings that are registered with the protection authorities. In the opinion of the residents the late nineteenth and early twentieth century merchant manors are the historical monuments that form the identity of the town. These houses, which are not always in perfect condition, convey the atmosphere of the life in a chief town of a district.

The manor type of buildings, the outbuildings, fences, entrance gates and front gardens all together form a unique type of urban environment of the bygone times. By examining the revealed in the course of the survey negatively affecting elements of the environment and the depressive reviews about the service sector, it becomes clear which elements of the system slow down the development of the town and destroy the unique and inimitable code of place (Fig. 4b). The study of the traditional handicrafts, crafts and industries made it possible to identify for each of the towns under study the unique local skills and craft traditions. Belozersk has always been famous for the bakery traditions, in particular of merchant Kalinin and his famous Belozersk pies with smelt and sander. Manufactures of merchants Kaparulin and, Vereshchagin produced sweets and treats made of dried vegetables. The unique for this place crafts were production of local Lake Beloye boats, cattail weaving and woodcarving.

Totma brand can be based on the traditional technologies of sugar production, syrup production of merchants Kholodilov, salt production and toy making. The town uniqueness, identity and sustainable image, according to the respondents, is manifested through the local architectural style "Totma Baroque" and through Totma merchant seamen. Ivan Aleksandrovich Kuskov, a merchant, navigator and explorer of Alaska and California, founder and later administrator of Fort Ross in California until 1821, is a historical figure for Totma. The house where Kuskov lived his last years and died in 1823 is nowadays a museum and a place of interest for the town. The churches and merchant manors provide Totma with the unique look.

The uniqueness and identity of Veliky Ustyug, according to the respondents, is formed by traditional crafts such as northern niello and felting. The architectural complexes Cathedral Square and Dymkovo Sloboda give a unique look to the town. The modern brand of the town is the Votchina (Residence) of Ded Moroz.

3 Conclusion

A comprehensive study of the historical and cultural potential of a small historical town, using an integrated analysis methodology consisting of mental mapping, a sociological survey, graphical methods of quantitative assessment, made it possible to identify the most unique places in small Russian towns. These will invest in the renovation that will ensure the active development of the tourism industry and sustainable urban development.

The methodology of determining the boundaries of the most attractive places (TAA) by the examples of small Russian cities will contribute and effectively invest own funds of citizens and the funds of municipalities into regeneration of the priority urban environment fragments and consequently will provide an impetus to the development and revival of small historic towns. It is the initiative of the local residents and enthusiastic businessmen that can initiate the development of historical, cultural, nature and gastronomic tourism. Prerequisites for such initiative are personal interest, enthusiasm, diligent continuous work with local documents and materials as well as deep knowledge of the family traditions and lifestyle of the place. Interaction with the residents of the towns revealed their high level of involvement and interest in the preservation of the architectural heritage and a creative initiative capable of vitalizing development of the small Russian towns.

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The Semiotic Aspect of Metareconstruction of Historical Architecture

T. G. Artemyeva and E. M. Balzannikova

Abstract Methods and approaches to the issues of preserving historical architecture are considered. The need to consider the axio-semiotic transformations of historical architecture, associated with the form of preservation, and the identification of conflict potentials of meaning formation at the levels of objects and chronotopes using this method are specified. The axiological aspects of preservation have been identified, which make it possible to determine the dynamics and characterize changes and potential deviations. The syntagmatic semantic chains of actions-consequences for all types of "historical object-form of preservation" relations have been built. Based on the research carried out, it was proposed to include the method of metareconstruction in the list of legal ways of preservation as a tool for working with historical objects at the semiotic level. The main differences of the metareconstruction method from the existing methods of preserving buildings, which are based on the restoration of the metaphysical qualities of an object within the existing historical environment, are listed.

Keywords Valuable city-forming objects · Historical environment of the city · Preservation of buildings · Metareconstruction · Axio-semiotic transformation

1 Introduction

The living organism of the city is in constant development. The issues of recognition of buildings constructed during the lifetime of living generations as objects of cultural heritage are being actualized [1–3]. Architecture, traditionally considered historical, turns into "primeval history"; its specific cultural role is constantly being re-evaluated. The problematization of this continuous process is formed by the constantly deepening conflicts involving the axiology of historical architecture [4–6].

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Some values are gaining strength, e.g. uniqueness, irreplaceability, identity connections with place, time and ethnic groups, informative role—the possibility of direct cognitive contact with history. And some values are weakening up to the loss of materiality of what can be cognized by the senses—perceived visually and tactilely, imprinted and used. At the same time, historical architecture, by the very fact of its presence in the urban fabric, continuously changes the economy of specific urban locations [7].

Historical architecture initially forms the cultural and functional framework of the urban environment and directly participates in the generation and evolution of economic and metaphysical meanings of specific urban locations.

Actualization of the problems involving ecology of cultural heritage reveals the need for the emergence of new techniques and approaches to the preservation of historical architecture, the new axio-semiotic criteria for assessing forms of conservation, determining the choice of techniques with clarification of the boundaries of relevance in accordance with the new evaluation criteria.

The complexity of the cumulative and all-encompassing definition of the phenomenon of the urban environment requires taking into account a quantifiable pair of attributes "economy/comfort" and an unquantifiable pair—"culture/identity". Interconnected explicitly within pairs and implicitly with each other, they are in a state of permanent, but interdependent variability [8–11].

The culture/identity pair is semiotically defined as a chronotope. Chronotope, according to the definition of M. M. Bakhtin—"artistically mastered … essential interconnection of temporal and spatial relations", enshrined in a meaningful concrete whole—in this context, in fragments of the urban environment [12]. The urban environment can exist as a collection of separate chronotopes evolving at different rates, or as a single chronotope, also subject to changes.

The historical environment develops and exists as a means of communication between history and citizens. Environment variability should be considered as a property of the continuous semiosis of the concept of the environment—semiosis in action. This directly depends, among other things, on the forms of preservation and functioning of all types of historical architecture, which, in addition to the officially identified and registered monuments, should also include valuable city-forming objects that are important for the formation and sustention of urban identity, regardless of their historical age.

The processes of sustaining or changing the entire variety of meanings are also implemented through methods of preserving historical objects. The choice of a method for preserving historical architecture has a significant impact on the change in the qualitative characteristics of the urban environment and on the stability of chronotopes.

The emerging problems of the axiological and semiotic nature of the ontology of the urban environment indicate the need to consider the forms of this kind of influence, determined by the concretization of choice.

Frequent conflicts between the necessary and the desired form of preservation and functional potential of the object provoke a negative forecast for the preservation of the monument and require diversified choice of methods of working with a historical architectural object. In conditions of uncertainty, in order to prioritize the choice of a preservation method, it is possible to use a semiotic approach to establish a hierarchy of values at the levels of a specific object and the urban environment as a whole. Hence, the need for the conventional nature of the final choice, the determination of the prevailing intentions, their rationality (in the system of value factors) are optimal objectivity.

2 Methods

The method of considering the axio-semiotic transformations of historical architecture associated with the form of preservation is considered the most rational and allowing an objective assessment of the prospects for the coexistence of historical and modern buildings and the identification with the help of this method of conflict potentials of meaning formation at the levels of objects and chronotopes.

The choice of the types of works aimed at preservation determines the future fate of historical architecture. It is possible to restore, preserve or lose the following types of value: material (utilitarian); historical and cultural (historical value of an object or its fragment with confirmed historical authenticity) and metaphysical (urban planning value of the existing historical urban landscape—parameters of visual ecology and historical urban planning morphotypes), which ultimately determines urban identity and implicitly affects the comfort and economic potential of the urban environment.

Consideration of axiological aspects must be supplemented with a semiotic analysis of the results of environmental transformations as a consequence of certain protective measures, the conversion or inversion of its economic and metaphysical meanings, realized in the form of changes in historical architecture.

The semiotics of such transformations is directly related to a specific method of preservation. Preservation of the monument in its original form (the possibility or absurdity of preservation of meaning); saving it in a modified form (change of meaning); with loss or replacement (meaning generation).

3 Results

Consideration of the axiological aspects of preservation allows us to determine the dynamics and characterize changes and potential deviations in both pairs of attributes. For the greatest clarity of the identification method, syntagmatic semantic chains of actions-consequences are built for all types of "historical object-form of preservation" relations according to the "royal burger" principle:

- status of the object (valuable city-forming objects, cultural heritage sites of local, regional, federal, global significance,) →
- state of the object (degree of depreciation) →

- form of preservation (conservation, repair, restoration, adaptation, etc.) →
- axiology of the preservation form (material and intangible values of a historical object preserved by choosing a method of preservation) →
- semiotic (semantic aspect) changes in the historical object (semantic transformations and inversions of denotations and connotations) → potential semantic conflicts at the object level;
- semiotic (syntactic aspect) changes in the historical object (syntagmatic transformations and inversions of tectonic, compositional and typological structures) → at the level of the object with the preservation or transformation of the chronotope;
- semiotic (pragmatic aspect) changes in the historical object (pragmatics of transformations and inversions of primary and secondary functions) → object proxemics at the levels: "object and environment", "object and person" → the nature of the chronotope change.

It is necessary to separate and consider the different levels of transformations of meanings associated with two types of changes.

At the level of an object (building or structure):

1. Restoration. High budget types of work. Preservation of authenticity depends directly on the specific subject being preserved. Thus, it remains possible not to preserve the authenticity of the parts of the building that are not subject to preservation. The original meanings of the building are almost always lost by replacing the primary function with secondary ones. And not only by changing the referential function, replacing its primacy with the aesthetic and metalinguistic functions of historical architecture, but also by transforming the proxematic relations "historical object—city", "historical object—person" as intercultural communications.
2. Reconstruction, adaptation. At the building level, these are high-budget types of work the need for which is justified either by the status of the monument, or by relatively short period from the time of loss, or by the conditions of adaptation to the adaptation project. The advantages of the method (legalized form of preservation) nevertheless raise questions about the appropriateness of this approach in the new urban context.

At the level of the urban environment:

1. Restoration, adaptation. Complete or partial loss of the primary (referential) function changes the connotations of a building or structure. The replacement of a residential function with a museum, industrial function with a residential or public one creates a new context and new meaning. During the restoration process, the aesthetic function is maintained, preserved, recreated, the content of the emotive, metalinguistic, imperative and phatic functions changes, with the introduction of an implicit hierarchy and a change in the functional and social meaning of the location. While maintaining the primary function, changing the context also changes the meanings of the urban environment.

2. Reconstruction, adaptation. Reconstruction is aimed at replenishing the loss of a monument, restoring the integrity of the historical urban environment, restoring or enhancing urban identity. This raises a contradiction with Article 9 of the Venice Charter [13].

At the urban planning level: the changing ontology of historical objects is mainly associated with the conversion or the complete loss of the primary historical context, the changing urban syntagmatics and, associated with this process, the translation of old meanings into a new context.

This objective process of evolution of the urban environment is accompanied by contradictions of a semiotic nature that arise as a result of choosing the method for preserving certain historical objects. Most often, they arise when using techniques to reconstruct lost historical buildings. As a rule, the reconstruction proceeds along the line of restoring the external appearance of the building with a complete change in all meanings, replacing the primary utilitarianism with complementarity to adaptation, and the loss of independence.

Losing syntagmatic connections (compositional and typological) and changing the meaning, i.e. by allowing manipulation of the denotation, historical architecture can become the object of legitimate violations in order to achieve certain economic goals.

The solution to this kind of problems involves including the method of metareconstruction in the list of legitimate ways of preservation, as a tool for working with historical objects at the semiotic level, which is able to expand the regulations of legally permissible actions. The proposed method assumes working with highly depreciated historical objects—buildings and structures that are in a state of significant destruction or complete loss. The main difference between the method of metareconstruction and reconstruction is the absence of imitation purposes, one way or another inherent in the restoration and, moreover, in the method of reconstruction.

Metareconstructive techniques are aimed at weakening the materiality, material meanings and enhancement of metaphysical ones, which play a basic role in preserving the iconicity of historical architecture as the primary (visual) signs of the identity of a place.

The question of rationality and the meaning of metareconstruction should be immediately clarified.

"Reconstruction" concerns only the metaphysical essence of the historical object, its image, traces, that is, some kind of virtual reality. Metareconstructed parts are devoid of their original functional meaning, they cannot be used in the way they were originally intended.

Metareconstruction works as a way of preserving an object according to the principle of architectural metonymy, when the replacement or restoration of a lost monument or its individual parts occurs in the form of substitution on the basis of contiguity, does not imply exact correspondence, but being in the closest connection instead. This principle makes it possible to observe, on the one hand, the attributiveness and differentiation of genuine historical values and their replacement, to avoid confusion in the definition of the genuine and restored, which is characteristic of scientific restoration. On the other hand, the methods of metareconstruction make it possible to reproduce (restore at the level of many of the most important meanings) of an architectural object at the level of conventional integrity.

Metareconstructive methods are closely related to the axiological aspects of preservation, which, in turn, are largely determined through semiotic analytics. Some freedom, admissible within the framework of the conceptuality of decisions aimed at sustaining and preserving mainly metaphysical values, both formal and substantive meanings of the urban environment, makes it possible, operating with semiotic argumentation, with adequate techniques to enhance and, if necessary, emphasize the meaning and role of specific historical objects in the formation of the identity of the place.

Metareconstruction is essentially a form-making act based on historical material, in which the enhancement of interaction forms between modern and historical architecture occurs by the medium of and through the awareness of semiotic constructions.

Let us consider the mechanism of this interaction. While choosing methods, the main task is to preserve as much as possible the semantic structure of the links between the monument and the environment, to preserve or transform the types of relations between the sign and the signified that has changed.

It should be added that in the process of evolution, historical architecture acquires additional semantic connotations, the meaning of a so called "package" of time—both an icon and a symbol, on the one hand, and acting as the basis for the formation of new proxematic relations in the urban environment—the creation of fixed and non-fixed configurations and changes in the publicity status—on the other.

With the complete or partial loss of the denotation, the connotations carry the attributes of the relationship of the lost denotations with their sign, supplemented by relations that allow us to assign them the status of both iconic and symbolic signs.

Metamorphoses of meaning can be traced in the already cited examples of metareconstruction, which are well suited to illustrate the mechanisms of preserving and transforming the semiotic connections of historical architecture with the environment.

An example of the Benjamin Franklin Court Memorial Complex in Philadelphia Historic Park, Pennsylvania, arch. Robert Venturi and Denise Scott-Brown (Fig. 1).

1. At the level of buildings and structures. Complete loss of meaning is the primary function of a residential estate, the connotations (semantic communications) of which included the attributes of the family life of the American middle state: privacy. New connotations associated with the history of the establishment of US independence have endowed the historical object with a special meaning: the place where a statesman was born received the status of a "birthplace" of the state—and in the memorial complex they assumed the role of a denotation—a museum function. Thus, with the help of the metareconstruction methods, the meaning was transformed through the conversion of the sign.
2. At the urban planning level (environment). The meaning of the complex is completely inverted from private closed to public open.

Fig. 1 General view of the Benjamin Franklin memorial complex

An example of the preservation is in the Reichstag building, Berlin, Germany (Fig. 2).

Parts of the building which formed the main meaning—the symbol and presence of the state authority—were lost.

In the course of restoration of the building, the denotation was completely restored with the addition of new utilities, which, however, made a significant transformation in the social perception of the renewed Reichstag. The meaning of the "power-people" relationship was inverted by architectural means.

Fig. 2 General view of the Reichstag building

The decrease in the level of materiality of the dome—the center of the architectural composition and the symbol of the "head" changed the perception of the "decapitated" building, thereby implicitly consolidating and sacralizing the historical event—the fact of the surrender of the Third Reich in World War II.

The tasks of establishing a connection between pragmatic and syntactic transformations of preserved architectural monuments, as a result of the choice of the form of preservation by the method of metareconstruction, come down to the selection of techniques aimed at the maximum possible (permissible) adequate reflection of the emerging new narrative of the urban environment. With their help, the inclusion of new meanings makes it possible to perceive the chronotope in the dynamics of the history of the place.

This kind of technique can be exemplified by the nature of the recovery actions in the place of the ITC complex, built according to the project of Minoru Yamasaki and lost as a result of the terrorist act of September 11, 2001. The complex formed a local chronotope in the body of Manhattan, which had and still has definite and distinct pragmatic and metaphysical meanings, separately recorded in the space–time phenomenon of Manhattan. Using this example, one can trace the transformation of the chronotope as a result of the inversion of the main reference function of the place—from the commercial center of New York to the memorial center, which roots down a new historical reality in the chronotope (Fig. 3).

The same example can be used to trace the nature of changes in the pragmatic aspects of the chronotope. The specificity of the relationship "sign-person" in relation to architectural objects and the urban environment is expressed in the duality of such relationships. "Utilization" and perception in the process of use, on the one hand, and perception as a result of various kinds of contacts that go beyond the immediate use, on the other. "Utilization" is referred to referential functions of a building, complex or environment, as well as to metalinguistic ones. A person "utilizes" an architectural object in the process of activity and in the process of randomly arising situations, which nevertheless activate the primary essence of architecture—the function of shelter. At the level of the urban environment, this type of pragmatic relationship

Fig. 3 Twin Towers in New York. The use of the site of improvement in place of the towers

can be attributed to a pair “economy-comfort”. Perception, as a type of relationship between architecture and a person, involves secondary functions of architecture, first of all, the aesthetic function, which allows assigning subjective evaluative characteristics to objects, then imperative—determining the modus of human behavioral reactions, metalinguistic, determining the orientation features of the environment; and other semantic communications between man and architecture at the level of the second pair of attributes—“culture-identity”.

Thus, the mutual influence of both pairs of attributes can be significantly reflected in the changes in the chronotope through the constantly updated semiosis of the environment in its pragmatic aspect: utilization as objectification of interdependent “comfort-economy” attributes and perception as the ability to mark and record the stability or changes in the “cultural context-identity” pair.

The specific potentiality of the metareconstruction should be noted. It is aimed at axiological goals to focus public and individual attention on:

- the value of the disappearing;
- the values of historical forms of art (architecture) in the era of digital forms of culture;
- the ability to evoke through sublimation explicit associations with lost real historical objects;
- the ability to mentally, and not only, reproduce, based on the fragments preserved within the framework of the method, the lost historical forms that formed the chronotope;
- the stable consolidation in the collective and individual consciousness of signs—meanings and senses that determine the chronotope.

Metareconstruction is capable of solving the problem of “articulating authenticity in a narrative; the problem of requesting (and responding) to imitative activity—“an attempt to pass the inauthentic as genuine—became the main intention of the educated class …” (A. G. Rappaport).

Metareconstruction as a form of preservation can work as an instrument of axiological compromise—in the issue of existential choice in relation to a specific historical object and to its symbolic role in identifying the urban environment.

Rationality in the use of metareconstruction methods lies in being the alternative of restoration actions in relation to the lost valuable individual buildings and complexes. Such rationality seems reasonable both in terms of honesty in relation to history and in terms of economic expediency.

Metareconstruction affects the mental layers of the relationship “environment-monument”, “monument-person-environment” at the levels of denotations, replacing the utilitarian meaningfulness of signs with its visual form—by iconizing the lost monument. It prevents existential changes in the meaning of specific locations when they change their composition.

Basic principles of metareconstruction: conceptuality—an artistic expression within the framework of strict compliance with the articles of the Venice Charter, and contextuality—the maximum preservation of the features of the existing chronotope, allow this method to occupy an “ecological” niche in a number of legalized types of works for the preservation of the historical architectural heritage, and thus, to obtain another tool for solving cognitive and axio-semiotic problems of the interaction of modern and historical architecture (Table 1).

4 Conclusion

1. In conditions of uncertainty, in order to prioritize the choice of a preservation method, it is necessary to use the methods of semiotic analysis of the consequences of works on the preservation of historical architecture at the levels of a specific object and the urban environment as a whole.
2. A simultaneous consideration of axio-semiotic transformations of historical architecture associated with the form of preservation with the identification of conflict potentials of meaning formation at the levels of objects and chronotopes is proposed.
3. Frequent conflicts between the necessary and the desired form of preservation and functional potential of the object provoke a negative forecast for the preservation of the monument and require diversified choice of methods of working with a historical architectural object.
4. Unlike the existing methods of preserving, adopted in practice of working with historical objects, metareconstructive techniques are aimed not at recreating identical materiality, but at restoring and enhancement of metaphysical meanings that play a basic role in the iconization of architectural monuments as carriers of primary (visual) attributes of a place's identity.

Table 1 Axiological and semiotic aspects of works on the preservation of objects of historical architecture

Types of preservation works	Axiological aspects								Semiotic aspects		
	Material value	Preservation forms			Intangible value	Preservation forms			Semantics	Pragmatics	Syntactics
		Sustaining	Recreating	Loss		Sustaining	Recreating	Loss			
Conservation	Functional use	–			Historical authenticity	+			Loss of meaning and most of the connotations	Complete loss of referential function with museumification	Changing urban syntagmatics
	Physical condition of the building and life support systems	–			Historical and cultural value	+					
					Aesthetic value	+					
					Metaphysical value	–					
Repairs	Functional use	+			Historical authenticity	+			The change, decrease or loss of general cultural meaning At the urban planning level At the level of a building or structure	Reduction of aesthetic function Full or partial decrease in the level of emotive function	Preservation or modification of urban syntagmatics inclusion of the object into the structural center with the development of urban fabric
	Physical condition of the building and life support systems	+			Historical and cultural value	–					
					Aesthetic value	–					

(continued)

Table 1 (continued)

Types of preservation works	Axiological aspects								Semiotic aspects		
	Material value	Preservation forms			Intangible value	Preservation forms			Semantics	Pragmatics	Syntactics
		Sustaining	Recreating	Loss		Sustaining	Recreating	Loss			
					Metaphysical value	–					
Restoration	Functional use	+			Historical authenticity	+	–		Change, gain of common cultural meaning At the urban planning level At the level of a building or structure	Partial decrease in the level of emotive function	Preservation or modification of urban syntagmatics inclusion of the object into the structural center with the development of urban fabric
	Physical condition of the building and life support systems	+			Historical and cultural value	+	–				
					Aesthetic value	+	+				
					Metaphysical value	?	?				

(continued)

Table 1 (continued)

Types of preservation works	Axiological aspects								Semiotic aspects		
	Material value	Preservation forms			Intangible value	Preservation forms			Semantics	Pragmatics	Syntactics
		Sustaining	Recreating	Loss		Sustaining	Recreating	Loss			
Adaptation	Functional use	+			Historical authenticity				The change, gain, decrease or loss of general cultural meaning At the urban planning level At the level of a building or structure The need to control adequate transformations and conversions of markers	Changing the reference function Partial or complete emphasis on the “utilization” relationship	Changing urban syntagmatics inclusion of the object into the structural center with the development of urban fabric
	Physical condition of the building and life support systems	+			Historical and cultural value						
					Aesthetic value						
					Metaphysical value						

(continued)

Table 1 (continued)

Types of preservation works	Axiological aspects								Semiotic aspects		
	Material value	Preservation forms			Intangible value	Preservation forms			Semantics	Pragmatics	Syntactics
		Sustaining	Recreating	Loss		Sustaining	Recreating	Loss			
Reconstruction	Functional use		+		Historical authenticity		–		The change, gain, decrease or loss of general cultural meaning At the urban planning level At the level of a building or structure The need to control adequate transformations and conversions of markers	Partial or complete emphasis on the “utilization” relationship	Preserving urban syntagmatics
	Physical condition of the building and life support systems		+		Historical and cultural value		+				
					Aesthetic value		+				
					Metaphysical value		?				

(continued)

Table 1 (continued)

Types of preservation works	Axiological aspects								Semiotic aspects		
	Material value	Preservation forms			Intangible value	Preservation forms			Semantics	Pragmatics	Syntactics
		Sustaining	Recreating	Loss		Sustaining	Recreating	Loss			
Metareconstruction	Functional use	±			Historical authenticity	+			The change, gain, of common cultural meaning At the urban planning level At the building or structure level. The need to control adequate transformations and conversions of markers	Partial or complete loss of the "utilization" relationship increased level of perceptual relationships	Preservation and enhancement of urban syntagmatics
	Physical condition of the building and life support systems	±			Historical and cultural value	+					
					Aesthetic value	+					
					Metaphysical value	+					

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Idea of "Garden City" and the Conception of Capital Cities as the Basis of the Architectural and Urban Paradigm of the Yerevan Master Plan of 1924

Margarita Arustamyan and Elena Bagina

Abstract The architectural and urban planning paradigm, based on which the general plan of Yerevan in 1924 (architects A. Tamanyan and N. Buniatyan) was developed, is built on two foundations—the concept of a garden city, taken outside of its economic component, and the concept of "capitalism", formed because of a series of reconstructions of European capitals. This concept as the history of design and construction of the capital of Armenia is proposed for the first time. At the turn of the nineteenth and twentieth centuries, the idea of a garden city gained a huge number of supporters in European urban planning. Most of the urban planning reconstructions, as well as projects for new settlements, were built within the framework of this idea. The ideas about the worthy appearance of the capital city were also general. The main landmark was Paris after the Ottoman reconstruction. That is why the methods of compositional constructions of master plans of new cities and projects of reconstruction of old ones had common structural features. The disdainful attitude to the existing vernacular building and planning, characteristic of the professional consciousness at the turn of the nineteenth and twentieth centuries, gave rise to several architectural and planning conflicts laid down in the general plan of 1924. In modern conditions, the attitude towards vernacular building has changed, projects are proposed for its inclusion in modern residential and public areas. However, the facades of private houses of the nineteenth century are often used as elements of heterochronous collages. With this approach, the vernacular buildings disappear, and the city loses material evidence of its history. Similar urban planning conflict situations are typical of other cities, designed starting with the concepts of the early twentieth century, which fundamentally ignored the existing vernacular building. Overcoming old architectural and planning conflicts is possible, but this requires a correction of values.

Keywords Architectural and urban planning paradigm · Garden city · Capital city · Compositional urban planning conflicts · Vernacular

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1 Introduction

The formation of Yerevan as the capital is happening mainly during the twentieth century. The urban planning structure is formed in the 20s–80s in three stages. Each of these stages corresponds to its own architectural and urban planning paradigm, which includes basic representations of the image of the capital, as well as how the life of the population will be organized, how residential areas will be formed, how places of public attraction should look like, how the dominant ideology will be reflected in the city's planning generally.

The first stage was in the 1920s–1930s, when the general plan was implemented by A. O. Tamanyan and N. G. Buanityan 1924, based on the ideology of the garden city and the ideas of the capital, characteristic of architecture for European architecture.

The second stage was in the 1930–1950s, when the ideology of the garden was replaced by the ideology of the socialist city; the ideas of both national socialist models were formed based on the experience of Moscow.

The third stage is the 1950s–1980s. During this period, the international principles of urban planning modernization became accepted in the USSR, and the ceremonial neoclassical constructions of the Stalinist era no longer corresponded to the ideas about the modern capital.

This article presents the first stage of the formation of Yerevan as the capital of the Armenian SSR and the tendencies that influenced the creation of architectural and urban planning conflicts that have not been overcome to this day.

In the process of working on the article, the works of Russian and foreign authors (T. P. Kazhdan, E. A. Borisova, M. G. Meerovich, D. S. Khmelnitsky, V. S. Goryunova, M. P. Tubli, A. V. Bunina, T. F. Savarenskaya, and others) were used. They were dedicated to the history of urban planning at the turn of the XIX—first quarter of the XX century.

A. A. Aloyan, K. V. Balyan, M. A. Gasparyan, V. M. Harutyunyan, M. M. Asatryan, L. K. Dolukhanyan, A. V. Ivanov and others studied the history of the formation of Yerevan.

Letters of A. O. Tamanyan, decrees and orders concerned the construction and organization of the city economy, government decisions. They were introduced into the scientific revolving archival materials concerning the history of the creation of the general plan of Yerevan in 1920–1924.

2 Methods

When studying the sources noted above, the methodological principles of comparative analysis and historical analogies were used. The focus of the research was the relationship of goal setting in the development of the city, the specific decisions made, the degrees of their implementation and the obtained results, as well as the degree of architectural and artistic incompatibility of certain urban planning decisions.

3 Objects of Study

The architectural and urban planning structure of Yerevan formed during the period of 1880–1930.

Architecturally and artistically conflicting zones were generated by a change in urban planning paradigms.

4 The Purpose and Objectives of the Study

Based on the analysis of the formation of Yerevan at the turn of the nineteenth and twentieth centuries, the authors identify the principles of transformation of the frame and fabric of the city, as well as the formation of architectural and artistic conflict zones in the context of a change in urban planning paradigms.

According to the above goal, the following tasks have been set:

1. to show that the architectural and urban planning paradigm, based on which the general plan of Yerevan in 1924 was developed, is built on two bases—the concept of a garden city, taken outside of its economic component, and the notions of "capitalism" that had developed by the beginning of the twentieth century;
2. to identify the reason for the emergence of architectural and artistic conflicts, laid down in the general plan of Yerevan in 1924;
3. to consider the possibility of resolving architectural and artistic conflicts, laid down in the general plan of 1924, in modern conditions.

5 Short Prehistory of Yerevan

The history of Yerevan begins with the Urartian fortress Erebuni, to which the name of the city "Yerevan" ascends. The earliest mention of this city in medieval sources dates from 607. Located on one of the lowest points of the Armenian Highlands, it is located on the easternmost edge of the Ararat valley, at the junction of the Getar and Hrazdan rivers, in the Ararat region of historical Armenia.

After the annexation of a part of the ancient territory of Armenia to Russia in 1828, Yerevan became the administrative center of the Armenian region and then served as the center of the Erivan province.

By the beginning of the twentieth century, it was a one-story eastern city. In the center there was a church or a mosque, small shopping areas, stone one-two-story houses made of black tuff, adobe buildings with flat roofs on the outskirts.

Life under the rule of the Russian Empire adjusted the planning structure of Yerevan. It was partly streamlined: a quarterly layout appeared, which was combined with a spontaneously developed labyrinthine layout.

On the plan of the end of the nineteenth century, Yerevan is a small city, breaking up into separate districts that were formed on the site of former villages (Fig. 1).

At the beginning of the twentieth century, the western part of Armenia was under the rule of the Ottoman Empire, and the eastern part was part of the Russian one. After the First World War and the revolutions in Russia and Turkey, the situation changed. The empires that divided the territory of Armenia ceased to exist. However, gaining independence in the political and economic conditions of 1919–1920 was practically impossible for Armenia, although the implementation of this idea was beneficial for many political forces.

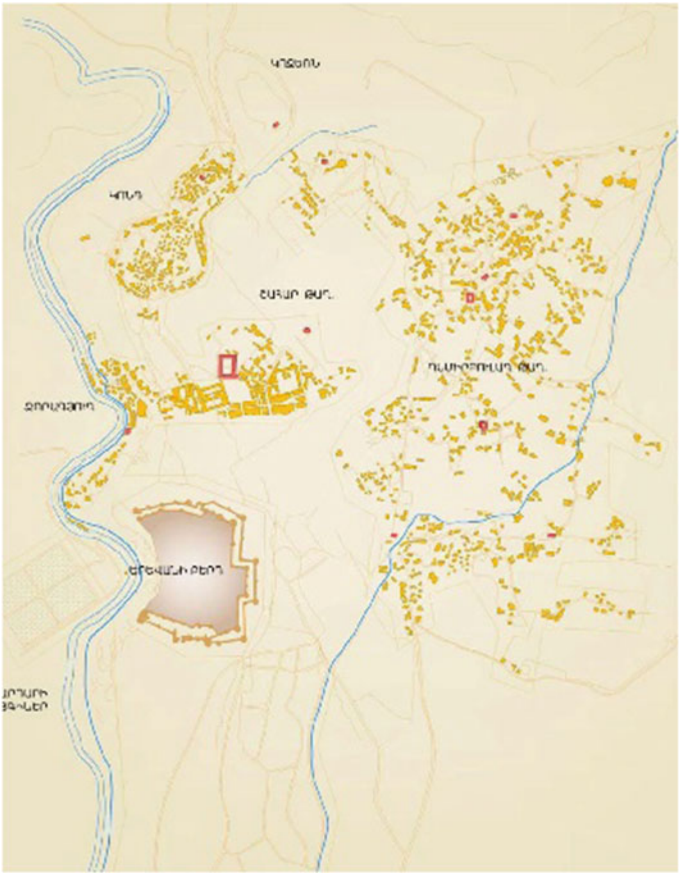

Fig. 1 General plan of Yerevan in 1880 [1]

6 Creation of Yerevan Master Plan in 1924

The idea of making Yerevan the capital of an independent Armenian state in the first quarter of the twentieth century took the minds of both the leaders of the diaspora, replenished after the Armenian Genocide in 1915, and politicians who did not leave their historical homeland. It would seem that the stars aligned, [2] provincial Yerevan was to become the 12th capital of independent Armenia. Nevertheless, Armenia was an independent republic for a very short timeless period of less than two years.

After a series of shocks from 1915 to December 1920, power passed to the Bolshevik, the independent Republic of Armenia ceased to exist, but the hope of creating a new national administrative and cultural center in Yerevan still lived.

In the early 1920s, Armenia's economy was in decline. The situation was aggravated by the fact that after the Turkish genocide of 1915 in cities and villages there were crowds of refugees who had neither housing nor work. Many Armenians left their homeland at that time, replenishing the large Armenian diaspora.

In 1921, the Armenian Aid Committee (AAC) was established. It was a link between the world Armenian diaspora and Armenia. At this time, the activities of the AAC and the idea of reviving Armenia were supported by the Soviet leadership [3]. At that time, settlements were built with the money of the AAC, for example, Nubarashen, which later became part of Yerevan. The "ideal city" of Lukashen was also built for orphans who lost their parents during the genocide. The layout of the villages of Nubarashen and Lukashen was created under the influence of Howard's idea of a garden city, which at the beginning of the twentieth century was the most popular in urban planning. Typical structural elements of a garden city in these settlements can be traced (Figs. 2 and 3).

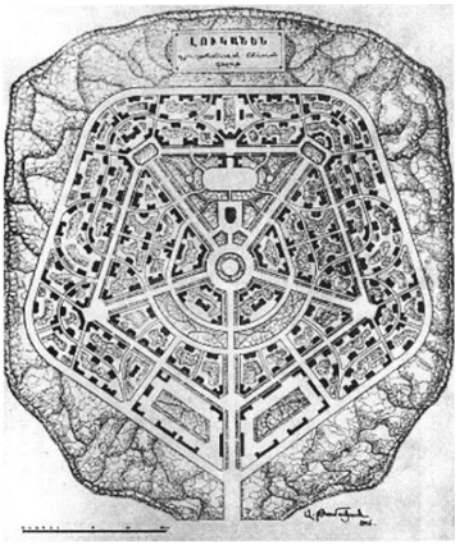

Fig. 2 General plan of Lukashen village [4]

Fig. 3 General plan of Nubarashen [4]

To create a master plan for the capital city of the independent Republic of Armenia, the governments invited the famous in St. Petersburg architect, Alexander Tamanyan. So, he decided to move to Armenia in 1919. There was a lot of work ahead, and Tamanyan received permission to invite to Armenia his friend and coworker Nikolai Buniatyan, who at that time lived in Moscow and taught at VKHUTEMAS. When Buniatyan finely arrived in Armenia, a group of specialists was formed to develop the master plan of Yerevan as a capital city. But soon the project had to be stopped. The situation in Armenia was extremely tense; the governments were changing. Many of Tamanyan's employees were arrested, and he himself was forced to escape in 1921 to Persia (Iran). He lived in Tabriz for two years [2]. There was a large Armenian diaspora in Persia, so Tamanyan had an opportunity to pursue the profession. He returned to Armenia only in 1923. The idea of creating a capital city in Yerevan became actual again. That is true that the customer of the project was already the new Soviet government, whose position in the Transcaucasia at that time was strengthened.

The decision-makers had a very ambiguous idea of how the new capital of Armenia should look like. Tamanyan and Buniatyan, who were again involved in the work of the master plan, had to rely on their knowledge and those norms and standards that were typical of urban planning traditions at the end of the 19th and the beginning of the twentieth centuries.

Large European cities in the middle—late nineteenth century dramatically changed their appearance. The solution to most of the problems, such as spontaneous territorial growth, poor sanitary and hygienic conditions, congestion of narrow streets with transport, were unsolvable without fundamental reconstruction.

But then in addition to the tasks of improving the urban environment, artistic tasks were also solved during the reconstruction. The idea of how the capital should look like in the nineteenth century has changed significantly. It was no longer about separate ceremonial squares or palace complexes—the capital city was presented as a single whole, where the ensembles of squares were connected by straight main highways, the houses should have the same height and it is desirable that they be built in the same style. The width of the streets had to be enough to include landscaping elements or the formation of boulevards. And at the same time, Camillo Zitte’s romantic ideas about the artistic problems of urban planning were popular among architects and involved the planning of new cities and the reconstruction of old ones. Zitte wrote about contemporary urban planning: “… technically, a lot has been achieved, but almost nothing in the artistic sense. In most cases, the magnificent new monumental buildings do not fit in any way with the layout of the surrounding area and the unfortunate configuration of the squares. Therefore, it seemed advisable to finally try to investigate several town-planning formations and, in particular, old squares in order to find out the reasons for the wonderful impression they made. Based on the correct identification of these reasons, it is possible to determine a set of rules, the observance of which even today can give favorable results. Zite [5] believed that the cold, symmetrical neoclassical ensembles of modern cities were artistically unsatisfactory and suggested that new ensembles of squares be formed asymmetrically, similar to those that had developed historically. These ideas were close to Tamanyan. But he was also close to the idea of “capitalism”, developed in the second half of the nineteenth century in Europe based on the experience of reconstruction of Paris, London, Vienna.

The capital of Armenia was not comparable in scale to European capitals, but nevertheless it seemed like a small Paris.

The social utopias of the Bolsheviks as a technical task for designing the capital of the Socialist Republic of Armenia on the site of a small settlement did not fit well, but, nevertheless, influenced the choice of an architectural and planning solution. The abolition of private ownership of land gave unprecedented freedom to designers. The general plan of Yerevan was completed in the shortest possible time and submitted to the government commission, which was headed at that time by Alexander Fedorovich Myasnikyan—a unique personality in all respects. Since 1922, Myasnikyan was the chairman of the Union Council of the Transcaucasian Soviet Federative Socialist Republic, then he was the first secretary of the Transcaucasian Regional Committee of the RCP (B). In the approval of the general plan of 1924, his vote was decisive. Myasnikyan supported the planning ideas of the architects [6].

7 The Main Structural Base in Master Plan of Yerevan

According to the master plan of Yerevan designed by Alexander Tamanyan and Nikolai Buniatyan in 1924 (see Figs. 4 and 5), it was turned into a socialist garden city and the administrative and cultural capital of Armenia. In this master plan, the symbolism that was originally laid, the master plan of the capital city was supposed to express the main idea of the new state. For Armenia, with its ancient history and culture, this idea was to recover the lost traditions. Independence, democracy, national traditions, the unity of the people and the honor of historical territories are the main aspects that should have been expressed in the master plan of Yerevan. Therefore, Mountain Ararat, as a national symbol of Armenia, was the main spatial landmark and ideological core in this project. It was supposed to close the perspective of the most significant avenues outlined in the 1924 project.

The main concept of Tamanyan's capital city of the Armenian Socialist Republic was based on the garden city. The customer liked this idea, since it was consistent with the official ideology proclaimed by the Bolsheviks. And no matter how untruthful this ideology was, no matter how it diverged from reality, it influenced the urban

Fig. 4 General plan of Yerevan in 1924 [4]

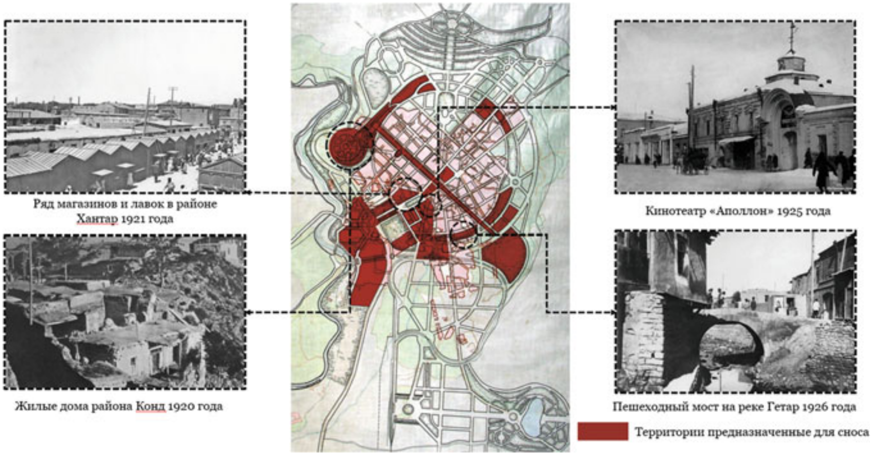

Fig. 5 Photo of old Yerevan from 1930 to 1940

planning of the mid-20s because. That was the most progressive urban planning idea of the early twentieth century although a utopian. It was supported by all socialists, including the Bolsheviks.

7.1 The Influence of the "Garden City" Idea on the Formation of the General Plan of Yerevan in 1924

Howard's idea of a garden city at the beginning of the twentieth century had a strong influence on the formation of general plans for new cities and the principles of reconstruction of existing ones. Garden cities began to be designed in many countries. However, in these projects and implementations, the economic component of the idea of a garden city was forgotten and only the idealistic one remained.

Low-rise garden cities were built by large industrialists for workers, but workers could live in them only if they worked at an enterprise. In fact, these were green departmental settlements for skilled workers. During the reconstruction of existing cities, the idea of a garden city initiated the appearance in the master plans of numerous parks, squares, boulevards. A low building density was adopted, the center was usually designed as a classicist ensemble, which implied symmetry, green ceremonial esplanades, vast squares with fountains and sculptures and other attributes of "a beautiful city" [7].

In 1913 A. Tamanyan with V. A. Semyonov, A. V. Shchusev, A. P. Ivanitsky, N. G. Buniatyan participated in the project of the garden city next to the Prozorovskoye station. Prozorovsky's project experience was naturally used in the design of the master plan of Yerevan in 1924.

In Prozorovsky (see Fig. 6), on an area of more than 700 hectares, it was decided to build a comfortable village, consisting of low-rise buildings (each has a plot of 12 acres), a cultural center, as well as a hospital and a school campus. The entire settlement was to be cut through by a system of ring and radial roads, the largest of which were supposed to be run by an electric tram. As a "source material" for the plan of Prozorovsky, specially commissioned by von Meck from the London International Exhibition, they brought photographs, descriptions, schemes of the already existing garden city in Letchworth. It was decided to interpret much of what the British had "spied on" in the Russian version of the "village of the future".

Tamanyan and Buniatyan, therefore, had an idea not only of Howard's scheme, but also of the general plan of the garden city of Lechward. The information about this project repeatedly appeared in the professional press, Lechward's plan was published and in Dikansky's book "Building cities, their plan and beauty" was published in large circulation in 1913.

In the center of cities, which were designed according to the principle of a garden city, they usually planned a public and administrative ring, then a garden and park belt, separating residential areas from the noisy central part. This planning technique can be traced in the general plan of Yerevan by Alexander Tamanyan and Nikolai Buniatyan in 1924 (see Fig. 7).

Graduates of the St. Petersburg Academy of Arts, academician Alexander Tamanyan and the future chief architect of Yerevan, Nikolai Buniatyan, designed not just a garden city, but a garden city in the capital.

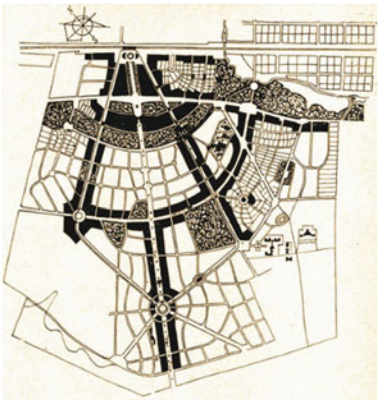

Fig. 6 General plan of Prozorovsky [8]

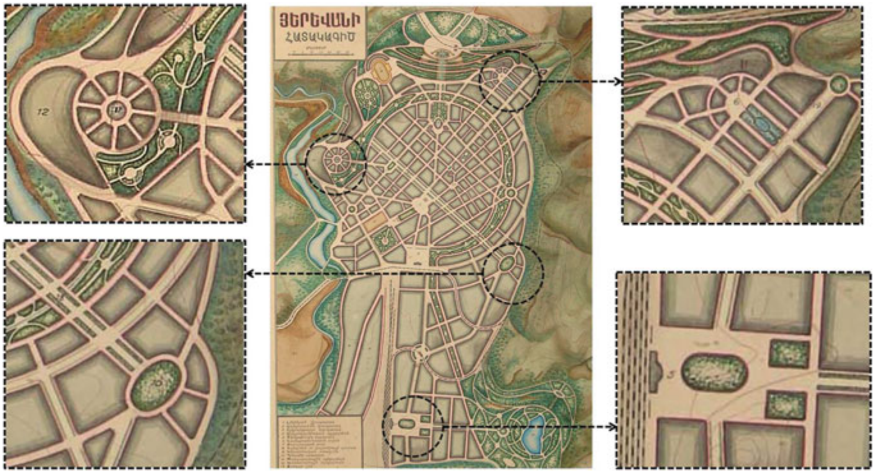

Fig. 7 Structural elements of the “garden city” on the general plan of Yerevan in 1924 [9]

7.2 *The Influence of European Capital Cities on the Formation of the General Plan of Yerevan in 1924*

Their ideas of how the capital city should look like were typical of the turn of the nineteenth and twentieth centuries. In Yerevan we envisaged, ceremonial classic ensembles of administrative and public buildings, museums and theaters, star shape squares, straight avenues, green lines, an extensive park, a zone allocated for the university and scientific institutions. The buildings of the organizations were supposed and adjacent to individual houses for scientists, for a university campus was imagined by the example of the best educational institutions in the world.

The image of Paris, formed because of the Hausmann redevelopment, became a reference point for the formation of the general plan of Yerevan in 1924, the ceremonial squares, boulevards and highways laid down in it. As an example, the square in front of the building of the Opera House brings to mind composer Spendiarov, the square in front of the Grand Opera, and the Roman Piazza del Popollo. The placing of the theatrical building, conceived by Tamanyan, in such a way that the building closes the perspective of two squares, resembles the methods of forming ceremonial squares in European capitals. The center part of the capital city forms a cascade of ceremonial squares—this kind of presentation was formed in the nineteenth century and goes back to the experience of creating baroque and classicist ensembles of European capitals. Of course, there were also planned ceremonial avenues with houses trimmed with Armenian tuff and decorated with architectural details copied from historical national buildings.

The 1924 plan assumed that the city’s population would increase to 150,000 in 20 years. Where the residents of Yerevan will be employed was not clear according to the master plan. At the beginning of the twentieth century, mainly handicraft production was developed in Yerevan. There were no large factories. It is not very clear whether the authors of the master plan deliberate the location of industry in Yerevan. Most likely, it was assumed that Yerevan would be somewhat like Washington. New Yerevan was assigned the role of the administrative and cultural capital.

The idea of creating a global cultural Armenian center in Yerevan was largely utopian. But, nevertheless, prominent figures of science and art of Armenian origin accepted the invitation of the KAP and came to their historical homeland. Among them were artist Martiros Saryan, composer Alexander Spendiaryan, linguist Rachia Acharyan, surgeon Ambartsum Kechek and others [2].

But after the arrival in Yerevan, it became clear to them that there was nowhere to live. The city was overflowing with repatriates, the number of whom exceeded the population that lived in the territory of Yerevan before the First World War. In 1921, about 50,000 people already lived in the city. First, the Committee for Armenian Aid helped the invited intelligentsia to settle down. Some of them were able to build their own mansions, but most lived in rented houses and apartments, some were provided with temporary housing.

When developing the general plan of 1924, Alexander Tamanyan and Nikolai Buniatyan solved two actual problems—creating optimal living conditions for the population due to the maximum possible landscaping of the territory, allocating a place for building mansions, territory for a university campus, etc. At the same time, Yerevan was thought of as a capital.

The garden city and the idea of “capitalism” as components of the architectural and urban planning paradigm, influencing the layout of Yerevan, are contradictory. European ideas about “capitalism” presupposed the presence in the city plan of main highways, a cascade of squares, multi-story residential buildings in the center. But this circumstance did not make it possible to fully realize the idea of a garden city. To some extent, the chamber scale of the ceremonial ensembles and their dissymmetry were reconciling.

The internal inconsistency of the architectural and urban planning paradigm of the early twentieth century also affected the plans for the reconstruction of existing cities, which, on the one hand, wanted to turn into a garden city, and on the other hand, to make them at least a little like the world cultural capital—Paris. In the plans of new cities the first half of the twentieth century, which were based on the idea of a garden city, played a significant role in terms of the centripetal structure of the planning structure and the representative function of the center. This was formed on the basis of classical norms of order, the architectural and urban planning paradigm that had developed by the 20s of the twentieth century, thus, had internal contradictions that created quite tangible problems. In Yerevan, these problems were solved by transforming the principles of the garden city in favor of the “capital”.

There was one more significant contradiction in the formation of the master plan of Yerevan in 1924: it was created without taking into account the historically formed vernacular buildings, which, due to the opinions mainly in the professional environment, was not a value.

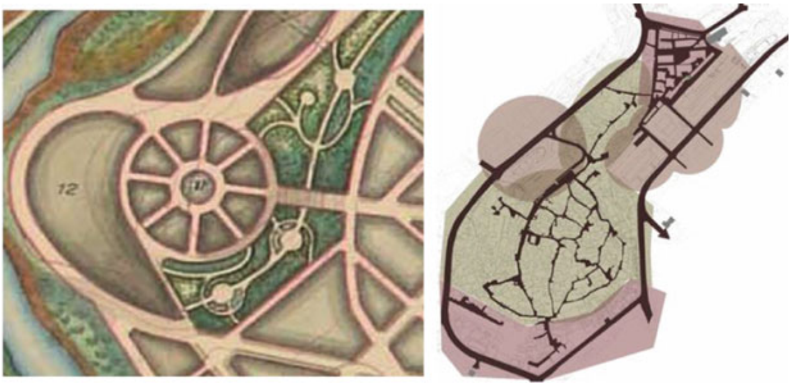

Fig. 8 Kond district planed by Tamanyan in 1924 and its current condition

For example, on a hill where one of the most ancient districts (Kond) of Yerevan is located (see Fig. 8), Tamanyan and Buniatyan planned museums drawn in form of concentric circles for new streets. The tracing of them ignored the existing labyrinthine frame, and, consequently, residential buildings, ancient churches and mosques of this district according to the Tamanyan project are doomed to be demolished.

In the plan of 1924, only the most significant religious buildings, whose age totaled several centuries, were considered. But in the ensembles of squares, which were supposed to appear according to the new plan, they did not play any serious role. Sometimes these historic buildings fell into the courtyards of new quarters, sometimes they were built into the line of new houses.

8 Conflicts with Reality and the General Plan of Yerevan in 1924

Thus, the compositional connections that existed between significant church and monastery complexes with the old vernacular buildings were destroyed. This conflict, laid down in Tamanyan’s plan, could not but arise, since Yerevan was planned as the capital city of Soviet Armenia, where atheistic ideology was in every possible way implanted certainly everywhere on the territory of the USSR.

An interesting fact concerns the beginning of the 30s in Yerevan, when almost all Russian Orthodox churches were demolished, but the temples of the Armenian Autocephalous Church and some mosques escaped demolition. This was not an accident that since the Soviet leaders feared popular indignation. In addition, until 1937, money was still received from the AAC and subsidies connected with the destruction of Armenian churches could be stopped.

Fig. 9 An example of neglecting the vernacular building

The lack of private ownership of land and real estate made it possible to demolish individual houses and build new multi-story houses on their place. However, the situation with a housing lack in the mid and late 1920s in Yerevan was so serious that one-story buildings were preserved. And in the late 1930s, when the 1924 plan was already partly implemented, it coexisted with new houses. In many places, this architectural and urban planning conflict was overcome due to the demolition of old houses, but in many central districts of Yerevan it remains critical. Moreover, if in the 1920s and 1930s even strong vernacular houses made of tuff did not seem valuable, now their demolition seems to be unwelcomed to both architects and residents of the city (Fig. 9).

At the same time, since the first half of the twentieth century until nowadays, the existence of dilapidated stone buildings in the center of the city creates architectural and planning conflict zones. Currently architects are trying to solve these conflicts in various ways, but mainly the old buildings changed urban environment, but modern solutions are extremely rare. Recently fashionable superstructures and heterochronous installations are destroying low-rise old houses (Fig. 10 and 11).

There were practically no challenges to overcome such urban planning conflicts in the 30s–50s. Also, existing projects and programs such as "Old Yerevan" planned in 2018 did not solve the problem fully architectural and urban planning conflict with vernacular buildings, laid down in the plan of 1924.

Researchers of the history of Yerevan and the formation of its urban planning structure put forward different versions of the development of the city. But everyone agrees that at the beginning of the twentieth century according to the plan of 1924, the ancient history of the place was practically "taken out of the brackets". As a result, the physical evidence of the city's history continues to deteriorate today.

The historical modernism of Yerevan, about which Andrei Ivanov writes [10], does indeed take place. But the reasons for this continuous modernism are in a

Fig. 10 An example of an architectural and artistic conflict of religious buildings

Fig. 11 Example and heterochronous editing

sharp change in the architectural and urban planning paradigms that Soviet and post-Soviet urban planning experienced. In all cities of the USSR, similar phenomena are observed since the urban planning policy was the same.

In the 20s of the twentieth century, the main world concept of urban planning was the "garden city". Then in the 30s in the USSR it was replaced by the idea of a social city, which met the policy of industrialization of the country. Then the era of district-micro-district free planning and modernist ensembles began, and aesthetic attitudes initiated a change in architectural and urban planning paradigms. The processes that took place in Yerevan were characteristic of all cities of the USSR. In the capitals of all national republics, which were interpreted as "the front facade of socialism" and were material evidence of the "success of national policy", the architectural and urban planning paradigm of almost all periods of the city's development in the twentieth century was influenced by the changing concept of "capitalism". The national style was emphasized by explicit and implicit quotes from architectural monuments and urban planning.

9 Results

1. In the master plans of the cities, designed according to the principle of a garden city, urban conflicts were originally established. Overcoming these conflicts is possible if their nature is understood.
2. The architectural and urban planning paradigm, formed at the beginning of the twentieth century, based on the idea of a garden city and the idea of the form of representativeness of the capital city, formed the basis of the ideology of the general plan of Yerevan as a new capital, first the independent Republic of Armenia, and then the Soviet Socialist Republic of Armenia.
3. The ideology of the garden city initiated the appearance in the general plan of Yerevan, created by A. O. Tamanyan and N. Buniatyan, planning structures characteristic of garden cities: wide green stripes, circular highways, beam structures, the allocation of vast territories given for individual development.
4. The concept of "metropolitanism", formed in European culture on the basis of the experience of the reconstruction of Paris, Vienna, London, Berlin, initiated the appearance in the general plan of Yerevan of a cascade of squares in the central part, territories given over to the university campus and the Academy of Sciences, as well as ceremonial central highways built up multi-story buildings facing the street decorated with decorative elements.
5. Ignoring the historically established planning and development of old Yerevan, during the implementation of the 1924 plan, led to the emergence of several urban planning conflicts:

   - Significant religious buildings lost their natural surroundings and ended up either in courtyards, or in the line of new development of main highways, or were demolished as they interfered with the implementation of the master plan.
   - The old vernacular buildings, which remained after the demolition of the bulk of private houses, did not fit into the new buildings. Within the limits of one street, at best, unplanned differences in number of story's were obtained, the scale of the courtyards did not correspond to the new quarterly layout. There were many such conflict zones during the implementation of the 1924 master plan. Conflicts of this kind in the development of the 20s and 50s have not been overcome until now.

- The unrealized buildings and green stripes of the 1924 plan made it possible for the emergence of potentially conflict zones, since free spaces allowed for a change in the functional purpose of these territories.

10 Conclusion

The architectural and urban planning paradigm that influenced the structure of the general plan of Yerevan in 1924 was formed under the inspiration of two fundamental ideas of European urban planning—the “garden city” and ideas about the image of the capital, formed after the reconstructions of Paris, Vienna and London.

The change in the political and economic situation led to the transformation of the structure of the general plan of Yerevan in the 1930s and a change in the architectural and urban planning paradigm. Tamanyan’s ideas as a result were not fully implemented.

Ignoring the vernacular development in the 1924 plan led to the emergence of architectural and urban planning conflicts that have not been overcome to this day: historical religious buildings and individual residential buildings found themselves in an unusual urban planning situation. These conflicts, laid down in the 1924 plan, require attention in today’s urban planning practice.

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Cluster Principles of Cultural Identity Preservation for the Monotowns

N. G. Blagovidova, N. V. Iudina, and E. V. Vanyurskaya

Abstract The problem of balanced urban development is urgent all over the world, including Russia. In the context of globalization, single-industry urban formations are in the most critical state. The restoration of their well-being is not facilitated by modern programs and doctrines of strategic planning and sustainable development. The authors propose an approach that focuses on the local and primarily historical and cultural potential of regions with a limited diversified economic base—a cluster. The research is carried out by the example of single-industry cities of the Southern Urals. The main directions of development and cluster principles are highlighted that work at the economic, spatial, social and cultural levels. On the basis of the already emerging quasi-cluster structures in the field of tourism in the South Urals, the prospects for the application of cluster principles on a regional scale are considered.

Keywords Cluster · Cultural identity · Single-profiled towns

1 Introduction

In the modern world, the issue of the balanced development of urban systems is becoming more acute. International organizations note that globalization trends threaten the stability of the socio-economic and ecological state of settlements, as well as the preservation of the cultural heritage, and Russia is no exception in these processes. According to the agendas and documents of an interstate nature, the balanced development of the country depends on the stable position of all its regions.

A number of authors considered the problems of urban development and the consideration of their causes, among them are Haase et al. [1], Couch et al. [2], Cheshire [3]. In particular, Haase et al. [1], consider the issue of population reduction in medium and small cities in the process of deindustrialization and the lack of effectiveness of state policy in this matter; the authors work with urban regeneration schemes not only in the economic, but in the planning sense, asserting the relationship

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of territorial and economic aspects. Other trends of modern urban development, including the decentralization of production in cities and regions, the formation of subcenters, the role of such transformation, localization in the development of degraded territories is considered in the works of Maoh and Kangarlou [4], Rosenthal and Strange [5], Cuthbert and Anderson [6]. They also refer to clusters as models of urban development of monocentric cities.

A number of studies have noted a significant connection between natural and rural areas on the one hand and small towns—on the other. The works of Escalona-Orcao et al. [7], Naldi et al. [8], Jakob and Van Heur [9] are devoted to the issues of their economic development, including on the basis of creative clusters. The works classify rural areas and adjacent cities according to their creative potential and note the trends towards increasing localization of cultural activities in rural areas. It is also worth noting the criticism of modern policy in the development of rural areas and small towns associated with them in the direction of creative production.

In this regard, small and medium-sized cities are in the most critical state. For many of small and medium-sized towns (or, SMESTO), the following economic problems are relevant: limited economic base, the loss of enterprises, and, as a result, the oppression of the socio-cultural sphere of life of urban formations. The so-called single-industry towns, or "monotowns", occupy a special niche in the Russian economy. These are municipalities, in which the socio-economic and environmental situation depends on the activities and position of the city-forming enterprise, despite the fact that the economic base of such settlements is not diversified [10]. The vulnerability of single-industry towns to unfavorable external influences is combined at the same time with a unique historical, geographical and cultural component characteristic of any small and medium-sized urbanized formation. Mostly historical, single-industry towns and settlements represent a unique environment that bears the imprint of the traditions and customs of the local population. Previously, when studying the formation and functioning of monotowns, the emphasis was mainly on economic parameters. The study of the existing cultural-historical and architectural-planning framework of such settlements were ignored, therefore, today in many monotowns, objects of historical and cultural heritage are declining or are completely lost.

Systematic study and design of methods in order to activate single-profile cities in Russia were first carried out in the late 90s by the city Scientific and Methodological Center "Cities of Russia" of the State Institution "IMEI", according to which every tenth resident of Russia lived in single-profile settlements [10]. Raising the problem of single-profile cities, V. Ya. Lyubovny in the monograph "Cities of Russia" indicates that 7 out of 8 federal districts of the Russian Federation possess more than a half of monoprofiled cities, considering all the bulk of cities. Among them, the largest percentage is in the Privolzhsky and Ural Federal Districts. Lyubovny notes that, in addition to objective problems with the sustainability of the economic base, single-industry cities also suffer from methods of resilience determination, where life cycles of an enterprise and urban education are identified, while alternative ways and sources of city development are completely ignored. The desirable factors for the development of a single-industry town can be attributed to the historical, cultural and natural heritage, the existing scientific and applied potential, the location in the influence zone of large urban agglomerations. In this regard, it is worth noting that in terms of the number of historical settlements and monuments in the region, the Southern Urals occupies a worthy place, far ahead other areas of the most densely populated and economically attractive Central Chernozemny District and the already mentioned Volga District. Based on the information above, the authors of this article decided to consider an alternative, based on the historical, cultural and landscape development potentials of single-industry towns by the example of the Southern Urals and specifically the Chelyabinsk region.

In the article, urban transformations based on cluster principles are considered by the example of cities in the Southern Urals. In modern science, heritage studies were conducted mainly by local historians: V. S. God, I. V. Degtyarev, M. M. Eliseev, V. S. Samigulova, E. I. Skobelkina, I. V. Shamsutdinov and others, who collected material on individual architectural monuments. Studies that reveal the historical, cultural and planning features of the formation of settlements in the Southern Urals, including factory cities, comprise the papers of R. M. Lotareva, N. S. Alferova, E. G. Neklyudova, E. V. Ponomarenko, L. P. Kholodova, V. V. Alekseeva, V. D. Belov, S. V. Golikova, Z. I. Gudkova, V. V. Pyatkov, P. A. Vagina, D. V. Gavrilov. In the works of E. A. Animitsa, E. N. Bubnov, N. I. Bugaeva, V. L. Kolyasnikov, A. V. Lemigova, N. N. Lyaptseva the issues of the development of the Ural non-factory settlements are considered.

That is why, the need for adoption of measures to restore the urban balanced development seems to be urgent. At the present, the problems of single-industry towns are mainly considered as a result of their economic inefficiency in the current free market conditions. However, the authors argue that elaboration at the spatial level, the study and development of complex territorial and economic principles for the enhancement of monotowns can be much more effective than attempts to improve specific economic indicators.

The purpose of this study is to develop principles and approaches aimed at supporting urban integration and, first of all, solving the problem of preservation and adaptation of historical sites and territories in order to maintain local cultural identity.

The authors chose the path of local urban development as the main paradigm, which explains the use of clusters. This method requires identifying and using local potentials for socio-economic evolvement; therefore, the study sets the following tasks:

1. consider single-industry towns of the Southern Urals, determine their potential and identity;
2. identify the main directions of balanced development;
3. determine the cluster principles for the integrated development of their territory;
4. consider the prospects for their application on a regional scale.

2 Monotowns of the Southern Urals—The Assessment of Development Potential

Emphasizing the theoretical significance of the study and the illustrative example of the Southern Urals region for consideration of this topic, it is worth noting that many scientists and specialists have paid attention to the importance of preserving cultural heritage sites. However, comprehensive studies of historical and cultural monuments of the region have not been conducted, and their impact on the formation of sustainable development has not been determined. Existing approaches to sustainable development pay attention to environmental, economic, and social aspects, neglecting the importance of the historical and cultural environment. The actual task of this study is to pay attention to the unity of natural, cultural and industrial complexes that form the unique landscape of the territory.

An important incentive for the development of the Southern Urals in the XVIII century was the Orenburg expedition. The Industrial Revolution and the need for the formation of a production base marked the beginning of the one-time construction of large enterprises in the region. Factory towns were united by merchants and industrialists (the Lugins, Stroganovs, Knaufs) into single territorial complexes—mining districts, which included metallurgical plants, mines and mines, forests used for coal burning, rivers and hydraulic structures, as well as auxiliary industries. Thus, a group of industrial settlements, closely related to each other, was formed on a single territory at the same time.

Resource-rich natural areas and an identical cultural environment were attractive for narrow specialists of different directions. Based on these studies, several types of historically established settlements are identified: factory cities, workers' settlements, fortresses and redoubts, strongholds and Cossack villages, agricultural settlements that form the settlement system of the South Ural region [11].

All scientists and specialists emphasized the importance of preserving cultural heritage sites, however, comprehensive studies of the historical and cultural monuments of the region were not carried out, and their influence on the formation of sustainable development was not determined. Existing approaches to sustainable development pay attention to environmental, economic, social aspects, missing the importance of the historical and cultural environment. The actual task of this study is to draw attention to the unity of the natural, cultural and industrial complexes that form a unique landscape of the territory.

An example of a large industrial region of the South Urals is the Chelyabinsk region. Basic industry enterprises, mining industries, and nuclear research centers are concentrated on its territory. Out of 30 cities in the region, 16 are mono-cities, which are mostly located in the mining zone. The single-industry towns of the Chelyabinsk region have good labor-force and natural resources, production and scientific potential, an advantageous transport and geographical position, and a rich historical and cultural basis. Most of them were formed on the basis of factory cities, which were large production centers for several centuries.

The object of the study is the mining zone of the Chelyabinsk region, located in its northwestern part. The active development of the region and the construction of an industrial complex began in the middle of the 18th century. The city-plants that formed the mining zone were compactly located in two districts: Zlatoust-Miassky based on the Bakalsky deposit and in Kyshtymsko-Kaslinsky.

Today it includes 15 monocities: Asha (founded in 1898), Bakal (1757), Upper Ufaley (1761), Zlatoust (1754), Karabash (1822), Miass (1773), Minyar (1771), Nyazepetrovsk (1747), Ozersk (1945), Satka (1758), Snezhinsk (1955), Sim (1759), Trekhgorny (1952), Ust-Katav (1758), Chebarkul (1736). 4 cities have the status of a historical settlement: Zlatoust, Kyshtym, Miass, Minyar. Ehe mining zone includes such historical settlements as the cities of Kasli (1747) and Kyshtym (1757), which do not have the status of a monocity, but were formed like the listed monocities on the basis of the plant (Fig. 1).

There are monuments of architecture, archeology, history and monumental art in the region, belonging to all periods of the formation of the region. Religious architecture of the 18th–early 20th centuries here is outstanding—more than 80 objects have survived (Fig. 2). Along with Orthodox churches, the heritage includes preserved mosques (Fig. 3), Catholic churches and synagogues. There are also over 30 monuments of industrial architecture in the mining area, about 230 buildings are classified as monuments of public and civil architecture (Fig. 4). There are over 63 archeological monuments.

Satka can be called a striking example of an old industrial monotown. The Satka settlement was founded on the basis of an iron-smelting plant in 1758. Today the

Fig. 1. Karabash. Copper-melting factory

Fig. 2. The church of the icon of the sign of the most Holy Theotokos (Kaslinsky district, the village of Voskresenskoye)—Regional Heritage Object (1822–1835)

Fig. 3. Minaret in Miass, late XIX century. Municipal heritage object

Fig. 4. Kyshtym. The mason of the Demidov's «The White House» (second half of the XVIII century)—Federal Heritage Object

population of the town is forty thousand people. The monocity is located in the most picturesque part of the Chelyabinsk region in the vicinity of two national parks: Zyuratkul and Taganay. The rich architectural and spatial environment of the city, picturesque relief, as well as a partially obsolete industrial zone in the historical part allow the use of elements of both ecological and industrial tourism. In the Satka region alone, there are 43 cultural heritage sites: 23 archaeological sites (10 identified), 20 historical and architectural monuments (newly identified 4). The most outstanding ones are presented at Fig. 5.

The Urals are known as a multinational region with a rich culture based on ancient traditions. Not only Russians live here (who began to actively populate the Urals since the XVII century). Historically, three powerful linguistic communities—Ugro-Finnish, Slavic, and Turkic-speaking—were formed, coexisted and developed on this vast territory. For many decades, Russians, Tatars, Bashkirs, Kazakhs, Ukrainians, Belarusians, Chuvash, Mordvins, Germans and other peoples have lived in the neighborhood and cooperated with each other [12]. As a result of their interaction with each other, a heterogeneous ethnographic and anthropological composition of the local population appeared. Interethnic consolidation was the result of the successful adaptation of migrants to the conditions of the Southern Urals with the adoption of non-ethnic economic and cultural experience. Already in the first decades of the XX century, the peoples had common farming methods, an assortment of cultivated

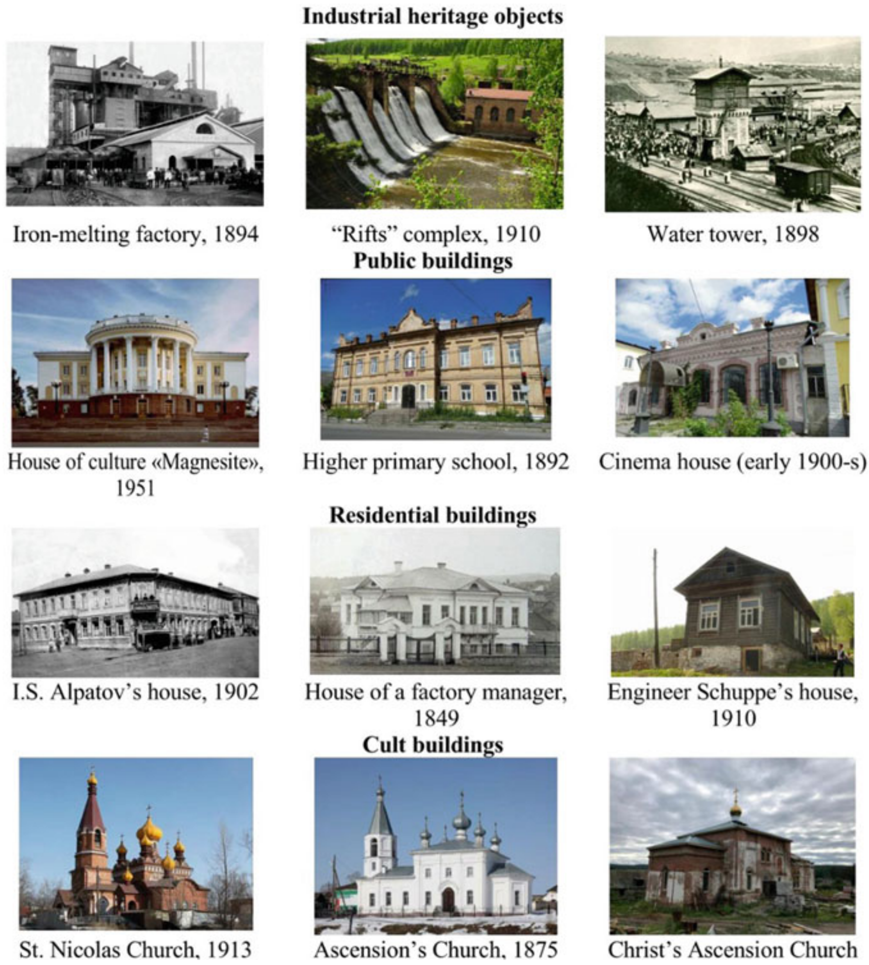

Fig. 5. Cultural heritage objects of the Satka municipal region

crops and tools. By means of capitalization and transportation, industrial development of the region, intercultural interactions intensified. To date, there are over 130 nationalities in the region. Interethnic consolidation was the result of the successful adaptation of immigrants to the conditions of the South Urals with the adoption of a different ethnic economic and cultural experience. The peoples had common methods of farming, an assortment of crops grown, tools of labor. With the capitalization and transport-industrial development of the region, intercultural interactions intensified (Fig. 6).

Folk crafts such as blacksmithing, pottery, working with birch bark, wood carving, patchwork, stone carving, hand embroidery and many others have survived in small settlements to this day [13] (Figs. 6 and 7).

Fig. 6. Folk crafts

Fig. 7. Folk arts, crafts and ethnic compositions

Based on the above analysis, it can be noted that the mining zone today occupies about 26 thousand square kilometer. The functioning of cities is ensured by maintaining orientation to the production, mining complex and the existing infrastructure. The enterprises, despite the outdated technical base, continue to work and for the most part retain their original field of activity. Among the features of the region, the most characteristic features of its development should be highlighted:

- uniform settlement and formation of mining and factory complexes;
- the significant role of interethnic ties in stimulating economic development;
- the need for economic and spatial structuring of a large area of the territory.

3 Results

The functioning of the cultural, natural and industrial landscape must be considered in a single system. The approaches to sustainable development used today do not contribute to the development of the cultural, historical and natural environment, but are aimed only at the modernization of the industrial complex. Therefore, within the framework of the study, it is proposed to use the cluster approach, which ensures the integrated development and rational use of the territory's potentials.

The use of the cluster approach for the formation of sustainable development of the historical and cultural environment of a small settlement was first exposed in the monograph by Blagovidova N. G. and Iudina N. V. "Cluster approach to valorization of small historical settlements by the example of Sestroretsk". The study opened up the diverse potential of small towns for the implementation of clusters as a universal model of sustainable environmental development [14].

Today, clusters in mono-settlements are considered only as industrial formations, the emphasis in which is on the economic sphere. However, the current trend towards an increase in territorial-production complexes, technopolises and technoparks based on single-industry towns shows its inefficiency. The cluster approach in this study is for the first time applied to the territory of single-industry towns from the point of view of preserving and maintaining the cultural and natural landscape, as an integrated model of sustainable development not of a separate territory or sphere, but of the region as a whole. To ensure the stable development of the old industrial mining monospecialized territories, it is necessary to develop particular principles and approaches to the balanced development of such zones.

For several centuries, architectural styles, local traditions, and crafts have been closely intertwined with each other, forming a multi-layered environment. This phenomenon is reflected in the principle of layering, which is responsible for the preservation and maintenance of the unique urban environment, the identification of the historical and cultural framework, the inclusion of these territories in an active urban life.

An important stage in the development of monotowns is the preservation of the leading key industry in conjunction with the modernization/restructuring of production, which is expressed in the principle of diversification. It is also necessary to maintain the system of workers' training, research and development of production facilities.

The formation of the space of a monotown should be based on a natural framework, features of the relief, climate, and hydrography. This provides the principle of regeneration, which gently introduces the urban structure into a natural framework that maintains the integrity of the existing biocenosis and biodiversity. The principle includes a set of measures for the restoration and reclamation of depressive unused areas, the use of treatment facilities.

The need to involve local residents and active communities in urban processes, the groups initiative forms the principle of self-organization, contributing to the involvement of interested residents and their direct interaction with the authorities, the most effective and democratic solution of urban issues. Transport accessibility to all city facilities is important for the functioning of a monotown. The principle of connectivity will help to ensure the modernization of both transport and engineering infrastructure, will make it possible to use the resources of the territory most efficiently, and will establish a business economic network.

On the basis of the above principles of sustainable development, cluster principles have been elaborated. The application of the cluster approach at the regional level will take into account local characteristics of the territory. Within the study, the cluster is considered as a method of creating a self-sufficient spatial component, structured by a system of internal relations of specialized industrial enterprises, research and experimental organizations, commercial companies, state institutions, local communities, historical, cultural environment and a natural resource complex based on the existing monocity in accordance with its potential.

The main principle that unites the mining structure is the symbiotic cluster principle, which considers natural and cultural landscapes as a symbiosis and a driver for the development of monotowns.

Subsequent cluster development principles are developed within the framework of the economic, territorial, social and cultural aspects. This will allow the most comprehensive and holistic approach to the growth and development of the territory.

Within the economic aspect, diversification of functions, internal interaction, external self-sufficiency, the cyclical nature of the network organization and the use of local potentials are considered. Measures to diversify functions ensure an increase in the efficiency of enterprises in order to obtain economic benefits and avoid bankruptcy, contribute to the development of new industries, expand the production of all types of goods, update export and import markets, establish business connections. Internal interaction helps to identify the interdependence of companies and their involvement in the process of resource and information exchange, contributes to their cooperation, the emergence of loyalty. External self-sufficiency forms the competitiveness of the cluster in the market relative to other participants in market relations, ensures its financial independence from the state and other cluster structures. The use of local potentials contributes to the improvement of the local production and economic base, the rational use of natural and cultural potentials to expand the sphere of production and services.

In the territorial aspect of the development of the cluster, concentration, adaptation, integrity, rootedness in the structure of the city are considered.

The concentration emphasizes the geographical location of the territory, the peculiarities of historical, cultural and landscape ties. The transformation of already existing enterprises/objects to the functional needs of the cluster occurs through the adaptation of objects. The system of interconnection between the parts of the cluster and the urban environment, which ensures the optimal functioning of all elements of the structure, is formed within the framework of the integration of objects. The cluster is also rooted in the structure of the city.

The social aspect of development includes the self-organization of the local community and its joint activities, involvement in creative activities, the use of intellectual, creative "capital", social cooperation, which ensures coordination of interaction and joint work of several interested social groups to coordinate and realize their own interests.

The cultural aspect of the cluster is characterized by the identification of objects of historical and cultural heritage in the territory of the settlement; preservation of identified objects; restoration through restoration, conservation, repair of objects; adaptation of objects to the modern pace of life and conditions of the urban environment, adding new functions.

All the indicated principles are represented on Fig. 8.

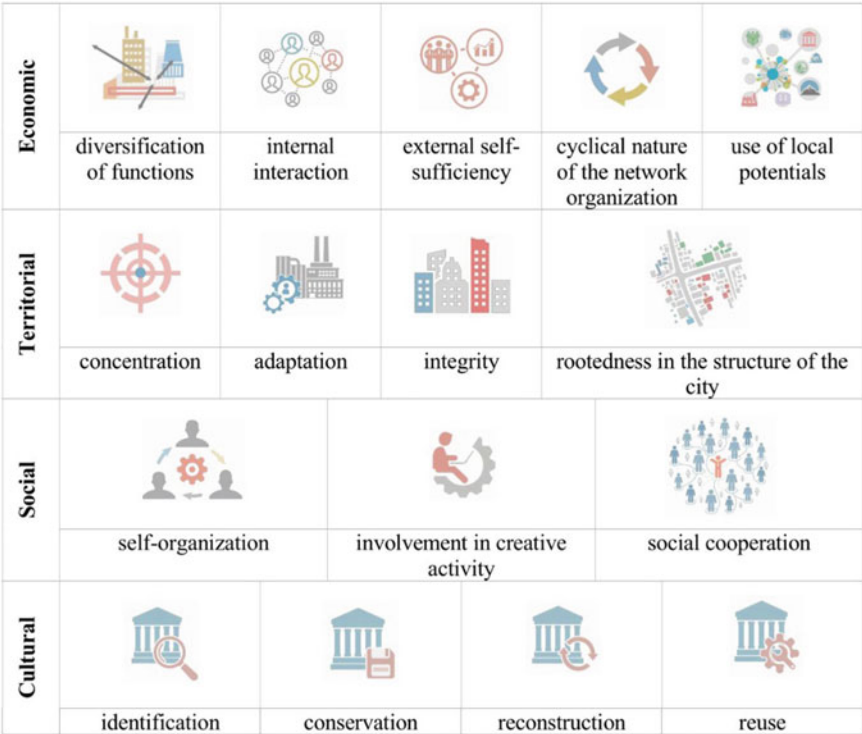

Fig. 8. Cluster principles of the Souther Urals region development

4 Discussion. Regional Features of the Cluster

The article attempts to prove that in the post-industrial period, the main engine of the development of single-industry settlements is not the production complex, but the value and uniqueness of historical, cultural and natural landscapes.

During the study, over four hundred registered objects of cultural heritage were identified on the territory of the mining zone. The interweaving of interethnic traditions, local crafts have the potential to develop the handicraft industry. Numerous monuments of history, architecture and archeology attract a lot of attention to this territory from both specialists and the world community. The historical environment and rich natural complex, developed transport infrastructure contribute to the formation of a self-sufficient mining cluster, one of the areas of development of which will be the tourism sector, capable of supporting and financing the historical and cultural heritage of single-industry towns. The cluster approach discussed above is a set of complex measures for structuring and consolidating the economic and architectural planning development of a city or associations of cities for the purpose of their economic rehabilitation and functional development. At its core, it has the decentralization of city-forming functions and assumes appropriate transformations of the urban environment at the planning level.

An integrated cluster approach to the development of single-industry towns and mining zone of the Chelyabinsk region allows the most holistic and rational approach to the development of cultural and natural landscape, the preservation of the identity of the local environment.

The formulated conclusions are reflected in other studies on the topic.

The nature of the interrelationships of the economic and urban planning structure has been considered in a number of works on the topic, for example, by Maoh and Kanaroglu [4]. At the same time, most of the articles focus on large urban formations. In such cities, secondary centers appear in the process of expansion: employment, leisure and other activities that perform the function of structuring within agglomerating cities and suburban areas. The authors of this article argue that for small and medium-sized urban formations that do not use agglomeration effects for development, nevertheless, the diversification of the functional base is extremely important, but already as a method that stimulates the balanced development and restoration of urban education.

Quantitative comparison and multifactor analysis confirm the ideas of creative potential in small towns and settlement systems that include them in the works of Escalona-Orcao et al. [7], Blagovidova and Iudina [15]. It is the creative industries that most often become the basis of cluster development.

Current research [7, 16] examines the relationship between cultural and creative industries and spatial organization, focusing specifically on the cluster type of organization, and this work supports and develops their point of view using identity factors—something consonant can be found in the mentioned “localization externalities”, which were also considered by Branzanti [15, 17]. The authors of this article support the statement about the importance of informal social institutions in the organization of cluster network interaction, which is especially important in creative industries and which can be found analogous in the craft artels of Russia and the USSR of the 19th and 20th centuries. At the same time, Gong & Hassink argue that the methods of analysis and development of creative industries based on profitability and economic efficiency indicators are a big problem, which practically excludes public and non-profit organizations from consideration. Their role is extremely large and underestimated in small and medium-sized cities of Russia, which face all the problems of single-industry.

The cluster approach, which focuses on material production, is also supported by Haase et al. [1, 17] highlighting deindustrialization, instability and insufficient growth as a result of the development of the service sector as the reasons for the degradation of European small and medium-sized cities. The emphasis on the positive role of economic, territorial and social planning, broad state participation in such cities is also indicative, which is actually a method of separating intra-city processes from the influence of global market relations.

Nevertheless, in a number of works one can see the attraction to alternative approaches to working with single-profile urban formations, which are associated with criticism of the cluster approach. The objective complexity of cluster formation in the current economic conditions and in relation to vulnerable urbanized settlements is revealed. Haase et al. [1] point out the need for long-term significant financial injections into shrinking urban formations, which are also single-industry cities in Russia. Such scenario seems unlikely mostly because mass-social activity in single-industry small and medium-sized cities is as small as their economic efficiency. That is why the authors of this article highlight the cultural aspect of the cluster as a way to stimulate social integration. The cultural integrity of the city is inseparable from the planning transformations, and therefore should be closely linked with the economic component, which is provided by the transformations within the framework of the cluster approach.

Naturally, when developing depressed territories, it is important to take into account the problems not only of individual industrial facilities and single-industry towns, but also of the region as a whole—the authors see the prospect of further practice-oriented research in the scalability of the approach to regional interconnections. As it was noted in Sect. 2, the Southern Urals have not only the potential of local unique production, but also provide resources for cultural and leisure activities, the development of the hospitality industry, which has already begun to progress towards the formation of cluster structures. It is also worth noting that the services sector is currently the most progressive in the field of economics. Cities and settlements, national parks and nature reserves are combined into routes depending on the orientation of both internal and external tourist flows to certain types of activities.

Industrial tourism is becoming more and more popular among Russians and the foreign public. We can mention the factory-settlement in Zlatoust, as a creative association of a network nature. Ecological tourism is conditioned by the variety of landscapes of the Urals, their uniqueness. The most favorable ones for this type of interaction, for example, Satka, are located between national parks. In recreational tourism, its material basis was laid by the Soviet era with the construction of sanatoriums on numerous Ural lakes and in areas of agricultural land—such cluster can form the suburbs of Ozersk, such as Kasli, Kyshtym and sanatoria Sinegorie, Uvildy, Akakul, and Sungul. The role of cultural tourism in the infrastructural development of the Southern Urals is much greater than one might imagine. On the considered territory, objects of cultural heritage and tourist attraction are often located off the beaten track, and it is their allocation into routes that contributes to the structuring of regional links.

As we can see, there is already a tendency in the Southern Urals to single out local structures based on the characteristics of cultural identity. The cluster approach is designed paying special attention to the most vulnerable urban formations—monotowns—to stimulate recovery and transformation processes and create viable territorial economic systems in intra- and intercity space.

5 Conclusion

Thus, the article suggests an alternative way of working with single-industry cities, involving the allocation of alternative potentials as a basis for the subsequent development of long-term development plans. The authors proposed the principles of the development of single-industry towns based on the cluster method. The application of the cluster method is innovative, because for the first time when developing approaches to small towns, factors of cultural identity and the potential of local economic development are organically combined in one approach. Using the example of the Southern Urals, it is shown how effectively cluster principles can be used in cities of increased economic vulnerability.

The main trends and challenges of the development of this territory were outlined:

- uniform settlement and formation of mining and factory complexes;
- the significant role of interethnic ties in stimulating economic development;
- the need for economic and spatial structuring of a large area of territory.

The principles developed in response to the above-mentioned trends are complex, strategic and structured. In addition, they can be universally applied to any single-profile urban formations. The authors for the first time distinguish:

- the symbiotic cluster principle as a key principle of consolidation of the potentials of the territory;
- in the economic aspect: diversification of functions, internal interaction, external self-sufficiency, cyclical network organization and the use of local potentials;
- in the territorial aspect, concentration, adaptation, integration, rootedness in the structure of the city;
- in the social aspect, self-organization, involvement in creative activities, social cooperation;

- in the cultural aspect, identification; preservation; restoration; adaptation of objects of historical and cultural heritage.

Based on the conducted research, theoretical developments and analysis of sources on the topic of the article, the thesis was put forward that single-industry cities need not relocation, which on average 20–30 times exceeds the cost of budget expenditures of single-industry entities, decentralization and enrichment of functions, both economically and spatially. The possibility of localized and structured development is provided by the cluster method. The flexibility of the developed principles makes it possible to work with urban entities with unique ethnic, landscape, industrial and historical-cultural conditions at different scale levels, which gives the right to assert the prospects for further development and testing of the proposed principles.

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Factors of Sustainable Architectural and Urban Development of Samara (Kuibyshev) in 1940s–1950s

V. A. Samogorov and E. A. Gromilina

Abstract A study of the architectural and urban development of the city of Samara (Kuibyshev) in the 1940–1950s was carried out. This process was presented as a sequence of projects, the implementation of which became a condition for the next urban development projects, which became the basis for the sustainable development of the urban planning system in the future. This made it possible to conclude that the stability of the urban development evolution was determined by such factors as the construction of the Volga waterworks and Bezymyanskaya TPS, the formation of the oil industry, the creation of defense aircraft complex and a new residential area Bezymyanka, the transformation of Kuibyshev into the reserve capital of the country, the construction of the Kuibyshev waterworks. An overview of the evolution of urban planning structure is one of the ways to understand not only sustainability, but also the interaction of architecture and urban planning with the environment throughout history, and relation between social, political and economic aspects in urban development. The topicality of the research is the fact that sustainability in a broad sense is the goal and benchmark of modern urbanism. Taking into account the special aspects of the urban development evolution of Samara will make forecasts more reasonable of its future urban development.

Keywords Sustainable development · Special aspects of architectural and urban development of Samara in the 1940–1950s · Volgostroy · "Second Baku" · Industrial district Bezymyanka · Kuibyshev waterworks

1 Introduction

In the aspect of determining the factors of sustainable development of Samara and taking them into account when developing prospective urban planning forecasts, it becomes relevant to study the features of urban development evolution. The rapid

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growth of the city of Samara, in the past Kuibyshev, was associated with its transformation into a large industrial center in the 1940–1950s, which determined the peculiarities of the development of the urban planning structure in the subsequent period, right up to our time. The city today is perceived as a complex system, metabolism, ecology, agglomeration economy, as a place of social interactions. The urban planning structure creates a build environment that differs in many respects from the natural environment that has evolved historically over time.

Contemporary research in sustainable development focuses on the study of sustainable architecture. At the same time, there is an increased interest in the enduring features of vernacular architecture. This is due to the need to respond to climate change, environmental pollution and the desire to reduce energy consumption. The study of regional architecture and knowledge of traditional structures is most often aimed at using them as a resource or guideline in the field of sustainable development [1–3].

The term "sustainable development" was originally coined in the field of forestry and included afforestation and harvesting measures for interconnected forests that should not undermine biological renewal of forests. This term was first mentioned in the Strategy for Conservation of Nature and Natural Resources of the International Union for Conservation of Nature, published in 1980 [4]. Although initially sustainable development was primarily considered from an environmental point of view, it soon spread to various fields of study in the field of sociology and economics and became a multidisciplinary concept. In addition, an integrated approach to the consideration of the problem of sustainable development implies a historical assessment of the events that had a direct impact on the formation of the architectural and planning structure of the city.

This study aims to clarify the factors that have the sustainable development of Samara. The object of the research is the urban planning structure of Samara, the subject of the research is the factors that determine its sustainable development.

The research problems are evolution of the urban planning structure of Samara, finding the features that determined the sustainable development of the city, definition of the factors influencing the sustainable development of the urban planning structure.

The study is novel in the study of social and economic factors in the evolution of urbanism. The study of architectural and planning evolution of Samara (Kuibyshev) in the 1940–1950s shows that at the first stage the process was rather undetermined, although it implemented the directions of the Party and government. The fact that these decisions were often not fully thought out and justified is indicated by the complex path of their implementation and the constant change of priorities in determining the prospects of the city. Urban planning evolution of Kuibyshev is presented as a process of implementation of individual projects, each of which became a factor determining the implementation of the next stage.

The architectural history review has several objectives that address the relationship of sustainability and the urban planning structure. These historicize the problems that arose during the implementation of general development plans, understanding the structure of the city as an ecosystem, identifying the main management decisions that ensured sustainable development, as well as studying the dynamics of the changes that took place [5].

A lot of research has been done on this topic, but they usually concern the study of the history of the architectural and urban development of cities. These are domestic works devoted to the theoretical foundations of Soviet urban planning (Astafieva-Dlugach M., Barkhin M., Belousov V., Bocharov Yu., Glazychev V., Gradov G., Gutnov A., Ikonnikov A., Kosenkova Yu., Lezhava I., Smolyar I., Khan-Magomedov S., Khait V., Yakovleva G., Yargina Z. and others). International studies of the issues of architectural formation of cities include the works of theorists Aureli P. V., Rowe K., Ketter F., Rossi A., Sennett R. and others [6–8]. However the aspect of the relationship between the factors of urban planning and sustainable development is byway.

The development of long-term urban planning plans requires careful study of the process of city development during this period, since exactly in the 1940–1950s, elements of the urban structure of Samara were laid, which had a significant impact on the change and formation of the city. For example, the construction of the Volga Hydroelectric Complex changed the natural and climatic features, in particular, the coastline and air humidity. The construction of the aviation complex and the location of large production facilities significantly reduced about air quality, but at the same time gave a significant impetus to the development of the regional economy, which made it possible to further develop and make the rest of the city more comfortable. This study aims to review the history of architectural heritage and provides an opportunity to further explore the sustained development in the context of the social, environmental and economic balance that historically influenced sustainability.

2 Methods

Methodology is based on a comprehensive study of the problems of sustainable development of the city. The study used evolutionary and systemic methods. The evolutionary method consists in identifying the time perspective of the development of the city and its individual elements and is aimed at determining the factors that, at certain stages, have a significant impact on the formation of the architectural and planning structure of the city, ensuring its sustainability. System analysis is aimed at a systematic consideration of the elements of the architectural and planning structure of the city, whose formation is a factor in the sustainable development of the city. Evolutionary and systemic analysis in the study of the architectural and planning structure of a city in the context of successive development is aimed to identify elements that ensure sustainable development. The basic methods underlying the study were the contextual method, which determines the mutual influence of the socio-political context and the architectural and town-planning facts of the city's development [9]; a method for studying the facts of the urban environment as complex phenomena of architecture [10].

A retrospective forecast based on studying the uncertainties faced by society, creating opportunities, managing political action and improving decision-making processes is used to make better forecasts of the development of the architectural and planning structure of the city and to further investigate the issue of city development. This allows new development options to be assessed from a rational perspective, thereby broadening the understanding of what might be feasible and realistic in the long term.

Accordingly, hindsight begins by identifying the desired future and then works backwards to identify the strategic steps needed to build workable and logical pathways between future and present states [11]. Developing pathways from this perspective allows one to imagine the impact of alternative scenarios that are commonly used as a strategic planning tool, especially with regard to sustainability. Being strictly normative in nature, retrospective forecasting is particularly well suited to be applied to sustainability issues [12].

The framework of the study was established: chronological—1940–1950s, spatial—the city of Samara, subject—the study of the architectural and planning structure.

The material under study was obtained from the study of graphic documents, as well as archival search and field study of the urban environment. An archival research method is one of the most common methods used in the study of architecture. Materials of the Central State Archives of the Samara Region, city planning schemes of the 1940–1950s years, as well as prints of that time. Comparison of the schemes of the master plan of the city with historical events made it possible to establish a connection and assess the influence of social and political factors on the development of urban planning structure of Samara.

3 Results and Discussions

3.1 Volgostroy

The beginning of the town-planning evolution in the considered period of Kuibyshev was connected with the construction of the Volga Hydroelectric Complex on Krasnaya Glinka in 1938. This project was called "Volgostroy" and became a key component of the large-scale state project of integrated use of water resources of the country—"Big Volga". Volgostroy solved two tasks: to be the energy basis for industrial development of the region and to become the basis for agricultural development through irrigation of the region.

On August 10, 1937 a joint decree of the USSR SNK and CC of All-Union Communist Party (b) No. 1339 "On construction of Kuibyshev waterworks facility on Volga river and hydrosystems on Kama river" was issued. It stated that in order to further electrify central regions of the European part of the USSR, to carry out extensive irrigation of Zavolzhye and to improve navigable conditions on the Volga, it was necessary to build dams, hydroelectric power stations and locks on Samarskaya Luka near Kuibyshev city. It was planned to complete the design task and necessary survey works by January 1, 1938. At the same time, it was planned to carry out preparatory works such as construction of auxiliary power stations, roads, housing, repair bases, procurement of local building materials, etc. The technical project was to be submitted for approval by the USSR Council of People's Commissars not later than May 1, 1939. The production of the necessary equipment by Narkomtyazhprom's factories was to be completed in 1941 [13]. To implement the project, the Kuibyshev Hydroscheme Construction Department (KHCD) was set up and headed by S. Y. Zhuk.

The construction was unfolded at two complex sites. The first, the "Ruslovy node", was located near Krasnaya Glinka station, 30 km upstream of Kuibyshev, where a dam, spillway and hydropower plant of 2.5 million kW capacity were to be built (see Fig. 1). The second, the "Derivation node", was located in the Perevoloky watershed, 80 km below Kuibyshev. There were plans to build a navigable canal with a two-chamber lock with a capacity of 80 mln tons and an oil pumping unit with a capacity of 18 mln tons of oil.

By January 1940, the outline of town of builders of Kuibyshev hydroelectric installation—future village Upravlencheskiy—began to appear. Houses of the first ten quarters were settled. In the central part, capital buildings of hydrotechnical, concrete and other laboratories were built. More than 130 houses were put into operation including a 4-storey school building, a hotel, a club, a cafe and a canteen. The construction of a 63-apartment block of flats was coming to an end. In 1940 funds were allocated for the construction of eight 4-storey and 5-storey buildings, a polyclinic, 15 wooden cottages. Works on the improvement of the town were carried out. There were plans to build a stadium for 3000 spectators [14].

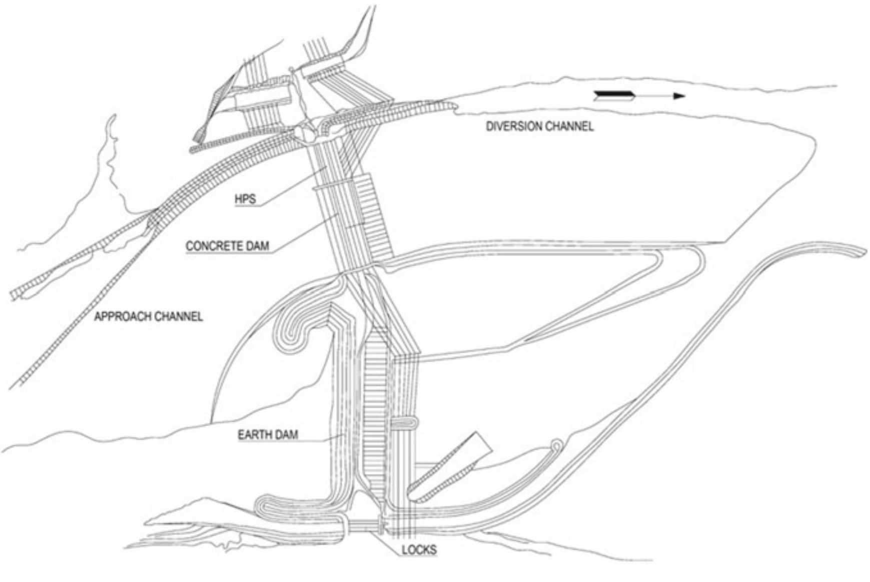

Fig. 1 Scheme of the dam hydroelectric unit on Krasnaya Glinka, 1940 (from the book by M. Kuznetsov, Kuibyshev hydroelectric power plant. Regional magazine, Kuibyshev, 1940)

In 1938 the construction of Bezymyanskaya CHPP began. In February 1940 the frameworks of the main building, machine-shops, garage and warm-cold warehouses had already been constructed. The stone house occupied by the headquarters, canteen and other buildings were put into operation. The workers' camp was erected and two stone houses for 46 flats were built. By the end of 1940 the builders of the hydroelectric plant had to prepare for erection a part of the main building of the power station. The first stage of the Bezymyanskaya CHPP was to provide power in 1941. The 100,000 kW power plant was to be fully put into operation in 1943 [15].

However, despite the fact that the final deadline for the technical project was set for 1 July 1940, it was never submitted by that date or later. High costs of cementation works for installation of the impervious blanket in the Volga river channel, fractured limestone bedrock under the construction of the hydroscheme, and oil-producing wells in Samarskaya Luka, which were not taken into consideration in the project and were under flood [16], were among reasons for such situation. Although it is known that the principal and decisive reason of the stoppage of construction of Kuibyshev waterworks was the Decree [1] 343ss of the State Defense Committee under SNK of the USSR dated August 6, 1940 "On construction of aircraft factories for aircraft and engine building".

3.2 Aviation Complex

The Defense Committee decided to start in 1940 the construction of three aircraft plants in Kuibyshev area on Bezymyanskaya site: aircraft plant 122 on production of 1500 two-engine bombers per year, aircraft plant 295 on production of 2000 single-engine bombers per year and engine plant 337 on production of 12,000 engines AM-35a and M105 per year. The construction of the plants was imposed on the NKVD and was planned to be completed in 1942. Design was undertaken by the People's Commissariat of the Aviation Industry (GPI-1), which was instructed to issue master plans for the plants by September 1, 1940, and to begin issuing working construction drawings for the initial work from that date (see Fig. 2).

After acceptance of the decision on construction of air plants, the economic council at the Council of People's Commissars of the USSR approved the scheme of the general plan of Kuibyshev by the decision from November, 23rd, 1940 [17].

In October, 1940 on Bezymyanka station the building of the main shops of aircraft plants No. 122, 295 and 337 and living quarters for employees of these enterprises began [18].

To supply the plants with electric and heat power the design capacity of Bezymyanka CHPP was supposed to be increased from 100 k kW to 150 k kW and the construction of Bezymyanka CHPP with the capacity of 50 k kW was to be finished in 1941 and 100 k kW—by the end of 1942.

In October 1941 the Bezymyanskaya CHPP supplied its first current. The layout of Bezymyanka CHPP and residential area shows that by 1938 the territory of Bezymyanka from current Aurora Street, Kirov Ave. and Samara River and K. Marx

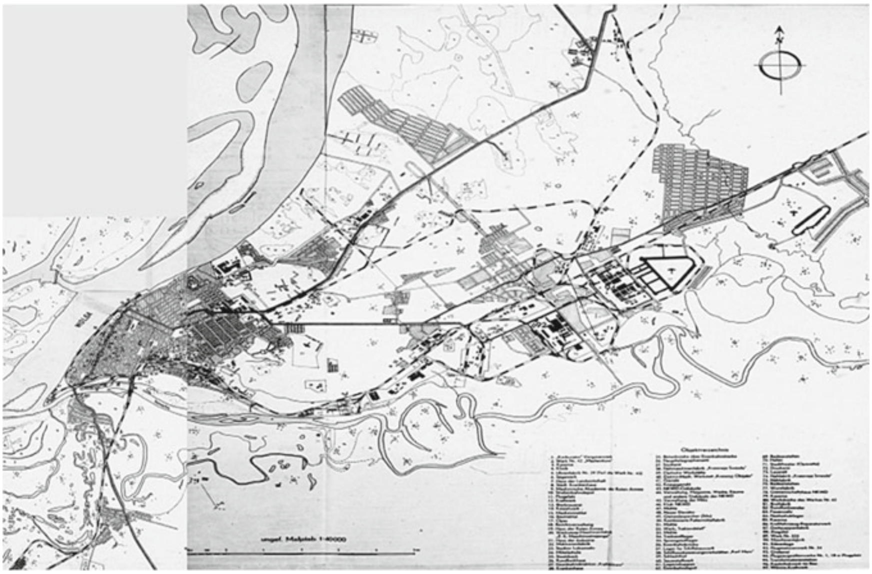

Fig. 2 Map of Kuibyshev including location of industrial enterprises on Bezymyanka, 1943 (http://gregorkon.wordpress.com/2010/10/19/22-101-1)

Ave. had been solved in planning terms. On the substrate, on which the institute Teploelektroproekt was working, the routes of the modern streets of Kirov Ave., Novo-Vokzalnaya, XXII Party Congress, Volskaya, Pobedy streets, and the layout of Bezymyansky industrial area had already been outlined. It was located between the railway and the bank of the Samara River from Avrora Street to Kirov Highway. The scheme indicated both the existing plants—Tolevo-tarpaper Plant, Brick Factory, Artel "Chod", Meat-Packing Plant, N.K.P.S. Spare Parts Plant, and newly projected plants—Valve and Pump Plant, Compressor Plant, Bezymyansky TPS, Truck Plant, Hydraulic Turbine and Generator Plant, Cable Plant and others, as well as prospective areas for industrial production. Industrial and residential zones were connected in planning scheme—they had common planning grid and city highways—14th line (XXII Party Congress street) and 1st Bezymyansky proezd (Kirov highway) had continuation in structure of industrial area with allocation of pre-factory zones. Precisely these reserve areas became in wartime a place of dislocation of evacuated enterprises.

The Special Construction Administration of the NKVD of the USSR built in 1941 in Bezymyanka new industrial area includes aircraft-building plant 122 (on the base of evacuated from Moscow plant No. 1 named after I. V. Stalin). Aircraft-building plant No. 295 is on the base of evacuated from Voronezh Voroshilov plant No. 18. Engine building plant No. 337 is on the base of evacuated from Moscow Frunze plant No. 24 named after A. V. Frunze. The airfield; plants 454 and 145 produce armament for planes; plant 305 producing normalisers; plant 35 producing propellers; plant 1 of Orgaviaprom producing pneumatic equipment for planes. The first stage of the Bezymyanskiy thermal power station produces 50,000 kW; the mechanical plant producing pneumatic equipment for planes, the plant 1 producing pneumatic equipment for planes, the plant 1 producing pneumatic equipment. The first stage of the Bezimyanskiy thermal power plant with a capacity of 50,000 kW; the mechanical plant for the production of armoured housings for "Il" aircraft and armoured housings for tanks; a special workshop of the People's Commissariat for Arms on the territory of the Kuibyshev Locomotive Repair Plant. In total, about one million square metres of production and living space were put into operation.

The agency that determined the development of the Bezymyanskiy industrial hub was the People's Commissariat of the Aviation Industry (PCAI). The district layout project was developed by Giproaviaprom institute together with local architects, with the direct participation of A. L. Kanevsky, the chief developer of the city master plan, who was appointed head of the Kuibyshev branch of Giproaviaprom—SPB-1.

3.3 Residential Area "Bezymyanka"

New residential quarters were being built along 1st Bezymyanskiy Proyezd (Kirov Highway) and 2nd Bezymyanka Street (Victory Street). In 1940, the Moscow Department of the Planning and Engineering Equipment Sector of "Gorstroyproject" Institute of People's Commissariat for Construction of the USSR completed two projects is a detailed planning project of residential quarters Nos. 613, 634, 657 of the NKAP factories complex and a detailed planning project of residential quarters Nos. 707, 709, 710, 711 of the PCAI builders settlement, in accordance with which the residential, cultural and community buildings were constructed (see Fig. 3).

Quarters Nos. 613, 634, 657 were located within the boundaries of existing streets Victory, XXII Party Congress, Svobody, Novo-Vokzalnaya and had dimensions in plan of 336 × 350 m. In longitudinal direction they were divided by boulevard, in transverse direction—by public gardens. Schools for 880 and 440 pupils were projected at the crossing of the boulevard and squares. As a result 4 residential quarters were formed in each block with kindergartens for 150 children, nurseries for 120 children and outbuildings inside. On the perimeter of each block there was a 4–5-storey building, and inside—2-storey buildings. From the Pobedy Street side on the ground floors of the dwelling houses there were objects of social services as well as a detached cinema for 800 seats. In blocks 634 and 657 from the side of Victory Street there are green courdoner. The size of the blocks was 10, 11.6 and 11.8 ha. Two variants of the housing area were calculated on the basis of the housing standard of 9 sq m/person and 6 sq m/person. Accordingly the population density averaged 450 persons/ha (under the first option) and 660 persons/ha (under the second option).

Quarters nos. 707, 709, 710, 711 were also projected by Gostroyproject Narkomstroy of the USSR in 1940 and were located at the intersection of 2nd Bezymyannaya Street (Victory Street) and Kirov highway. Quarter No. 710 was situated between present-day Victory Street, Voronezhskaya Street and Krasnodonskaya Street; blocks No. 711, 709, 707 are along Kirov Avenue between Pobedy Street and Kirov Avenue.

Fig. 3 New residential area Bezymyanka with neighbourhood signs (author's scheme)

Kirov Avenue, between Pobedy Street and Yuny Pionerov Street. The area for construction of the builders' camp was allotted by the Executive Committee of the Kuibyshev City Council by decision No. 22/19 of April 10, 1940.

In Block 710, from the side of Victory Street, a green courdoner was arranged with the Builders' Club. A longitudinal boulevard parallel to Victory Street divided the quarter into two parts. As a result, 5 residential courtyards were organised within the block. The development of the blocks is perimeter. There are 4–5 storey blocks of flats on Victory Street. Within the block there was a school for 880 pupils, two kindergartens for 100 children, two kindergartens for 120 children, a bath-house for 180 places, a laundry, a boiler house, a transformer, sheds, sales stalls. Inside the blocks there were 2-storey blocks of 12 and 18 flats, ordinary and corner blocks. All the buildings were designed in accordance with standard solutions.

3.4 Reserve Capital

On October 15, 1941 the State Defence Committee issued decree No. GKO-801 ss "On evacuation of Moscow, the capital of the USSR". And if the new Bezymyanka district during the war turned into a major industrial hub, the Old Town became a place of dislocation of important government agencies and diplomatic missions, having become, in fact, the second capital of the Soviet state. Apparatuses of the Central Committee of the CPSU, the Presidium of the USSR Supreme Soviet, the USSR CPC, the Central Committee of Komsomol, the People's Commissariat for

Foreign Affairs, the diplomatic corps moved to Kuibyshev. The presence in the city of party and government agencies contributed to the rapid commissioning of evacuated enterprises and strategic objects. During the war in Kuibyshev was built the headquarters of the Supreme Command and Government, known as "Bunker of Stalin", the command post of the Naval Staff and a bomb shelter (Object "A"), a high-power radio station near the village of Novo-Semeikino ("Object number 15").

3.5 "Second Baku"

Beginning from the mid-1930s, oil fields were explored in the vicinity of Samarskaya Luka. In 1943 the first oil wells were discovered. Their productivity showed that large oil reserves were concentrated in the region. On August 21, 1943, the USSR leadership decided to build the Kuibyshev oil refinery. In this regard, by the Decree of the Presidium of the USSR Supreme Soviet in the same year Kuibyshev district was established. In September 1943, construction of cracking plant [1] 443 began near the village of "116 km". The construction was carried out by the Special Construction Department of the USSR NKVD. In 1944 the installation of the equipment, which had been received under lend-lease from the USA, began. By the end of 1945 the main facilities had been built and commissioned. In the same year the first automobile petrol was produced.

The design of the plant and the working village of oil workers, the so-called Sotsgorod, was carried out by the Architectural and Design Workshop of Academician V. A. Vesnin "Giproneftezavod" of the USSR Ministry of Oil Industry, which he had been since 1934. This workshop later developed the design of the city of Novokuibyshevsk. The chief architect of the workshop was I. S. Nikolaev, one of the founders of industrial architecture in our country. The chief architect of the No. 2 department of the workshop was S. E. Vakhtangov; the chief architect of the projects was M. N. Slotintseva. The workshop was engaged in designing oil industry enterprises and settlements attached to them throughout the Soviet Union. The architects of the workshop, S. A. Maslikh, M. N. Slotintseva and O. A. Yafa, developed standard projects of one- and two-storey residential buildings, which were combined into a general series number 210 and were widely distributed throughout the country in the 1940s and 1950s [19].

In September 1945 the Kuibyshev refinery was included in the number of operating enterprises. A workers' camp with a House of Culture and a stadium was built next to the enterprise. The workers settlement was first called Novo-Stroyka, later Settlement of Oilmen, and in the 1950s it was renamed Sotsgorodok.

3.6 The Urban Planning Structure by the End of the 1950s

By the end of the 1950s, Kuibyshev city had a two-part structure in its planning: the Old town and a new industrial area Bezymyanka. Industrial enterprises were concentrated in two industrial districts—Bezymyanka and Kuibyshev district.

In 1949 a group of specialists, which included architects, economists and engineers, worked out a new master plan for the city of Kuibyshev with the perspective of development until 1965, and determined its first implementation period until 1955. The group of developers included A. I. Matveev (chief architect of the city), A. L. Kanevsky (head of the architectural and planning group), V. Zaraiskov (acting head of the architectural and planning workshop) I. I. Gordeev (head of the engineering and economic group), N. I. Boltunov, M. I. Matyunin, V. N. Piskunov, V. P. Mikheev, B. P. Markovsky, P. Chernyshev (acting head of the APM). The basis of the development of the master plan was the determination of the city's population size for the estimated period. By 1955, it had been forecasted at 700 thousand people.

The general plan of 1949 determined the directions of the spatial-planning development of the city. Like in the previous general plan of 1937, it had to develop along the Volga river in north-east direction. To the north development we planned to reach green area of Privolzhsky gardens and KATEK plant, and to the east—the railway line of the 4th GPP. The idea of urban development was based on the consideration of the natural features of the area, in particular the topography. Residential districts were located in the most advantageous places from the point of view of architecture and sanitary perception.

The Volga River was perceived as the main structural and compositional axis of the city. The main highways and the public centres formed its composite framework. Architecturally significant buildings, squares and boulevards were designed with the main compositional axis taken into account. From the Volga the new master plan had planned to form the main city frontage from Strelka to the city water pipeline.

The existing city planning grid and the indicated direction of its growth determined the routing of the city's main thoroughfare Novo-Sadovaya Street along elevated territory parallel to the Volga River, from Samarskaya Square to Podpolshchikov ravine, past the Central Park of Culture and Recreation, Privolzhsky Gardens and to Krasnaya Glinka. At Podpolshchikov ravine Novo-Sadovaya street branched off to the centre of Kirovsky district. This diagonal thoroughfare, as well as the existing Churnovskaya transport thoroughfare, linked the existing part of the city with the new district by the shortest route.

Parade exits to the Volga River were projected perpendicular to the main architectural axis: Samarskaya Ploshchad—Yarmarochnaya Street; Polevaya Street; along the Central Park of Culture and Recreation along the 4th alley; the 11th line from the centre of Kirovsky District; and Kirov highway through a green area of Privolzhsky gardens along the 7th alley.

On the main architectural axis parallel to the Volga river there was the main administrative and cultural centre of the city, which included four existing squares—Chapaev, Kuibyshev, Samara and Selskiy, as well as the embankments from the water station and Nekrasovsky spusk to KINAP plant. The second most important social centre was the Industrial district centre (now Kirovsky). The third important Science Centre was designed in the area between the Botanical Gardens and the Clinical Hospital with an exit onto the architectural diagonal street.

An example of a complex ensemble development at that time was Victory Street in the Kirovsky district. It had a width of 50 m, two asphalt passages with a wide boulevard between them with tram tracks on a detached strip. The street was built up with 4–5 storey houses. The blocks alternated with the big squares, which were the resting places of the citizens. Another street with an architectural design was Kirov street.

After the war a metal bridge across the Samara River was built and put into operation on September 15, 1954. The new bridge had a trolleybus route to the Zasamarskaya part of the city to connect with the Kuibyshev district.

A plan of Kuibyshev, published in Volzhskaya Kommuna newspaper in 1956, showed that the city was divided into seven administrative districts: Samara, Lenin, Stalin, Molotov, Kirov, Krasnoglin and Kuibyshev [20]. The city was organized into blocks, which were numbered and there were a total of 949 blocks [21]. The city plan of 1959 showed that its structure consisted of two large spots—the Old Town and Bezymyanka district and smaller working-class settlements: Schmidt's, beyond the Samara river, Kuznetsova, Tolevyi, Myasokombinata, Stakhanovsky, Zapadny, Tomashevka, Yablonka and others. Between Old Town and Bezymyanka, sections of development along Chernovskoe highway (ul. Gagarina) and ul. Promyshlennosti could be seen. This development had to fill the gap between the two largest parts of the city, to form a unified city frame along the main traffic arteries.

The project of the Kuybyshev coastal area was the largest urban planning project in the history of Samara, which defined the scale of the new socialist city. The project was developed in 1953 by the architectural department of Gorproject (chief of the department A. L. Kanevsky). Architects I. G. Salonikidi, N. V. Podovinnikov, I. M. Zobina, P. A. Scherbachev, M. G. Moshkova, A. V. Godzevich, M. A. Trufanov, V. A. Larionov, M. I. Gololobov, K. I. Yatsenko, engineer N. I. Rozanov and technician M. A. Korchagina participated in the design.

The projected Coastal area continued the development of the historic centre including Samarskaya Street and the three associated squares—Samarskaya, Socialist Farming and Osipenko. Along the axis of Yarmarochnaya Street a wide boulevard with flower beds, fountains and sculptures was designed. In the centre of Samarskaya Ploshchad an administrative block with a 14-storey central section would be situated (see Fig. 4).

The upper and lower embankments were designed on the basis of natural features. The upper embankment was built up with large residential buildings of 5–7 storeys. The lower embankment was built up by separate residential complexes with gaps between them to open up the space in front of the upper embankment [22].

In 1949, under the directions of the chief architect of the city, A. I. Matveev, a closed competition was held at the APM of the Municipal Architecture Department to design the development of Samara Square. According to the design of the local architects, the central part of the ensemble was completed by the high-rise building

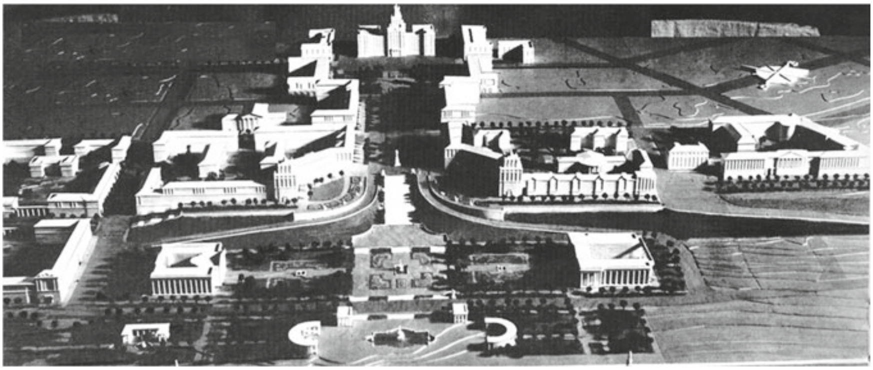

Fig. 4 Project of the coastal area of the Old Town, 1953 (photo from the personal archive of architect P. A. Shcherbachev)

with the spire of the Hydroproject. The perimeter was formed by the residential and administrative buildings "under one ledge". The landscaped square was turned into a boulevard, which led to the embankment of the Volga River.

In 1954, construction of the First Stage of the embankment was resumed. During two years a reinforced concrete retaining wall of 1350 m was built on the section between Nekrasovsky and Vilonovsky descents.

The second stage of the embankment started at the Kuibyshevskaya hydroelectric power station and continued to the KINAP plant. Along the whole embankment, a boulevard was organized with a swimming pool, pavilions for recreation, sports grounds and playgrounds for children.

In the post-war years the Bezymyanka residential area continued to develop. The blocks adjoining to the main highways of the district—Kirov highway and Victory street, were built up in complex and belonged, mainly, to the department of aviation industry. At first, during the war years along Kirov Highway the Central settlement was built—the Settlement of builders of NKAP factories, represented by the blocks of 2-storey building (blocks No. 707, 709, 711 and 710). Then, after the war, Quarters Nos. 712 and 713 were built. And in the 1950s the aircraft factories built up Victory street, from Novo-Vokzalnaya street up to Kirov highway (blocks No. 718–719, 721).

Quarter 718–719 was designed by Giproaviaprom in 1949. The land within the boundaries of Voronezhskaya, Pobedy, Krasnodonskaya and Fizkulturnaya streets was allocated to the aviation plant for residential development. The size of the block was 346 × 150 m. Quarter No. 718–719 was designed and developed as a unified architectural complex. In the area of 5.14 ha 11 residential buildings, a school for 880 pupils, a nursery for 88 children and a kindergarten for 110 children were planned to be built. All the buildings were designed in the Soviet classical style. Pursuant to the USSR Council of Ministers' resolution (No. 3772 of November 4, 1948), which prohibited local bodies of the USSR Committee for Architecture under the Council of Ministers to approve individual designs for residential and civil buildings and to issue permits for works on individual designs, in 1949 Moscow-based Giproaviaprom developed standard residential sections of series No. 10. By order No. 569 of May 30, 1949 of the USSR Committee for Architecture under the Council of Ministers, they were approved and recommended for construction in the Central and Eastern regions of the USSR. In the architecture of Kuibyshev, houses of the No. 10 series were found in different districts of the city. The buildings composed of three sections were especially popular. Their structure allowed for clear compositional solutions with classic symmetrical facades. In block No. 718 there are six 3-section buildings of this series.

Quarter No. 721 within the borders of Pobedy, Kalinina, Fizkulturnaya and Novo-Vokzalnaya Streets was also designed by Giproaviaprom in 1952. The size of the block was 393 × 156 m and the area was 6.13 ha.

The settlements of Nizhny, Shlakoblochny and Bruschaty belonged to the Kuibyshev area, which was called Mashstroi. By the early 1940s the Meat-packing plant and production artel "Chod" were already located near Stakhanovskaya platform. Not far from them, it was decided to start building a gas-compressor plant. Since this plant was to be a part of the USSR People's Commissariat of Machine Building, the construction trust Kuibyshevmashstroi was established in our town. Hence the name "Mashstroi" was used in October 1938. In 1941 the site of gas compressor plant was given to another company—future "Metalist" plant. On July 10, 1941 four trains from Donbass arrived in Kuibyshev. Just before the war they started to build plant number 525 in the town of Artemovsk, but when the war started it had to be evacuated to Kuibyshev. Being a part of aviation complex, "Metalist" manufactured machine guns ShKAS and DShK. They were put on planes and torpedo boats.

In 1951 in Kuibyshev construction of the largest in Europe metallurgical plant began. In 1953 the construction and assembling trust Metallurgstroy was established, the main task of which was to speed up construction of the plant. On November 4, 1955, the first ingot was cast and in December 1955 the foundry started serial production. In February 1956, the pipe-rolling shop was put into operation and on December 28, 1958 the plant's largest workshop—the rolling one—was put into operation. On the 5th of July 1960, the government commission accepted the plant into operation [22].

Houses for workers, schools, shops and other facilities were built together with the plant. The workers town of metallurgists appeared. First houses of ironworks were built by "Promstroi" trust in 1952. Later on the construction of metal workers town was begun by "Metallurgstroy" trust, headed by P. Mochalov. From the present square, named after him, and to KMP, a boulevard, built up with 5-storey blocks of flats was laid. The Metallurg stadium was built. On the territory of Metallurgov settlement there were 6 schools and 12 kindergartens, a club for young technicians, and music school 9. The entire spectrum of Soviet specialty shops were situated in close proximity to one another in the Metallurgov community: House of Clothes, Thousand Melochy, Ocean, Bookstore, Gastronome. "The Metallurgov Town" was in many ways a "state within a state", providing its inhabitants with an autonomous existence.

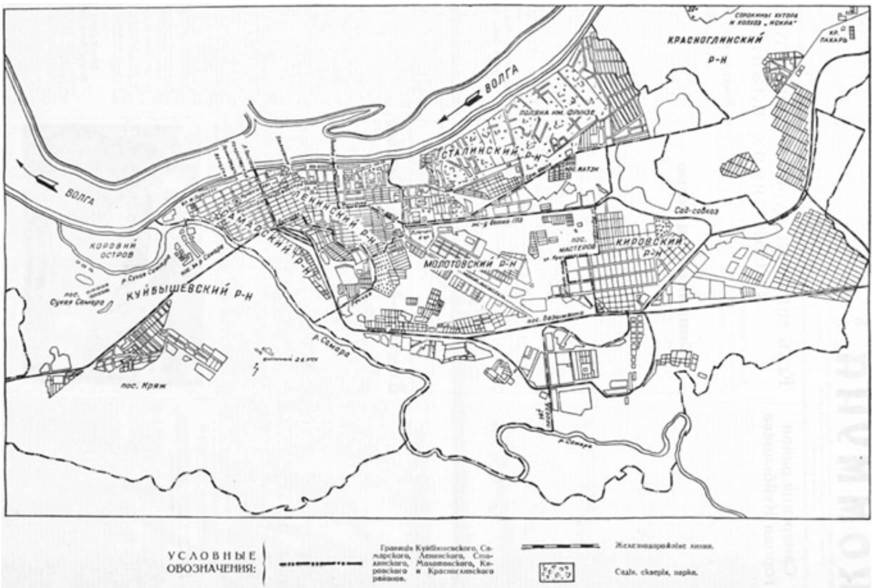

Fig. 5 Scheme of arrangement of Kuibyshev city districts, 1956 ("Volzhskaya Kommuna", 06.10.1956, p. 2)

Until the end of the 1950s the town was a conglomeration of dispersed workers' settlements, built near industrial enterprises. Most of them gravitated towards the Volga and Samara rivers and the railway, as the most important structural elements of the urban plan. Within this conglomerate of planning formations the Old City and new Bezymyanka industrial district were the main ones. The former had a polyfunctional structure with many workplaces in the form of relatively small enterprises; the latter had a monofunctional structure with two distinct zones—residential and industrial. Bezymyanka was linked to the Old Town by rail, road and tram lines (see Fig. 5).

On June 30, 1949, the Council of Ministers of the USSR adopted a resolution "On the construction of the Kuibyshev hydroelectric power plant on the Volga River". Design, survey and research works were to be carried out by the "Gidroproekt" Institute, which was to submit a design statement by October 1, 1950, and a technical design of the plant by January 1, 1952, with a commissioning date of 1955. The USSR Government Decree "On Construction of Kuibyshev Hydro Power Station on the Volga River" dated August 21, 1951 officially started the construction. A construction organization Kuibyshevgidrostroy was established to carry out the construction of the hydropower plant.

The main construction and installation works were carried out in 1953–1955. In summer 1955 works on covering of the Volga river began and were completed in October 31st and then the filling of the reservoir started. In December 29, 1955 the water level in the artificial sea allowed to start up the first hydro-generating unit of the Kuibyshev hydroelectric plant. In May 1957 the level of the reservoir reached the design mark. In October 14, 1957 the last, the twentieth hydro-unit was started up and in August, 10, 1958 the government commission approved the act of acceptance of Kuibyshev HPS for regular operation.

Completion of the Kuibyshev HPP coincided with the completion of the era of socialist realism architecture and summed up the architectural development of Kuibyshev on the principles of Soviet classics. Maintaining a certain inertia, the construction of buildings on the principles of architectural classicism continued until the end of the 1950s. The last buildings built in this style were the Metallurgov Palace of Culture and the Kirov Palace of Culture in Bezymyanka district.

4 Conclusions

The results show: determination of the relationship between the evolutionary stages of the city's development and the factors of the formation of urban planning structure determine the sustainable development of the urban planning system; systematization of the elements of the architectural and urban structure demonstrate the factors of sustainable development of the city, identification of the features of the architectural and planning formation of the city, which determine its identity and authenticity against the background of sustainable development.

The study of architectural and urban planning evolution of Samara (Kuibyshev) in the 1940s–1950s has shown that the factors that ensured its sustainable development were the availability of enormous water resources in the form of the Volga river basin, which became the basis for the formation of a major hydro-energy complex that determined the direction of the city's industrial and agricultural development in the region; the creation of a major defence aviation industry complex and the creation on its basis of the new industrial district of Bezymyanka. The discovery of oil deposits near Samarskaya Luka and the formation of the oil industry became the basis for the development of Kuibyshev district in the city with the largest oil refinery transformation of Kuibyshev city to reserve capital of the country during Great Patriotic War which became a basis for development of the Old city. Formation of the unified transport system which basis transformed city from two town-planning formations—Old city and new Bezymyanka district—into single socialist city; construction of Kuibyshev hydrounit—the largest in the country and formation on this basis of energy-intensive metallurgical works. Thus, architectural and planning elements, realized in the period 1940–1950-x years, determined the further development of the city of Samara. Management decisions made by the government determined the direction of growth against the background of pronounced structural changes. The social aspect during the World War II had a strong impact on the possibility of implementing strategic plans for the deployment of the defence complex and the development of industry.

Considering these features is a significant factor in the validity of the development of forecasts for the future sustainable development of Samara. By adding knowledge of the sustainable development and the architectural history, the surveys can be closely aligned to better understand the needs, reactions and experiences of people in the build environment, as well as influence the direction of research in architecture and urban planning.

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Historical Stages of the Development of Types of Parking Garages Under the Influence of Scientific and Technological Progress

Evgeniya V. Malysheva

Abstract The article considers the evolutionary development of the typology of parking garages under the influence of scientific and technological progress. The purpose of the study is to identify the chronological sequence of a number of "key events", associated with the emergence of certain innovative technologies for their time, that influenced the typological features of buildings and structures for storing cars. Advanced technologies are considered, such as: "Internet of Things" (IoT); flexible mobility on demand systems (FMoD); cloud technologies; automotive vehicles, which in the future will affect passenger transport and transportation, which in turn will affect the appearance of cities and the architectural and planning solutions of buildings. As a result of the study, the need to search for effective space-planning solutions for parking garages, which not only provide the required number of parking spaces, but also consider modern trends and technologies related to transport infrastructure, is emphasized.

Keywords Parking · Sustainable development · Flexible mobility on demand systems · Automotive vehicles

1 Introduction

The relevance of the study stems from the problems caused by the uncontrolled growth of road transport. In the dynamically developing world, especially in large cities, there are acute issues of transport problems. The measures taken (increasing the speed of traffic, expanding the road network, creating paid parking zones) are aimed at improving the situation associated with moving vehicles. However, these transformations do not solve problems of accommodating personal vehicles. In the process of searching for a solution to the problem of ensuring efficient storage of vehicles in a modern environment, we should turn to historical experience, trace the main stages of the evolution of parking garages from the moment of the appearance

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of cars and the first objects for its storage to the development and implementation of modern multi-level fully automated parking garages, including those built into buildings of other typologies [1]. The purpose of the study is to identify the chronological sequence of a number of “key events”, associated with the emergence of certain innovative technologies for their time, that influenced the typological features of buildings and structures for storing cars.

It should be noted that car parks are a relatively new type of buildings that appeared simultaneously with the invention of the car in 1769 (Cuyuglot’s steam carriage). Depending on the growth rate of the level of motorization, in Russian and foreign scientific literature to subdivide the history of the formation of a typology of parking garages into several main stages: the pre-war period (1930–1940s), post-war years (1950–1960s), and modern history (1970s–1990s). The history of the development of road transport and the typology of parking is directly related to scientific and technological progress [2]. Constantly developing technologies directly affect the improvement of vehicles and their storage locations. In this study, it is proposed to add to the above stages of the historical development of parking garages a stage of recent history (from 1991 to the present), and also to identify in chronological sequence a number of “key events” associated with the emergence of certain innovative technologies for their time, influencing the typical features of buildings and structures for storing cars.

2 Methods

The evolution of the development of a typology of car parks is usually studied in the context of historical events, taking into account stylistic architectural projects and described as a phased appearance or another type of car park. In the work of L. Yu. Voropaev, several stages in the development of the typology of parking lots were identified: open flat parking lots, single-level flat parking lots, multi-level parking lots, underground ramp-type garages, semi-mechanical garages, mechanized parking lots, automated mechanized parking lots, rotary mechanics parking lots. S. Henley’s research describes the evolution of parking lots under historical events, levels of motorization and trends in architecture. This study is based on S. McDonald’s work on the history of design and construction of parking lots, which analyzes key issues related to architectural typologies of parking lots and presents ideas and visions for the future [3] (Table 1).

The article reconstructs the relationship between the evolution of the typology of parking lots and technological innovations, the degree of their influence. Also, the study is aimed at identifying technologies that in the future will affect the typology of parking lots. The study uses modern methodologies for the collection and processing of statistical and graphic information, including an integrated approach and research methods such as the collection and systematic analysis of theoretical and practical material; and the conduct and analysis of field surveys; systematizing examples of project practices; computer modelling in graph analysis diagrams.

Table 1 Analysis of existing approaches

Research title/Author	Historical stage name	Timespan
Principles for the design of parking lots in residential complexes/L. Yu. Voropaev	Open flat and single-level parking lots	20s of the XX
	Multi-level parking lots	
	Underground ramp-type garages	20s of the XX
	Semi-mechanical garages	
	Mechanized parking lots	It wasn't detected
	Automated mechanized parking lots	
	Rotary mechanics parking lots	
The architecture of parking/S. Henley	The predating World War I	1905–14
	The post-war year	1918–28
	The great depression and World War II	1929–60s
	The revolution in car ownership	1970s–now

3 Results

The appearance of the first cars (1770–1904). Initially, the car was used for entertainment, and driving it was one of the pastimes. In the cities and suburbs, the car was kept in the former stables and in the coach houses. This fact, as well as the low level of motorization of that time, limited the impact of the car on the urban environment. Many cars made before 1910 were electrically powered, and electric companies encouraged the rapid growth of technology. Thus, many of the first garages were specifically for electric cars (taxis or private vehicles) (see Fig. 1). In 1894, Henry Morris and Pedro Salom began commercial production of the Electrobat in Philadelphia, the company later developed into the Electrobat Vehicle Company, and in 1898

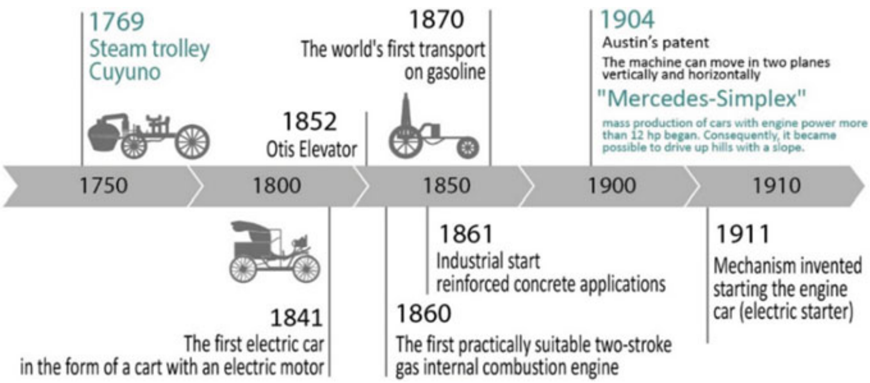

Fig. 1 Timeline of "key events" influencing the typology of parking (1796–1911)

the company built the first US-registered garage. The first known multi-level car park was opened in central London in May 1901. The City and Suburban Electric Carriage Company, an electric car manufacturer, built a seven-storey car park for 100 cars. This is probably the very first multi-level indoor parking in history [3].

Early garages for cars powered by other sources, such as steam and gasoline, followed the pattern of electric garages. In fact, electric, gasoline and steam vehicles were often stored together. These garages include: Auguste Perret's garage on rue de Pontier (1905) in Paris, the Marshall and Fox Automobile Club of Chicago (1907), the Marvin and Davis garage for Palmer and Singer in New York, built in 1908 [4].

The introduction of the conveyor method of production of cars (1904–1918). American inventor and industrialist G. Ford, who widely used the conveyor system for assembling cars, made a significant contribution to the widespread use of cars. The advent of assembly line made the car affordable for the emerging middle class. The car began to personify physical and economic mobility. By the mid-1920s motor vehicles began to acquire a utilitarian value, and there was a need to park a car in public places. With the increase in the number of cars, public garages began to appear, but outwardly they were no different from other types of buildings (see Fig. 2) [5].

Development of various ramp configurations (1918). In the 1920s modern technologies such as the elevator and turntable were ubiquitous in early multi-level garages for cars. The Otis Safety Elevator, used to lift passengers and cargos since 1852, seemed the logical choice for lifting cars to their storage location. Garages equipped with elevators had numerous advantages, but by 1925 they began to disappear. The most widespread ones were garages with ramps—inclined structures designed to move cars between levels in a multi-level parking garage, which significantly influenced the design of garages. By the mid-1920s, more and more car parks appeared, equipped with both an elevator and ramps. These car parks include Portland Street Garage and Eliot Street Garage. By the end of the decade, garages equipped with elevators existed only in high- density cities such as New York.

Invention of the all-metal car body (1935). By 1935 a steel car body appears, durable paints are used, gasoline becomes suitable for year-round driving. All these factors have led to the emergence of open parking garages. In 1948 Robert Lowe in

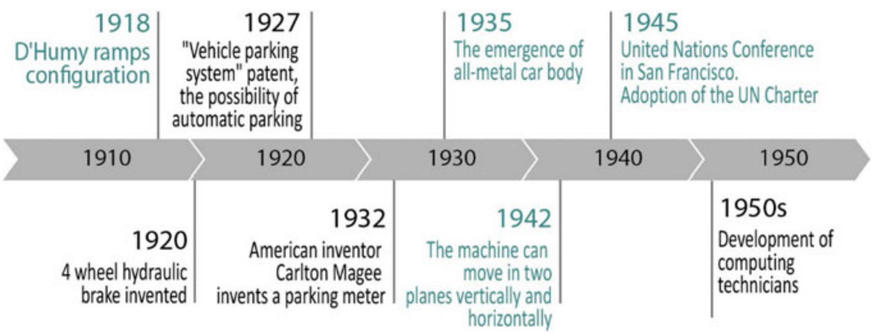

Fig. 2 Timeline of "key events" influencing the typology of parking (1918–1950s)

Miami designed a garage that was completely devoid of walls, windows, and various eclectic façade elements reminiscent of other types of buildings. "Removing" the facade of the building reduced the cost of building the parking garages and provided the necessary ventilation [3].

In 1930–1950 two main characteristics of garages were manifested: first, the rejection of enclosing structures; the second is a complete transition to independent movement of the motorist inside the building. These characteristics are fully consistent with the spirit of modernism, when form follows the function. In this regard, in the 1950s parking garages with open spiral ramps were widespread. The Great Depression and World War II halted the development of the parking typology. In the postwar years, especially in the 1950s, the car becomes available to a wider mass of the population and a boom in the construction of parking garages begins [4].

Invention of fully automated car parks (1942). Despite the fact that by the 1930s the most popular ones were ramp car parks, mechanized car parks still continued to attract the attention of designers and engineers. Mechanized garages of that time were far from perfect, the parking process was controlled by an operator using control levers and buttons. The patent "Mechanical parking: a new generation", issued in 1942 to E. W. Austin, became the basis for many later developments of fully automated parking garages, which did not require the participation of an operator or driver in the parking process. In 1955 Charles A. Bertel, who by that time had a patent for a container sorting mechanism, changed the purpose of his mechanism and placed a car in a container. This car park became the prototype of modern three-dimensional matrix car parks. Poor development of automation and materials led to the use of very limited types of parking systems. Several unsuccessful experiments in the application of the Bertel system put an end to its development. But the idea remained alive and was implemented at the next stage of the development of parking technologies [6].

The development of computer technology, the creation of the Internet (1970s). Since the early 1960s the idea of compact automated car parks is gaining popularity in Japan and Europe. The Japanese economic miracle is in full swing, West Germany has recovered from the aftermath of World War II, and economic growth has led to an increase in the number of cars. In the mid-1960s, Bob Lichty developed the 22 capacity rotary parking, which compares favorably with its counterparts.

Initially, mechanized parking systems collapsed rather quickly, since a large number of moving parts participated in the parking process. In addition, to identify problems, it was necessary to rely on a subjective assessment of the person: there was no exact way of monitoring, maintenance and repair. With the development of computing systems (1950s) and the advent of portable computers (1980s), in fully automated car parks, computer monitoring ensures the reliability and safety of parking systems. For example, laser sensors can now pinpoint the exact location and operation of every element of the system, and software can track usage times and send alerts to ensure that worn parts are replaced in time.

Implementation of "sustainable" technologies (1980s). After the founding in 1978 of the UN program to promote sustainable development of human settlements, strategies of "sustainable" development and "sustainable" technologies are being introduced everywhere in all spheres of life. Energy efficient buildings are part of a comprehensive solution to environmental problems [7]. Parking at the Fairfield Multimodal Transportation Center (Fairfield, Calif., 2002), designed by Gordon Chongand Associates, has set a new standard in energy efficient parking. Solar panels were installed on the facade of the building, and there were places for parking bicycles and charging electric cars inside [8].

The 2003 Stop Go, Chicago Portal Project challenged designers to create a 1000-car parking lot located between Madison and Monroe Streets and connected to the expressway. In most projects, it was proposed to hide the parking lot behind landscaping. An innovative approach stood out for the project called "Filter Garden", which won first place and was a fully automated tower-type parking lot with a height of 40 m, separated by a "filter garden" for cyclists and pedestrians. The towers served as a visual reference point—"gates to the city", and also provided information to passing cars that there were parking spaces. In the 2000s, the typology of garages goes beyond the concept of a warehouse for cars; much attention is paid to interiors, comfortable pastime of owners of personal vehicles inside the parking lot, and safe movement of pedestrians [9].

Implementation of the concept of "Internet of Things (IoT)" (1990s). As the population grows and the traffic density in modern cities increases, the surest solution to the parking problem is to create a traffic system that "disappears" after it is used. At the moment, technologies for self-drive cars that will solve this problem are still being developed, but technologies for wireless intelligent parking have already appeared. Special smart sensors located in the parking lot, the creation of which is based on the IoT concept, collect information and transmit it back to the central platform. Thus, the system provides parking data in real time, allowing drivers to determine which places are occupied and which are available for parking. The smart parking industry continues to evolve as more cities suffer from traffic congestion and a lack of affordable parking garages [10, 11].

Implementation of "flexible mobility on demand (FMoD)" (2012). Disruptive trends in mobility can fundamentally change the relationship between the consumer and the car. The popularization of car sharing by companies such as Airbnb, Zipcar, Uber, Yandex, Delimobil has shown significant growth in these organizations over the past few years. Mobility offered as a service, rather than car ownership, enables consumers to choose the best solutions for specific trips: intercity or commuter, for "the last kilometer" journeys. "Flexible Mobility on Demand" (FMoD) is a mode of public transport (private or municipal), the purpose of which is to use advanced technologies to provide users with convenient services that are flexible in terms of route selection, vehicle type and payment method, as well as available for different categories of citizens. The widespread use of FMoD makes it possible to reduce the number of cars and the duration of parking, which in turn will affect the capacity of parking garages, and a decrease in the number of private cars will entail a decrease in the need for private parking lots (see Fig. 3) [12].

Building "sustainable urban mobility" (2013). With the rise in the level of motorization everywhere, more and more researchers involved in strategic urban planning are coming to the conclusion that it is necessary to move to sustainable transport systems. The 2013 UN global report on human settlements «Planning and Design

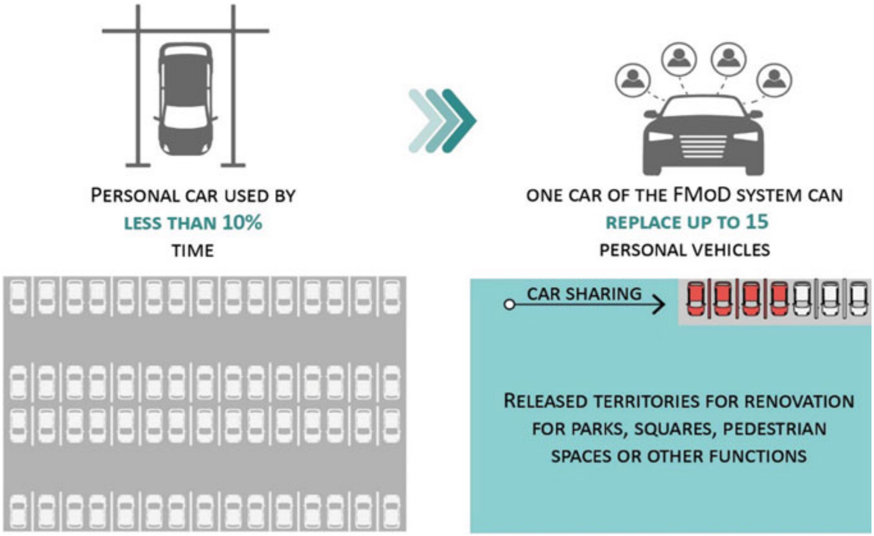

Fig. 3 Impact of "flexible mobility on demand (FMoD)" on the capacity of parking

for Sustainable Urban Mobility» notes that improving the sustainability of the urban transport system can be achieved by changing modes of travel: reducing travel by private car and increasing the share of public transport and non-motorized travel (walking and cycling). The challenge of the concept of sustainable mobility is to create a city of such quality and scale, which minimizes the need to use personal transport and reduce for storage places [13]. Rethinking approaches to the design of parking garages, which are links in the transport infrastructure, will contribute to the formation of "sustainable mobility" in cities.

The first flight of the air car (2014). Over the years, flying car projects have been created, for example the Curtiss Autoplane, developed in 1917, was the world's first flying car. The most successful design to date is possessed by the AeroMobil 3.0, the first flight of which took place in 2014. The emergence of new modes of transport is always reflected in architecture and urban planning [14]. So with the advent of the aeromobile, new types of buildings will appear with new unusual shapes of roofs and consoles, functional connections will be reduced, and urban planning concepts will change.

The appearance of the first serial automotive vehicles (2015). Automotive vehicles (AV) are an unconditional trend of the future, which, according to the forecasts of world scientific and analytical centers, will come pretty soon. In 2004, the first ever car competition with the participation of DARPA robocars took place. In 2010, the world saw the first Google autopilot based on the Toyota model. Equipped with radars, video cameras and the LIDAR system, this Googlemobile could navigate in space, recognize road signs and interact with other participants in the traffic. In 2015, the first serial self-drive cars appeared—Tesla Model S, which move on the

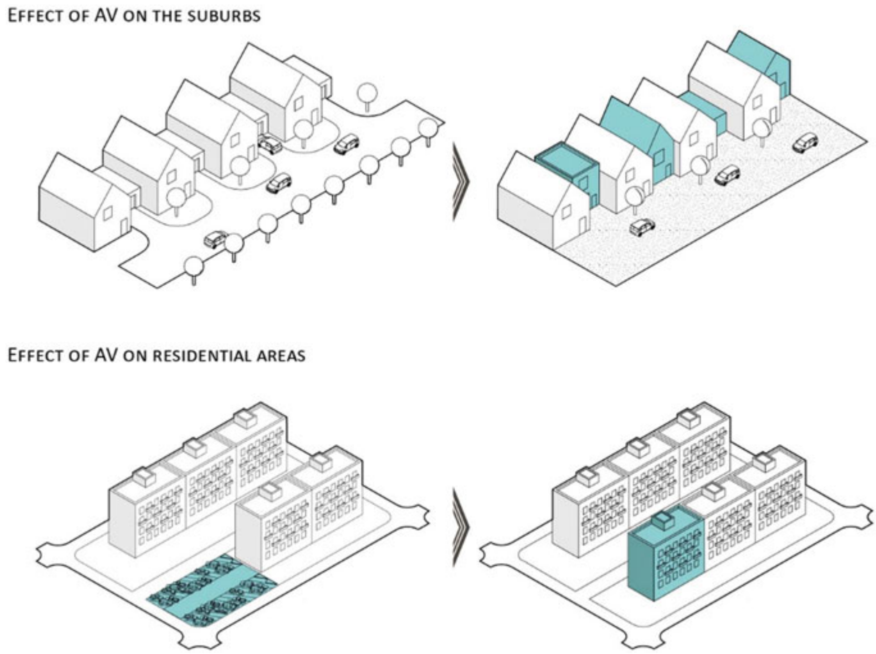

Fig. 4 Impact of automated vehicles on urban form

roads completely independently. They, along with Googlemobiles, are considered the benchmark for self-drive technologies. In the period of 2016–2017 all major auto companies announced the development of their own proto-types of "robocars" and plans for their serial production. The emergence of automotive vehicles is a reality for the next decade [14]. The technical and economic issues of self-drive technologies are being studied all over the world. However, there aren't practically studies of their possible impact on the urban environment. At the same time, without a doubt, the technologies of automotive movement will change the urban environment and these changes will be irreversible, so it is important to have an idea of the consequences of their implementation in order to avoid negative developments in the situation and try to get the maximum benefit from the use of AV (see Fig. 4) [15, 16].

4 Discussion

Analysis of the influence of scientific and technological progress on the evolution of the typology of parking garages showed that their space-planning solutions are closely related to the development of forms of movement and innovative solutions in construction. Based on the analysis, a chronological sequence of a number of "key events" associated with the emergence of certain innovative technologies for their

Table 2 Proposed historical stages of the study

No	Historical stage name	Timespan
Early garages		
1	The appearance of the first cars	1770–1904
2	The introduction of conveyor method of production of cars	1904–1918
3	Development of various ramp configurations	1920s
Pre-war period		
4	Invention of the all-metal car body	1935
5	Invention of fully automated car parks	1942
Period of modern history		
6	The development of computing technology, the creation of the Internet	1970s
7	Implementation of “sustainable” technologies	1980s
8	Implementation of the concept of “Internet of Things (IoT)”	1990s
Recent historical period		
9	Implementation of “flexible mobility on demand (FMoD)”	2012–now
10	Building “sustainable urban mobility”	2013–now
11	The first flight of the air car	2014–now
12	The appearance of the first serial automotive vehicles	2015–now

time influenced the typological features of buildings for storing cars: the appearance of the first cars (1770–1904); the introduction of conveyor method of production of cars (1904–1918). This includes development of various ramp configurations (1918); invention of the all-metal car body (1935); invention of fully automated car parks (1942); the development of computing technology, the creation of the Internet (1970); implementation of “sustainable” technologies (1980s). There is also implementation of the concept of “Internet of Things (IoT)” (1990s); implementation of “flexible mobility on demand (FMoD)” (2012); building “sustainable urban mobility” (2013); the first flight of the air car (2014); the appearance of the first serial automotive vehicles (2015) (Table 2).

5 Conclusions

Demographic trends, changes in consumer preferences, price changes, improved transportation, the Internet of Things, cloud technologies and other technological innovations are already influencing how much people travel by car. Car parks play a key role in the process of adapting to these changes, as the space in which man and machine interact. The most important challenge in the design of car parks today is to identify the unique needs of a particular location—not only now, but in the future—and fully meet those needs. This requires an understanding of past decisions, a willingness to apply innovative approaches, and respect for the aesthetics, functionality and social structure of the environment. This study has achieved the stated goal identified in chronological sequence «key events» that have already influenced or in the future can influence architectural and planning decisions of parking lots.

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Architecture of a College as a Form of Existence of the Material Environment of Higher Education in Medieval Europe Modern Campuses Formation Prerequisites

Aleksey Popov

Abstract The article reviews the architecture of a medieval European college as a form of existence of the material environment of higher education of this period. Various examples of such objects in countries of Southern, Central and Western Europe are analyzed. The morphological similarity of this type of buildings arising in different regions of Europe is confirmed. The features of the development and functioning of the special space of the university courtyard and the prerequisites for its development and the formation, ultimately, of the environment of modern university campuses are considered. The study of the medieval period in the development of the architecture of higher education is especially important. This period defines a clear place, goals and objectives of higher education in the society of European countries. The structure is fixed by legally significant documents and the boundaries of the liberties of the university community are determined. A system of academic degrees, recognized both in the inter-university community and outside it, is being established. Teaching methods and a list of knowledge requirements at each level are being developed. Universities develop in synergetic relationship with the settlements where they are located, their organizational structure becomes more complicated and a special material architectural environment is formed. The research topic seems to be quite important, but typological research on it is currently very limited. Thus, the article traces the development of college architecture in medieval Europe as a form of existence of the material environment of higher education and its influence on the formation of modern campuses.

Keywords College · Campus · University · Material environment of higher education · Higher education · Architecture · Form

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1 Introduction

The study of the history of the development of the architectural and urban planning tradition of the formation of the higher school environment is particularly relevant in the light of the current socio-economic transformations in Russia and the world.

European universities in the first centuries of their existence, being corporate structures—communities (universitas) that had an internal organization, hierarchy, rights and freedoms, etc., however, did not have a material environment for existence and even a rigid connection to a geographical area or settlement. Moreover, there are known cases of “moving” of universities from city to city because of a conflict with the city authorities. The most famous cases of university migration led to the formation of Padua (migration of Bologna in 1222) and Cambridge (migration of Oxford in 1209) universities [1]. After some time and reconciliation with the local authorities, the university usually returned to its original place. Later, the universities had such right to leave the city in case of a conflict, enshrined in legal documents. For example, the Bull of Pope Gregory IX “The Foundation of Sciences” (Parens scientiarum) of 1231, which defined the freedoms and privileges of universities, directly granted the latter the right of secession, i.e. “moving” to another city [2].

Since the absence or lack of real estate assigned to the university was often observed [3], the classes and accommodation of students took place in this early period of existence on a variety of conditions in buildings and premises of various typological groups.

The main structural unit and the primary level of the hierarchical organization of the lower faculties (faculties of liberal arts) of early universities are the school of the master-regent. Firstly, it was understood as a social structure under the leadership of the master-regent and including his assistants—one or more bachelors and many students—scholars, and secondly, as a room in which classes took place. This room was sought and rented directly by the head of the school at his own expense. Thus, a variety of premises were sought for classes, from public and residential to religious [2].

For example, the University of Salamanca had no buildings at all during the first two hundred years of its existence. Having received the status of “Studium Generale” from the Spanish king Alfonso IX, i.e. high school, in 1218, until 1401 it did not have its own educational building, and classes were held in the churches and cathedrals of Salamanca, as well as other rented premises.

A strict specialization of universities, which might require special buildings or premises, was not revealed during this period. Although, for example, the University of Paris initially emerged as a theological, and, for example, Bologna, as a school of law, a similar organizational structure and a similar list of disciplines taught, united in senior and junior faculties, are quickly formed in all universities. There the faculties of the seven liberal arts belong to the younger ones—trivia (grammar, dialectics, rhetoric) and quadrivia (arithmetic, geometry, astronomy, musical harmony), and the elders—theological, legal and medical.

It is possible to speak about the existing system of higher education only by the beginning of the thirteenth century, when the number of European universities reached 30–40 [4], and the characteristic forms of the architectural environment of their existence took shape.

University privileges are finally approved and accepted by the secular and ecclesiastical authorities, and the inner life in universities is strictly legalized by a system of statutes. Due to the system of non-university agreements on the mutual recognition of academic degrees and titles, which is being formed during this period, a special European educational space for academic mobility and knowledge exchange is being created. Holders of academic degrees are becoming in demand in government structures and the church hierarchy, the availability of an academic degree is gradually becoming the key to a successful career, and universities play the role of a social elevator in society [5]. At the same time, a new type of building appears, which has stable space-planning parameters—a college.

2 Methods

Research methods:

- system analysis, allowing one to consider in interconnection various factors of the formation and development of an object based on an integrated interdisciplinary approach;
- study and systematization of scientific papers on the topic, professional literature on architectural and construction design of an object, materials of socio-research on the problem, as well as analysis of real and experimental projects, practical examples of buildings and complexes;
- surveys using photographs of objects and data obtained during field observations and from written sources;
- method of complex assessment of design solutions.

The theoretical basis of the research was the materials of the archives of European and Russian universities, museums and libraries.

From the theoretical positions of the research of the topic, the works of Ginzburg A. M., Ikonnikov A. V., Predtechensky V. M., Gelfond A. L., Gulyanitsky N. F. on the design of residential and public buildings are fundamental and significant.

The history of development and design issues of scientific and educational objects were studied by Nazárov V. D., Ouvárov P. Y., Védyushkin V. A., Potokin A. A., Komarova L. K., Liluyeva O. V., Kireeva T. V. Le Cœur, M.

The architectural and planning aspects of the design of buildings and complexes of student dwellings were developed by Brandenburg B. Y., Whitens M. E., Rothamel P. F., Kossakowski V. A., Riehen O. I., Krasilnikova, K. N., Kurochkin, L. A., Rudakov P. V., Chepelyk V. V.

The organization of life and time budget was raised in the works by Lobanov Yu. N., Lumisade J., Naranco A. V., Grushin B. A.

Some aspects affecting the architectural solutions of university complexes (social, economic, psychological, etc.) are considered in the works of Antonova A. V., Dukhnovsky S. V., Kologrivova L. B., Dianova-Klokova I. V., Rumyantsev A. A., Agirrech A. A., Frezinskaya N. R., Khrustaleva A. A., Khrustaleva D. A., Krysova V. V., Minata V. N., Prikazchikova O. F., Avdulova A. N., Kulkina A. M., Salibaeva A. H., Skiba A. N., Sukhovey A. F., Shukshunov V. E., Phillips F., Tatsuno Sh.

3 Results and Discussion

Thus, by the thirteenth century, university communities finally take their place in society, acquire a system of connections with a territory or settlement, where they exist and form the need for specialized buildings that meet the needs of higher education and accommodate university departments on a permanent basis.

Medieval architecture responds to this demand, and a new type of building with similar functional schemes and planning solutions emerges in different regions. A college or colegium becomes such building ("collegio"—in Italian Bologna, "collège"—at the University of Paris, "college"—English Oxford, "colegio"—in Spanish Salamanca, etc.), designed to accommodate a separate administrative and financially independent university division. And it provides for the provision, practically of the entire spectrum, of educational and scientific, household, religious and even part of the leisure needs of students and teachers.

There is a widespread theory, developed, for example, in the works of P. Yu. Uvarov [2, 6, 7] and with which one can agree, of the emergence of colleges, as, to some extent, imitation and further development of order-monastery households for monks-students, also enrolled in universities. Specialized halls for classes were sometimes attached to such habitations, and sometimes classes were held in rooms for the performance of cult rituals.

In the XIII century, an active process of colleges establishing begins in the likeness of the aforementioned monastic habitations but intended for the residence and study of secular scholars. Colleges were founded and funded, both by individuals and by state, public or church institutions. For example, one of the first such colleges was founded in the middle of the thirteenth century at the University of Paris by the confessor of the French king Louis IX, Saint Roberto de Sorbon. Colleges were originally established as collective dwellings for students and, later, teachers; however, already in the thirteenth century, classes were held there, and in the fourteenth–fifteenth centuries, this practice has become ubiquitous.

The college, being a part of the university, as a unit with a certain autonomy, had its own legislative basis—statutes and its own officials: the rector (sometimes a pharmacist or regent), vice-rectors, bedels (coordinator-administrators) and others.

The innovation turned out to be quite viable, and by the fifteenth century, a radical restructuring of the structure of universities took place. Their structure is now dominated by the college-based organization, where the majority of students live, and the overwhelming majority of classrooms are implemented.

Let us consider, with specific and at the same time characteristic examples, the buildings that housed the structural divisions—colleges, and which had the same name.

Collegio di Spagna (full names "Reale Collegio Maggiore di San Clemente degli Spagnoli" or "Real Colegio Mayor de San Clemente de los Españoles") in Bologna, Italy was founded by Cardinal Gil Álvarez Carrillo de Albornoz and was designed by the Italian architect Matteo di Giovannello Gattapone. The construction was completed in 1365–1367. The composition of the college is built around an open courtyard surrounded by a two-story building with open galleries overlooking the specified courtyard (Fig. 1). The galleries overlook educational, residential and

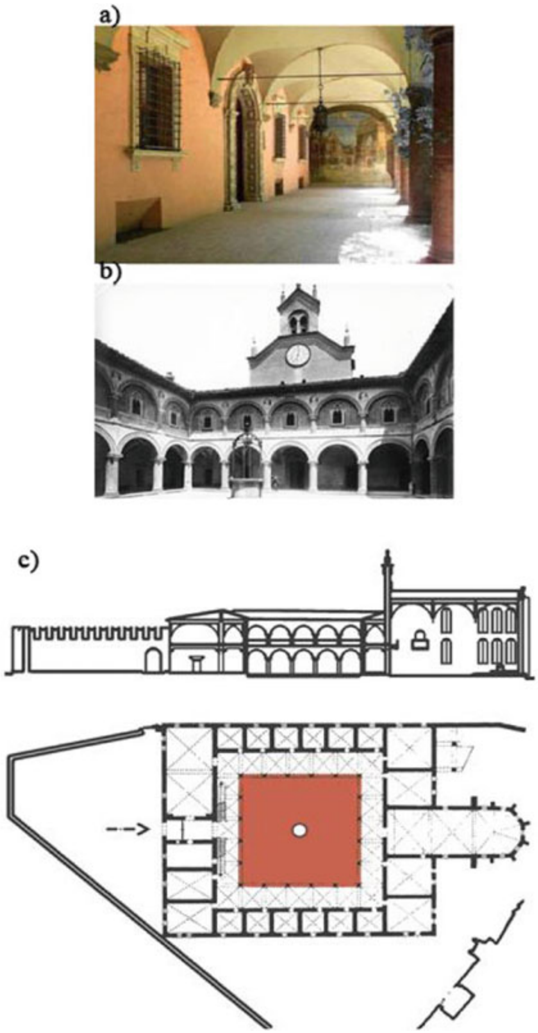

Fig. 1 Collegio di Spagna, Bologna Italy (**a** view of the western gallery, **b** courtyard, **c** plan and section)

Fig. 2 Format of lectures and the corresponding premises (**a** is a miniature from "Liber ethicorum des Henricus de Alemannia", the famous lawyer and expert in canon law Heinrich of German lectures at the University of Bologna in the fourteenth century; **b** is the interior of the fifteenth century lecture hall preserved in memory of Luis de Leon (Fray Luis de León) at the University of Salamanca Spain)

administrative premises, as well as the chapel of St. Clement in the eastern part. There is a well in the center of the yard. The college building is surrounded by a lush garden of shady deciduous trees and a tall brick fence along the edge of the grounds.

The main form of knowledge transfer at the universities of that time, especially at the senior faculties, was lectures. At the lectures, the teacher, mainly, read literary primary sources or the works of famous scholars of his contemporaries, necessarily accompanying them with his reflections on the problem under study (Figure X). Accordingly, to conduct classes in this form, spacious halls were formed—lecture halls equipped with a chair for the lecturer and places for listeners, where they could sit, arrange a book and make appropriate notes (Fig. 2). The prototypes of such premises were religious buildings, in which classes were previously conducted in the absence of specialized premises. Practical classes also played an important role, especially in the lower faculties (liberal arts), supposed to be modern in terms of area and organization of premises.

An example of a college in English architecture is the old Lincoln College Front Quadrangle in Oxford. Built in 1430–1437, the complex is a multifunctional closed structure, the composition of which is built around a courtyard of a shape close to a square and surrounded by premises for various purposes: residential, educational, domestic and leisure. The purpose of the premises was constantly changing in accordance with the changing needs of the college. So, for example, the rector lived in the gate tower until 1470, and later an archive was arranged there, and, for example, the chapel in the eastern part in 1655–1660 was converted into a library, and in 1906—into a recreation room. The hall (Fig. 3b) has always served for eating, but public events, debates, lectures, and conversations were also held there. The interior shown in the illustration (Fig. 3b) refers mainly to the seventeenth–eighteenth centuries. The courtyard plays an important role in the social and educational activities of the

Fig. 3 Lincoln College Front Quadrangle, Oxford, England (**a** general view, **b** historical interior of the hall, **c** plan)

college, serves for the performance of traditional rituals and a number of leisure and recreational tasks.

Collegium (college) Maius, Jagiellonian University (Collegium Maius Uniwersytet Jagielloński) Krakow, Poland. The construction of the collegium was carried out in fragments for more than a century: from 1400 to 1507, when it acquired its finished form. Although, later, individual fragments were rebuilt and changed. The device is typical of colleges of its time (Fig. 4). The building materials for the Mayus College were red brick and stone. Gothic motives are clearly visible in the building, especially the portals and vaults. The yard is open with a well in the center. Lecture halls were located mainly on the ground floor, while residential, administrative and utility rooms were located on the upper floors.

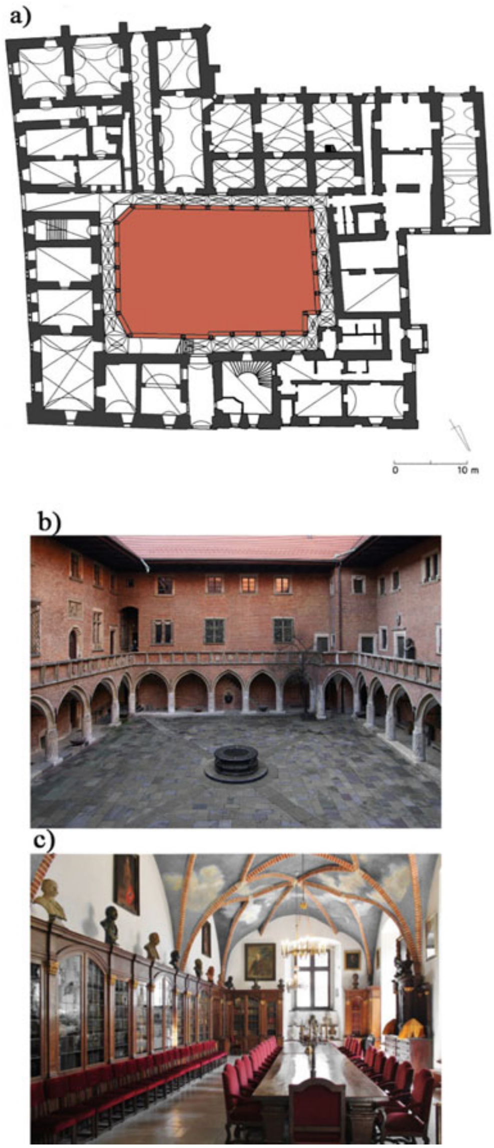

Fig. 4 Collegium (college) Mayus Jagielloński University (Uniwersytet Jagielloński) Krakow, Poland (**a** ground floor plan (based on research by R. Frazikowa, S. Sławiński and J. Hiżycka), **b** courtyard, **c** interior)

Another representative example of the architectural organization of the reviewed type of buildings during the specified time period is the Colegio Mayor del Arzobispo Fonseca at the University of Salamanca Spain.

The college was being built over almost 60 years from 1519 to 1578 with the participation of such architects as Diego de Siloé, Rodrigo Gil de Hontañón and Juan de Álava. The building is an interesting example of Spanish plateresco. The planning decisions are similar to the previous examples, although the college belongs to a different geographic, climatic and cultural region (Figure X). Such planning similarity of colleges in different parts of the European continent allows us to speak of a morphotype in which the compositional center is the public space of the courtyard, as a rule, the cloister. And along the perimeter there are residential, educational, administrative, utility and religious premises.

During this period, there were, much less often, buildings that were similar in structure, but did not implement a full set of functions for the college. Sometimes in colleges, an educational function did not arise, and they were dormitories—houses, courtyards, bursa. However, the name of the college could be retained, or there was no residential function and they were educational buildings—schools [8]. An outstanding example of an educational building without residential function can be illustrated by the example of the Escuelas Mayores high school building at the University of Salamanca, Spain. The construction of the high school began in 1413 by architect Alonso Rodríguez Carpintero and was originally a one-story building. The first floor was added much later, but without changing the structure of the ground floor, which allows us to talk about the architectural solutions of the fifteenth century (Fig. 5).

Returning to the peculiarities of the formation of modern campuses [3, 9, 10], we can conclude that the courtyard space of the medieval college, having undergone a series of successive transformations, formed the public space of the modern campus.

4 Conclusions

Thus, Europe is approaching the end of the Middle Ages with the formed basic principles of the system of higher university education. The further development of the entire system of European higher education, its models of architectural organization and the worldwide expansionary potential of these models refers us to the original patterns formed during this period.

A new type of buildings is also being formed—a college that meets the needs of higher education at this stage with characteristic and clearly distinguishable from others typological groups of space-planning characteristics.

The space of a college courtyard that combines educational, scientific, household and leisure functions is a particular point of interest. Over a considerable period of time, the development of such space will probably lead to the formation of the environment of modern campuses of higher education institutions.

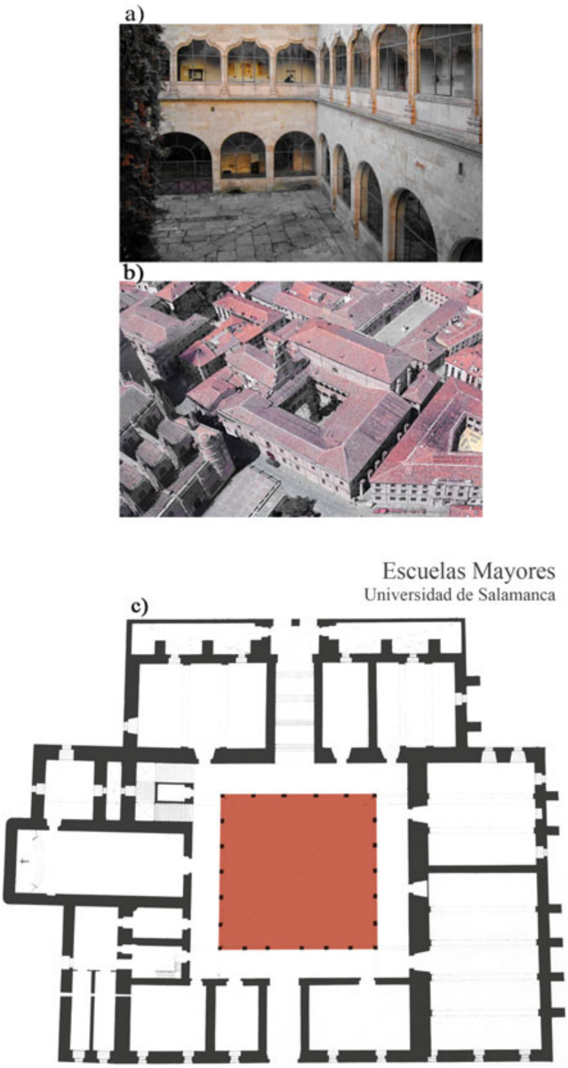

Fig. 5 Escuelas Mayores University of Salamanca Spain (**a** view of the galleries and courtyard in the new building, **b** view in the new building, **c** plan of the ground floor)

Thus, the article traces the development of college architecture in medieval Europe as a form of existence of the material environment of higher education and its influence on the formation of modern campuses.

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Culture of Pedestrian Public Spaces

Y. L. Raikhel and M. G. Zobova

Abstract The culture of pedestrian public spaces of the twenty-first century is a tool of various world urban planning development methods such as steady evolution, revitalization of historical urban landscape, disclosure of urban identity and others. However, alongside with cities in developed countries where the culture of public pedestrian spaces is highly developed, there are still some cities in developing countries where pedestrian life is practically reduced to zero. As a rule, the reasons for retarding the development of pedestrian public spaces are as follows: poor economy, lack of political will, unformed civil initiative. In relation to pedestrian public spaces, a retrospective analysis of the development of pedestrian culture in developed countries (Europe, America) was carried out and a graphic-analytical method of constructing an evolutionary scheme for changing the urban planning paradigm was used. Three periods of culture development of pedestrian public spaces have been identified. They are a spontaneous city (up to the 1920s), a city for cars (1920s–1960s) and a city for people (from the 1960s till the present time). In each period the key factors influenced the formation of the urban planning paradigm are identified, the pedestrian transport system and the functional city scenario are described as well. The results obtained during the research can serve as a tool in the process of conscious changing of the urban planning policy in developing countries from a city for cars to a city for people.

Keywords Pedestrianization · Walkability · Historic urban landscape · Sustainable development · Urban identity · Urban planning paradigm · Liveable cities · Urban life · Environment · Pedestrian · Public space

1 Introduction

More than half a century has passed since Jane Jacobs defended a city park in the campaign against highway construction in Lower Manhattan in the 1950s. Since

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then, in most developed countries of the world the value of public spaces has been recognized by professional communities, city administrations and citizens. Qualitative public spaces form urban culture and they are a democracy symbol in the United States and Europe. But also, there are some cities in which the beneficial effect of pedestrian public spaces has not been appreciated yet. As a rule, they are provincial cities in developing countries where public spaces are given for the sake of motorways. The reasons retarding pedestrianization development are as follows ailing economy, lack of political will, unformed civil initiative.

The relevance of the study is determined by a high social role of pedestrian public spaces [1] for the full development of cities in a socially oriented post-industrial society. The backbone concept of pedestrian public spaces in a city was laid in the theoretical studies of Jacobs [2], Whyte [3], Gehl [4]. The organization of pedestrian public spaces is directly related to the issues of urban planning [5], transport planning [6], pedestrian accessibility [7], urban improvement and the creation of a comfortable urban environment [8].

The formation of pedestrian public spaces has become a priority area for strategic city development in Russia over the last decade. New pedestrian squares, streets, parks, embankments [9] appear not only in the capital cities like Moscow and St. Petersburg, but also in non-capital cities such as Kazan [10], Samara, Nizhny-Novgorod, Belgorod, Tver, Saratov, Novosibirsk, Izhevsk, Kaliningrad, Krasnodar, Ivanovo, Yakutsk, Naberezhnye Chelny and so on.

The purpose of this study is to identify the stages of development of the culture of pedestrian public spaces in developed countries from the end of the 19th to the beginning of the twentieth centuries and to form the evolutionary scheme for changing the urban planning paradigm in relation to pedestrian public spaces.

To achieve this goal, the following problems were solved:

- Analysis of changes in the urban planning paradigm in relation to pedestrian public spaces from the end of the 19th to the beginning of the twentieth centuries.
- Analysis of the impact of the change of the urban planning paradigm on the pedestrian transport system and on the functional scenario of the city from the end of the 19th to the beginning of the twentieth centuries.
- Identification of the factors that caused these changes from the end of the 19^{th} to the beginning of the twentieth centuries.

The solution of these problems will reveal the stages of development of the culture of pedestrian public spaces in developed countries from the end of the XIX to early XX centuries and form an evolutionary timetable for changing the urban planning paradigm in relation to pedestrianized public spaces.

2 Methods

To achieve the research goal and solve the problems settled by the authors, a graphic-analytical method to create an evolutionary scheme for the culture development of pedestrian public spaces was used. This method implies displaying a linear time chart (see Fig. 1) and fixing data on it. The conclusions are based on comparing various data and identifying time periods with similar characteristics.

The data for creating an evolutionary scheme have been obtained during the analysis of theoretical works relevant to pedestrian public spaces and published over the past 15 years. The issue of the functional city scenario is disclosed in a theoretical study written by J. Gehl and L. Gemzoe, and published in the book "Winning back public space" [11]. The authors of the article illustrate the functional scenario of the city described by J. Gehl with five graphic models (see Fig. 2), in which the letter designation corresponds to the three functions of a traditional medieval city: m—moving; c—communication; t—trade. The sizes of the circle diameters indicate the ratio of these functions between each other and the city space. The city area is indicated by the dotted line. The arrows show the process of growth or contraction of the field of a particular function.

The research carried out by Vukan R. Vuchic and published in the book "Transportation for Livable Cities" is devoted to a retrospective analysis of the city's pedestrian transport system. The authors of the article have developed some pictograms representing different pedestrian and transport models by Vukan R. Vuchic (see Fig. 3) [6].

The factors influenced the change in the urban planning paradigm in relation to pedestrian public spaces described in the studies of a number of other scientists: in the book "The mediacity: Media, architecture and urban space" by S. McQuire [12]; in the article "Digital transformation of existing cities" by Akhmedova and Vavilonskaya [13]; in the study of Y. Raikhel, being one of the authors of this article

Fig. 1 A linear time chart

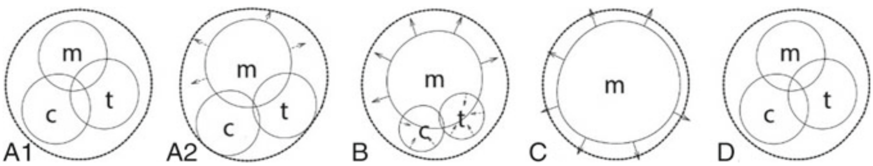

Fig. 2 Author's illustration of the functional scenario of the city by J. Gehl: A1. Traditional city—three functions of a traditional medieval city are equal to each other: m—moving, c—communication, t—trade; A2. Traditional city—the growth of the movement function (m) is planned, the functions of communication (c) and trade (t) still retain their sizes; B. Transport-filled city—the function of moving keeps on growing, the other functions reduce. C. Abandoned city—the function of moving displaces the function of communication and trade beyond the city boundaries; D. City conquered by pedestrians—the functions of a traditional medieval city return to the city

Fig. 3 Author's pictograms of the city's pedestrian transport system by Vukan R. Vuchic: 1—pedestrian city; 2—public transport-oriented city; 3—critically motorized city; 4—automobile-oriented city; 5—intermodal city

co-authored by E. Rozhdestvenskaya. It was published in the article "Historical city center in the XX–XXI centuries: Back to pedestrian" [14].

3 Results

Using a graphic-analytical method, the evolutionary schemes by three periods were created. (1) The first period up to the 1920s is the formation of the culture of pedestrian public spaces. (2) The second period beginning from the 1920s up to the 1960s is the formation of the culture of pedestrian public spaces called "City for cars". (3) The third period beginning from the 1960s up to the present time is the formation of the culture of pedestrian public spaces called "City for people".

According to the evolutionary scheme of the first period of the formation of the culture of pedestrian public spaces up to the 1920s (see Fig. 4), the following conclusions can be made:

1. Urban planning paradigm "Spontaneous city": a. The view of urban pedestrian public spaces in the engraving of German artist Hans Sebald Beham "Great Festival of the Consecration of the Church", detail, 1539. b. The photo of the city boulevard Vestre with many pedestrians walking along the tram lines in Copenhagen, Denmark, 1918.
2. The pedestrian transport system of the city according to V. R. Vuchic [6]: 1. Pedestrian city—the predominance of pedestrians in the city before 1880. 2. Public transport-oriented city—from the 1880s to the 1920s.
3. Functional scenario of the city according to Gehl and Gemzoe [11]: before the 1880s—three functions of a traditional medieval city are equal to each other: m—moving, c—communication, t—trade. A2. The traditional city from the 1880s to the 1920s—the growth of the function of movement (m), the functions of communication (c) and trade (t) still retain their sizes.
4. Key factors: 1. The first tram started operating in Berlin, Germany in 1881 [14].

According to the evolutionary scheme of the second period of the formation of the culture of pedestrian public spaces called "City for cars" beginning from the 1920s to the 1960s (see Fig. 5), the following conclusions can be made:

1. The urban planning paradigm "City for cars": c. Photo of a critically car-filled street in New York City, USA, 1930s. d. Photo of a car-oriented street in New York City, USA, 1960.

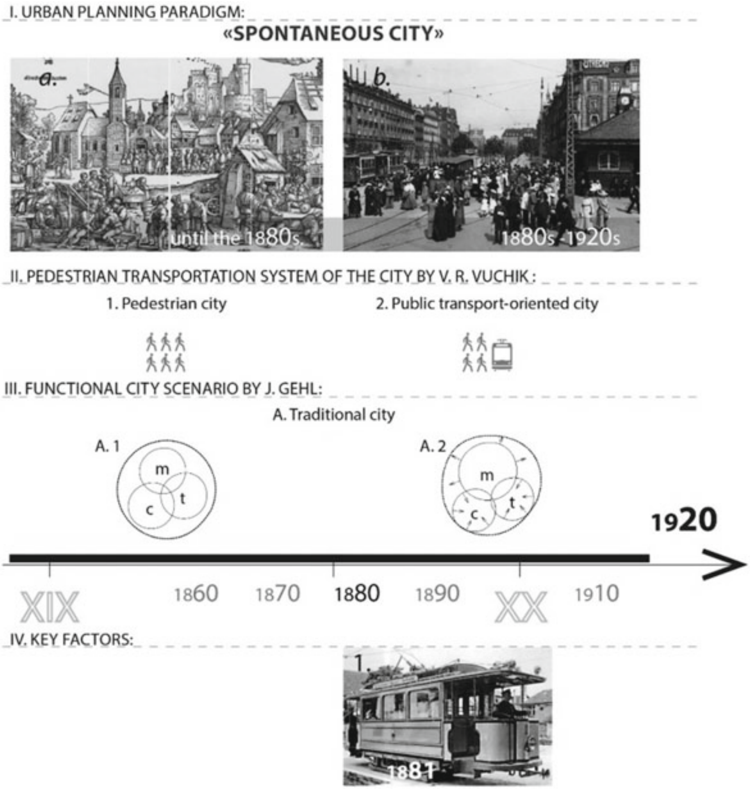

Fig. 4 Evolutionary scheme of the first period of culture formation of pedestrian public spaces "spontaneous city"—from the middle ages to the 1920s

2. The city's pedestrian transport system according to V. R. Vuchic [6]: 3. Critically motorized city from the 1920s to the 1950s. 4. Automobile-oriented city from 1950 to 1960s.
3. The functional city scenario by Gehl and Gemzoe, [11]: B. Transport-filled city from the 1920s to the 1950s—the displacement function (m) continues to grow, other functions (c, t) reduce. C. Abandoned city from the 1950s to the 1960s—the function of movement (m) displaces the function of communication (c) and trade (t) beyond the city boundaries.
4. Key factors: 2. The beginning of regular radio broadcasting, telephony, television in the 1920s. 3. Massive motorization of Europe and the USA in the 1930s. 4. Adoption of the urban planning manifest drawn up by Le Corbusier at the CIAM Congress in Athens in 1933. 5. World War II and its destructive consequences, 1939–1945.

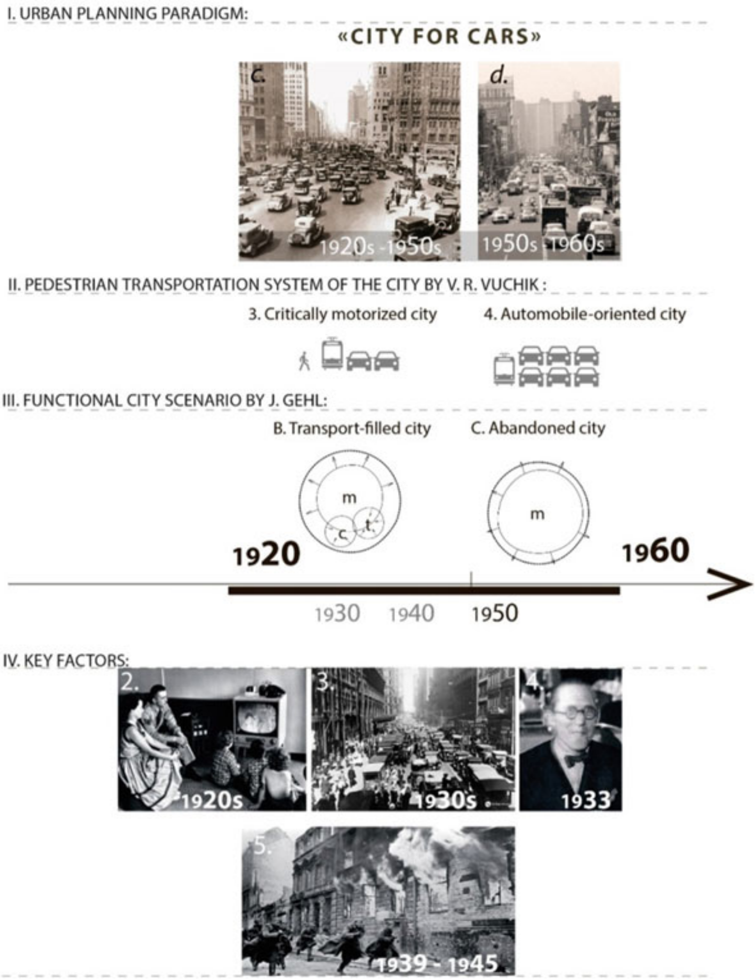

Fig. 5 Evolutionary scheme of the second period of culture formation of pedestrian public spaces "City for cars"—from the 1920s to the 1960s

According to the evolutionary scheme of the third period of the formation of the culture of pedestrian public spaces called "City for people" beginning from the 1960s to the present time (see Fig. 6), the following conclusions can be made:

1. Urban paradigm "City for People": a. The photo of the street representing variability in modes of travelling—walking, cycling, using rental cars, Toronto, Canada, 2016.
2. The city's pedestrian transport system according to Vuchic [6]: 5. Intermodal city from the 1960s to the present time—a balanced pedestrian and transport

Fig. 6 The evolutionary scheme of the third period of the formation of the culture of pedestrian public spaces “City for People” from the 1960s till the present time

model, in which pedestrians and cyclists, various public transport, and personal transport participate in movement but the priority of low travel speeds remains.

3. The functional city scenario by Gehl and Gemzoe, [11]: D. City conquered by pedestrians—traditional city functions return to the city—moving, communication, trade.
4. Key factors: 6. In the 1960s the democratization of the power of most European cities occurred. 7. Jane Jacobs, an American civic activist, was one of the first people who started talking about the perception of the city from the pedestrian’s eye level. In 1961 she published “The Life and Death of Large American Cities”,

which had a major impact on changing the perception of the city by the professional community, city administration and city dwellers [2]. 8. In the 1980s the town-planning concept "New Urbanism" considering pedestrian spaces as a tool for the formation of a compact city appeared. 9. In 1992 the Olympic Games were held in Barcelona, Spain. In the process of preparing the city for the games, a large number of new pedestrian public spaces were created. The successful experience of Barcelona has become a vivid example of the formation of pedestrian public spaces in other countries [11]. 10 Jan Gale, a Danish urban architect, has been engaging in research and design of public pedestrian spaces since the 1960s. 11. In the 1970s in many cities the efforts to create a high-quality urban environment were made and pedestrian zones appeared in the historical centres of cities.

4 Discussion

A retrospective analysis of urban development has revealed a change in the urban planning paradigm in relation to pedestrian spaces. The paradigm change has had a significant impact on the pedestrian transport system [6] and the functional scenario of a city [11].

4.1 A Spontaneous City

From the Middle Ages to the 1920s there was a paradigm of a spontaneous city with pedestrian spaces as constantly developing networks in historically established European cities. The key factor forming this paradigm was the majority of pedestrians in public spaces of the city. Until the 1880s the pedestrian-transport system was a model of a pedestrian city mainly where a carriage-way for horse carriages was not separated from a pedestrian one. In the 1880s the electric tram appeared and until the 1920s the city's pedestrian-transport system was developing towards public transport. The functional scenario of a spontaneous city corresponds to a traditional city with pedestrians moving through urban pedestrian spaces, exchanging information and engaging in market trading.

4.2 A City for Cars

In the period from the 1920s to the 1960s there was a change in the vector of the urban planning paradigm in the direction of a city for cars as a response to the growth of mass motorization and a reflection of the Athenian Charter provisions of 1933 (L.

Corbusier). The new paradigm was expressed in the spatial growth and decentralization of cities. The city's pedestrian-transport system from the 1920s to the 1950s experienced a turning point and became a critically motorized city with a spontaneous increase in motorization, displacement of pedestrians and pedestrian spaces from the city centre. The scenario of urban environment functioning corresponded to the scenario of a city filled with transport with a priority function of automobile traffic. From the 1950s to 1960s the pedestrian-transport system was transformed into an automobile-oriented city with adaptation for further motorization. The functional scenario of a city corresponds to the scenario of a city abandoned by pedestrians when a city finally ceases to be a place for meetings, exchanging information and market trading.

4.3 A City for People

From the 1960s to the present time there is again a change in the urban planning paradigm towards the direction of the city for people. In the middle of the twentieth century the provisions of the Athenian charter were criticized by a new generation of urbanists and city planners (Jacobs [2], White [3], and others). There was an increase in pedestrianization and the birth of an urban planning concept "New Urbanism" under the influence of ideological ideas such as:

- the disappointment of the majority in technological progress and the desire to return the medieval pedestrian city;
- political ones as democratization of power in most European cities;
- architectural and urban planning factors like an increased interest in the protection of cultural heritage;
- social and cultural factors such as the development of event tourism and an increase in pedestrians in historic city centres.

The pedestrian-transport system since the 1960s and to the present time is an intermodal city with the variability of urban public transport for comfortable travelling and restrictions for personal vehicles. The functional scenario of a city during this period corresponds to the scenario of a city conquered by pedestrians where the functions of communication, trade and movement are returned.

5 Conclusion

5.1 Change of the Urban Planning Paradigm in Relation to Pedestrian Spaces

Using the method of graphic analysis for creating an evolutionary scheme, three periods of change in the urban planning paradigm in relation to pedestrian spaces from the end of the nineteenth century to the beginning of the twenty-first century have been identified. They are a spontaneous city (until the 1920s), a city for cars (1920s–1960s) and a city for people (1960s–present).

5.2 Change of the City's Pedestrian Transport System from the End of the 19th to the Beginning of the 21th Century

According to the research of Vuchic [6], from the end of the nineteenth century to the beginning of the 21th century five models of the city's pedestrian transport system were identified:

1. pedestrian city from the Middle Ages to the 1880s;
2. public transport-oriented city from the 1880s to the 1920s;
3. critically motorized city from the 1920s to the 1950s;
4. automobile-oriented city from the 1950s to the 1960s;
5. intermodal city since the 1960s to the present time.

5.3 Change of the Functional Scenario of the City from the End of the Nineteenth Century to the Beginning of the 21th Century

According to the studies of J. Gehl and L. Gemzoe, [11], from the end of the nineteenth century to the beginning of the twentieth century four models of the functional scenario of the city are identified:

1. Traditional city—the first period until the 1880s—three functions of a traditional medieval city are equal to each other: moving, communication, trade; the second period from the 1880s to the 1920s—the growth of the function of movement is outlined, the function of communication and trade still retain their positions.
2. Transport-filled city—from the 1920s to the 1950s—the movement function continues to grow, the rest of the functions decline.

3. Abandoned city—from 1950 to 1960s—the function of moving displaces the function of communication and trade outside the city;
4. City conquered by pedestrians—since the 1960s up to now—the functions of a traditional medieval city return to the city.

5.4 *Factors Influenced the Change in the Urban Planning Paradigm*

The key factor forming the urban planning paradigm of the period of a spontaneous city was the numerical advantage of pedestrians in public spaces. The factors influencing the change in the urban planning paradigm towards the city for cars in the 1920s were:

- scientific and technological progress with mass motorization, the development of radio, telephony and television;
- the adopted urban planning manifesto of the Athenian Charter of 1933 and the spatial growth and decentralization of cities.

The change in the vector of development of the urban planning paradigm from a city for cars to a city for people was:

- facilitated with the military-political factor such as tragic consequences of the Second World War which led the majority to disillusionment with technical progress and the desire to return the medieval pedestrian image of a city;
- the political one as the democratization of the power of most European cities;
- the architectural and urban planning factor like an increased interest in the protection of cultural heritage;
- the social and cultural factor such as the development of event tourism and the increase in pedestrians in the historical centers of cities.

The results of the study can serve as a justification for the choice of urban planning policy in the direction of the development of pedestrian public spaces. The authors plan to compare the culture of pedestrian public spaces in Russia, Europe and America in the following studies. The purpose and objectives of the research were fully achieved.

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Legislative Regulation and Fundamentals of Architecture and Construction in the First Half of the Nineteenth Century (Russian Experience)

M. V. Zolotareva and A. V. Ponomarev

Abstract Modern Russia's experience in architecture and construction gives rise to the need for considering the history of legislative regulation relevant to the architectural and construction process. The disruption of features that make the urban environment sustainable and define its identity, as well as various architectural and planning mistakes in modern praxis, makes this study all the more relevant. Considering the current situation, the relevance of studying the legal foundations of the architectural and construction process in the first half of the nineteenth century is reviewed through the lens of the legal process's efficacy and impact on sustainable urban development. Researching the control process and urban planning strategy choices during the period in question makes it possible to also assess the architectural and construction directions and priorities today. This paper reviews the events of the first half of the nineteenth century: a period of reform in public administration and legislative codification. The purpose of the study is to assess the efficacy of a new form of legislation: the Digest of Laws. We take a look at how this new document affected the practice of construction control at different governance levels. The basis for our study is the analysis of documents that were issued in 1832 and 1842 and integrated into the Digest of Laws, becoming the core of design, control, and construction regulations for all types of buildings, as well as of the regulations concerning fields adjacent to design and construction, throughout the first half of the nineteenth century. The study results in the following conclusion: the reforms of the first half of the nineteenth century changed the government policy of controlling civilian construction, while also helping improve regulations on territorial development, architecture and construction control and monitoring, the development of the urban economy, transport, industry, and more. Architecture and construction have always been in the focus of the state authorities' attention, and during the period in question, this field gained not only its very own governance body but also a whole legislative package, all assembled together into the Digest of Laws, which became the main source of architecture and construction guidance for all government levels and property ownership types.

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1 Introduction

Architecture and construction have always been a vital structural part of any country's life and have always been subjected to a certain degree of state regulation. However, the nature, scale, and administrative side of such regulation have differed throughout history, depending on multiple factors. Russia is no exception. The first half of the nineteenth century resulted in a set of codified documents that regulated architecture and civil engineering policies, relevant both to controlling the field overall and to resolving specific construction issues. Thanks to the above, laws in the architecture and civil engineering sector became highly efficient by the early twentieth century. The rise of the Soviet Union brought about a lengthy planned economy era that turned the efficient control and regulation system into a hurdle on the path towards progress in architecture and civil engineering. The socio-economic transformations in modern Russia call for the actualization of previous domestic experience in regulating the field of architecture and civil engineering. Numerous examples of "mistakes" and conflicts in this field only further reaffirm the relevance of this study.

Another relevance factor is the permanent demand for any research that helps clarify important comprehensive review aspects relevant to the historical development of functional, methodological, and organizational forms of regulating the architectural and civil engineering processes in Russia during the optimization of the sector's legislative system.

State reforms of the first half of the nineteenth century mostly involved: collecting laws in all fields into a single digest; transforming the state governance systems; and defining the legal status of the administrative territorial units and local authorities (zemstvos, cities). These processes, in turn, impacted the search for rational forms of regulating and controlling the architecture and construction complex. The cornerstone of this process was to be the Digest of Laws, which brought together all legislation that had been published haphazardly since the latter half of the eighteenth century. In some cases, laws from the seventeenth century and the first half of the eighteenth century also remained relevant.

In summary, the Digests that were issued during the period in question specified the phenomena that the legislation was applied to, providing them with maximum regulation.

This study consistently reviews those Digests of Laws that concerned local construction initiatives, architecture and construction overall, and the control and supervisory functions of the state authorities.

The efficiency of architectural and civil engineering regulation is directly evidenced by the patterns in territorial, urban planning, and compositional development, alongside with architectural praxis. The historical zones and historical environment of a modern city are the results of these processes, which are indirectly connected to the legislative principles of planning, architecture, and civil engineering.

This is why the works of those authors who paint a multi-factor picture of urban planning development and common architectural and compositional features in historical areas constitute factual material that proves the efficacy of regulating the architectural and civil engineering praxis. This process can be exemplified by fundamental works by Russian history theorists, which, among other sources, can also be found in foreign professional periodicals. The results of these theoretical overviews can be roughly divided into the following aspects:

- the historical aspect, which reveals the overall development of the architectural and civil engineering processes during the period in question, was analyzed by authors: Goryunov [1], Kirikov [2], Lisovsky [3], Nashchokina [4], Ponomarenko [5], Punin [6], Sementsov [7], Slavina [8], Shvidkovsky [9], Stieglitz [10] and others.
- the theoretical aspect, which defines the essential methodology for studying the development patterns in the history of urban planning and architectural and civil engineering complex (Akhmedova [11], Vaytens [12], Gelfond [13], Esaulov [14], Zavarikhin [15], Kurbatov [16] and others).

2 Methods

We base our research on the science-informed historicism principle, which implies looking at the study subject (legislative documents) in terms of its mutual links with other phenomena (architectural and construction praxis) in a specific historical context. Methodology-wise, we use historical comparison and legal comparison. This study is based primarily on legislative documents from the first half of the nineteenth century, which formed the legal foundation for controlling the architecture and construction process in all its aspects. Furthermore, we compare the Digests of Laws issued in 1832 and 1842. These documents reflect the gradual shift from the "Alexander-style" to the "Nicholas-style" governance in architecture and construction. Aside from studying the legal framework as the regulatory basis for this process, we also analyze cartographic and bibliographic sources related to urban development in the second half of the nineteenth century. This has allowed us to track the changes in urban construction and amenity improvement, as compared to the latter quarter of the eighteenth century [17].

3 Results and Discussion

The Digest of Laws of the Russian Empire was issued in the first half of the nineteenth century and became a fundamental tool for regulating the main types of construction.

The Digest of Laws of the Russian Empire was the official collection of all legal acts currently valid in the country, sorted by theme. It was first published over the course of the year 1832. The royal manifesto of January 31, 1833, designated the Digest as a legally valid source of regulations coming into force on January 1, 1835.

Documents on architecture and construction processes in the Empire are found in three sections of the Digest. Grouping the works on controlling the architecture and construction complex allows us to single out the following aspects: regulating relations in the field of urban planning and land use (including land survey legislation); setting management principles for architecture and construction activities and urban improvement and economy; developing methods for legal regulation in the fields of transport and industry (Fig. 1).

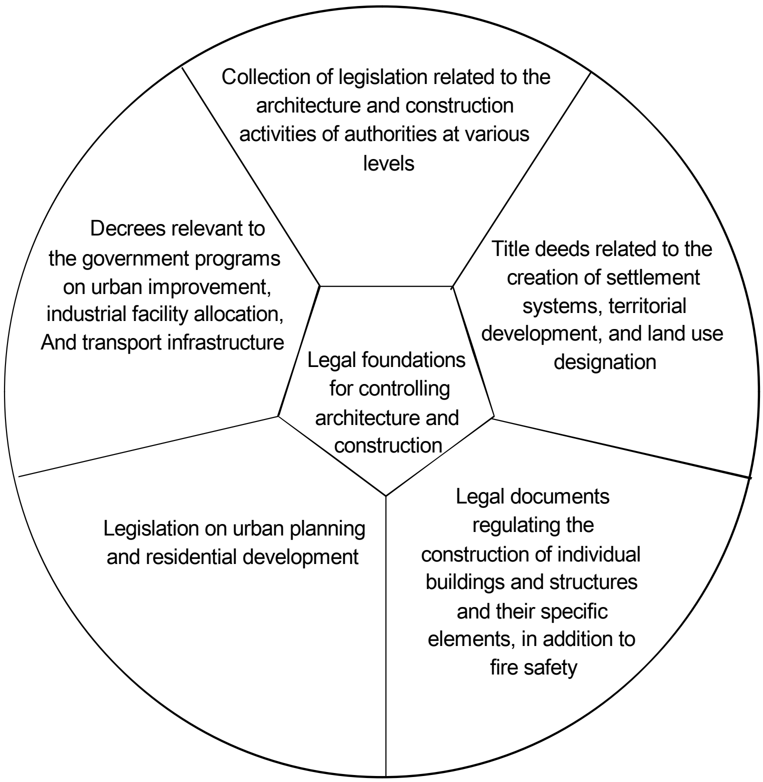

Fig. 1 Graph representing the legal foundations for regulating architecture and construction processes

No.	Digest of Laws	Digest section	Digest/charter name
1	Digest of Laws on State Property and Land Surveys	2	Digest of Laws on Land Surveys
2	State Governance Code	3	Mining Charter
3	Collection of Charters on Bettering the State	3	Decrees on Factories, Plants, and Artisan Enterprises
4		4	Institutions and Charters on Transport Routes
5		4	Fire Charter
6		5	Decrees on Improvements in Cities, Towns, and Villages

Fig. 2 Sections of the digest of laws that complement the building charter

The Building Charter was part five of the Collection of Charters on Bettering the State. Figure 2 demonstrates the collections of laws that regulated civilian architecture and construction and expanded the provisions of the Building Charter. Furthermore, a separate block was dedicated to legislative documents that defined the powers of government bodies at various levels when it comes to initiating, regulating, and controlling the domestic architecture and construction processes. These matters were discussed in the "digests of legislative acts" published by state authorities and various institutions on the governorate level, as well as in the Charter on Recruitment and Zemstvo Duties and some others.

3.1 Building Charter

This document was the most essential law that was applicable at all levels of civilian construction governance and included specific rules of design and construction. In addition, the Charter listed the rules of urban improvement and economy, as well as the rules of managing the transportation system in populated areas. It had seven sections with the following structure. The first section described the state policy on construction management, designated government bodies for managing the architecture and construction complex, and assigned functions to institutions responsible for construction in cities, krais, and governorates that had special governance systems.

Those included the capitals (Saint Petersburg and Moscow) [18], the Transcaucasian Krai, the Stavropol Governorate, Siberia, etc.

Other sections outlined the rules of design and construction, as well as the procedure for approving the designs of different types of buildings and structures, such as:

- government buildings,
- religious buildings (these included various rules for Orthodox churches and churches of other faiths),
- public buildings,
- streets, squares, bridges, and pavements,
- privately owned buildings in cities,
- village buildings.

Aside from design and construction rules, each of the aforementioned sections also specified the rules of drawing up budget estimates and various approval issues and procedures. Government buildings also had their own control procedure for financial documents and activities at all construction stages, from buying construction materials to opening the building for use.

The first Building Charter featured a collection of legislation from both the 18th and the early nineteenth century. It should be noted that in some cases, the 18th-century legislation was represented by the following fundamental documents [19]:

- decrees describing the duties of governorate authorities and the police in the field of urban improvement, construction, and road infrastructure. For instance, we may find references to the Charter of Policy Propriety (1782);
- decrees describing the duties of the urban community members with respect to controlling urban improvement and construction. The key document in this field was Catherine the Great's City Regulations (1785);
- decrees calling for fire safety and structural integrity measures in new buildings. In this case, some provisions had been in force since the reign of Peter the Great;
- decrees regulating the construction of religious buildings;
- general decrees on construction in cities and villages.

The first section of the Building Charter, which defined the state policy on architecture and construction governance, featured a collection of title deeds issued since the beginning of the nineteenth century. That period saw not just reforms in construction management, but also the laying of a whole new foundation for the empire's entire governance structure. In this context, the regulations On Ministries (1802 and 1811) were fundamental.

Construction governance was entrusted to the Ministry of the Interior. The process of building a rational structure for construction regulation took 20 years. On top of that, the industry also needed robust, productive authorities at the ministry, governorate, and city levels.

The Building Charter of 1832 recorded the nature of architecture and construction governance in Russia during Alexander's reign. The experience of that period highlighted the need for a new fundamental reform of construction management. Over the course of 10 years, the Building Charter received six Additions, which demonstrated the law-makers' thorough effort to transition to the new basic principles of governance in the field.

A new edition of the Building Charter was issued in 1842.

How did it differ from its predecessor of 10 years before (1832)? The main difference is the change in the government apparatus of the architecture and construction complex in 1842 (this provision was recorded in the very first Addition to the Charter). The Building Charter of 1842 appointed the Main Directorate of Transport Routes and Public Buildings (MDTRPB) as the Empire's central construction authority. This change in the central administration also led to the change in the structure of government bodies that reviewed documents and issued construction permits. In the Ministry of the Interior, this function was performed by the Building Committee at the City Economy Department. At the MDTRPB, the design drafts and budget estimates were reviewed by the Main Directorate of the Design and Budget Commission. This authority also had another branch, responsible for inspecting technical reports from different localities.

Quite obviously, the construction authorities in the governorates were overhauled as well. If the authorities reported to the Ministry of the Interior, the local governments created Building Expeditions. The overhaul of the governorate authorities was accompanied by the establishment of special Building and Regional Building Commissions, which reported to the respective districts within the MDTRPB. The division into districts had been carried out back during the first ten years of the nineteenth century, to facilitate control over transport route construction. This allowed for promptly resolving issues that did not require the central administration's attention.

The 1842 document also featured an addition to the chapter On Building Capital. A new section governed the process of requesting funding for construction and building repair (On Writing the Building Sums). There was also another section, On Accepting, Issuing, and Approving Building Sums. It was mostly characterized by the introduction of strict control and reporting procedures for tracking how the construction funds for government buildings were being spent. Aside from strict reporting on expenses, the parties responsible for construction operations also needed to submit technical reports, which were reviewed by Building Commissions. The technical report review was meant to result in a confirmation that "the building does indeed match the estimates and drawings applicable thereto". These sections were further expanded by decrees that were issued in 1840, such as, for instance, On the Rules of Financial Reporting to the Main Directorate of Transport Routes.

We must highlight that the system of controlling and regulating construction, as well as the new financial diligence introduced by the MDTRPB, made it possible to effectively oversee government buildings and structures, and to overcome the emergency situations typical of the turning of the century.

The 1842 Building Charter's chapter on private construction in cities included the following sections: On the Rules Observed in Saint Petersburg, On the Rules Observed in Moscow (1836), and On the Rules Observed in Governorate and Uyezd Cities and Towns. These sections were based on the relevant decrees: On Building

Citizen Homes in Small Spaces, On the Extension of the Mitigation Measures on Building Citizen Homes in Small Spaces to the Capital of Moscow (1833).

In addition, the appendix to the Building Charter of 1842 included the Regulations on the School of Architecture. The creation of this new school was meant to address the issue of a lack of architects and assistant architects in different provinces.

Here, we must quote G. V. Baranovsky, a researcher of fundamental architecture and construction laws who discussed the differences between the two Charters of the first half of the nineteenth century: "while the first Charter was, in essence, a set of guidelines for the Ministry of the Interior, the 1842 version was more universal" [20].

Let us now consistently review the Charters that governed other fields, but were nevertheless related to the issues of construction, urban improvement, architecture, and urban planning.

3.2 Sections of the Digest of Laws that Complement the Building Charter

Fire Charter. Fire prevention and fire safety had always caused public concern, so the Fire Charter was included in the Collection of Charters on Bettering the State. Its chapters included the following regulations:

- fire department management,
- fire prevention measures,
- fire extinguishing measures,
- fire cause investigation,
- compensation for fire-related damage.

Fire departments were also affected by reforms in overall public administration at the beginning of the nineteenth century. They were now governed centrally, by the Department of the Executive Police, which, in turn, was part of the Ministry of the Interior. Fire safety was the responsibility of the Department's first division. It was entrusted with "the appropriate affairs in government and police locations in governorates, uyezds, and towns and cities". This included the affairs relevant to the "appointment and upkeep of city guards and fire brigades" [19]. This alone is enough evidence that, after getting centralized, local fire departments were organized in line with laws dating back to the eighteenth century.

For instance, the section On the Means of Keeping Safe from Fire abounds with Peter-era instructions like "burn naught in the yards and streets", "keep basins of water in attics of dwellings and other places found suitable", "see to it that chimneys be cleaned each day, and stoves be looked over most often", and more [21].

This Charter had direct links to the Building Charter. In most instances, ensuring fire safety was an important part of building design and new construction in cities, therefore the Fire Charter would often contain references to following the Building

Charter in this context: "Any building there be, in a town or a village, owned by the state, or by the public, or by a citizen, must be assembled and maintained in a manner befitting the fire precautions, which are all provided for in the Building Charter" [22]. These requirements were listed in Chap. 3, "General Rules of Building in Towns and Cities". In 1838, the government adopted "the Special Rules of Fire Warning, Observed in Saint Petersburg". This document was reflected in new Fire Charters as soon as in 1852 and 1857.

Digest of Decrees on Bettering Cities, Towns, and Villages. The Building Charter contains paragraphs on construction in urban and rural communities; the latter have a separate section dedicated to them. At the same time, the legislator additionally groups the decrees on the improvement and layout of populated areas.

This Digest was integrated into part five of the Collection of Charters on Bettering the State and divided into three books [22]:

- decrees on urban and rural economy,
- a digest of decrees on special regulation and supervision in state-run settlements,
- a digest of decrees on foreign settlements.

This document also had close links to the Building Charter, which defined the technical rules of construction. The Digest of Decrees on Bettering Cities and Towns mostly contained government orders that outlined the urban improvement responsibilities of the local authorities. This covered construction, fire safety, and the construction and repair of roads [23].

The City Regulations of 1785 were still in force at the time. Consequently, the jurisdiction of the local authorities and the approaches to problem-solving were largely governed by that document, a relic from the reign of Catherine the Great [24]. There were not that many documents published on the subject in the early nineteenth century, and those that were published, merely expanded and commented on the City Regulations of 1785; according to the latter, local governance, including the issues relevant to urban improvement, was handled by governor-controlled City Dumas or Town Halls. The local authorities were supposed to fund their improvement efforts out of the city budget, which kept running catastrophically dry [25].

Digest of Institutions and Charters on Transport Routes. Published in 1832, this other Digest was part of the Collection of Charters on Bettering the State. In some ways, it overlapped with the Digest we discussed above [26]. The Digest of Institutions and Charters on Transport Routes of 1832 described the state policy on road construction in general (water and land routes) and the improvement of urban roads.

An analysis of this Digest reveals some regulations from the Council Code (Sobornoye Ulozheniye) of 1649, as well as some 18th-century documents. At the same time, a major block of laws resulted from overhauling the industry's core authority: the Main Directorate of Transport Routes. In this case, the defining documents were On Overseeing Water and Land Routes (1809) and On the General Work of Ministries (1811). They created a certain vertical hierarchy in the industry at different levels: the Main Directorate—the Okrug (District) Administration—the

Governorate Administration [27]. This hierarchy would later see further development due to the transformation of civilian construction governance. In other words, construction of the first third of the nineteenth century was focused on roads, but starting from the 1830s, this field expanded to include general civilian construction issues. These changes were already reflected in the 1842 Digest [28].

The Digest contained regulations on the following [23]:

- the rules of allocating land plots for road construction,
- the process of funding road construction administered by the Main Directorate of Transport Routes,
- the process of funding road construction administered by the local (governorate, city) authorities,
- the duties of institutions entrusted with road security,
- the process of enacting punishments for improper road conditions,
- the rules of making design drafts and budget estimates, as well as the process of reviewing and approving them;
- the process of reporting major road work.

Digest of Decrees on Factories, Plants, and Artisan Enterprises. The Building Charter had a section on industrial facilities located within city limits. So we might say that the purpose of this Digest was to elaborate on the relevant provisions in the Building Charter.

Furthermore, the Digest of Decrees on Factories, Plants, and Artisan Enterprises (published in 1832) was part four of the Collection of Charters on Bettering the State. It listed the rules of maintaining industrial facilities in populated areas. The idea was to ensure both environmental and fire safety [29].

The local authorities bore most of the responsibility in this field. This is affirmed by the documents in the Digest. The eighteenth century and early nineteenth century laws were the most vital. They included: *On the Factories and Plants Remaining in the Care of Governorates*, 1804 [30], and *On the General Mandate for Civilian Governors*, 1837 [31]. The latter law was included in the Digest later on, in 1857.

Mining Charter. This document, aside from industry-specific issues, covered architecture and construction, also making it part of the relevant legislation [12]. Such regulations included:

- the rules of maintaining mining enterprises and allocating land plots for them,
- the rules of building production facilities in cities,
- the rules of designing and approving new city layouts and developing existing cities,
- the rules of allocating land plots for public and private property and for the construction of charities, hospitals, etc.,
- regulations on industrial real estate and their land plots,
- laws on improving mining communities,
- and more.

This document supplements the Building Charter, specifically when it comes to construction and improvement in different locations within state institution jurisdiction.

Digest of Laws on Land Surveys. The last collection of laws that we are going to review here was part of the Digest of Laws on State Property and Land Surveys. It was published on 1 January 1835. Its importance far exceeds that of all other laws relevant to architecture and construction [32]. We might say that the land survey regulations cover issues related to settling in different areas; using and developing the land; establishing the boundaries of cities and their suburbs; defining functional areas and various land use types; establishing the boundaries for landowner plots, and more.

The Digest had five books, encompassing laws from the eighteenth century and early nineteenth century:

- Manifesto on the General Land Survey Throughout the Empire, 1765,
- Instructions for Land Survey Chanceries and Offices in Governorates, 1766,
- On the Relations Between the Moscow Governorate Land Survey Chancery and Places Elsewhere, 1766,
- Digest of Governorate and State Institutions,
- On the New Order in the Land Survey Body, Bolstered by the Staff of the Land Survey Chancery and Offices, Complete with a Description of Public Servant Uniform, 1819 [33].

The next major overhaul of the land survey administration concerned the governance principles. The reform occurred in the mid-1830s, so it would not be officially recorded until the next Digest of Laws on Land Surveys, in 1842. The main change was the creation of a separate land survey administration at the Ministry of Justice. This was also reflected in the formation of land survey bodies in governorates.

The above reaffirms that the period in question witnessed the compilation of digests of laws in all fields of architecture and construction. Notably, the foundation of these laws included not just the documents from the first twenty years of the nineteenth century, but also legislative acts from the eighteenth century, and sometimes even parts of the Council Code of 1649. This prompts a conclusion that, aside from new documents, the Digests of Laws at the time also preserved the time-tested regulations on the different elements of the architecture and construction complex.

3.3 Nature of the Architectural and Civil Engineering Processes in Saint Petersburg, Based on the Building Charter

As evidenced by the set of documents that formed the Charters, special attention was paid to the urban development of Saint Petersburg, it being the nation's capital.

The Building Charter of 1842 included, among others, such sections as On the Rules Observed in St. Petersburg (published in 1836).

It bears noting that, according to statistics, by 1830, urban development accounted for 20% of the city's area. As for stone structures, they did not account for more than 5%.

A single decade is a fairly short period of time as far as major urban transformations are concerned. Therefore, let us examine how the legislative documents published by the government and included in the Digest affected construction in the capital throughout the latter half of the nineteenth century. Notably, central development is not the most illustrative example; what is far more telling is construction along the periphery of the city, specifically Petrovsky Island, which is where Saint Petersburg was founded.

After the urban center was moved to the Admiralty Part area, Petrovsky Island began performing the same role as any city's periphery: it became home to regiment settlements, orchards, and kitchen gardens. In addition, there was a thoroughfare passing through here, Kamenny Island Road. By the middle of the year 1830, the total number of residential houses in the area reached 1239, and only 85 of them were built out of stone. Savinkov's layout of Saint Petersburg (1835) provides a good representation of the nature of the urban environment in this part of the city (Fig. 3).

The wooden city was under constant threat of fire. This was why the Fire Charter had direct links to the Building Charter. Following the transition to a unified construction regulation system in the field of architecture and civil engineering, the issue of expanding the share of stone structures came into special focus. A special decree,

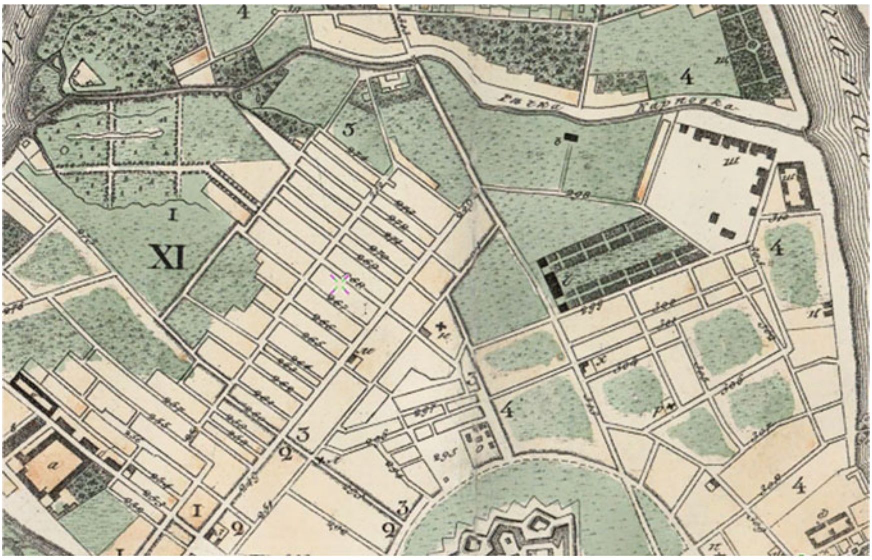

Fig. 3 Savinkov's layout of Saint Petersburg, 1835. Petrovsky Island: development type [34]

issued back in 1830, forbade the construction of residential buildings with basement levels in some parts of Saint Petersburg, including Petrovsky Island. Later on, wooden buildings were outlawed entirely almost throughout the whole city, except for a few locations where repairs of existing wooden buildings were allowed until such buildings wore down completely [35].

Furthermore, the year 1833 and further saw the introduction of special rules for locating industrial facilities within Saint Petersburg's city limits. The special rules applicable to Petrovsky Island made it possible to retain the waterfront; consequently, there is no fee-based industrial belt.

Stone construction around Petrovsky Island began towards the end of 1850. The first stone buildings appeared in Bolshoy Prospekt, and later on in Kamennoostrovsky Prospekt as well. The area's layout system was finalized in 1861, with new streets being laid down as well.

The layout from Suvorin's 1894 guide to Saint Petersburg (Fig. 4) shows the significantly diminished size of the territories allotted for private orchards and kitchen gardens, and also features dotted lines that indicate construction along Kamennoostrovsky Prospekt [36]. Just a few years later, the nature of development in this part of the city changed radically, as demonstrated by the layout of 1911 (Fig. 5).

The example we have reviewed reveals a link between the regulatory documents and legislative guidelines, on the one hand, and the issues of the real-life architectural and civil engineering processes, on the other hand. Work in this field enabled a transformation of the territory in question. Within just ten years, the small wooden houses remaining in the places of regiment settlements and local manors gave way

Fig. 4 Travel guide. Publisher Shchepansky, 1894 [37]

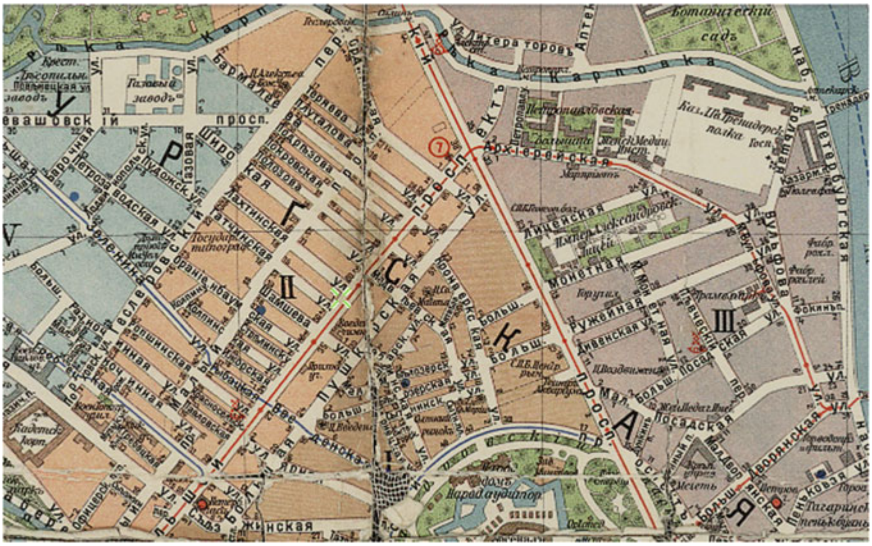

Fig. 5 Layout from Suvorin's guide, 1911. All Petersburg [38]

to multi-story stone residential houses, turning the main streets into respectable thoroughfares. Kamennoostrovsky Prospekt, with its unique ensemble, became the area's most representative street. The buildings of Kamennoostrovsky Prospekt, which were erected primarily in the late 19th and early twentieth centuries, produce a holistic artistic impression.

4 Conclusion

The paper studies the main aspects of regulating and standardizing processes in the field of architecture and civil engineering in Russia. This research contributes both to theory and to the practical search for new means of optimizing architecture and civil engineering today.

The particularly important thing is the starting point of this process, which reveals the specific set of legislative materials that were included in the first editions of the Digest of Laws.

This makes it possible to trace the dynamics of managing the main elements of the architectural and civil engineering complex. Furthermore, it allows us to provide a more informed representation of the regulation issues affecting the architectural and civil engineering complex today and find the mutual links between the regulation process in this field and the development of statehood and law-making. The stages of the legal framework's historical development in architecture and civil engineering show that legislators strive to include as many entities into the regulation process as possible. The historical period reviewed in this paper (the first half of the nineteenth century) witnessed the consolidation of a chaotic mass of laws, resulting from the specific urban planning, architectural, and civil engineering government programs, into Digests. The legislation targets were also specified and provided with maximum regulation.

This allows us to draw the following conclusions:

1. Reforms in the central administration system coincided with legislative codification.
2. The Digests of Laws of 1832 and 1842 were among the results of this process. The Digests were further supplemented by Additions, which reflected the different legislative changes.
3. Aside from the actual Building Charter, the state policy on architecture and construction laws (including the issues of territorial development, architecture and construction control and monitoring, the development of the urban economy, transport, and industry) was reflected in the following documents:
    - Collection of Charters on Bettering the State;
    - Digest of Governorate and State Institutions;
    - State Governance Code (including the Mining Charter);
    - Digest of Laws on State Property and Land Surveys.
4. Our analysis of the legal documents from the different digests and collections has revealed that the above included not just 19th-century laws, but also legislative acts from the eighteenth century, and sometimes even certain provisions of the Council Code of 1649, which still remained valid.
5. The creation of a clearly defined vertical hierarchy in the supervision and financial control of the architecture and construction processes within the construction complex at all levels brought the process of state and urban property construction to a whole new level.

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The Effectiveness of the EIA Procedure in Industrial Zone Development in the City

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Abstract The article examines the development of industrial areas of the city, increasing their investment attractiveness, economic efficiency of land use, environmental safety of industries, the introduction of modern technologies for cleaning emissions and discharges, etc. The basic principles of city industrial zones environment protection by applying the procedure of environmental impact assessment (EIA) are analyzed. The international and Russian experience and history of EIA procedure development are considered. Statistical materials on pollution of the territory of large cities of Samara region (Togliatti) and industrial enterprises which make the greatest contribution to the pollution of the region were studied. By the example of the project of development of the land plot occupied by the industrial site of PJSC "KuibyshevAzot" on the territory of the Northern industrial hub of Togliatti, Samara region, the structure of the EIA project is analyzed, the main environmental impact monitoring measures are considered. The effectiveness of the EIA system and its role in the development of the industrial zone of the city were assessed.

Keywords Environmental impact assessment (EIA) · Eco-city technology · Urban ecology · Smart city · Industrial areas

1 Introduction

The globalization influence changes the living conditions of people, which is most evident in cities. As a result of urbanization the number of urban population increases, the area of megacities grows, so the issues of development and implementation of a "smart city" system become urgent. In the concept of a "smart city" an important characteristic is the so-called "green city" in which an effective ecological infrastructure is created and the environmental protection is at a high level, including the territory of industrial zones [1].

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The problem of environmental pollution is especially actual for territories of urban agglomerations, according to the statistical reporting data for 2020 in the Russian Federation the urban population (74.7%) prevails (as of 01.01.2020) [2]. At the same time each year the share of the urban population increases not only in the Russian Federation, but also all over the world. The improvement of the urban environment and the attractiveness of the city are becoming increasingly important.

The population of cities with a developed industrial sector is particularly vulnerable to the negative impact of air pollutants due to the dense construction and location of industrial sites in close proximity to the residential area. At the same time, industrial enterprises have not only a negative environmental impact, but also have a negative impact on the value of residential real estate and reduce city revenues.

The use of large industrial zones in the spatial organization of urban areas is given great importance in the works of architects and urban planners [3–6]. The majority of works studied the ways of transferring industrial enterprises from the city center and using the released territories for other functions (socio-cultural, educational, residential, innovative-technological, etc.). The study of the Samara-Togliatti agglomeration, which is the third largest in Russia after Moscow and St. Petersburg, is devoted to a number of works that study the problematic issues of the post-industrial city [7–9].

When developing the territory of a city, an important but poorly studied issue is the environmental impact assessment (EIA) of industrial facilities, which is carried out in order to prevent negative consequences. EIA makes it possible to implement the most environmentally friendly design and management solutions at an industrial facility to reduce the possible negative impact of both individual facilities and entire industrial agglomerations within the city limits.

The EIA system was first introduced in the USA in the late 1960s and in the EU countries—in the 70s and is still the key instrument of the ecological policy of the European Union [10–14]. The adoption of SNIP 1.02.01-85 in 1985 [15] is considered as the official beginning of the environmental impact assessment activity in the Russian Federation, but in Russia the EIA procedure was actually initiated in 1988 by the state ecological expertise (SEE). This is largely due to the fact that in the domestic system of preparation and adoption of environmentally significant decisions the issues of environmental impact assessment are inextricably linked to the analysis of the regulation of the SEE. In 1997 the "UN Convention on EIA in a transboundary context" came into force, and the international aspects of the regulation of the environmental impact assessment began to become more and more important and needed an effective legal regulation [16].

Today, the comprehensiveness of environmental impact assessment of economic activities is one of the basic principles of environmental expertise, and the materials of EIA must be submitted on a mandatory basis to the state environmental expertise together with the materials of discussions of the object of SEE with citizens and public organizations (Federal Law "On Environmental Expertise"). Thus, the need to discuss with the public the immediate and long-term consequences of planned economic and other activities as part of the EIA assessment seems to be one of the most important measures to ensure the observance of environmental constitutional rights of the citizens of the Russian Federation. At the same time, during the last decades the format of holding public hearings is quite often criticized, and some authors note that public participation in the EIA procedure requires improvement, since the Russian environmental law has virtually no detailed regulation of environmental impact assessment and public participation in this procedure [17, 18]. Since September 1, 2021 the Requirements of the Ministry of Natural Resources of Russia for the materials of the environmental impact assessment [19] came into force, in which the rules of the EIA procedure in general and public hearings, in particular, are supplemented, specified and substantive. However, the requirements of this Order do not apply to the materials of the environmental impact assessment, public discussions of which were held before September 1, 2021. [20, 21].

Spatial development of modern cities is largely inherited from past historical periods. Often, with the active growth of the territory of the city, land plots occupied by industrial enterprises, previously located outside the city limits or on the outskirts far from the center, were seized. At the same time, the industrial zone ended up next to residential areas and became a source of negative impact on the urban environment and public health. The development of environmental legislation since the 2000s has led to stricter control over the content of pollutants in the air of settlements, soil and air environments. The requirements for the content of pollutants in the air of the working zone on the territory of industrial facilities have undergone changes towards regular inventory of emission sources, checking the efficiency of gas purification equipment, developing a list of measures in case of unfavorable meteorological conditions, etc. The above-mentioned changes have led to the need to increase the responsibility of the owners of industrial facilities for the possible negative impact on the natural environment. At the same time, the owners of industrial facilities began to bear more costs for environmental measures and almost all the costs are borne by business representatives rather than by municipal authorities.

A little-studied issue is the possibility of increasing the role of government agencies in the promotion of environmental policy on the ground, as well as in the organization and implementation of environmental protection measures, improvement of gas purification equipment, modernization of wastewater treatment facilities of industrial enterprises, etc. In the Russian Federation, decisions on the development of economic or other activities, including the design and construction of enterprises, buildings and structures include the development of EIA projects, public hearings, etc. [22].

The territory of Samara region is an industrially developed region with more than 600 industrial enterprises which have a significant impact on the environment. The share of industry in the structure of the gross regional product of the Samara region is more than 42.9%. Therefore, the problems of pollution of atmospheric air, surface and ground water, soil cover as a result of industrial enterprises are very acute in the cities of Samara region. According to the assessment of the environmental condition of the Samara region by FSBI "Volga Department for Hydrometeorology and Environmental Monitoring" in 2020 the greatest contribution to air pollution in Togliatti was made by emissions from automotive industry, petrochemistry, production of chemical fertilizers and building materials, CHP, boiler houses and river port. During the period under review 81 cases of exceeding maximum permissible concentrations of pollutants were registered in Togliatti: 33 cases of exceeding formaldehyde, 29 cases of exceeding ammonia, 15 cases of exceeding phenol, 3 cases of exceeding hydrogen fluoride, 1 case of exceeding nitrogen dioxide. Hydrochemical research of surface water bodies of Samara region revealed regular observations of 6 polluted, 8—very polluted, 3—extremely polluted and 1—extremely polluted water. In the area of Togliatti city the water of Kuibyshev and Saratov reservoirs had 2 MPC of hard-to-oxidize organic substances and 3 and 2 MPC of copper compounds, respectively [23].

It should be noted that all the listed pollutants have a pronounced biological activity and in elevated concentrations can have a damaging effect on the ecosystem as a whole and living organisms in particular. The necessity of obligatory assessment of the possible negative impact of enterprises on the environment and the adjacent residential area (especially within the framework of creation of an effective ecological infrastructure) is indispensable. Analytical evaluation of EIA system efficiency and its role in the development of the industrial zone of the city, review of various methods and technologies used in the impact assessment becomes especially relevant in the territory of the Samara region.

In the city of Togliatti most industrial enterprises are concentrated in the Samara region, which are located within the city and borders with the residential area, and taking into account the wind rose the transfer of pollutants goes in the direction of residential neighborhoods. The main sources of pollutants entering the natural environment include: LLC "Togliattikauchuk", PJSC "Togliattiazot", JSC "Avto-VAZ", LLC "KHIMTEKO", PJSC "T Plus" TPP of Volzhsky automobile plant, LLC "TOMET", JSC "TOLYATTISINTEZ", LLC "Togliatti Transformer" and others. In order to reduce the negative impact on the air environment of Togliatti, these enterprises regularly carry out industrial environmental control in the field of air protection by implementing the environmental management system ISO 14000 and its certification, which is confirmed annually.

The fact that the area occupied by industrial enterprises is not less than 25% of the total area of urban land poses a particular danger. At the same time, according to the wind rose, the main air transfer of pollutants is carried out in the direction of residential buildings (to the south and southwest).

Having analyzed the Scheme of Urban Zoning of Togliatti [24], we can say that the greatest negative impact have Avtozavodskoy and Central districts of the city, bordering with the territories of large industrial hubs. In the original planning of Togliatti were laid large buffer zones, intended to separate the air flow, dispersal of pollutants in the green space and protection of residential areas. However, at present, we can observe that the industrial sites are concentrated in the northeastern and northern parts of the city and directly border the residential areas of the city. At the same time, the "green zone" (the zone of urban forests and parks, recreational and landscape areas and specially protected natural areas) are concentrated in the southern and southwestern parts of the city. Thus, the issue of organizing green buffer zones, for example, in the territory of abandoned industrial sites, in the areas where residential and industrial sectors come together, as well as "reasonable" development of the industrial zone of the city, taking into account all the environmental aspects, becomes particularly relevant. A promising direction is the redevelopment of abandoned industrial spaces through the re-profiling and reuse of industrial heritage [25].

The aim of the article is to assess the effectiveness of the EIA procedure in the development of the territory of industrial zones of cities by the example of the industrial site of the company "KuibyshevAzot" located in Togliatti, Samara region. To achieve the goal the tasks were set: (1) to study the results of the EIA project prepared by one of the authors of the article for the industrial site of PJSC "KuibyshevAzot"; (2) to analyze the effectiveness of the EIA procedure; (3) to assess the possible impact of EIA project preparation on the territorial development of urban industrial zones (using the example of Togliatti).

2 Materials and Methods

An empirical generalization of data on the impact of an industrial facility on the environment is the basis of EIA evaluation. At that a set of engineering-geological and ecological research methods are often used which are complemented with modeling, GIS-technologies, methods of multidimensional statistics (correlation, regression, cluster and factor analysis), results of public discussions and expert assessments of specialists. When carrying out ecological assessment of technologies and production, methods of material balance, technical alternative, forecasting of technological risk and registration of technological consequences of production are used. A very promising method seems to be carrying out EIA on the basis of BIM-technologies, which allows designers to run an automated EIA at any moment at the design stage and immediately assess the environmental impact for the choice of the project [14].

To perform an environmental impact assessment, developers use different data: the results of engineering surveys (engineering-geological, meteorological, engineering-ecological, etc.); the results of monitoring the existing state of the environment (atmospheric air, water basin, territory, fauna and flora); documents of state, regional and local authorities that contain data on environmental pollution, etc. All the listed information is necessary, first of all, for forecasting—the process of obtaining data on the possible state of the object under study and natural-anthropogenic landscapes in the area of its influence for a given period of time.

As part of the EIA procedure, the state of the environment in the area where the projected/operating facility is located is characterized. For example, such industrial cities as Togliatti are characterized by an increased content of pollutants in the residential area due to the fact that chemical enterprises are located north of the residential area, and the city is dominated by mainly south- and south-west wind direction.

Analysis of the technological scheme of production (as well as the existing schemes of peer facilities); parameters of the technological process of the enterprise; transport network; utilities, etc., allows you to identify sources of possible pollution of the atmosphere, soil, ground and surface water, plant and animal habitats in the zone of influence of the industrial site of the enterprise. The results of such survey often help to prevent possible leakage of priority environmental pollutants into natural objects. Assessment of methods of handling hazard class 1–3 wastes containing toxic components allows preventing emergency situations during transportation, processing, utilization, neutralization or disposal of these wastes at RWDF facilities on the territory of the enterprise's industrial site.

In the process of development of the EIA project a list of measures is usually proposed to control the possible negative impact of the enterprise on natural objects, prevent accidents and increase the efficiency of gas purification equipment or treatment facilities, etc. A network of observations and control over the processes of formation of components of the natural complex in technogenically altered conditions is organized, which includes monitoring of ground and surface waters, soil, atmospheric air, etc. A procedure for exercising industrial environmental control at the enterprise is being developed, which includes an audit of the enterprise's documentation (positive conclusions, licenses, waste management instructions, etc.) allowing the enterprise to operate in compliance with the requirements of environmental legislation.

PJSC "KuibyshevAzot" is located in the city of Togliatti, Samara region. The city of Togliatti is one of the largest industrial centers in the region, it is located on the left bank of the river Volga, at the junction of the Kuibyshev and Saratov reservoirs, 8.5 km from the coast. The area of Togliatti is 314.8 km^2, population about 720 thousand people. PJSC "KuibyshevAzot" is a part of the enterprises of the Northern industrial hub in the Central District of Togliatti, is a large industrial enterprise and the leader in the production of caprolactam, polyamide, textile and technical yarns in Russia, CIS and Eastern Europe. PJSC KuibyshevAzot annually spends a lot of funds on environmental protection measures, for example, in 2019, 3.2 billion rubles were allocated for measures to reduce the impact on the air environment. To eliminate the shortage of necessary raw materials (sulfuric acid and oleum), the company has developed a plan for the development of the industrial site and prepared an EIA project.

According to the SanPiN 2.2.1/2.1.1.1200-03 regulations "Sanitary protection zones and sanitary classification of enterprises, installations and other facilities" KuibyshevAzot PJSC is a first class chemical facility, for which an approximate sanitary protection zone (SPZ) is set at 1000 m. Within SPZ of PAO KuibyshevAzot there are industrial facilities of hazard classes I–V and facilities and industrial enterprises: LLC SIBUR Togliatti, PJSC T Plus, LLC Khimzavod (Fig. 1).

The calculation of surface air pollution made in the draft EIA showed that the concentrations in the calculated points on the border of the sanitary protection zone and in the residential area and on the border of the garden plots will exceed 0.1 MPC only for sulfur dioxide—sulfur dioxide, but will not exceed 1 MPC. Therefore, emissions of pollutants from the planned development of the industrial site will not create concentrations in the air of the sanitary protection zone, residential area and on the border of garden and garden plots, exceeding the maximum allowable values, and will not have an additional negative impact on the environment.

Fig. 1 Boundaries of the sanitary protection zone of PJSC KuibyshevAzot

Production of sulfuric acid and oleum will provide an additional contribution to gross pollutant emissions and to total atmospheric pollution. The operation period will be accompanied by the emission of harmful pollutants in the amount of 500.56 t/year. As the results of calculations of dispersion of pollutants in the atmospheric air during the operation of the facility have shown, for all pollutants the maximum calculated concentrations in the residential area and on the border of the SPZ of PAO KuibyshevAzot are below 1 MPC.

Atmospheric conditions of the area shall be monitored directly at the object of the planned activity by taking samples from all sources of pollutant emissions into the atmosphere and on the SPZ boundary. For all stationary sources of emissions, it is necessary to constantly monitor the composition and quantity of emissions of harmful substances (Table 1). Sanitary and hygienic assessment should be carried out according to approved methods. Scheduled periodic monitoring of atmospheric conditions shall be carried out by a sanitary laboratory accredited by the Federal Accreditation Service. The main controlled substances will be suspended substances, carbon monoxide, hydrocarbons, sulfur dioxide, nitrogen dioxide, hydrogen fluoride, sulfuric acid (by molecule H_2SO_4), sulfurous anhydride, dihydrosulfide (hydrogen sulfide). Periodically, once a month, analytical monitoring of the condition of the air basin at the boundary of the SPZ and the nearest places of residential development is necessary.

Territorial development of industrial zones of the city is carried out in order to increase attractiveness, attract investment, increase economic efficiency of land

Table 1 Sources of pollutant emissions (according to the EIA)

Emission source	Pollutant	Emission volume (t/year)	Periodicity
Factory pipe	SO_2	471	Continually
	Acid Fog and SO_3	29	Continually
Sulfur melting tank	H_2S	0.55	22 h a day
Intermediate pit and flushing pit	H_2S	0.01	Continually

use, development of technological equipment, including environmental protection measures. For example, PJSC "KuibyshevAzot" on its own initiative, with the involvement of specialized design organization CJSC "Ecopolymer-M", Moscow, has developed and started implementation of the first stage of the project of complete cycle of treatment of storm and polluted wastewater of enterprises of the Northern industrial area and part of the residential area of the Central district of Togliatti to water quality standards of fish industry water bodies. The implementation of this project will reduce the negative impact on the water basin of the Volga River.

Identification of significant impacts based on the survey data was performed using exhaustive lists of environmental components and highlighting those of them on which the planned activities may have a significant impact. Analysis of the results of engineering-ecological surveys at the construction site of sulfuric acid and oleum production and reporting data of PAO KuibyshevAzot allows making a conclusion about the prospects of placing new production on the territory of the industrial site of PAO KuibyshevAzot for the planned development of the territory. Positive aspects for the development of the land plot in the industrial area of Togliatti are a wide range of economic and socio-environmental factors: constantly growing demand in the domestic and global markets of sulfuric acid and oleum; use of modern production technologies that meet the requirements for safety and environmental production, business scale and resource consumption level; availability of developed transport structure and engineering communications; provision with natural resources; availability of human resources.

3 Results and Discussions

Study of project documentation of the investment project "Sulfuric acid and oleum production", analysis of generally available data base of Togliatti city environment protection, systematization of PJSC "KuibyshevAzot" enterprise reporting data and results of conducted research as a result of EIA project preparation have led to the following results. (1) Project solutions fully justify possibility and safety of sulfuric acid and oleum production on PJSC "KuibyshevAzot" territory. (2) The suggested technological scheme of sulfuric acid and oleum production at PJSC "KuibyshevAzot".

It should be noted that the proposed use of a land plot in the industrial zone of Togliatti, along with the absence of a negative impact on the environment will contribute to a potential increase in economic efficiency by increasing land payments while increasing the cadastral value of the property. Since land tax and rent are local taxes, there will be an increase in the revenue part of the regional budget, as well as replenishment of budgets of other levels and social funds [26, 27]. Other positive consequences should include: additional employment of the population in various areas; support of domestic manufacturers; substitution of imported goods in the machine-building, automobile, tire and textile industries; increasing the competitiveness of Russian products on the world market; ensuring sustainable growth of population income on the basis of effective employment; improving the environment.

4 Conclusions

As a result of the study conducted in this paper, the following results were obtained. (1) Industrial areas have both negative environmental impact on the surrounding areas and affect their economic indicators, such as the price of residential real estate. (2) Analysis of EIA project for the industrial site of PJSC "KuibyshevAzot" revealed the possibility of placing new production of sulfuric acid and oleum on the territory of the considered industrial area, provided regular environmental monitoring and implementation of a list of environmental protection measures. (3) Evaluation of EIA procedure first implemented in this study.

According to the results of the study, it can be concluded that the regulatory and legal documentation governing the EIA procedure at present allows a high degree of reliability to assess the possible negative impact of the production facility on the environment and determine the priority direction of development of the industrial area of a particular city. However, the EIA procedure is mandatory in many countries and is carried out at the design stage of a wide variety of industries and construction projects [3–6], so it is necessary to continuously improve the legal regulation of this assessment system. In addition, a periodic analysis and study of the effectiveness of the EIA procedure for various facilities would allow the regular development of proposals and recommendations to correct deficiencies in the procedure, in accordance with the legal acts of the Russian Federation and the UN Economic Commission for Europe, both in Russia and at the international level.

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Analysis of Urban Ecology Framework in Urban Green Spaces and Infrastructure Component

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Abstract In the present study, with a "descriptive-quantitative and analytical" approach, an attempt has been made to determine the priorities for the development of the ecological framework of the city at the level of urban districts while assessing the current situation. The results showed that over the past decade, the per capita urban green space in Tehran has increased from 11.63 m^2 in 2010 to 16.27 m^2 in 2020. But at the same time with this increase in per capita, the per capita difference between the privileged and deprived districts has also increased significantly and the imbalance in the spatial distribution of green spaces and infrastructure has intensified. The statistical population of the study includes the twenty-two districts of Tehran, which are ranked on the basis of 12 criteria. For this reason, the studied criteria using the TOPSIS method have been used as a multi-criteria decision-making method. Finally, in GIS software, the asset levels of Tehran's districts has been determined in 5 levels. The results of this study show that the distribution of green spaces and infrastructure in urban districts of Tehran is not balanced.

Keywords Urban ecology · Urban green space · Green infrastructure · TOPSIS

1 Introduction

The understanding of the environment development patterns in modern cities is associated with the awareness of the interaction of environmental and urban planning processes. These processes are currently accompanied by poorly controlled exploitation of natural resources, degradation of the natural environment, and violation of the ecological balance that has developed as a result of evolutionary processes.

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Defining strategies for large cities development urban planners have to deal with disparate existing settlement structures, where each building and area become an object of support for natural components that determine the totality of green spaces and elements of green infrastructure. Modern digital technologies make it possible to identify fragments of the urban fabric, determine their ecological state and select protocols for their natural and anthropogenic harmonization.

The environmental hazards that large cities face today can be overcome by their discretization and individual modernization, taking into account the peculiarities of the social organization of local communities and the state of the environment. Digital technologies are aimed to conduct a more detailed criteria analysis of the existing urban environment; its discretization and consideration from the standpoint of the organization of local ecological urban systems open up new opportunities for solving the problems of improving the comfort of urban environments.

This accepted continuous landscaping, “natural wedges” and “green corridors” concepts are now poorly implemented in many cities, since the requirements for restrictions on external urban expansion have been adopted, and the inner city territories are already all occupied.

The expansion of environmental and ecological perspectives in the literature on sustainable development, the concept of ecological city or ecosystem in the topics of urban planning and economic development are in the literature on theoretical foundations. Although an ecological city is a relatively new concept, it is based on concepts that have a long history. An urban equator, which is the origin of the ecological city and the creation of ecological cities, follows the following principles:

- Reviewing land use priorities in order to create compact, diverse, green and healthy communities.
- Creating comfortable and cheap housing, creating urban social justice.
- Rehabilitation of damaged urban environments, support of local agriculture, urban green space plan and urban gardens.

In a general consensus in the definition of ecological city, it can be said that an ecological city is a city whose physical and economic structure has been formed by observing environmental considerations or in other words, compatible with natural environmental conditions.

Ecological sustainability means maintaining basic interests at levels that do not take away future authority, or maintaining or enhancing the ecosystem’s capacity, quality, and flexibility. This dimension is strengthened by reducing resource and energy consumption, reducing the volume of waste, pollution and recycling, and finding the right technology.

A large city has become the embodiment of the most acute conflicts of preserving the biological basis of humanity. It is necessary to search for environmental, ecosystems restoration in the existing conditions.

Since the main problem of natural and anthropogenic modernization is connected with the fact that spatial resources are already exhausted in the cities. There is no free land for additional green spaces and infrastructure. It is necessary to develop new approaches using the most modern technologies for monitoring and regulating the processes of urban development. At the moment, the solution to these problems is seen in the methods of atomized placement of natural components and digital systems for coordinating the development of the urban environment. One example of such an approach is the concept of point modernization of areas with poor ecology, proposed by the French firm Vincent Callebaut Architectures, based on the design of biomimetic energy-efficient buildings, "vertical lemmas" and urban agricultural farms. The authors propose the formation of autonomic areas of ecological sustainability as a kind of vehicles for a new conscious way of life [1–3].

Another direction how to solve the environmental urban greening problem can be the method of "coevolutionary totality", proposed by the Long-term firm "EcoLogicStudio" and based on the creation of harmonious interactions of the artificial anthropogenic environment with biological organisms that perform a compensatory ecological role [4]. This direction is also represented by the Urban Algae Folly project, presented at the EXPO 2015 in Milan (Italy). As mentioned, the framework of urban ecology is one of the categories related to the environment and sustainable development and is one of the current topics of urban planning and urban planning. Many books and articles that have been published in this field, as well as conferences that are held every year about green space in the world and in Iran, show the importance of this issue. Table 1 lists some of these studies conducted in Iran and other countries [5, 6].

Different regions of the world face different challenges to achieve sustainable development. Therefore, in the formation of the urban ecology framework, they first identify the existing problems and then, based on urban ecology indicators, in order to moderate the problems, their development is prioritized. Table 1 provides examples of cities with challenges and approaches in urban ecology. As you can see, most of the approaches that help to solve the desired challenge have been prioritized by city managers [7, 8].

Although urbanization has brought prosperity to human beings, it has also led to some problems, and as the population of cities increases, so do the problems of cities, which ultimately affect the health and well-being of the people. It directly endangers one, because the population growth, on the one hand, leads to issues such as increasing traffic, increasing small and large workshops, and increasing the volume of waste, and on the other hand, destroys forests and trees, and green space to create residential units. The most important effect of green space in cities is their ecological functions, which have made cities meaningful as the environment of human society and deal with the effects of industrial expansion and misuse of technology, increasing the quality of urban beauty. Components of urban development effects can disrupt the ecological framework of cities in various ways. Proper green spaces and infrastructure in cities are effective factors in reducing these effects. Especially in relation to air pollution, green space is similar to the forest of the respiratory lungs of cities. The most important effect of green space in cities is temperature adjustment, increase in relative humidity, gentle air, and dust absorption. Therefore, if green space and infrastructure as a part of the context of cities and also a part of urban services

Table 1 Background of urban ecology research [5, 6]

Researcher	Title	Year
Daniele La Rosa	Accessibility to greens paces: GIS based indicators for sustainable planning in a dense urban context	2014
Jennifer R. Wolcha, Jason Byrneb, Joshua P. Newellc	Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough	2016
I.P. Senanayake, W.D.D.P. Welivitiya, P.M. Nadeeka	Urban green spaces analysis for development planning in Colombo, Sri Lanka, utilizing. THEOS satellite imagery A remote sensing and GIS approach	2013
Fanhua Kong a, Haiwei Yin b, Nobukazu Nakagosh	Using GIS and landscape metrics in the hedonic price modeling of the amenity value of urban green space: A case study in Jinan City, China	2008
Sarah Nahibi Maryam Sadat Hassan Dokht	Investigating the effects of urban green space on improving the quality of urban life	2017
Shiva Ajililen Premium Faezeh Naemi Narges Ghadmagahi	Investigating the importance of urban green spaces in order to achieve sustainable development	2015
Jamal Mohammadi Asghar Zarrabi Mehdi Ahmadian	Spatial prioritization of development of green spaces and urban parks using AHP method	2014
Mustafa Amir Fakhrian Baratali Khakpoor Majid Danaei Asomeh Tavangar	Investigating the role of social functions of urban parks based on location	2012
Messenger of the Sacrifice Razia Teymouri	An analysis of the role of urban parks in improving the quality of life	2010
Mehdi Khan Sefid	Investigating the distribution pattern of urban green spaces with the approach of urban landscape ecology and its relationship with urban sustainability	2008

are necessary, it can not be separated from the needs of urban society, so green space and infrastructure must be quantitatively and qualitatively commensurate with the physical volume. The city (buildings, streets, and roads) and the needs of the community (psychologically, leisure, and health needs) should be built according to the ecological conditions of the city and its future development process so that it can have continuous environmental efficiency as an active green space. Public access to urban services and social justice dictates that all classes of citizens have equal access to urban green spaces and not that certain classes of citizens can choose parts of the most beautiful landscapes of cities for their livelihood and gradually all these landscapes will belong to these prosperous classes of society. This research, which is one of the series of researches of Tehran Ecology Framework, aims to analyze urban green spaces and infrastructures component and seeks to eliminate the deficiencies and fair distribution of access to urban green spaces for citizens. Also in this research, prioritization of Tehran urban districts will be done to continue the development process of the Tehran urban ecology framework [9–12].

2 Research Method

Green spaces and infrastructures in urban ecology have been proposed as one of the criteria for sustainable urban development of communities and at the same time are considered as a criterion for improving the quality of living space. Therefore, its distribution and balanced distribution at the city level are very important.

According to the criterion under study and the nature of the subject, the approach of this research is "descriptive-quantitative and analytical". This approach implies a combination of methods, in which:

- descriptive is aimed at presenting the results of existing field studies of green areas;
- quantitative—at presenting the results in quantitative parameters;
- analytical—a comprehensive analysis of data from field surveys and calculated indicators to assess the situation with the sustainable development of green areas in the cities.

The statistical population of the study is 22 districts of Tehran. The required information based on the year 2020 has been received from Tehran Municipality, Parks and Green Space Organization of Tehran, and Statistics Center of Iran. Then, according to the framework of urban ecology in urban green spaces and infrastructures component, 12 criteria were identified for research (Fig. 1). After the stage of "selection of criteria", to achieve the purpose of the study, the TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) method has been used as a multi-criteria decision-making (MCDA) method in Excel software. Finally, using the geographic information system (GIS), the result is determined in the form of a map of the asset levels of Tehran's districts in five levels (very privileged, privileged, relatively privileged, deprived, and very deprived). To rank the districts of Tehran for the future development and improvement of the urban ecology framework using the TOPSIS method, it is necessary to form a decision matrix that includes matrix rows (alternatives) of 22 districts of Tehran and matrix columns are 12 indicators that feature Specifies green spaces in alternatives (districts). Also, the cells inside the matrix express the position of the districts in relation to their corresponding column criteria. The TOPSIS algorithm is a very strong compensatory multi-criteria decision-making method for prioritizing alternatives by simulating the ideal answer, which has very little sensitivity to the weighting technique and the resulting responses do not change profoundly. In this method, the selected alternatives (districts) should have the shortest distance from the ideal answer and the farthest distance from the

Fig. 1 Criteria of green spaces and infrastructure

most inefficient answer. In the continuation of this research, the steps of evaluation and prioritization, as well as the description of the model, are shown. In the TOPSIS method, the matrix m * n, which has m alternatives and n criteria, is evaluated. In this algorithm, it is assumed that each alternative in the decision matrix has a uniform incremental or decremental utility.

The steps of the TOPSIS method include seven steps, which are [13, 14]:

Step 1: Format the data matrix based on m alternatives and n criteria.
Step 2: Standardize the data and form a standard matrix using the normalization method.

$$A_{ij=}\begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix} \quad r_{ij=}\frac{a_{ij}}{\sqrt{\sum_{k=1}^{m} a_{kj}^2}} \quad r_{ij=}\begin{bmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ r_{21} & r_{22} & \dots & r_{2n} \\ \dots & \dots & \dots & \dots \\ r_{m1} & r_{m2} & \dots & r_{mn} \end{bmatrix}. \tag{1}$$

The basis of the analysis is the decision matrix $A_{m,n}$ including ratings of considered alternatives i = 1, 2, …, m in the context of the accepted criteria j = 1, 2, …, n.

Step 3: Determine the weight of each indicator based on Eq. 2, in which case the more important indicators have a higher weight.

$$v_{ij=w_j r_{ij}} \quad \sum_{i=1}^{n} w_i = 1. \tag{2}$$

Step 4: Determine the best (max performance of each criterion) and worst (min performance of each criterion) alternatives through the distances between each alternative with the ideal solution which is represented by symbols A^+ and A^-:

$$A^+ = v_1^+, v_2^+, ..., v_n^+ \tag{3}$$

where

$$\begin{aligned} A_j^+ = &\left\{\left\langle \max\left(v_{ij} | i = 1, 2, \ldots, m\right) | j \in J- \right\rangle,\right. \\ &\left.\left\langle \min\left(v_{ij} | i = 1, 2, \ldots, m\right) | j \in J+ \right\rangle\right\} \\ \equiv &\left\{v_{ij} | j = 1, 2, \ldots, n\right\} \end{aligned}$$

$$A^- = v_1^-, v_2^-, ..., v_n^- \tag{4}$$

where

$$\begin{aligned} A_j^- = &\left\{\left\langle \min\left(v_{ij} | i = 1, 2, \ldots, m\right) | j \in J- \right\rangle,\right. \\ &\left.\left\langle \max\left(v_{ij} | i = 1, 2, \ldots, m\right) | j \in J+ \right\rangle\right\} \\ \equiv &\left\{v_{ij} | j = 1, 2, \ldots, n\right\} \end{aligned}$$

and $J_+ = \{j = 1.2...., n|j\}$ which criteria have a positive impact, $J_- = \{j = 1.2...., n|j\}$ which criteria have a negative impact.

Step 5: Calculate the distance between target alternative i and best condition (s_i^+):

$$s_i^+ = \sqrt{\sum_{i=1}^{n} \left(v_{ij} - v_i^+\right)^2}. \tag{5}$$

Also, calculate the distance between target alternative i and best condition (s_i^-):

$$s_i^- = \sqrt{\sum_{i=1}^{n} \left(v_{ij} - v_i^-\right)^2}. \tag{6}$$

Step 6: Calculate the similarity coefficient of particular alternatives represented by c_i^+ and based on Eq. 7:

$$c_i^+ = \frac{s_i^-}{s_i^- + s_i^+}. \tag{7}$$

Step 7: Final ranking of the alternatives based on the coefficient c_i^+, which is between zero and one. C_i^+ equals 1 representing the highest rank and c_i^+ equals zero representing the lowest rank.

3 Results and Discussion

In order to develop the urban ecology framework of Tehran, first in this study, the status of urban green spaces and infrastructure component in the districts of Tehran was studied and recognized. This research determines the priority of development and improvement in these districts (Fig. 3), using the TOPSIS method as a system of preferred preferences, considering the similarities with the ideal solution and calculations, the districts were assessed (Fig. 2) and 22 districts of Tehran in five Groups are ranked (Table 2).

To evaluate urban green spaces and the infrastructures component in districts of Tehran we use asset levels with the specific gradation depending on the quality of a green space and its role in a city environment. Also, for every asset level we define a priority of green space development to provide the plan of activities for city authorities (Tables 2 and 3).

According to Table 2 and Fig. 2, the results of the analysis show that districts 1, 2, 4, 5, and 22 are at the very privileged level in terms of green spaces and infrastructure assets and have a ranking coefficient (c_i^+) of 0.64, 0.50, 0.67, 0.47 and 0.53, respectively. The ranking coefficient in districts 15, 19, 20, and 21 according to the results is 0.34, 0.30, 0.42, and 0.34, which indicates the privileged level of these districts. The level of assets of green spaces and infrastructure in districts 3, 14, and 18 with a ranking coefficient of 0.23, 0.20, and 0.24, are relatively privileged. But in districts 6, 8, 9, 13, and 16 with ranking coefficients of 0.14, 0.13, 0.13, 0.17, and 0.12, the level of assets is deprived. The very deprived asset levels are for districts 7, 10, 11, 12, and 17, which are confirmed by the ranking coefficients of 0.08, 0.05, 0.03, 0.08, and 0.09. The final prioritization of Tehran city districts for future development and improvement according to the results of analysis and ranking coefficient is shown in Fig. 3.

As shown in Fig. 3, the development and improvement priority for the districts of Tehran is based on the asset levels of those districts in urban green spaces and

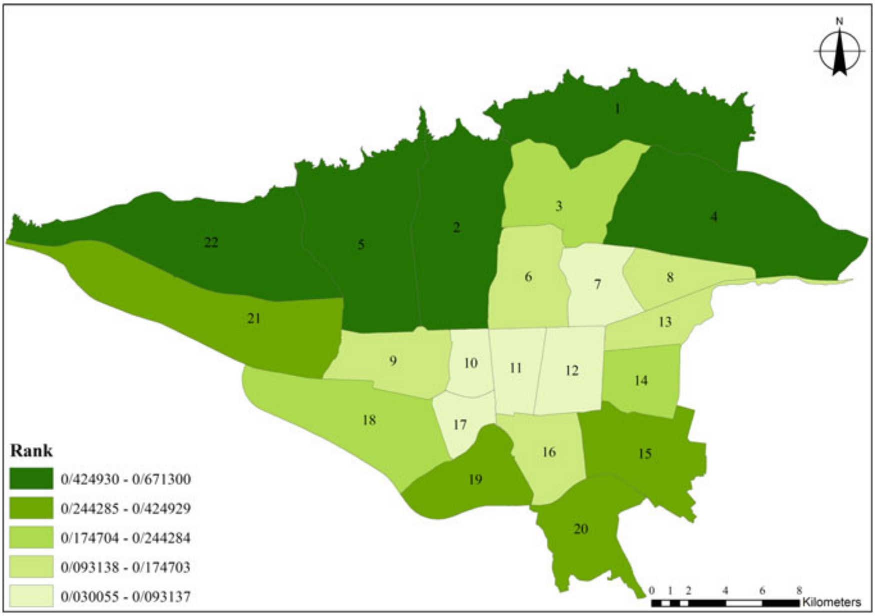

Fig. 2 Green spaces and infrastructure component ranking coefficient

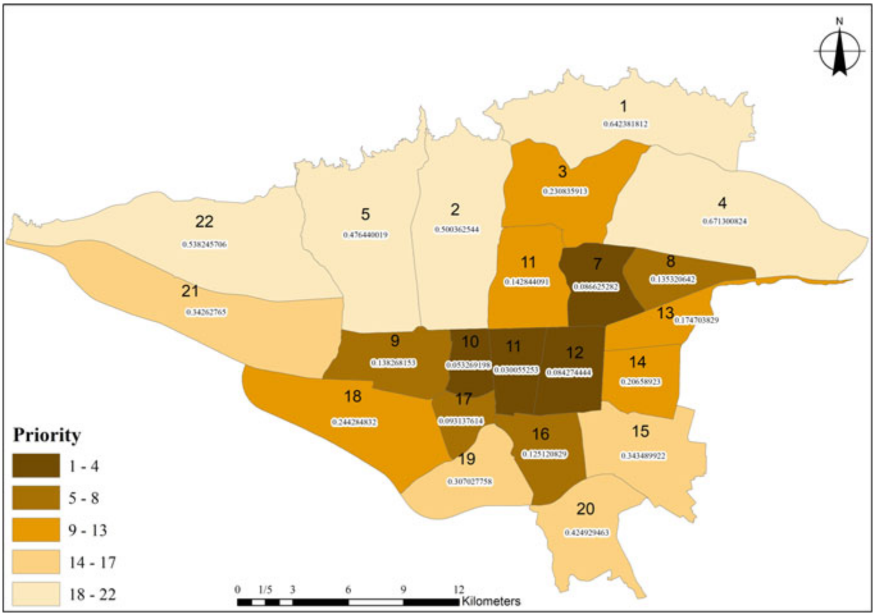

Fig. 3 Prioritized districts of Tehran for future development and improvement

Table 2 Experiences of different cities in the field of urban ecology [7, 8]

City	Challenges	Approaches	Resources
Dangtan	– Sudden increase in population, – Severe rural–urban migration, – environmental problems, – High energy consumption	– Use of renewable energy Carbon-free transportation system, – Independence in water and food supply, – Increase biodiversity, – Environmental protection with emphasis on urban green space, – Water management and river flooding, – Waste management	United Nations Human Settlement Program (Head 2006; Joss et al. 2011)
Infinitive	– Become a global leader in sustainable energy technology	– Use of clean energy (solar, wind, geothermal energy), – Do not use the car, – Electric and solar transportation system, – Use of waste to generate electricity and heat	United Nations Human Settlement Program (Joss et al. 2011)
Freiburg	– Scattered growth of the city, – Use of personal car, – Emission above CO_2	– Using solar energy as an economic booster and even a tourist attraction, – Emphasis on public transport (tram), – The desire to have a compact and stable society, – Realization of social justice	Wong and Yuen (2011), Joss et al. (2011)

(continued)

Table 2 (continued)

City	Challenges	Approaches	Resources
Curitiba	– Sudden increase in population, – Formation of slums and informal settlements, – Lack of public transport, – Environmental degradation	– Garbage exchange with bus ticket, food ticket, – The possibility of housing advancement by allocating only a part of the property to the green space, – Expanding the network of parks and green spaces, – Emphasis on public and underground transportation, – Integration of social justice, – Social services and environmental quality, – Promoting the environmental, social and cultural dimensions of urban life, – public education	Ziari et al. (2014), Joss et al. (2011)
Tianjin	– Overpopulation, – environmental problems, – Lack of resources (water, energy and land), – Increasing demand for a better life	– Development of urban green space and green roof approach, – Increase biodiversity by preserving wetlands around the city, – Attention to energy efficiency, – Use of clean energy (solar and geothermal energy), – Water purification and recycling, – Use of public transport, – Waste management	Loh (2011), Boom (2012), Joss et al. (2011)

Table 3 Asset levels and priority development and improvement of urban green spaces and infrastructures component in districts of Tehran

Asset levels	Districts	Ranking coefficient	Development and improvement priority
Very privileged	4	0.671300824	22
	1	0.642381812	21
	22	0.538245706	20
	2	0.500362544	19
	5	0.476440019	18
Privileged	20	0.424929463	17
	15	0.343489922	16
	21	0.342627650	15
	19	0.307027758	14
	18	0.244284832	13
Relatively privileged	3	0.230835913	12
	14	0.206589230	11
	13	0.174703829	10
Deprived	6	0.142844091	9
	9	0.138268153	8
	8	0.135320642	7
	16	0.125120829	6
	17	0.093137614	5
	7	0.086625282	4
Very deprived	12	0.084274444	3
	10	0.053269198	2
	11	0.030055253	1

infrastructure component in order of priority, including districts 11, 10, 12, 7, 17, 16, 8, 9, 6, 13, 14, 3, 18, 19, 21, 15, 20, 5, 2, 22, 1 and 4.

4 Conclusions

From the perspective of urban planning, urban green spaces and infrastructure are part of the structure and morphology of the city. In other words, urban green spaces and infrastructure are some of the most decisive component of the ecological framework of the city. In Tehran, which has 22 urban districts, the results of this study showed that the urban ecology framework in urban green spaces and infrastructure component in district 11 has very deprived assets, so this district is the first priority for future development and improvement. On the other hand, district 4 with very privileged level assets is the last priority.

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Adaptation of Industrial Territories

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Abstract Historic industrial facilities and their territories are an integral part of the urban environment. Depressed industrial areas in cities need to be transformed, as they do not meet modern requirements for the development of the territory and destroy the appearance of cities. The article examines urban industries, identifies stable enterprises and degrading industrial areas that need to be reorganized and developed. The principles of adaptation of depressed industrial territories depending on the degree of preservation of the industrial function has been described: reorganization with preservation of the industrial function, partial functionalization and complete functionalization. The study presents an adaptation of the degrading industrial area in the central part of the city. The main problems of the territory are natural-ecological, planning and socio-economic. As a result of the development of the historical-cultural reference plan, a number of industrial buildings are recommended for inclusion in the list of cultural heritage sites. The concept of development of the industrial territory which assumes partial preservation of industrial functions of the territory, reconstruction of industrial facilities with further reprofiling, construction of new buildings, creation of a multipurpose embankment and a sports park is proposed. A project proposal for the renovation of an industrial degrading area is developed. It includes four functional zones: residential (multifunctional residential complex with parking, hotel), public and business (administrative and office buildings, shopping complex with parking, sports centers), industrial (mineral water bottling plant), and recreational (multifunctional promenade, parks and squares). This will create a more comfortable urban environment, develop social infrastructure and comfortable public spaces.

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Keywords Reorganization · Depressed areas · Industrial areas · Re-innovation · Adaptation

1 Introduction

The issue of reorganization and transformation of industrial zones has become acute. Historically, in the central part of cities, industrial zones do not meet modern development requirements and destroy the image of a city as a holistic architectural and urban development, limit opportunities for its development, reduce the economic and urban value of lands and destroy the ecological situation. However, the degrading production zones are a potential resource for the development of urban areas, housing construction, business and shopping centers, and recreational areas. This is a significant land reserve, which can eliminate the shortage of building space in the central part of the city. In foreign practice, the issue of renovation of industrial facilities has been studied by L. Bergeron, R. Brutgomesso, D. Mazotti, F. Mancuso, E. Anderson, B. Gabrielli, R. Picco, M.T. Pontis, F. Lauro et al.

Historic industrial facilities and their territories are an integral part of the urban environment. It is necessary to examine industrial territories to be reorganized, to assess their transformation over time in the implementation of federal and regional programs and strategies [1]. Almost all industrial enterprises of the XVIII–early XX centuries are architectural monuments, and the problem of their preservation is one of the most pressing ones. To date, there are urban contradictions in the development of such areas [2]. In this regard, it is necessary to identify conflicts between the participants in the urban planning and find a compromise in solving the problems of renovation of existing buildings [3].

Depressed urban areas are the unrealized potential of large cities. Investment, renovation and redevelopment programs will help create a more comfortable and safe environment [4–10].

Thus, the relevance of the study is due to the reorganization of industrial areas, preservation of cultural heritage sites and identification of their socio-historical component, as well as integration of post-industrial facilities in the advanced urban environment.

2 Methods and Materials

The study is based on a comprehensive study of the process of adaptation of industrial zones of cities in the context of changing urban planning system and socio-cultural priorities. To solve the main tasks, the following methods were used: complex assessment of the territory; cartographic analysis and landscape-visual analysis of the territory; environmental approach to the development of a conceptual design proposal and quantitative methods for evaluating the effectiveness of design solutions.

3 Results

3.1 Industries in Belgorod

The industry of Belgorod has gradually developed forming residential areas around itself. As a result, large industrial enterprises are located in the central part of the city (Fig. 1). The industry is represented by chemical, pharmaceutical, woodworking, light, food, mechanical engineering and construction materials manufacturing enterprises.

As a result of the study of the current situation in the industrial zones of Belgorod, stable and degrading industrial territories which need to be adapted to the modern conditions of society development have been identified.

1. On the territory of the cannery "Konprok" there are industrial facilities that negatively affect the ecology of the city. They are located on the embankment of the Vezelka river next to a multi-storey residential building. There are also private garages, dilapidated individual buildings, no social infrastructure and amenities.
2. The vitamin plant (the industrial park Vostochny). There are more than 150 respondents on the territory, 16 of whom are active. The lands are heavily polluted and require reclamation measures. The current state of the territory has a negative impact on the urban ecology.
3. The Energomash plant in the central part of the city occupies a large area. One of the large production buildings (more than 200 m long) has been demolished. The territory needs reclamation and renovation (Fig. 1).
4. The cement plant has a large-scale spent quarry, which has a great negative impact on the urban ecology.

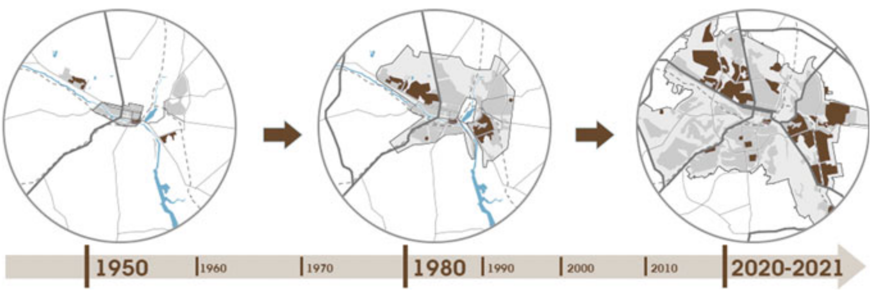


Fig. 1 The scheme of urban development of the territory of Belgorod

3.2 *Proposal for Reorganization of the Industrial Territory of the Konprok Plant*

A problematic industrial zone is the Konprok plant in the central part of the city on the coastal territory of the river. The factors which influence the transformation of industrial territories are as follows.

External factors: social (employment and public services), environmental (emissions, sanitary protection zones, transport), urban (location in the structure of the city, increasing the aesthetic level of construction), security and rehabilitation architectural monuments, the quality of the enterprise environment, socio-cultural significance of the enterprise).

Internal factors: economic (economics of architectural, construction and production processes, the nature of investment), planning (features of the planning structure, integration of functions, features of engineering and transport infrastructure, planning constraints), design, environmental (application of modern waste-free and environmental technologies, cooperation of various functions, the use of industrial symbiosis).

The aim of the study is to adapt the industrial territory of the Konprok plant taking into account the social and economic attractiveness.

The principles of adaptation are as follows:

1. partial preservation of the production function of the territory and identification of objects with features of cultural heritage (Fig. 2a);
2. increasing the density of construction of the central core of the city through the construction of new facilities (Fig. 2b);
3. saturation of the territory with new functions (Fig. 2c);
4. strengthening of a natural framework (Fig. 2d).

The project proposal for the adaptation of the Konprok plant includes:

1. Strengthening of the ecological framework (embankment of the river).
2. Renovation of valuable historical objects of industry and their inclusion in the register of cultural heritage objects.
3. Development of the transport and pedestrian framework by creating a new quarter as a connecting element in the urban system.
4. Organization of four main functional zones: residential (multifunctional residential complex with parking, hotel); public and business (administrative buildings, shopping mall with parking, sports centers); industrial (mineral water bottling plant); recreational (multifunctional promenade, parks and squares).
5. The development of a brand name is based on historicism—the name of the canning and industrial complex "KonProk". The scheme of name development is "KonProk"—KonProk—Loft KonPRO.

Preservation of the historical function of the territory is the main purpose in the reorganization of the industrial zone. There is an operating artesian well on the territory of the plant; therefore, the object of reconstruction without changing the

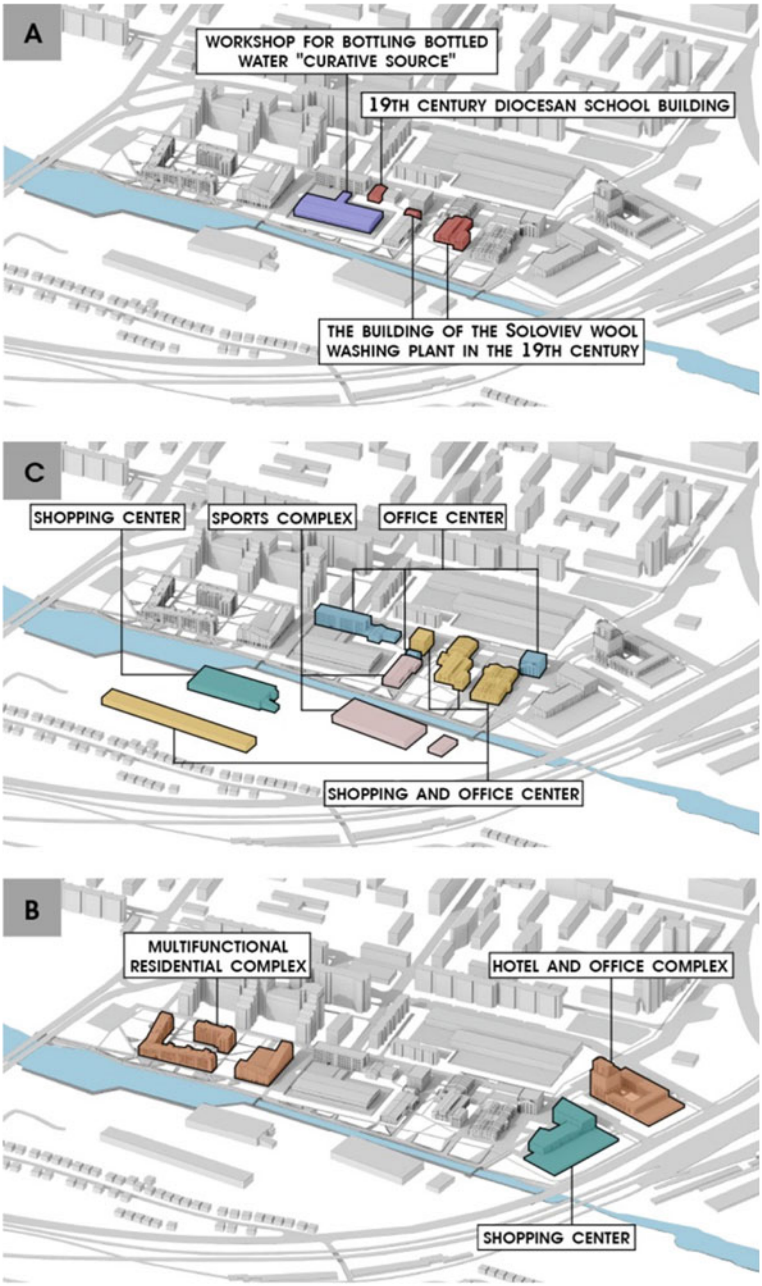


Fig. 2 Principles of adaptation of the industrial territory of the Konprok plant. Developed by Kasenkova Ya.A., Perkova M.V.

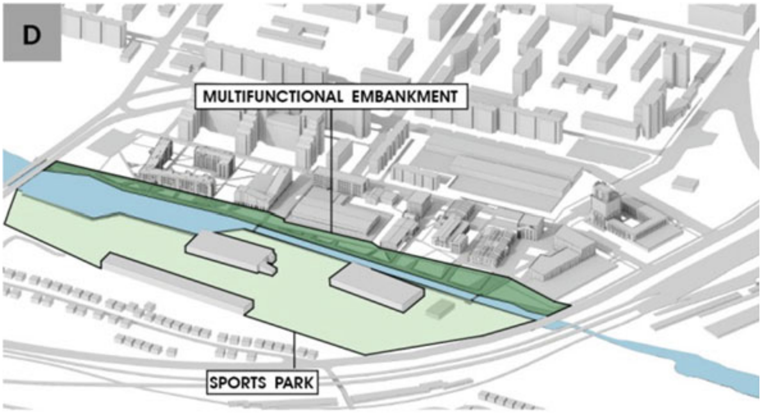


Fig. 2 (continued)

industrial purpose is the bottled water bottling plant "Healing source" which has a hazard class 5 (radius of the sanitary protection zone is 50 m) (Fig. 3).

The main building will be a museum on the site of a former wool wash. As a result of the reconstruction of the existing parts of the building, there will be a large internal space which allows for using it as an exhibition space with additional recreation areas for visitors. There will be a cafe, library, interactive halls and lecture rooms. The wool wash space will perform exhibition, educational and recreational functions.

A new industrial enterprise will create an influx of funds and investors, which makes it possible to recreate and maintain the industrial facility at a new historical stage (Fig. 4).

4 Discussion

The emergence of degrading industrial areas has a negative impact on the architectural and urban planning, natural and ecological (pollution of air, rivers and soils) and socio-economic systems of the city. It is obvious that the adaptation of degrading industrial areas is one of the most pressing tasks of urban planning whose solution affects the development of Belgorod region [11]. In the future, these areas can become new growth points.

Adaptation of the degrading industrial areas can be carried out in three ways:

1. Functionalization: variation in the industrial function; reconstruction of preserved industrial facilities for commercial premises; creation of parks, squares, sports facilities.
2. Modernization: industrial symbiosis; creation of an industrial park, a technopark (association of enterprises focused on specific products), a business incubator.

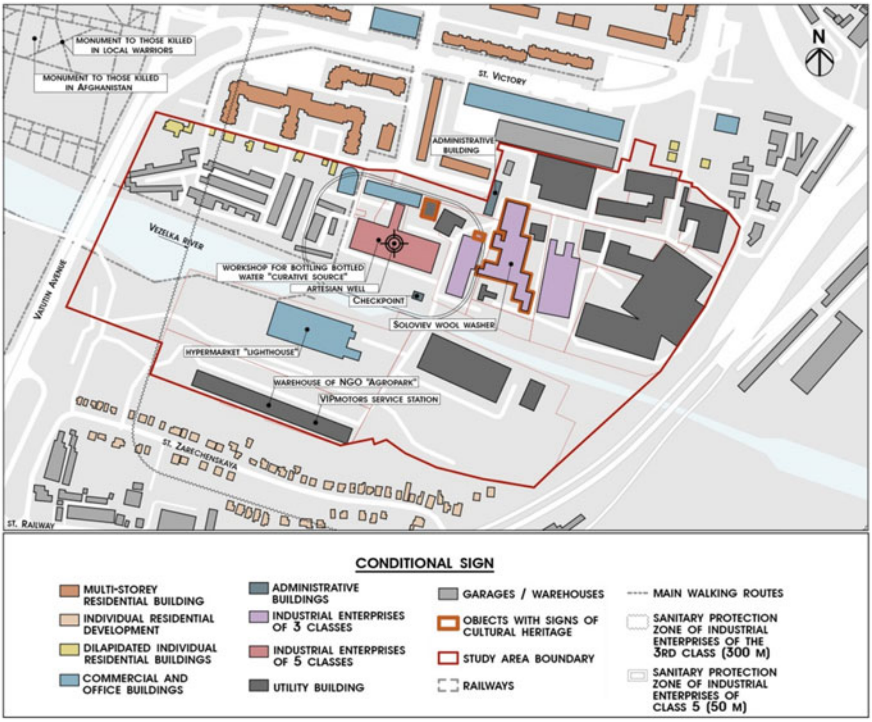


Fig. 3 Historical and cultural reference plan of the territory of the Konprok plant. Developed by Kasenkova Ya.A., Perkova M.V.

3. Renovation: partial preservation of the industrial function, reconstruction of preserved industrial facilities for commercial premises; construction of new residential and public buildings; creation of parks, squares, sports facilities.

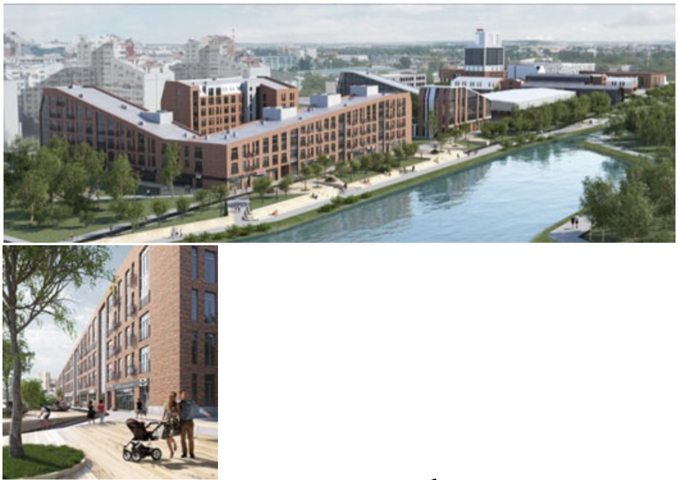
Renovation of depressed industrial areas can also be carried out in three ways depending on the degree of preservation of industrial functions: reorganization with preservation of industrial functions, partial functionalization and complete re-functionalization (Fig. 5).

5 Conclusions

Degrading industrial territories have been revealed and possible ways of their adaptation have been proposed: functionalization, modernization, and renovation.

The study presents a variant of adaptation of the degrading industrial area in the central part of the city. The main problems of the territory are natural-ecological, planning and socio-economic. As a result of the development of a historical and

a



b

Fig. 4 Project proposal for the renovation of the Konprok plant: general plan of the territory (**a**), visualization of the environment (**b**). Developed by Kasenkova Ya.A., Perkova M.V., Pertsev V.V.

cultural reference plan, a number of industrial buildings have been recommended for inclusion in the list of cultural heritage sites.

The concept of industrial territory development which assumes the partial preservation of the industrial function of the territory, reconstruction of industrial facilities with their further re-profiling for public functions, construction of new buildings, and creation of a multifunctional embankment and sports park has been proposed.

A project proposal for the renovation of an industrial degrading area has been developed. It includes four functional zones: residential (multifunctional residential complex with parking, hotel), public and business (administrative and office

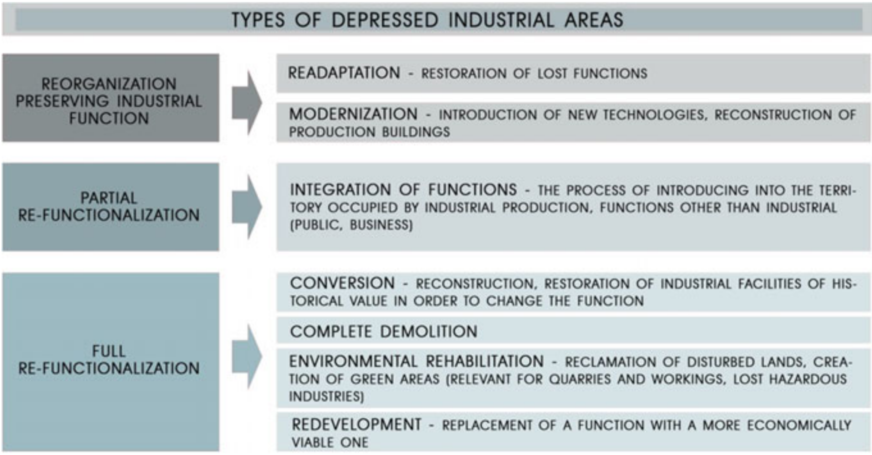


Fig. 5 Types of depressed industrial areas. Developed by M.Yu. Drebezgova

buildings, shopping complex with parking, sports centers), industrial (mineral water bottling plant), and recreational (multifunctional promenade, parks and squares).

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Modern Architectural and Urban Planning Reintegration of Cultural Heritage Objects in the Donbass Cities

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Abstract The information is provided about the modern architectural and town-planning reintegration of the cultural heritage objects, a new strategy in sphere of preservation of the cultural heritage in the Donbass cities, the region with specific historical and architectural development peculiarities. The existing approach to solving the problem of cultural heritage preservation today assumes the implementation of a set of measures aimed at the protection, preservation and use of objects of cultural and historical value. However, each of these measures suffers from a certain isolation of actions in terms of technology, architecture and urban planning, in terms of time and sequence of implementation. The general approach does not take into consideration the regional peculiarities of the architectural heritage of the Donbass, which results in a large number of non-functioning and deteriorating historical objects in the region. The proposed concept of the modern architectural and urban reintegration of objects of cultural heritage is aimed to compensate the drawbacks of the existing strategies and tactics of cultural heritage protection. This concept has the integral character and covers all the processes (regulatory and legislative, organizational and methodological, scientific and engineering, informational, implementation, financial and investment, operational) and levels of architectural and urban planning organization of the cultural heritage objects: their typological affiliation, peculiarities of the town-planning situation and environment, general site plan design and its development, functional and planning organization, structural and technical, volumetric and spatial, compositional and stylistic artistic solution.

Keywords Modern architectural and urban reintegration · Architectural heritage · Concept · The Donbass · The Donetsk region · Regional features

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1 Introduction

As you know, Donbass is an abbreviated name for the Donetsk coal basin, an industrial region of the former Russian Empire, historically formed in the eighteenth century, with socio-economic, political, cultural and historical characteristics. Currently, this name is associated mainly with the territory of Donetsk and Lugansk regions of Ukraine.

The relevance of the research topic is determined by the high socio-cultural significance of the cultural heritage. The preservation and revival of tangible and intangible heritage is based on the principles of restoration, reconstruction, modernization, revival and revalorization. At the same time, modern socio-economic and geopolitical conditions and other regional factors operating in the territory of Donbass and its Donetsk region dictate the need to develop an innovative strategy for the preservation and effective use of cultural heritage.

2 Literary Review

An analysis of recent scientific research and publications shows that the problem of preserving and using the historical and cultural heritage was, to one degree or another, considered in the publications of the international organization International Council on Monuments and Sites (ICOMOS) (on the features and current state of the protection of historical, architectural and urban planning heritage in the United States, which is characterized by its practical absence) [1]; in the scientific reports of Local Government for Sustainability Europe (principles of circular management of the process of adaptive reuse of cultural heritage, based on the wide involvement of large segments of the population in cooperation) [2]; in the scientific works of researchers in Ghada Al Slik (the problem of developing a set of measures to protect the architectural heritage of Iraq, including the modern one, in the current regional geopolitical conditions) [3], Kabila Faris Hmood (features of the general strategy for the protection of cultural heritage in modern conditions) [4], Ljubo Lah (the relevance and main issues of the concept of transition from the preservation, renewal and restoration of the architectural heritage to its integrated protection of the heritage) [5], Versacia Antonell (on the successful implementation of a consistent legislative policy for the protection of cultural heritage in France, which was founded on its recognition as an expression of national identity and a powerful factor of social stability and sustainable economic development of the country) [6], Mladen Obad Šcitaroci and Bojana Bojanic Obad Šcitaroci (on the need for integral actions of different fields, such as regional development, economy, tourism, transport and infrastructure) [7] and others.

It is emphasized that for the successful preservation of historical and cultural heritage, a complex intersection of aspects of planning, design, construction, legislation, tourism, protection of architectural heritage, infrastructure, services, environment, the historical value of the architectural heritage. The most important are the issues of financing and the correct functional continuity of objects [4].

In the article Berdnik T. O. (Russian Federation) [8], using a specific example, the modern phenomenon of renovation of architectural structures that are objects of cultural and historical heritage is investigated in order to preserve them. Taking into account the emergency state of the object in the process of its repair and restoration, compensating changes were made to the appearance of the building and its planning structure, which made it possible to give it the function of an elite suburban housing. A full range of measures was carried out, which made it possible to save and reintegrate the facility in specific regional conditions. The conclusion is made about the cultural significance and economic efficiency of the restoration of historical heritage objects in the context of the development of the region's tourism infrastructure.

Questions of preservation and research of monuments in Ukraine were studied by V. A. Gorbik, G. G. Denisenko, P. I. Skripnik; Yu. V. Opalko, G. A. Andres; A. I. Chervinsky, O. Rybchinsky [9], V. Akulenko, M. Boguslavsky, T. Katkova, O. Ikonnikov, O. Malysheva, T. Mogilina, O. Usenko, N. Fesenko, V. Kholodok [10] and others, including legal issues of preservation of cultural heritage are highlighted in the works of A. V. Malysheva and T. V. Kurilo "Legal protection of the cultural heritage of Ukraine"; the problem of state regulation of the preservation and popularization of historical and cultural heritage and architectural monuments in the work of V. V. Meshcheryakov [10]. It is noted that the currently used mechanisms of state regulation in the field of protection of historical and cultural heritage and architectural monuments are often ineffective and insufficient due to objective and subjective reasons. To overcome this situation, it is necessary to substantiate and develop innovative approaches in this area [10].

Most of the above works are focused on highlighting the general program and some specific aspects of the preservation of cultural heritage. None of the above concepts of the protection of historical and cultural heritage can be fully used in the modern specific conditions of the Donetsk region.

The researches in this scientific area on the territory of Donbass and its Donetsk region have been and are being carried out within the framework of theses researches, preparation of scientific articles [11, 12 and other], materials of lectures on history, regional features and problems of protection of the CHO at the Architecture Faculty of Donbass National Academy of Civil Engineering and Architecture (from 1996 up to now), as well as in the implementation of historical and architectural reference plans and projects of CHO protection zones within general plans of historical cities of the Donetsk region of Ukraine—Makeyevka (2009–2011), Artemovsk and Chasov-Yar (2011–2014); historical and urban planning justifications of design solutions of objects within the protection zones and in historical areas; projects of CHO restoration; regional scheme of territorial planning and the strategy of domestic and inbound tourism (for 2021–2025).

All works was carried out and is being carried out in accordance with the requirements and provisions of existing national, regional and international legislation in the field of cultural heritage protection, including the National Constitution, laws on culture, protection of cultural heritage, architectural activities, about nature reserve fund, regulation of urban development activities, the regulations governing the registration of newly discovered CHO, recognition of a settlement as historical, defining the categories of monuments for entering cultural heritage objects into the State Register of Immovable Monuments, concluding protection agreements for cultural heritage monuments, relevant provisions of state urban planning and land codes, building standards. The fundamental principles set forth in international documents were also taken into account: European Convention of November 16, 1992 on the Protection of the Archaeological Heritage; European Landscape Convention of October 20, 2000; UNESCO Convention of October 17, 2003 for the Safeguarding of the Intangible Cultural Heritage; Convention of 03.10.1985 on the protection of the architectural heritage of Europe [13]; the Venice Charter 1964 (on the conservation and restoration of monuments and places of interest) [14]; Washington Charter (on the protection of historic cities), Stockholm Charter 1998 (on the protection of traditional architectural heritage); Krakow Charter 2000 (on the protection and restoration of architectural and urban planning heritage); Davos Declaration 2018 (on a holistic integrated approach to the preservation of urban heritage in all its forms and historical layers, including modern development) [15]; ICOMOS Guidelines for the Post-Traumatic Rehabilitation of World Cultural Heritage Sites (Paris, 2017) [16] and other.

In 2001, the UNESCO World Heritage Center, the International Council on Monuments and Monuments (ICOMOS) launched a program to identify, research and preserve the architectural heritage of the modern era [17]. They undergo serious changes or destruction against the background of underestimation of their socio-cultural significance and cultural identity, the need for its continuity, as well as along with rapid socio-economic changes in modern society that require constant correction of the functional use of objects.

In modern conditions on the territory of the Donbass and the its Donetsk region there was a need to elaborate a new approach to solving the problem of protection and use of cultural heritage objects (CHO). Prerequisites for this were the influence of modern factors, the need to take into account historically evolved regional features, as well as the appearance in the 21st century new trends in international practice in the field of cultural heritage protection. The latter include the transition from the protection of only outstanding monuments to the protection of ordinary historical buildings and from the protection of only ancient monuments to the protection of monuments of the twentieth century, as well as the growth of the historical self-awareness of the population and its desire to participate in the preservation of cultural heritage, including through the integration of heritage into everyday life of the city and its transformation into an integral and obligatory part of it [15].

Generally, the existing concept of cultural heritage protection assumes opposition to aggressive encroachments and, to some extent, confrontation (countering) the natural course of events in the formation and evolution of urban development. The current general theory and practice of preservation of CHO utilizes known conceptual approaches, directions and definitions documented in the current legislation and scientific community: restoration, regeneration, revalorization, revitalization and others. At the same time, in essence, they all imply a certain unilateral and limited actions taken in terms of technology, architectural and urban planning, time and sequence of implementation, depending on the type of CHO or the degree of historical value of buildings, structures and their complexes.

Thus, the restoration of architectural monuments is the process of restoring its original authentic parts. Conservation is carried out in relation to the remains of historic buildings and structures—CHO, not planned for restoration in their original form. Regeneration involves the implementation of measures to restore the lost parts, the compositional integrity of historical cities or their centers, individual architectural ensembles and complexes, buildings and structures. The concept of revalorization as an activity has mutually contradictory interpretations from the restoration of the historical value of the CHO to the replacement of non-preserved and dilapidated historical buildings with buildings of modern architecture in compliance with its characteristic qualities (volumetric-spatial organization, modularity, local architectural flavor).

In the conditions of the Donbass and the its Donetsk region there are no examples of implementation of the whole complex of any monument preservation measures in relation to specific historical and cultural heritage objects. Almost all cultural heritage of the region is in danger of extinction. One of the most common root causes is the argumentation about the insufficient historical and architectural value of CHO, which results in limited funding of protection necessary measures. In the process of usage of such objects occurs a gradual loss of their subject of protection, which leads to the loss of the historical value of these objects and to their further destruction.

In counterbalance to the current situation in the preservation of cultural heritage in the Donbass and the Donetsk region there is a need to develop a common strategy of modern architectural and urban reintegration of all cultural heritage in the region, as well as the corresponding reintegration algorithm applicable to each of the objects, which integrally, systematically and comprehensively covers all sides and levels of the process.

The purpose of this research is to solve an important regional problem of modern architectural and urban planning reintegration of cultural heritage objects in the cities of Donbass. At the same time, the object of research is the entire set of objects—monuments of architecture and urban planning, monumental and decorative art, history and archeology, and the subject of research is a scientifically grounded complex of principles and methods of this reintegration. To achieve this goal, it is necessary to solve the following tasks: (1) identify and analyze complex of regional prerequisites, factors and conditions that determine the specifics of the protection and use of cultural heritage objects in the territory of Donbass, modern requirements for the architectural and urban planning aspects of this process; (2) taking these requirements into account, identify progressive directions of international architectural and urban planning practice in this area; (3) to formulate the principles and techniques of modern architectural and urban planning reintegration of cultural heritage objects in the cities of Donbass, taking into account the regionally determined modern requirements and the results of the analysis of international practice; (4) check the results of the research in design practice.

3 Materials and Methods

Over the last 20 years the research material for the declared subject is historical-architectural and town-planning cultural heritage of the Donbass in general and its Donetsk region in particular, as within the boundaries of the Donetsk region of Ukraine, so as individual settlements (Makeyevka, Artemovsk, Chasov-Yar, Donetsk, Druzhkovka, Kramatorsk, Gorlovka, other) and their individual objects:

- the whole range of historical real estate objects (buildings, constructions and their complexes, urban planning formations of civil and industrial character) with associated paintings, sculptures, decorative and applied arts, objects of science and technology and other objects of material culture, which are valuable in terms of history, archaeology, architecture, urban planning, art, science and technology, aesthetics, ethnology, anthropology, social culture;
- historical artefacts kept in state and municipal museums of the Donetsk region which are directly related to the development of regional architecture and urban planning, landscape and landscape architecture of the Donbass;
- the cultural landscape of the region as a topographically defined and limited part of the natural landscape, which has archaeological, historical, architectural, scientific value which meets the terms of authenticity [18].

On the state records of the Donetsk region there are 2340 monuments of cultural heritage, including monuments of architecture and urban planning (41), historical (813), monumental art (16), archaeological (1470). There are also 836 newly identified CHO of all sorts. Measures are taken to expand this volume at the expense of modern objects, the architecture of which interprets the specificity of the region, its natural and climatic, geolandscape, complex engineering and geological conditions, local construction materials, national-cultural, historical and cultural peculiarities.

The concept of modern architectural and urban planning reintegration of CHO in Donbass was developed on the basis of a systematic approach [19], is of an integral scientific and practical nature [20], covers all areas of solving this problem: scientific, informational, design, implementation, operational, as well as all levels architectural and urban planning organization CHO. To implement the concept, it is proposed to use the following methods:

- compositional and artistic understanding of the features of the non-preserved CHO in the architectural solutions of new construction objects;
- change of the historical functional purpose of the abandoned CHO or its parts;

- architectural and urban planning marking of the position and volumetric-spatial features and architectural solutions of non-preserved CHO or their parts, as well as objects of historical, geolandscape, geological, mining and technical, topographic and toponymic nature.

4 Results and Discussion

Preconditions for development of a new approach to the protection CHO in the Donbass cities, a concept of their modern architectural and urban planning reintegration, were the following peculiarities of the historical development of the region:

- “secondary character” of objects of historical architectural and urban planning heritage of the Donbass compared to “primary character” of their counterparts in common recognized regions of development of common history of architecture and urban planning, which is a decisive argument in making decisions on the need to preserve and include these objects to the state register of the CHO;
- comparative “young age” of the architectural and town-planning design experience in the region from the middle of 1930s; at the same time the projecting of the objects, which are now the CHO, was mostly made by Ukrainian and Russian scientific design centers outside the Donbass and was aimed mainly at solving practical tasks with significant restrictions on aesthetics;
- highly urbanized territory of Donetsk region, the development of which falls on the Soviet period (after 1917) amid cardinal change of society’s ideology and the lack of policies for the protection of architectural and urban heritage in this period, as well as against the devastation during the atheist campaign years of the 1930s and the war years 1941–1943, which led to the loss of a significant part of the CHO of previous historical periods;
- a certain spontaneity of practice of operation of the objects of architectural and urban heritage in the modern period (late 1980s–early 2010s), which led to the loss of CHO or their authenticity;
- “multilayered” cultural landscape of the Donbass, the need to expand the criteria for distinguishing of objects as the CHO, including modern ones, by representing the regional characteristics of culture; this will lead to the inclusion of modern objects of historical, architectural, as well as geolandscape, geological, mining and technical, topographical and toponymic character into the cultural heritage;
- the presence of a significant number of non-functioning historical buildings and structures of a civil and industrial nature;
- need for revision of the existing affiliation of the level status of the CHO in the cities of the Donetsk region (state, regional and local) in modern conditions with the consolidation of these changes in the legislative and regulatory and methodological sphere;

- the need for legislative consolidation and taking into account of the modern CHO, including architectural, which manifested the most significant features of the specific features of the Donbass and the Donetsk region;
- the need for ensuring the continuity and consistency of the implementation of the whole complex of measures for the protection of cultural heritage objects.

Modern architectural and urban planning reintegration of CHO. At the typological level, the proposed strategy covers objects of various categories and functional purposes varying degrees of preservation, including non-preserved historical buildings, structures and their complexes.

In each specific case, it implies the implementation of reintegration measures, taking into account the peculiarities of their urban planning at all levels of the architectural and planning organization of the CHO: the solution of the master plan and improvement of the site, the functional planning organization, constructive and technical solutions, the volumetric-spatial and style compositional-artistic organization.

The implementation of the strategy of modern architectural and urban reintegration of the CHO in the Donetsk region requires the following:

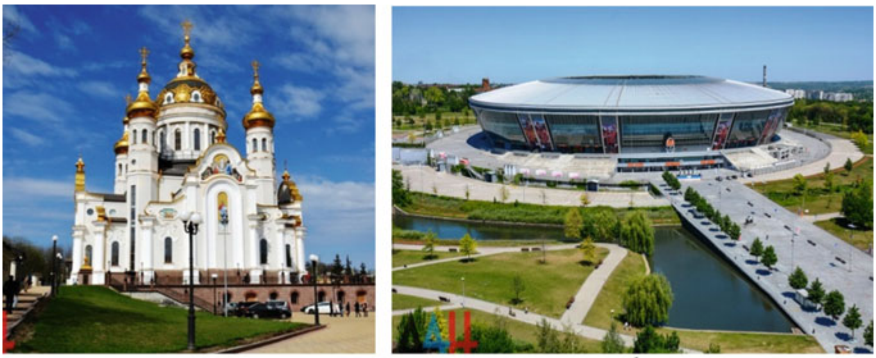
- improvement of state legislation in this area, including elaboration of criteria for the identification and selection of the CHO for their registration, further protection and control over the implementation of protective measures, including a system of penalties for crimes in this area;
- coordination of the project process in relation to the CHO by the state bodies—ministries of culture, construction and architecture;
- establishing and implementing regular training and retraining (including target training) of specialists-designers on reconstruction and restoration of architectural heritage, specialists-restorers, creation of the state system of their distribution and guaranteed employment;
- creation of full-time positions for specialists in reconstruction and restoration of architectural heritage in the departments and divisions of urban planning and architecture of state and municipal subordination;
- creation of the special state institutions: design and restoration workshops, laboratories;
- creation of multifunctional coordination centers, boards of trustees for the implementation of a comprehensive reintegration program for the CHO and individual objects;
- creation and establishment of a reliable financial and investment system of continuous and permanent process of modern architectural reintegration of the CHO and the establishment of its reliable operation;
- an integral approach, systematically covering all levels of architectural and urban reintegration of each CHO and all organizational and methodological directions at all levels of implementation of reintegration and conservation complex of measures;
- dynamic activity, continuity, consistency and completeness of both the process of the CHO reintegration, as well as control and monitoring of its implementation.

It is necessary to carry out comprehensive scientific and practical research aimed at:

- development of regional programs for the modern reintegration of CHO;
- identification, description, certification and cartographic fixation of the entire nomenclature of CHO on the territory of the region.

Figure 1a, b show examples of objects that are recommended for state registration as modern CHO. The architectural solutions of these objects reflect the regional features that are significant for the Donbass. Thus, the architecture of the Cathedral of Saints Peter and Fevronia of Murom on the territory of the Center for Slavic Culture in Donetsk (Fig. 1a), the authors of the project understood the features of the Slavic Orthodox culture and traditions of the Ukrainian Baroque, the influence of difficult engineering and geological conditions for design and construction. The compositional, artistic, volumetric and spatial solution of the Donbass Arena stadium complex in Donetsk (Fig. 1b) reflects regional features that are significant for Donbass—the interconnection of underground and surface spaces, the geological structure of the Donetsk ridge, as well as the "diamond on coal" symbol characterizing character traits of the production and professional group that is the title of the "Shakhtar" team, is significant for the Donetsk region.

Figures 2 and 3 show examples of modern architectural reintegration of non-preserved CHO by the method of compositional and artistic comprehension in the architectural solutions of new construction objects. Figure 2b shows a three-dimensional image of the eastern facade of the surviving 1906 mansion (Fig. 2a), which is reproduced as an architectural and compositional structural element on the eastern facade of the modern shopping and office center "Green Plaza" (2008, the project is a creative design center "Environment", Donetsk), built at the same address. Working drawings of the eastern facade of the mansion for this project



a b

Fig. 1 Examples of objects in Donetsk, recommended as modern CHO: **a** the complex of the Cathedral of Saints Peter and Fevronia of Murom on the territory of the Center for Slavic Culture in the Leninsky District (2012); **b** "Donbass Arena" stadium of regional soccer club "Shakhtar" (2009, project "ArupSport", England, architect Dj. Perrish)

a b

Fig. 2 An example of modern architectural reintegration of a non-preserved CHO by the method of compositional and artistic comprehension in the architectural solutions of modern objects: **a** general view of the eastern facade of the non-preserved mansion in 1906 (architect unknown) in Donetsk; **b** placement of a three-dimensional image of the eastern façade of the unpreserved 1906 mansion on the eastern façade of the modern shopping and office center "Green Plaza" (2008, project—Creative Design Center "Environment", Donetsk) at the same address

a b

Fig. 3 An example of modern architectural and urban planning reintegration of a non-preserved CHO by the method of compositional and artistic comprehension in the architectural solution of a new construction object: **a** general view of the non-preserved building of the "Donbass" Hotel (1936–1938, Design Institute "Oblproekt", architect I. I. Rechanik, with participation of architects A. A. Shuvalova, N. I. Porkhunov, B. A. Pilche) on the Artem str. in Donetsk; **b** general view of the "Donbass Palace" Hotel (2008) located at the same address

were prepared at the Research and Design Center for Historical and Architectural Research of the Donbass National Academy of Civil Engineering and Architecture based on the results of their own measurements (2007, architect S. A. Boroznov, chief architect of the projects Yevgeniy A. Gaivoronskyi).

Figure 3b shows a general view of the building of the "Donbass Palace" Hotel, in the architectural solution of which the authors of the project rethought the volumetric-spatial and compositional-artistic solution of the non-preserved CHO—the building of the "Donbass" Hotel (Fig. 3a), dismantled in 2002 due to an emergency condition.

In 2017–2018, within the framework of research in the direction "Development of a concept for the creation of social housing and the restoration of infrastructure facilities in areas affected by military actions" (Donbass National Academy of Civil Engineering and Architecture), proposals were formulated for the re-equipment and use of non-functioning historical buildings as residential facilities.

Figure 4 shows an example of modern architectural and urban planning reintegration by changing the functional purpose of a part of the CHO—an architectural monument of local importance—the building of the former hostel of the mine "Sofia"—them. A. B. Batov on the 250th anniversary of Donbass Street in Makeevka (1953, architect V. Gavrilov). The arrangement of apartments for the social housing stock is proposed. At the same time, the project prescribes the fulfillment of a number of conditions, including: restoration of the elements that make up the historical and cultural value and the subject of protection; minimal reconstruction of non-protected items.

Figure 5 shows examples of modern architectural and urban planning reintegration of CHO of a geographical and topographic nature using the method of architectural and urban planning marking. In Donetsk, such landmark objects are: the 48th parallel

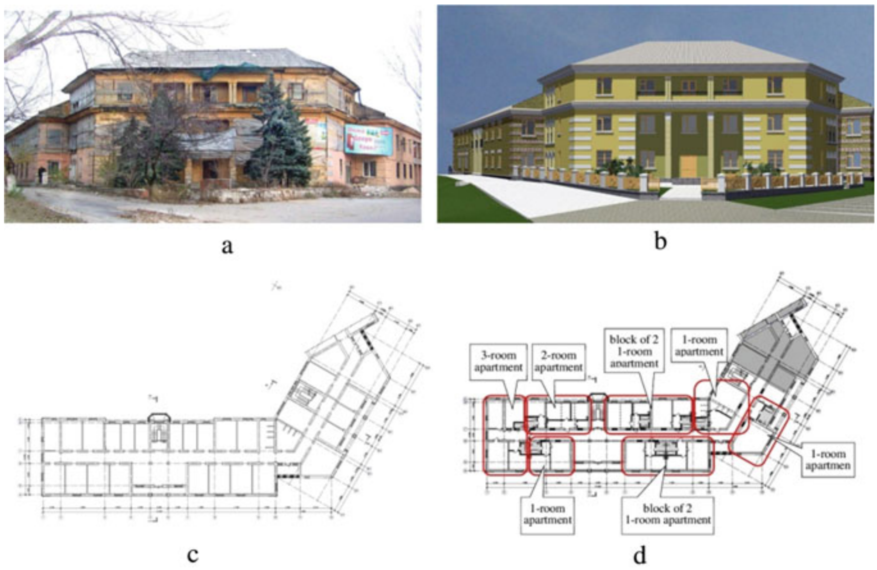


Fig. 4 An example of modern architectural and urban planning reintegration by changing the functional purpose of a part of the CHO—an architectural monument of local importance—the building of the former hostel of the mine "Sofia"—them. A. B. Batova on the 250th anniversary of Donbass Street in Makeevka (1949–1950, architect V. Gavrilov): **a** general view—current state, photo of 2014; **b** general view of the building—project (2014, Research and Design Center for Historical and Architectural Research of Donbass National Academy of Civil Engineering and Architecture); **c** existing plan of a building fragment, 2nd floor; **d** plan of a building fragment, 2nd floor, project proposal

a b

Fig. 5 An example of modern architectural and urban planning reintegration CHO of a geographical and topographic nature using the method of architectural and urban planning marking: **a** Prime Meridian in Greenwich (England); **b** the historical territorial-administrative border between the states of the European Union

to the north latitude, passing through the city center, as well as the spatial parameters of known geological faults and a number of other objects.

5 Conclusion

Historical and cultural peculiarity of development of the Donbass and its Donetsk region demanded the development and implementation of a new strategy to solve the problem of protection of CHO, the concept of their modern architectural and urban reintegration. This concept allows us to consider specific features of the Donetsk region and its historical and cultural heritage, as well as justify the formation of a mechanism and the material basis for its implementation. This takes into account the emergence of new trends in international practice in the field of cultural heritage protection.

The necessity of introducing a new concept of modern architectural and urban reintegration of CHO in the conditions of the Donbass is determined by one-sidedness of the existing common approaches to the protection of cultural heritage. The proposed concept is the result of a critical analysis of these approaches, selection and combination of their principles and techniques, taking into account their adaptation to the regional specifics of the tasks being solved.

A general description of the regional prerequisites is given, which served as the basis for the development of a new approach to the protection of historical and cultural heritage in the cities of Donbass and its Donetsk region in modern conditions.

We propose to introduce a new category—"modern objects of cultural heritage"—for objects of modern construction which reflects regional features of the Donbass (historical-cultural and national-cultural, symbolic manufacturing-industrial and others).

The offered concept of modern architectural and urban reintegration of the CHO is developed on the basis of a system approach, has an integral scientific and practical character, covers all aspects of resolving this problem: scientific, informational, design, implementation, operational and all levels of architectural and urban organization of the CHO.

As an CHO in the conditions of Donbass and its Donetsk region, it was proposed to consider all categories of historical buildings, structures and their complexes, including unpreserved objects, as well as modern cultural heritage sites that have historical and cultural value, including from the standpoint of the features of modern and recent periods of history.

The given examples illustrate the proposed general approach to the selection of methods of modern architectural and urban planning reintegration of CHO, including the selection of the category of modern CHO.

The main directions of the implementation of the strategy of modern architectural and urban planning reintegration of the CHO in the conditions of Donbass and its Donetsk region, taking into account its specifics, are listed.

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Abandoned Objects from Utopia to Reality Viability Criteria

Anna Gelfond

Abstract The article deals with the change in the architectural typology of abandoned objects over time. The influence of time on their urban planning position and typological components—function, design and form is analysed. Abandoned objects are structures created by man, but not used today. They have passed their way "from reality to utopia". Special attention is paid to the topic "cultural heritage objects and time". Adaptation of status objects protected by the state for modern use is analyzed. An attempt is made to unravel why this happened and whether the return path is possible—"from utopia to reality". In conclusion, the concepts of general and environmental criteria for assessing the viability of abandoned objects are introduced; the concept of architectural and typological potential of a structure is formulated on the basis of the criteria for assessing the viability of abandoned objects.

Keywords Utopia · Reality · Abandoned object · Life potential

1 Introduction

The period of the pandemic, the desire for self-isolation, encouraged the citizens to instinctively search for unused places, desert routes that would allow them to spend time in solitude not only at home, but also in the open air. This process has determined the relevance of scientific interest in identifying places and structures left by man. Moreover, they could not be claimed by the recipient "while still alive", or abandoned during the construction phase at the implementation stage. We will try to analyze what factors dictate this situation and whether a revival is possible. Let us consider this process based on the analysis of their urban planning position—the place—and typological components—functions, structures and forms. Fully aware that these are components of a single system that work only in a complex, we, however, will attempt to separate them as an experimental condition.

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Place and time. The urban planning position of the object is analyzed in the spatial and temporal aspect, including communications, as well as natural and anthropogenic risks.

Function and time. Generic and actual functions, the mechanism of transformation of functions are analyzed.

Construction and time. The scale of structures, fatigue of structures, problems of long-term construction are analyzed.

Form and time. Empty objects like the paintings of Giorgio de Chirico, Carlo Carr, and Jose Manuel Ballester are analyzed.

2 Place and Time

The territory of the complex of the shipbuilding plant of I. S. Kolchin-U. S. Kurbatov on Krasnaya Sloboda Street is located in the historical center of Nizhny Novgorod between two significant transport communications, the Kazansky Downhill Drive and the Nizhnevolzhskaya Embankment. On one side, there is the bank of the Volga River, on the other—a steep slope with the cultural heritage site of Aleksandrovsky Garden. It would seem that the territory has a high historical, cultural and natural potential, but it has a depressing appearance. The condition of buildings and communications is unsatisfactory. Construction of the “mechanical institution with a shipyard” began in 1857. Several objects of the complex are considered cultural heritage: the building of the board, where the first Marxist coterie was organized in Nizhny Novgorod; a hostel for workers; two office buildings. Since March 2020, the project of their restoration has been carried out. The beautiful natural environment—the proximity of the river, the steep slope of the Dyatlovy Mountains with beautiful trees, on the one hand, and the availability of transport communications, on the other, do not ensure the eventfulness of this place. It is abandoned. Why? The riddle is not solved.

After the historical centre of Nizhny Novgorod, let us turn to a fairly remote area of the Nizhny Novgorod region. In an abandoned or almost completely abandoned state, there is a rest house “Lesnoy Kurort”, which is located in one of the northern districts of the Nizhny Novgorod region—Krasnobakovsky—in a picturesque pine forest on the bank of the Vetluga River, more precisely, the Vetluga’s staritsa. During the reign of Peter the Great, the “Bakovskaya ship dacha” was located on the site of the rest house. Previously, the river was navigable, people got to the rest house from the station, also by water along Vetluga by boat, ferry or barge. This is one of the oldest health resorts in the Nizhny Novgorod region, the resort was opened in May 1935 by the Union of Workers of the automobile industry. It included a wooden administrative building, wooden residential buildings, a stage with a dance floor [1].

During the Great Patriotic War, the rest house was the international children’s boarding school of the Executive Committee of the Communist International. The “Lesnoy Kurort” became a home for children of German, Hungarian, Romanian, Finnish , Austrian, Japanese anti-fascists, a home for Russian, American, and English children. Everyone was fed, everyone was saved, no one was offended. There is no more beautiful place on earth than the “Forest Resort” [2]. In 1944, the children’s boarding school was disbanded.

In the early 1950s, a canteen for 200 people, a club (a summer cinema theatre) and a boat station were built. In 1967–1968, by the order of the Gorky Soyuzkurort, the GAZ Project Department developed a master plan, according to which it was planned to build four new bedroom blocks, a summer stage and to demolish four existing buildings. At the same time, the linking of the standard design of a bedroom block for 262 beds to the site was made, which was put into operation in 1972, as well as a residential building for employees was built, treatment and engineering facilities were constructed. In 1986, the design of a bedroom block for 256 beds was developed, the implementation of which was stopped.

The symmetrical T-shaped building of the canteen has a developed composition: two mutually perpendicular volumes of different heights are covered with high “four-faces” gable roofs and supplemented by side galleries and a portico of the main entrance along the longitudinal axis. In the same style—wooden neoclassicism of the early 1950s—the club—a summer cinema with an open gallery was built. The side porticos are topped with triangular pediments with semicircular cutouts. The third object of the same style and period is a boat station—an open structure—an aerial gazebo on the bank of the river. Three central arches mark the main entrance in the form of a wide staircase, along which the central alley opens to the river.

After analyzing the history of development, evolution and current state of the rest house, we come to the conclusion that, despite the inconsistency of the conditions in general with the modern requirements of living, the place has a high urban development potential, since it is:

- a place with a picturesque healing nature;
- a place with a rich history;
- a place devoid of public life: it is necessary to modernize the rest house that would include a comprehensive pre-project analysis, historical, cultural and engineering expertise of existing facilities, and the construction of new buildings based on modern architectural, structural and engineering concepts.

Using this example, we turned to the actual problem of revitalization of inactive recreation facilities, which can be observed, unfortunately, everywhere and which need to be addressed in the light of the revival of interest in domestic tourism. Abandoned places are like the works of Jose Manuel Ballester—paintings from which people were removed, but along with the people, the picture itself was removed—life. Like a palimpsest, they appear through a new pattern drawn by inexorable time. The riddle is not solved.

May these be non-places?

The concept of “non-place” was introduced by French anthropologist Marc Augé. He wrote, “If a place can be defined as creating identity, forming connections, and relating to history, then a space that is not defined either through identity, connections, or history is a non-place” [3]. That is, “a non-place” is a space devoid of meaning.

Let us return to these messages at the end of the article while identifying criteria for assessing the viability of abandoned objects.

3 Function and Time

Time influences all the factors that form the architectural typology of a building: functional purpose, planning structure, composition and artistic image. “Invading” an integral structure, it dictates new requirements, and being so, the function always comes to the fore. It is the most receptive and flexible component of any type of building. It is the function that at some point is able to dictate any form, as well as obey any form. The structure, wishing to survive under the influence of the new requirements of the time, opens up internal reserves, functional potential, just as a person mobilizes all his flexibility in a difficult moment. During the adaptation of an object for modern use, one of the accompanying or several accompanying functions comes to the fore, and the dominant function temporarily recedes, hides, becomes latent [4].

In this regard, it is easier to adapt for modern use what initially included the element of multi-functionality, versatility, the ability to transform constructive flexibility, had universal and special internal and external communications, and was ahead of the time technologically and environmentally.

As an illustration of the thesis about the special role of internal horizontal and vertical communications in this process, the fate of large Soviet administrative buildings of the 1970s is of interest. The buildings of research institutes, design organizations, and departments, which were a certain symbol of the city during the period of “developed socialism”, in a number of cases were deprived of their original, primary function in the 1990s. A period of oblivion, “idling” began, which threatened, it would seem, to end with the complete destruction of the object. However, built with strict observance of building codes and regulations, including fire protection, these buildings were able to respond positively to the change in the organizational paradigm and survive.

4 Construction and Time

The most mysterious object in Tallinn is the Gorhall, built as a Palace of Culture and Sports in 1980 for the Olympic Games on the shore of the Gulf of Finland (arch. R. Karp, R. Altmyae). A. V. Ikonnikov wrote about the idea of the architects: “Linking the city and the sea, they sought to make the building unobtrusive visually. According to their idea, it should not be a barrier, but a bridge that opens the way to the sea … The idea of the “bridge” defined the axial structure of the volume and its perimeter silhouette, reminiscent of the pyramids-platforms of the Maya culture in Central America” [5]. This quote seems to predict the post-Soviet fate of an abandoned object. Huge and empty, like the metaphysical paintings of Carlo Carr and Giorgio de Chirico, the Gorhall attracts attention, indicating an inappropriate "imperial" scope for a small European city. Large scale is one of the reasons for the lack of demand.

From this point of view, it is interesting that another very large object of this period in Tallinn lives and has many recipients. This is the building of the National Library of Estonia (arch. R. Karp, 1984–1992), which is called the last monument of the Soviet architecture, since the implementation was completed after the collapse of the USSR during the formation of an independent state in Estonia. The large-scale facility includes, in addition to the library premises, exhibition spaces, theatre and conference halls. Probably, the multi-functionality along with the actual dominant function of the library ensures the constant presence of people there.

A separate problem is the problem of long-term construction. For the buildings and structures left at the stage of unfinished construction it is difficult to come back to life. Natural aging and fatigue of structures, violation of temperature and humidity conditions as a result of being without heating during a long time lead to the fact that these objects sometimes turn into ruins. Examination of load-bearing and enclosing structures sometimes shows their emergency state, which occurred during the period of oblivion, and as a result—the lack of constructive potential.

5 Form and Time

West Gate of Belgrade GENEX Tower (arch. Mikhailo Mitrovich, 1980) is a high-rise 35-storey building with $h = 119$ m. It is located at the entrance to the city in the New Belgrade district. A bulky composition represents a giant arch of two towers of different heights, connected by a two-story bridge, with a rotating panoramic restaurant on top. One of the towers is the business centre of the company GENEX, the second, higher, is residential. The residential building has two entrances with semi-circular stairs. Currently, the office centre is almost completely empty, the restaurant is closed. The company GENEX—previously a large holding company with various activities—air transportation, tourism, foreign trade—has almost ceased to exist. In this regard, the fate of the building, which is a two-support arch—an integral inseparable form and structure—raises concern.

Architectural theorists have repeatedly turned to the analysis of the relationship between the architectural form and the function of the structure. For instance, I. G. Lezhava noted that "the spatial, figurative and functional elements are inextricably connected in the architectural form" and that "any form has a certain functional potential that expands the range of its purpose". He wrote, "Functional potential is a generalizing term that includes a branched hierarchy of polysemantic concepts … Adaptive capabilities are probably the foundations on which the interaction of architectural form and function develops" [6].

Let us pay attention to the word “interaction”. It is logical to assume that the structure has not only functional, but also compositional and artistic potential, which declares itself most loudly when it comes to aesthetically significant works of architecture.

6 Adaptation of Cultural Heritage Objects for Modern Use

The topic of adaptation of cultural heritage objects for modern use for a number of years is one of the most frequent project tasks, a social order. The objects are in different states, which is recorded by the primary registration documentation. An important aspect of the problem is that objects of cultural heritage adapted to new functions are subject to state protection in order to prevent their damage, destruction, changes in the appearance and interior, violations of the established procedure for their use. This imposes certain regulations when working with both the location—the territory of the monument, the boundaries of protected zones and zones of regulation of the site development, and with the object itself—accounting for the subject of protection.

On the eve of the 800th anniversary of Nizhny Novgorod, which will take place in 2021, let us turn to a cultural heritage object of federal significance—the complex of the bank of S. M. Rukavishnikov, architect F. O. Shekhtel. The complex consists of two independent buildings—a bank (1908–1910), facing the main facade on Rozhdestvenskaya Street—Nizhny Novgorod City of the XIX-early XX centuries, and a trading house (1911–1914), facing the main facade on the Nizhnevolzhskaya embankment. S. M. Rukavishnikov’s trading house—a work of late modernism—plays an important role in the river panorama of the city; it is perfectly perceived from the Volga, its large scale and high roofs, reminiscent of Gothic, form a pronounced silhouette and a memorable image. It is an accent object for the Nizhnevolzhskaya embankment, which is currently fully landscaped.

In addition to the urban planning and compositional-artistic, the object also has a high functional and constructive potential. Large undivided hall spaces, flexible frame structural scheme—these are qualities of the architectural object that make it possible to adapt it to new functions in order to create here a significant public space. The purpose of the building changed shortly after its construction: due to the outbreak of the World War I in 1915, it housed an evacuated sewing workshop, and since then, light and clothing industry enterprises have been located here. For a long time the clothing factory “Mayak” occupied the place, which moved out in 2015.

In 2018, NNGASU specialists conducted non-destructive testing studies of the building’s structures. Studies have shown that the existing damage, namely cracks and destruction of individual elements, including finishing layers, are mainly the result of violations of the parameters of the indoor microclimate. The building was not heated for a long time, which led to freezing building structures and intensified the destruction processes. Local leaks and soaking of the ground base affected the safety of the cultural heritage object. Facades require repair and restoration work. At the same time, the building has been preserved quite well.

Along with the engineering surveys a project proposal was made at the Department of Architectural Design during the course designing to adapt the Rukavishnikov Trading House as a Center for Industrial Initiatives. The general concept of adaptation and the specific purpose of the premises were outlined, depending on their compositional, artistic and planning solutions, on vertical and horizontal communications.

7 Historical and Cultural Areals, Potential Spatial Frameworks

It is a characteristic fact that historical buildings adapted to new functions, as a rule, are widely in demand. Although their static indicators associated with a specific space-planning solution are inferior to the newly designed object with a given initial function. However, dynamic indicators related to the quality of the architectural environment dictate an increased demand for such objects.

For each historically formed city, or its central core, the urban fabric is not a collection of individual buildings connected by a framework of pedestrian and transport communications, but a single architectural environment. From this point of view, an architectural monument included in the register is not a separate object with a specific function, design and form, but a certain "unit" that carries the historical code of the place. Inevitably, communications are formed around these objects, connecting them with other similar objects. Gradually, these communications turn into transit public spaces. As a result, not united by direct functional connections, these structures are tied into a single system—a spatial framework, a historical and cultural areal. As the analysis shows, such network allows identifying the spatial features of a historical settlement, on the one hand, and significantly increases the demand for each building or structure included in it—on the other.

Analyzing contextual approaches to design, let us turn to the human space "A workplace. A room. An apartment. A house. A yard. A micro district. A city. A country. A continent. A planet. An information space". What does a person perceive from this "set", first of all—engineering and planning communications at home and at work: elevator, stairs, corridor, heat, light, the Internet; the road to work and home: pedestrian or transport routes and improvement of inter-highway territories. Based on this position, it turns out that along with architectural objects and premises, the citizen will also demand spatial connections between them.

It seems that one of the reasons for the abandonment of a building or structure is its exclusion from the chain of objects united by the dramaturgy of movement around the city, or from the historical and cultural areal. A possible way to return to the fullness of life is to create potential spatial frameworks based on a scenario approach to the dramaturgy of movement, interpretation of such routes as alternation of reception areas (an architectural object or monument) and relaxation (communication).

Evolution of the public spaces of the historical settlement is formed on the basis of the real and potential interaction of history, nature and society and is determined by the type of their relationship with the person—the recipient. "The potential spatial framework of a historical settlement is formed as an integral one on the basis of natural-ecological, historical-cultural, social-business spatial frameworks and reflects the uniqueness of the polylogue of Nature, History and creativity of people. Depending on the given "dominant" that dictates a particular type of the potential spatial framework, it can be museum and exhibition, pilgrimage, tourist, physical culture and sports, ethnographic, etc." [7].

8 Architectural and Typological Potential of the Structure

The topic of this article sets the need to determine criteria of viability of abandoned buildings and structures. The materials of the analysis allow putting forward the hypothesis that the viability of an architectural object is determined by its typological potential.

Architectural and typological potential is formed on the basis of urban planning, functional, constructive and compositional-artistic potential. It is not their total, but it passes into a new synthetic quality under the influence of natural, historical, cultural and socio-economic conditions, on the one hand, and environmental characteristics—accessibility, safety, comfortability, information content, on the other.

According to the model of evolution of public spaces, the potential for the development of historical settlements includes natural, historical, socio-economic, as well as new potential opportunities. It is significant that these grounds coincide with the criteria for justifying the choice of the place for organization of public spaces, given in the documents of the competition "Formation of a comfortable urban environment":

- availability of the potential of spatial location (nature);
- availability of cultural and historical value (history);
- availability of socio-economic potential (society);
- availability of urban development potential.

We propose to interpret these requirements as general criteria for assessing the viability of abandoned objects (Table 1). In addition, we consider it necessary to introduce environmental criteria (Table 2). To do this, we turn to the criteria for adaptation of the environment for low-mobility groups of population. We consider this position quite appropriate, since the objects of this article—abandoned constructions—require exclusion of all possible risks in case of their use. The environmental criteria include:

- accessibility of the service area, ensuring smooth movement of visitors;
- safety of travel paths, places of service and recreation of visitors;

Table 1 General criteria for assessing the viability of abandoned objects

Criteria for assessing the viability of abandoned objects	Place and tine	Function and time	Construction and time	Form and time
Availability of the potential of spatial locations (NATURE)	Natural conditions—relief, water areas, vegetation	Natural conditions for organization of landscaping	Natural conditions for organization of pedestrian and transport communications	Natural conditions for organization of visual linkages
Availability of cultural and historical value (HISTORY)	Historical "legend" that identifies the place	Historical functional content	Historical structural elements	Presence of cultural heritage or valuable environment objects
Availability of socio-economic potential (SOCIETY)	Possibility of the presence of people	Possibility of temporary content—organization of exhibitions and festivals	Possibility to adapt objects for modern use	Possibility to preserve the aesthetically expressive architectural environment
Results in				
Availability of architectural and typological potential	Availability of **urban development** potential	Availability of **functional** potential	Availability of **constructive** potential	Availability of **compositional and artistic** potential

Table 2 Environmental criteria for assessing the viability of abandoned objects

Criteria for assessing the viability of abandoned objects	Place and tine	Function and time	Construction and time	Form and time
AVAILABILITY *(preserved, partially lost, lost)*	Accessibility of pedestrian and transport exteranm	Natural conditions for organization of landscaping	Natural conditions for organization of pedestrian and transport communications	Natural conditions for organization of visual linkages
SAFETY *(high, medium, low)*	Safety of visiting the place without the risk of injury	Safety of use of structures and buildings	Safety of use of structures and engineering communications	Safety of use of internal spaces
COMFORT *(high, medium, low)*	Comfort of using engineering and transport communications	Comfort of use of buildings structures	Comfort of use of auxiliary rooms	Comfort of use of internal spaces
INFORMATIVENESS *(high, medium, low)*	Content saturation of the place	Content saturation of buildings and structures	Navigation of communication spaces	Content saturation of internal spaces
Results in				
ARCHITECTURAL TYPOLOGICAL POTENTIAL *(high, medium, low)*	Ability to change based on **urban development** potential	Ability to change based on **functional** potential	Ability to change based on **constructive** potential	Ability to change based on **compositional and artistic** potential

- comfort of the environment where visitors stay and are serviced;
- informativeness—ensuring timely receipt of complete and high-quality information.

It should be emphasized that these groups of requirements work only in a complex, in a synthetic relationship, provided that they are balanced and subordinated. If one of the components falls out, the system no longer works or works differently.

9 Criteria for Assessing the Viability of Abandoned Objects

Even starting working on the design, the architect thinks not about the immediate demand, but about a long-term viability of his object, because "if the space does not change (or rather is not perceived by its creators as changing), then time is considered "frozen". Thus, only a change of space (external or internal) gives the subject a reference point in time" [8].

We propose to evaluate the viability of abandoned objects and identify their architectural and typological potential to determine the possibility of revitalization according to Tables 1 and 2. They reveal manifestations of each of the general or environmental criteria from the point of view of each of the typological components of the object. At the same time, as it has been mentioned above, the criteria work only together.

10 Integrity of the Man-Made and Natural

Let us turn to Nizhny Novgorod, which celebrates its 800th anniversary in 2021. It is in recent years that there has been an increased interest in organization of public spaces. This topic combines a number of conceptual and design works of different scales and levels: these are projects of redevelopment of urban areas, adaptation of individual buildings and structures for modern use, as well as projects of improvement of streets and squares. And sometimes, the design boundaries are extended to undeveloped areas adjacent to these territories. A special center "Environment-800" has been created, whose activities are aimed at the improvement program. The current task combined the creation of walking routes, both in traditionally operated and familiar places and in places that are not currently used. The drama of unhindered movement around the city, in particular around its historical center, is the potential on which the revival of places and individual abandoned objects is built.

At the same time, major repairs are being carried out on a number of structures, including cultural heritage sites and valuable environmental objects.

At the end of the article, we propose to consider an example of preserving a specific object of cultural heritage as an abstract spatial model of the relationship between Nature, History and Society.

The object of cultural heritage of regional significance "Stairs from the monument to V. P. Chkalov to the Volga River (Chkalovskaya)" in Nizhny Novgorod, (architects L. V. Rudnev, V. O. Munts, A. A. Yakovlev (Sr.), 1943–1949) is a memorial monument to the victory in the Battle of Stalingrad on the Volga River. Nizhny Novgorod is a unique city, due to the rich relief it has the upper and lower embankments, and the monumental staircase connects them into a single system, actively participating in the formation of the river panorama of the city—its main facade from the river. At the same time, vertical communication and a significant public space, this man-made monument, are perceived as an integral part of the natural landscape. This approach was described by Giorgio de Chirico: "Architecture complements nature. This was the progress of human intelligence in the field of metaphysical discoveries" [9].

And this relationship can not only manifest itself with a "plus" sign, but also conceal hidden natural and anthropogenic threats. So, on September 8, 2019, a retaining wall, including part of the parapet, collapsed on the section of the upper observation platform of the stairs. This required performing repair works to preserve the cultural heritage site. As a result of complex studies carried out by scientists of the NNGASU as part of the scientific and design team (supervisor I. S. Sobol, chief project architect A. L. Gelfond, chief project engineer A. A. Shaposhnikov), it was possible to identify that the destruction was caused by both natural and anthropogenic factors. Landslide phenomena on the slope, removal of soil, damage of the system of collecting and removing atmospheric precipitation and at the same time structures' soaking, destruction of the concrete and reinforced concrete of the retaining wall and its deformation, extensive corrosion of the working reinforcement, damage of the anchor fasteners in the support zone—these are inextricably linked phenomena.

Therefore, the project of restoration of the monument included structural solutions for the stairs themselves and for strengthening the slope. They are a replacement of the supporting structures of the upper observation platform with installation of boring piles and retaining the geometry of the structure. These include anti-landslide measures on the berms of the slope, ensuring its stability and safety, organization of the collection and removal of atmospheric precipitation outside and in the substairs space of the structure with restoration of the damaged elements.

Vittorio Gregotti, who died in the spring of 2020 during the pandemic, wrote in his manifesto about the special role of architecture: "To fight with nature or to comprehend it, to extract dialectical aspects from its unity, to geometrically organize or, by laying out a garden, to make an ideal nature of it, an improved, cosmological model, an earthly paradise, a nature that is friendly to human existence, opposed to wild nature, or a mirror of the truth and kindness inherent in the man. These are interpretations that have always found their precise and definite answers in architecture" [10].

11 Conclusion

In conclusion, it should be mentioned that some of the issues raised by the pandemic became relevant even before the pandemic. This concerns, in particular, the topic of creating recreational areas in cities. The national project “Creating a comfortable urban environment” is aimed at it. The pandemic has only aggravated the importance of creating a “total” comfortable urban environment, in which everyone can choose an unobstructed route, including one in deserted places. From the perspective of this article, it seems that possible transformations in urban development in the post-pandemic period will go further along this path. At the same time, the areals of improvement will include, among other things, inconvenient places, abandoned territories—ravines, hard-to-reach places. Today empty, these gaps in the cities are potential routes for the new development of urban space. An abandoned object that appears on the route of such a travel also carries important information for understanding the identity of a particular city.

At the same time, urban spaces will not be able to provide completely a full-fledged rest for a modern citizen. Therefore, the other side of the issue concerns the restoration of non-functioning suburban recreation facilities. It is known that a number of recreational complexes—recreation centres, children’s summer camps, sanatoriums, dispensaries, campsites, hunting and fishing camps—stopped working in the mid-1990s—early 2000s. In this regard, it is necessary to include programs for the renovation of currently inactive recreation facilities with the potential for development in the regional development strategy. In our opinion, restoration of external and internal communications and infrastructure of such institutions is one of the priorities in the post-pandemic period.

Will abandoned objects that have become utopias return to reality? We dare to assume that yes, they will, and after the pandemic people will be drawn exactly in deserted places and abandoned buildings in search of self-isolation, and perhaps, these places will come to life.

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Sensory Garden as a Perspective Type of Space for Habilitation of Young Children

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Abstract The relevance of the research topic is due to the widely implemented habilitation and inclusive approach to helping children with disabilities in Russia today. Habilitation requires new methods of treatment, psychological and pedagogical development and socialization of such children, starting from the earliest age. The period from birth to 7 years is extremely important for the development of body functions that affect the ability to lead a full life and social inclusion in the future. New approaches require the development of evidence-based recommendations for the formation of new types of spaces for habilitation classes and socialization of children. One of these types of spaces is the sensory garden. Studies show that the combination of elements of sensory impact, play with components of the natural environment has a beneficial effect on the physical and psychological state of people with disabilities. The paper discusses the main factors and principles of designing sensory gardens for children with disabilities. Based on the results of the study, an experimental project of a sensory garden in one of the cities of the Moscow region was developed. The results of the study can be useful for landscape architects and specialists in the field of habilitation of children.

Keywords Sensory garden · Architectural and landscape environment · Habilitation of young children

1 Introduction

Sensory Garden (from Lat. Sensus—perception, feeling) is specially organized landscape environment, including elements of stimulation of human senses, aimed at harmonizing his mental and physical condition [1].

Sensory gardens combine recreational and health-improving functions, and with a large area and the presence of tree plantations can form parks that have a positive impact on the ecology of cities.

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Sensory gardens appeared in the UK in the 1970s for the purpose of rehabilitation of disabled people, in particular, for the development of sensory perception of the world in visually impaired people. The gardens were located mainly in institutions for the disabled. Subsequently, sensory gardens are organically incorporated into urban recreational areas, accepting both people with and without disabilities [2].

The most visible effect of such gardens is on people with disabilities, especially if they are young children. According to the Federal State Statistics Service of the Russian Federation for 2019, the number of disabled children is about 2% of the total child population. Up to 6% of children have health problems, but are not officially recognized as disabled.

Learning the world through the senses, children form their first ideas about the most important properties of objects, their shape, color, size, position in space, smell, taste [3].

Thus, the sensory garden acquires a habilitation function—it contributes to the formation of psychophysical abilities and body functions that have not been developed in a disabled child since childhood due to health disorders. Children with visual defects learn to navigate in space better, children with mental disabilities through the stimulation of fine motor skills overcome problems with speech retardation, communication, etc.

For the most effective implementation of the habilitation function in the sensory garden, it is necessary to organize properly the landscape habilitation space.

The aim of the study is to determine the factors and principles for the landscape formation of sensory gardens, as well as to develop specific scientific and practical recommendations for their design.

2 Materials and Methods

In the course of the study, the method of complex factor analysis was used. The sensory garden is studied as an element of the landscape environment, as part of the habilitation infrastructure and as a space that is comfortable for a young child to stay in it. The landscape environment of a sensory garden is considered as a set of interrelated components, each of which has its own requirements.

The theoretical basis of the study is the results of scientific research of national and foreign scientists in the field of studying the landscape environment of the sensory garden, such as Vukovich [3], Moore and Cosco [4], Stoneham [5], as well as scientific research in the beneficial effect of the landscape environment of the sensory garden on the development of children, including children with disabilities, by scientists Hussein [2, 6], Trojanowska [7], Sukhareva [8].

3 Results and Discussion

The scientific novelty of the research consists in determining the main types of sensory gardens in Russia, the factors of their design at the macro and micro levels, the principles of designing sensory gardens as an architectural and landscape habilitation environment. The practical significance of the study consists in the designing of an experimental project of a sensory garden based on the design principles identified as a result of the study, which make it possible to consider a sensory garden as a platform for habilitation of children.

Sensory gardens created today in different regions of Russia are very diverse in structure, size, and composition of components. Some are aimed at the development of one (monosensory) or several sense organs (polysensory), they can be created for children with one type of health disorder (with visual, hearing, autism, etc.) or universal. As the child's knowledge of the world occurs through all sense organs, in this study attention is focused on polysensory universal gardens.

Sensory gardens include, as a rule, 5–6 main zones united by a green space: tactile, visual, auditory, olfactory, gustatory, and motor (game). Developing elements can be components of living (grass, flowers, shrubs, etc.), inanimate nature (stones, sand, water), as well as be artificially created by man from environmentally friendly materials [9].

Gardens are created both in public recreational areas and in specialized medical, rehabilitation, and educational institutions. The concept of summer modular design gardens, including flowerbeds, sandboxes, and tactile panels, implemented in Moscow (Sokolniki Park, Gorky Park of Culture, SerebryanyBor, etc.) and other cities is interesting. As part of the sensory garden, educational groups for young children are opened [10].

3.1 Design Factors for Sensory Gardens for Children with Disabilities

The landscape organization of the sensory garden is formed under the influence of a number of factors at the macro and micro level. Macro level factors are associated with the design of the sensory garden as part of a sustainable landscape environment and habilitation of the city's infrastructure, inner need to create habilitation educational space, attractive and safe for each child. At the micro level, the factors are largely similar to the factors of designing architectural habilitation and rehabilitation spaces (rehabilitation centers, centers of psychological and pedagogical assistance to families and children) [11].

1. At the macro level the following factors were identified: climatic (weather conditions of the territory, characteristics of topography and vegetation, etc.), socio-demographic (system of settlement, population distribution by age, number of children in need of habilitation), socio-economic (socio-philosophical paradigm

of the attitude towards people with disabilities, the level of development of habilitation infrastructure, economic potential of the region), territorial and town planning (placement of object in the urban structure of settlements, population density, pedestrian-accessibility, territorial relationship with existing objects habilitation, size), environmental (minimizing the level of negative anthropogenic influence on the ecological state of the territory and the health of the people), artistic and stylistic (stylistic features of architectural-landscape organization of the territory and adjacent buildings, forming a harmonious visual environment of the city, taking into account peculiarities of psychological perceevel the following key factors were identified: habilitation (what habilitation classes are planned in the ption of space by children) [11].

2. At the micro l garden), functional and technological (the effect of technology, habilitation on the characteristics and location of zones and components of the garden), ergonomic (the anthropometric data and physical characteristics of children in habilitation), and psychological (the psychological and cognitive characteristics of children in habilitation), sanitary (compliance of landscaping, equipment, and building materials with existing sanitary and environmental requirements for playgrounds) [12].

3.2 Principles of Designing the Habilitation Environment of Sensory Gardens

The requirements for sensory gardens as components of the landscape environment of the city as a whole do not differ from the requirements for other gardens and parks. They can be integrated into the city's infrastructure, forming communication or buffer zones that connect different spaces for different purposes [13].

At the same time, a number of principles of designing sensory gardens as an architectural and landscape rehabilitation environment were identified, including:

- accessibility and safety for visitors, taking into account the ergonomic, anthropometric, physical and intellectual characteristics of children, compliance of the environment with the current requirements of accessibility of the environment for people with limited mobility;
- interactivity—the possibility of direct human interaction with the elements of the sensory garden, which affect various sensory organs;
- attractivity—an interesting landscape and subject-spatial environment that does not scare children;
- informative and understandable for a disabled child—a simple scheme of communication paths on the territory, minimizing the risk of getting lost, using signs and symbols that are understandable for both adults and children;

- adaptability for the stay of children and parents at the same time—availability of places for parents in game areas, availability of game elements for children in quiet recreation areas;
- variability of the use of the subject-spatial environment depending on the scenarios of habilitation classes and game preferences of different groups of children [14].

These requirements are discussed in more detail in the candidate thesis "Architecture of early childhood habilitation facilities" and publications of Kasper [14].

3.3 Experimental Project of a Sensory Garden in the Moscow Region

The presented project was developed as part of the educational process by the Master of Architecture Dovzhik D. under the leadership of the Head of the Department of Architecture SULUP Doctor of Architecture, Professor Ilvitskaya [15].

The territory in the new residential area of Kuznechiki of the Podolsk city district of the Moscow region was chosen for the location of the sensory park. Among the problems of the area a lack of trees, low level of protection of the houses from noise and dust, the shortage of recreational areas, homogeneity of the visual environment, the predominance of similar multi-stored buildings with courtyards and passages completely out of scale man can be called. The projected sensory garden is designed as a "green island" for residents to relax and a "green corridor" connecting residential areas. The garden has good pedestrian accessibility for residents of the area, should remove some of the anthropogenic load from the surrounding forests, which contributes to their restoration (Fig. 1).

The sensory garden consists of 7 main zones: the zones of development of touch, hearing, taste, smell and vision, the game zone, and the zone of ecological therapy. In the center of the garden, there are reservoirs (Fig. 2). All playgrounds and communication paths are adapted for the stay of people with limited mobility. The plot has a gentle terrain with a slope of less than 5%.

The game zone consists of 3 parts for children of different ages. In the first part for children up to 6 years old, there are sandboxes and playhouses, swings, and places for watching parents' children and quiet recreation. The second part is aimed at children from 7 years old; the game environment is filled mainly with outdoor playgrounds. The third part is a common game zone designed for the socialization of children, filled with various game elements, including for disabled children (Fig. 3).

The ecological therapy zone is filled with a large number of different plants. Perimeter walking paths are playgrounds for active play; tracks paved with cobblestones, on the principle of step-by-step stages, large lawn area (Fig. 4).

The zone of touch is filled with small architectural forms with different textures, the main ones are: a modular sensory garden, a sensory path and a tactile wall. In the zone, there are modular sensor elements and sensor trails filled with mosses, sand,

Fig. 1 Placement of the sensory garden in the structure of the Kuznechiki district, Podolsk city, Moscow region

Fig. 2 Master plan of the sensory garden

sawdust, cones, needles, pebbles, gravel of small fraction, etc. These elements are designed to develop fine motor skills of the hands and stimulate the nerve endings of the feet. One of the main elements of the garden is the tactile wall; it consists of various coverings. Along the paths, there are tactile play areas and benches for relaxation (Fig. 5).

The zone of smell and vision consists of several mixborders with plants of different color and aroma (daffodils, petunias, hydrangeas, asters) (Fig. 6).

Fig. 3 Game zone

Fig. 4 Ecological therapy zone

The auditory zone is filled with small architectural forms, at interacting with which they can get different sounds: street xylophones, drums, and various wind systems. It is also supposed to install instruments on trees that extract sound from the wind "Wind Sounds", the device of systems of artificial imitation of the sounds of nature (Fig. 7).

Fig. 5 Zone of touch

Fig. 6 Zone of smell and vision

The taste zone includes planting of fruit-bearing shrubs and trees: currants, blackberries, cherries, etc. (Fig. 8).

The project offers all-season use of the garden. In winter, it is proposed to install ice rinks on reservoirs, snow and ice slides and figures. In the zone of sensory development-the arrangement of mazes and fortresses made of snow. For the development of hearing, it is possible to create ice instruments (organ, etc.) that make sounds.

All the images in Figs. 1, 2, 3, 4, 5, 6, 7 and 8 are made using ArchiCAD 18 (Graphisoft), Autodesk 3dsMax and Corona Renderer software.

Fig. 7 Auditory zone

Fig. 8 Taste zone

The proposed landscape solutions of the sensory garden zones meet the requirements identified earlier, so it can serve as a platform for habilitation classes for children with disabilities. The sensory park is proposed to be executed in a modern eco-friendly style using smooth contours of functional zones, which makes the area more visually attractive for residents.

4 Conclusion

The main factors of formation of the landscape environment of sensory gardens are revealed, on the basis of which the basic principles of their landscape design as an habilitation environment are determined. Their application is demonstrated by the example of a sensory garden in the Kuznechiki district of Podolsk, Moscow region.

The results of the study confirm that the creation of sensory gardens is effective and promising in order to create a space for habilitation of children and improve the quality of the architectural and landscape environment of cities. The presented experimental design of a sensory garden demonstrates a number of principles and techniques for designing urban sensory gardens. Nevertheless, further study by architects of the functional and planning structure of sensory gardens, their subject environment, search for suitable geoplastic and artistic techniques of landscape architecture will make the gardens more attractive and accessible to visitors, increase their habilitation and social efficiency.

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Architectural Features of the Scientific Research Zones in the University Technical Laboratory Centers

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Abstract In the paper the analysis of 50 technical laboratory centers of universities located in different countries of the world is presented. The main types of laboratories are part of the center identified and their features. The main parameters of the premises are considered: their overall dimensions (length, width, height) and the principle of inclusion in the structure of the building. The conclusion was made that the number and diversity of the laboratories types presented in one center depend on the needs of the university and the research tasks assigned to scientists, and therefore may differ significantly. The main principles of the internal organization of laboratory technical centers are interaction, dynamics and flexibility. The analysis showed that there are three basic types of laboratories—testing, research and information. Also, in technical laboratory centers with a more complex spatial organization, their combinations have become widespread.

Keywords Architecture · University · Laboratory center · Research zone

1 Introduction

The development of the science sector is one of the strategic priorities for achieving the economic development of the Russian Federation. A large amount of scientific research is carried out by Russian higher education organizations—universities, academies and institutes. In the higher education sector, research activities are carried out by 952 universities, that is 25% of the total number of scientific organizations in the Russian Federation [1, 2].

In the course of the study, it was revealed that currently in Russia, the architectural typology of laboratory facilities—the most necessary part of the innovative infrastructure of universities—has not been developed. At the same time, there are separate scientific and methodological works that considered the classical typological schemes of universities and the features of their functional and spatial solutions

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(V. V. Adamovich, A. L. Gelfond, S. G. Zmeul, T. G. Maklakova, M. V. Puchkov, etc.). A number of studies are devoted to the problems of development and modernization of universities (T. S. Dudina, S. A. Isakova, G. N. Chernenko, V. V. Panov), as well as to the features of the architecture of innovative scientific buildings and complexes (O. V. Liluyeva, D. A. Khrustalev, A. V. Antonov, A. A. Rumyantseva).

The review of the Russian regulatory framework for the design of infrastructure for research and innovation activities in universities showed that it needs to be updated. Today, there is no document that would meet modern requirements. A retrospective analysis of the archive of existing regulatory documents showed that some of them (SR—Set of Rules—31-06-2009, reference manuals to SR 2.08.02-89 "Design of educational complexes and centers" and to SR 2.08.02-89 "Design of higher educational institutions and institutes of advanced training") included only scattered design guidelines of these objects. In the current SR 118.13330.2012 "Public buildings and works", mainly the regulations for the design of universities in general are given, and the research area is considered only in connection with the need to comply the sanitary and epidemiological requirements. In SR 278.1325800.2016 "Buildings of educational institutions of high education. Design rules" provides only brief requirements for the premises for the theoretical work of research and production units.

Several circumstances increase the importance of the developing principles for designing university laboratories. Firstly, the problem has become more urgent in connection with Russia's accession to the World Trade Organization (2012). Secondly, on 20.09.2019, the Russian Government decree "On the recognition and assessment of compliance of testing laboratories (centers) with the principles of good laboratory practice, corresponding to the principles of good laboratory practice of the Organization for Economic Cooperation and Development" was adopted.

2 Materials and Methods

The main elements of the modern scientific life of universities are laboratory centers. As part of the study, more than 150 research facilities were analyzed that located in technical universities around the world. For selection of relevant examples of research centers, information from QS World University Rankings for several years was studied. Universities that located in different countries of the world and characterized by high efficiency of scientific results were selected. Then the work continued with the information posted on the websites of universities, of popular architectural magazines, and on the websites of architectural bureaus engaged in the design or modernization of research complexes.

For this, content analysis of text and illustrations (drawings, diagrams, model 3D, etc.) and the subsequent accumulation of data on the quantitative and qualitative parameters of laboratories in tabular forms were used. Then they were sorted, which made it possible to identify typical situations.

Special attention was paid to such facilities that allow universities to search for, implement and distribute innovative products. It was revealed that today, in the world practice, the most popular group of objects that are paid close attention to the modernization and development of the research infrastructure of universities, are laboratory centers of a technical profile. They make up more than 60% of the total number of objects [3–5].

Some efforts were made to get acquainted with the retrospective development of laboratory design regulations in different countries. The works of Legget and Hatcheon (1966, Canada) [6], Design Guide of Department of Veterans Affairs (1995, USA) [7], Griffin (1998, 2000, 2005, Australia) [8], Braun and Grömling (2005, Germany) [9], recommendations of James Cook University (2013–14, Australia) [10], report of National Research Council (2000, USA) [11], Klonk (2016, Germany) [12] and Guidelines of Stanford University (2019, USA) [13]. It is revealed that in recent years there has been an increasing interest to safety issues and engineering aspects of the design of laboratory buildings. Important results for clarifying their architectural and typological characteristics were obtained by scientists from the University of Hawaii at Manoa (2016, USA) [14], ASHRAE (2018, USA) [15], Babu et al. (2017, Singapore) [16], Quadrini et al. (2021, Italy) [17], etc.

3 Results

3.1 Systematization of the Main Laboratories Parameters

A comparative analysis of the university facilities selected for detailed study showed that the total area of the laboratory area of research centers varies in a wide range from 2200 to 26,000 m^2 (Table 1). The number of floors of buildings is from 2 to 8. The most common type of laboratories is those that are integrated with the educational process (50%), in the second place—autonomous laboratories (41%), in the third—universal laboratories (9%) [18].

3.2 The Main Principles of the Internal Organization of Technical Centers

The main principles of the internal organization of technical centers are interaction, dynamics and flexibility. The administrative group of premises is practically absent; preference is given to the specialized scientific and laboratory area. Training facilities are also compulsory. They may be miss, or they may be like compact classes for small groups of students, which ensures maximum personal participation in the work. Teams of scientists develop and propose concepts for prototyping products, as well as they conduct multimedia presentations for teachers and customers.

For example, in the Scientific and Technical Center of the State University in Coppin (USA), all laboratories and classrooms can be used for the development

Table 1 Basic parameters of laboratory premises

Building area, m^2	The number of storeys	The size of laboratory								
		Testing laboratory			Research laboratory			Information laboratory		
	Number of storeys	Area, m^2		Height, m	Area, m^2		Height, m	Area, m^2		Height, m
		Length, m	Width, m		Length, m	Width, m		Length, m	Width, m	
1	2	3	4	5	6	7	8	9	10	11
1. *Type integrated with the educational process*										
6500–20,500	2–8	60–600		3.6–9.9	40–225		3.3–4.5	9–120		3.3–4.5
	2–8	8–30	7–20		5–15	4.5–20		2.5–15	4–10	
2. *The universal type*										
6500–13,300	4–7	100–200		4.2–7.5	25–80		4.2	18		4.2
	3–7	10–20	10–15		3.6–13	6–7		4.5	4	
3. *The autonomous type*										
2200–26,000	2–6	65–500		4.5–8.4	35–100		3.6–6.6	15–50		4.2–5.1
	2–5	11–30	5.9–20		6–20	5–10		3.3–6.7	4.5–7.5	

and project implementation by teams from two to eight people. Here, for a closer interdisciplinary communication between teachers and students studying at different faculties, the designers abandoned the standard boundaries between the classrooms [19].

The principle of cooperate working is also used in the Bindley Center for High Technology at Purdue University (USA, design—Flad Architects). Despite the engineering orientation of the laboratories, there are no internal blind partitions, but the zoning of the space is provided by glass sliding structures. As a result, the premises of research and training laboratories are closely connected and form a single communication zone. Even the engineering systems that are not hidden in special technical floors are the part of the working space, remain opening to the eyes [20] (see Fig. 1).

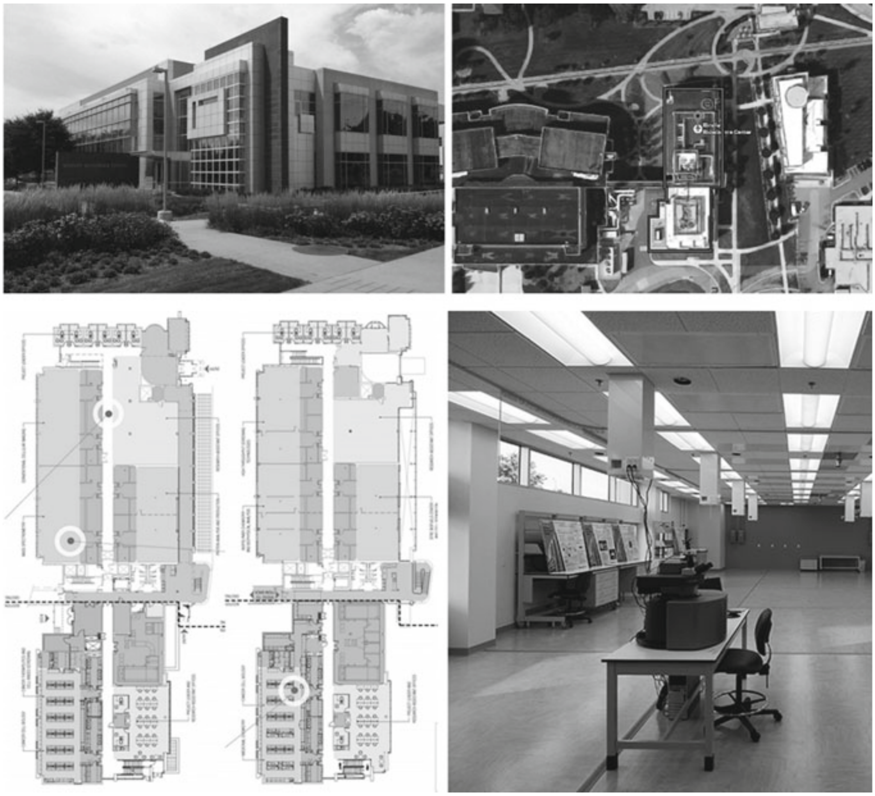

Fig. 1 Example of modern university technical laboratory centers. Type—integrated with the educational process. Bindley High Technology Center, Purdue University, USA. Designer—Flad Architects [20]

Table 2 Major kind of laboratory integration

The type of laboratory	Lab center integration kind to campus structure		
	Integrated with the educational process	Autonomous	Universal
Testing laboratory	•		•
Research laboratory	•	•	
Research + information laboratory	•	•	•
Testing + research laboratory	•	•	•
Testing + research + information laboratory		•	

4 Discussion

4.1 Basic Types of Laboratories

The analysis revealed that the laboratory area is the most developed in the research centres of technical universities. The study of factual data allows us to distinguish the following main types of laboratories: testing, research and information. Each of them has its own specific features.

We also identified centers that use additional opportunities to combine basic types of laboratories into more complex-integrated objects with a branched functional and spatial organization of zones: "research + information"; "test + research"; "test + research + information". Their combinations are shown in Table 2.

Let's consider the spatial features of the basic types of laboratories.

4.2 Features of Testing Laboratories

Testing laboratories are focused on conducting product diagnostics in one of the existing certification systems in accordance with their scientific branch (in this case, technical orientation). The height of the room in the testing laboratory reaches 12 m. For example, the Materials Technology Laboratory "Canmet" of Mac Master University (Canada, designer—Diamond + Schmitt Architects.) includes a complex of laboratory facilities for conducting mechanical tests for experimental casting, rolling and welding of metal. Overhead cranes capable of lifting loads weighing up to ten tons are installed in the laboratory premises [21] (see Fig. 2).

Depending on the size of the machines, mechanisms, etc. the total area of the testing laboratories most often varies in the range of 60–600 m^2. Underground floors are actively used, which can contain both an engineering support and transport service area, directly a research area (test stands). This technique was used in the design and

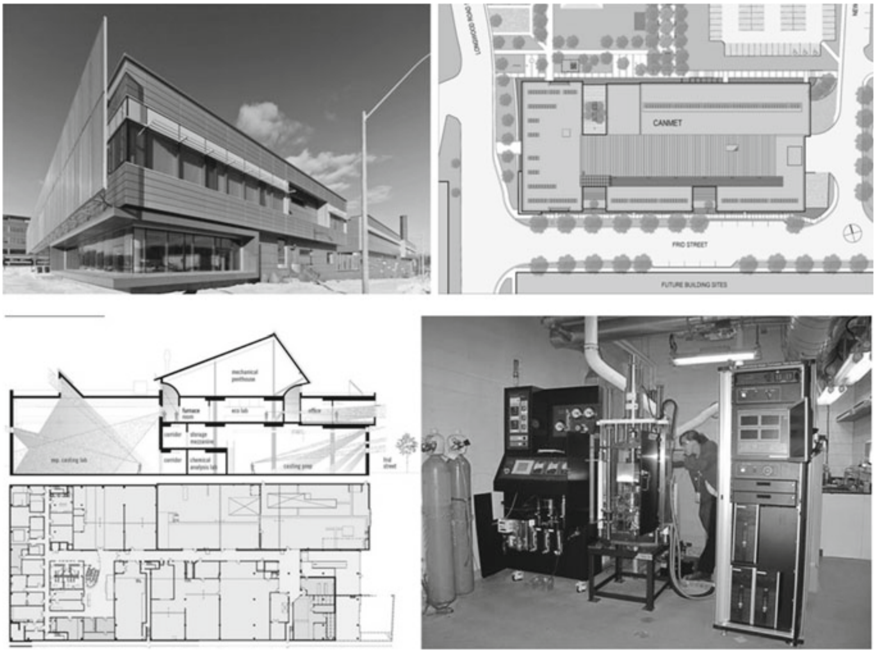

Fig. 2 Examples of modern university technical laboratory centers. Type—integrated with the educational process. Technical Laboratory of Materials Canmet, McMaster University, Canada. Designer—Diamond + Schmitt Architects [21]

implementation of the Center for Physics and Astronomy of the University of Western Ontario (Canada), the Laboratory of Integrated Science and Technology "LISE" of Harvard University (USA), the Laboratory Complex "Naughton" of Trinity College (Ireland), etc.

4.3 Features of Research Laboratories

Research laboratories are designed to carry out work related to experiments. Such laboratories can be located on any of the above-ground floors, but quite often occupy the upper levels. The working area required to ensure normal working conditions and maintain microclimatic parameters ranges from 25 to 225 m^2, depending on the number of employees and the size of the area for placing equipment. The height of the premises is accepted from 3.3 to 6.6 m.

4.4 Features of Information Laboratories

Information laboratories are designed to conduct theoretical works and prepare working documentation for projects. In a technical center, this type of laboratory most often occupies the upper floors, but can also be located dispersed throughout the building. The area of information laboratories is smaller than the area of other types of research facilities—from 9 to 120 m^2, and depends on the number of employees and the size of the necessary equipment. Room height is from 3.3 to 5.1 m. The analysis showed that the information and research laboratories are often located next to each other or even combined into a single larger room. For example, in the Laboratory of Computer Technology and Engineering Systems of the University of Michigan (USA), there are no test laboratories, but research and information are closely interrelated [22] (see Fig. 3).

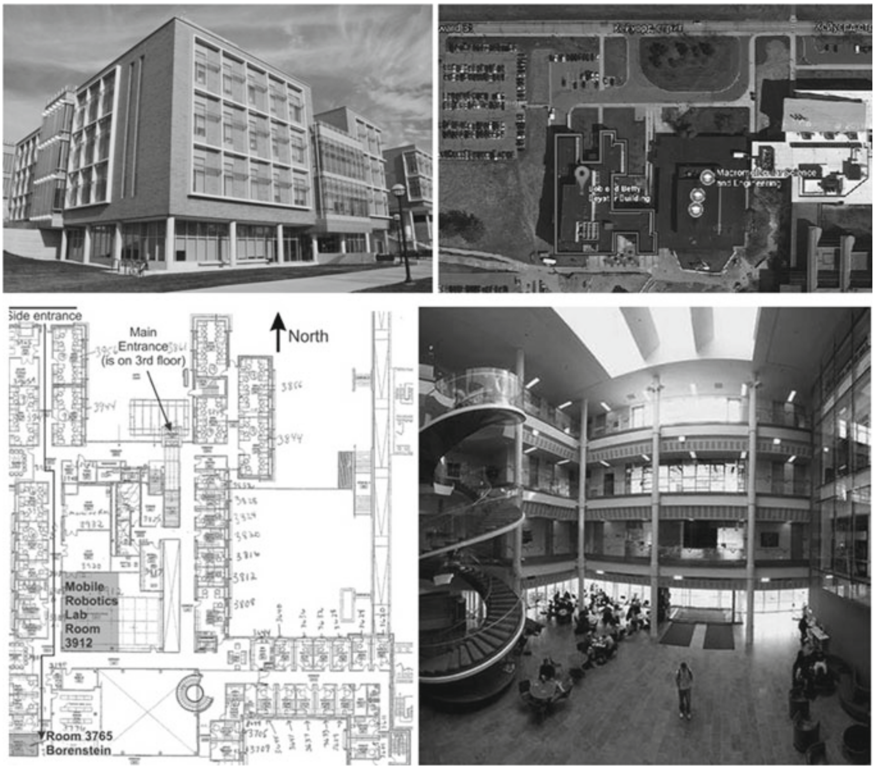

Fig. 3 Examples of modern university technical laboratory centers. Type—integrated with the educational process. Laboratory of Computer Technology and Engineering Systems, University of Michigan, USA. Designer—Diamond + Schmitt Architects [22]

4.5 Combination Types of Laboratories

The study of best practices in the design and construction of laboratories also revealed that combined models are mainly typical of large laboratory technical centers with a complex spatial organization. Among them are a significant number of facilities built in the USA and Canada. For example, in laboratory buildings integrated with the educational process, a combination of test and research functions is used at the Hodson science and technology center (Hood College), and the integration of research and information spaces in Integrated Science, Engineering, and Technology Complex (ISET, West Hartford, Connecticut), The Wisconsin Materials Research Science and Engineering Center (MRSEC, University of Wisconsin-Madison), and also at the Sutardja Dai Hall Center in the University of California campus (Berkeley), which is of the universal type. In autonomous-type laboratory centers, a combination of test and research laboratories is mainly used. They are created in Boston University's Engineering Product Innovation Center (EPIC), Center of Excellence in Nano Mechanical Science and Engineering (G.G. Brown Laboratories University of Michigan), in Brown University Engineering Research Center (ERC) and in a number of other educational organizations. A combination of research and information labs was identified at the autonomous Data Science Institute (DSI) at Columbia University.

The research showed that the most complex combination of laboratories, when both test, research and information functions are adjacent in one place, is infrequent in university construction practice. In the examples that were studied during the research, this option was used in the construction of Energy Environment Experiential Learning Centre (University of Calgary, Canada), Chu Hall and Molecular Foundry Lawrence Berkeley National Laboratory (University of California). One of impressive examples is the University of Calgary Energy Environment Experimental Learning Centre. It contains approximately 110 educational laboratories, including information, 250 classrooms and lecture halls, as well as about 30 research laboratories. A feature of the design process was the focused application of the principles of sustainable development. Designers emphasized the introduction of resource-saving technologies, for example, underground space is used to host test laboratories. Thanks to the integration of the efforts of architects and engineers, the building received the highest LEED rating—platinum certificate [23] (see Fig. 4).

5 Conclusions

The research showed that the university technical centres include, first of all, testing, research and information laboratories. It is noted that the number of laboratories and the type of their integration with each other, as well as with other areas and premises of research centers of universities, directly depends on the technological features of the laboratory centre and the nature of its interaction with the main functional

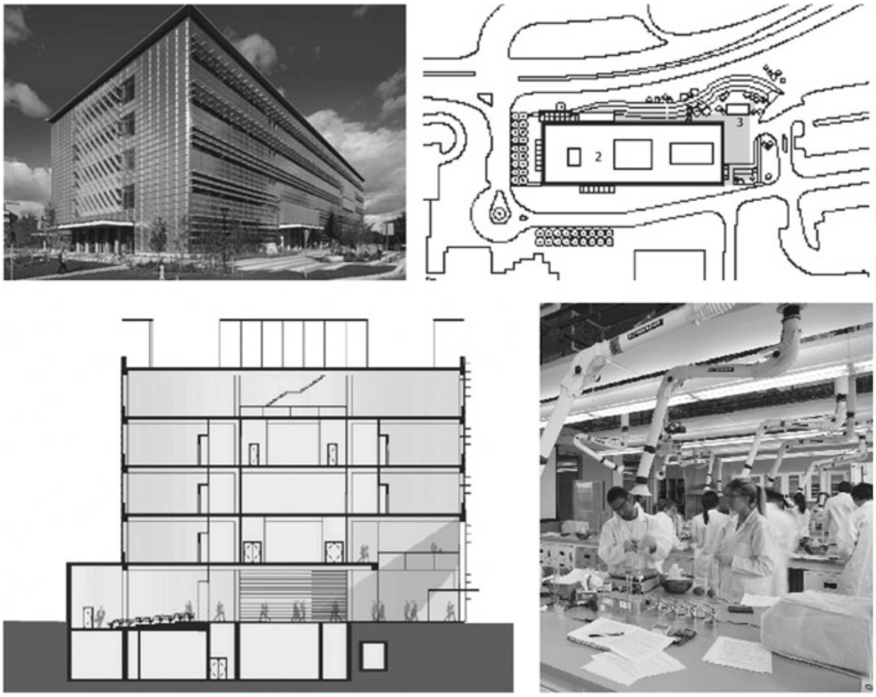

Fig. 4 Examples of modern university technical laboratory centers. Autonomous type. Energy Environment Experiential Learning Centre (University of Calgary, Canada). Designer—Perkins + Will + DIALOG [23]

areas of the university. The most complex model, which includes all three types of laboratories, is usually used only in an autonomous center. It is a complex with an internal structure and a system of communication spaces inside for organizing close interaction between employees. At the same time, the number and variety of laboratory areas and premises included in one laboratory centre is adapted to the needs of the university, specific research tasks and technological conditions.

During the data processing, in the research we determined the range of parameters of university laboratory facilities—the area of buildings, the number of floors and storeys, as well as the area, length, width and height of the premises included in the test, research and information laboratories. This original scientific result obtained by the authors is also related to the peculiarities of the functioning of laboratories in university conditions (integration with the educational process, autonomy, versatility). Such differentiation has not previously been used in Russian architectural science. It allows you to optimize technical tasks and design solutions in real practice.

The content analysis also noted that the construction of laboratory buildings is most often carried out on individual projects, which development involves reputable architects. One of the trends is the greening of design solutions, which allows to compensate for the high resource intensity of research processes. For Russian universities, the construction of modern buildings is the most urgent and complex issue, which, on the one hand, is a necessary condition for obtaining world-class scientific results, on the other hand, requires financial support not only from the state, but also from business. In this regard, there is an obvious need for the development of university science, combining its efforts and the production sector to solve the problems of promoting innovation and improving product quality.

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Management of Integrated Territorial Development Based on the Ecosystem Approach to the Reproduction of Residential Real Estate

A. M. Krygina and M. I. Oberemok

Abstract The article presents the concept of integrated sustainable territorial development based on the implementation of an ecosystem approach to the reproduction of residential real estate. The conception of eco-planning is taken as a foundation for defining the principles of integrated territorial development. The authors propose a model of the functioning and complex development of the organizational and economic territorial system of construction. This idea can be adopted as a basis for balancing the effectiveness and ensuring the sustainable development of territorial economic systems. A model of the effectiveness of the organizational and economic system for the construction of eco-housing has been suggested, that allows taking into account the entire set of indicators for the implementation of investment and construction eco-sustainable projects (the productivity of the organizational and economic system, the organizational and economic reliability of in-line construction, the efficiency of capital investments). The proposed strategy of implementing the ecosystem approach allows the sustainable reproduction of eco-residential real estate at all stages of its life cycle. As a result, citizens will be provided with affordable and comfortable housing while simultaneously solving the problem of integrated development of territories.

Keywords Integrated territorial development · Sustainable development · Green building · Eco-building · Energy-efficiency

1 Introduction

The problem of integrated territorial development (ITD) (Federal Law No. 494-FZ) [1] requires the creation of innovative approaches to the improvement of the territorial investment and construction complexes (TICC) and mechanisms of regional economic development. The introduction of ITD formulates requirements for the

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implementation of new systemic approaches to the formation of buildings in compliance with the principles of their compactness, functional diversity, ensuring the safety and health of the population, the comfort of movement, flexibility, and autonomy. The orientation of the model is based on the principles of sustainable development, the main direction of which is aimed at creating an economic model that allows meeting human needs at present, taking into account the interests of future generations.

A special role in the implementation of the ecological and economic model of sustainable development is assigned to the construction industry, as a formative environment of human activity, taking into account the objective critical state of the natural environment [2, 3]. The construction industry and real estate have a tangible negative impact on the environment as one of the active consumers of natural resources for their production, during operation and their disposal, primarily due to the high resource and energy intensity, low activity of the introduction of recycling technologies [4–6].

At the same time, the level of business activity in the reproduction of residential real estate and the perfection of organizational and economic mechanisms in this sector is one of the criteria for assessing the investment attractiveness of the government and individual regions [7]. The investment and construction complex is one of the drivers of sustainable development of territorial and regional ecological and economic systems, due to the involvement of related industries, innovative potential, primarily in the field of energy, resource conservation, and environmental friendliness [8, 9].

The presence of several factors hindering the development of domestic investment and construction complexes significantly reduces their competitive advantages. And the traditional organizational and economic models used in the reproduction of residential real estate constrain the implementation of the state concept of the ITD, which is most fully consistent with the key principles of eco-building [10, 11].

In conditions of aggravation of environmental problems, the main concept of sustainable regional development is a balance of socio-ecological and socio-economic systems [12] which is based on the interrelated interests of the participants: the balance of needs and capabilities of construction companies and contractors, construction industry enterprises, and the reproductive potential of the biosphere [13, 14]. This approach is correlated with the goals of the green economy that ensures economic growth while improving the quality of the environment and social integration.

Eco-cities and eco-villages are the concepts of real estate reproduction that focused on the introduction of product and process innovations as the most effective tools for implementing mechanisms for sustainable economic development [15, 16]. Eco-building claims to be one of the innovative mechanisms for solving key problems in the socio-economic sector of Russia [17].

The concept of innovative and sustainable development of residential construction at the regional level is a fundamentally new approach that is considered as the basic mechanism of expanded reproduction of residential real estate [18, 19]. It is based on the principles of rationalization of the intensity of the development of the population and ensuring the comfort of its residents.

The development of a new organizational and economic concept of eco-building solves the problems:

- reducing the negative impact of the construction industry on the population and the environment at all stages of the life cycle of real estate;
- creating a market for affordable and comfortable housing for the population with different income levels;
- increasing the productivity of the organizational and economic construction system while developing the regional labor potential through new jobs in the investment and construction complex;
- improving the efficiency of capital investments in the sustainable development of eco-housing facilities and reducing subsequent operating costs;
- reducing the level of regional resource and energy consumption and increasing the economic stability of the regional energy system, and the environmental and economic stability of the regional economic cluster.

The purpose of this article is to develop a concept of integrated territorial development based on eco-sustainable development of residential real estate reproduction market based on the introduction of innovative organizational and economic approaches and principles of green construction to ensure the formation of sustainable regional socio-economic systems.

2 Methods and Materials

The following research tools were selected: an initial retrospective analysis, economic and mathematical analysis, and functional and strategic modeling. The main sources of information are statistical data from official state and industry statistics, domestic and foreign publications, and analytical reviews.

The general model of the effectiveness of the organizational and economic system is formulated using the Saati method which takes into account a set of indicators for the implementation of an eco-sustainable project.

3 Results and Discussions

The paper proposes the basic principles of sustainable reproduction of residential real estate at the territorial and regional level based on the principles of eco-building:

1. The principle of balancing the growth rates of the total potential of the organizational, economic, environmental, resource, and social subsystems of the territories of the regional system with the innovative system of the TICC which increases the effectiveness of the economic construction system.

2. The principle of directed choice on the use of the components of the total resource potential to increase the efficiency of natural resource, investment, innovation, and labor components which intensively affect the efficiency of the TICC enterprises.
3. The principle of economic feasibility of implementing eco-building projects.
4. The principle of adequate compliance allows timely implementation of corrective actions related to the management of the innovative TICC and changes in the eco real estate sales.
5. The principle of mobility and flexibility implements the mobile adaptation of development companies to various types of eco-projects and the flexible use of innovative potential throughout the housing and public utilities of eco-construction.

The maximum effect in the reproduction of eco-residential real estate for sustainable territorial development is obtained by implementing the ecosystem approach to the large-scale residential real estate projects (eco-settlements, eco-parks, etc.). This is fully correlated with the principles of integrated territorial development in the Russian Federation and determines the number of significant features of such objects: long construction periods of eco-objects on large areas, a variety of types of built-up objects (including infrastructure), the involvement of a significant number of contractors, investors, labor, investment, material, and other resources. The scale of the objects determines the division of such objects into start-up queues and sets the task for designers and builders to gradually develop engineering, transport, and social infrastructure for the convenience of residents. Thus, it becomes obvious that it is necessary to develop fundamentally new organizational and economic mechanisms for the construction of eco-objects already at the design stage and their implementation at the construction stage.

A distinctive feature of the objects of eco real estate is a comprehensive accounting and systematic implementation of all the above requirements (Fig. 1) and at all stages of the life cycle of the real estate. The presented concept allows us to balance the regional ecological and economic system with the important cluster—the reproduction of eco real estate.

The general model of the sustainability of the regional organizational and economic system (1) is formulated providing the set of indicators of an eco-sustainable project:

(a) the efficiency of using the regional resource potential (x_1);
(b) productivity of the regional organizational and economic system of the TICC (x_2),
(c) organizational and economic reliability of in-line construction (x_3),
(d) efficiency of capital investments (x_4).

$$Y_{resultant}^{actual}(t) = f(x_1, x_2, x_3, x_4) \tag{1}$$

The conceptual economic and mathematical model of the effective development of residential construction at the territorial and regional level can be represented

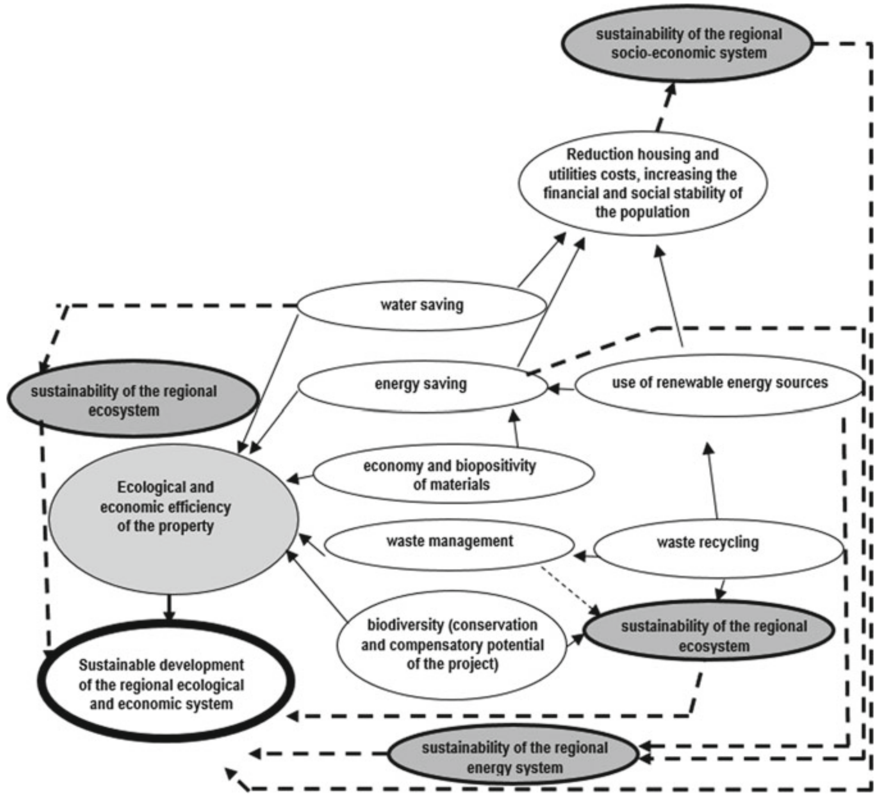

Fig. 1 The concept of implementing the system of sustainable regional development in the reproduction of eco real estate

by the conditional dependence of the solutions to the strategic tasks of regional management bodies to increase the productivity of the eco TICC, considering the organizational and economic reliability of in-line eco-building and the efficiency of capital investments in eco-projects [20].

$$U_{resultant}^{actual}(t) = \bigcup_{\omega,i,j=1}^{N} \{E_i\}, \{P_z\}_\omega, X_{\omega i} V_j \left\{R_{ij}^H\right\}, O_j K_j Q(\tau) \tag{2}$$

E_i efficiency of using the total potential of the region (x_1);

P_z productivity of the organizational and economic system of construction of the territory of the region (x_2);

$X_{\omega i}$ the full cycle of expanded reproduction of the territorial investment and construction complex, taking into account the economic potential of the region;

V_j many alternative options determine the choice of the optimal duration of the implementation of investment and construction eco-projects (ICEP);
R_{ij}^H organizational and economic reliability of in-line construction, including, respectively, labor, production, and natural investment resources (x_3);
O_j preference function for the choice of options for the priority of the construction of ICEP, taking into account the minimum “unit associated costs”;
K_j the indicator of capital return from the introduction of innovations from capital investments in the implementation of investment construction complexes (x_4), taking into account the risks (economic, industrial, and risk of the developer) of the eco-mobility object;
$Q_{(\tau)}$ a set of time parameters on the life cycle of an investment and construction eco-project on a segment (0, 1);
ω, i, j the number of hierarchy levels from 1 to N (region, territory, investment and construction eco-project).

The most effective and indicative implementation of the ecosystem approach is in the construction of large-scale residential real estate (eco-villages, eco-parks, etc.) that determines the number of essential features of such objects. First of all, these are long terms of construction of eco-facilities on sites of considerable area, a variety of types of built-up objects, the involvement of a significant number of contractors, investors, labor, investment, material, and other resources [21]. The scale of the facilities determines the breakdown of such facilities into start-up queues and sets designers and builders the task of step-by-step development of the engineering, transport, and social infrastructure of the eco-facility to prevent the inconvenience of residents. Thus, it becomes obvious that it is necessary to develop fundamentally new organizational and economic mechanisms for the construction of eco-facilities already at the design stage and their implementation at the construction stage.

Table 1 shows the increasing role of the “design” stage for eco-residential real estate. It is at this stage that the selection of optimal organizational, economic, and technological solutions for the implementation of the eco-project is carried out. Thus, the selection of energy-efficient equipment at the design stage does not lead to a serious increase in the cost of the object. At the construction stage, this will already cause the need for modification of the project and serious economic, organizational, and technological issues.

The analysis of the present value of the life cycles of eco real estate (Fig. 2) and the total cost of ownership of an eco-object showed an increase in costs at the design and construction stage of eco-objects compared to traditional buildings by 5–25%; and a significant reduction in operating costs: energy consumption is up to 25%, water consumption is by 30% which increases the energy, environmental, and resource sustainability (Fig. 1) of the regional ecological and economic system. In the context of the rapid growth of the utility fees in the Russian Federation the reduction of utility costs decreases the financial load on the population and contributes to improving the socio-economic stability of regional systems and the overall availability of residential facilities for the population.

Table 1 Analysis of the efficiency of heat-saving measures in buildings (% of total energy consumption)

Name of the event	Implementation effect (%)
Heat insulation of building structures, high-quality construction, reduction in operational losses in energy supply systems	6–9
Use of alternative sources of heat supply and low-potential heat	20–22
Reconstruction of buildings and engineering systems	9–15
Improvement of space planning solutions	8–10
Improvement of design solutions and regulatory approaches to construction	6–8
Use of automatic heat supply control systems and autonomous heat supply sources	20–30
Ventilated air recuperation	10–12
Thermostatic control of heat supply	10–15
Application of building envelopes with increased thermal protection	8–12
Use of energy-saving elements	6–8

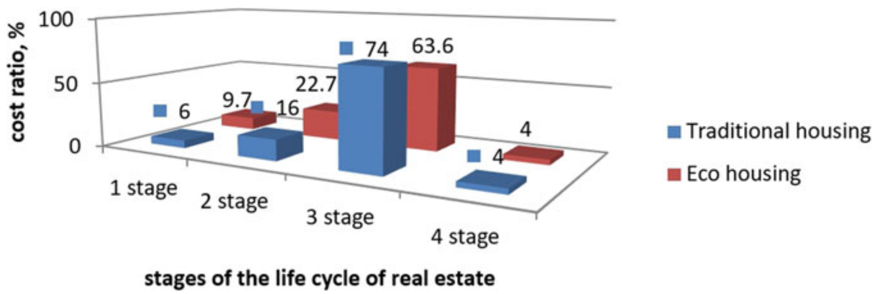

Fig. 2 Analysis of the cost ratio by stages of the life cycle of real estate (%): stage 1-design; stage 2-construction; stage 3-operation; stage 4-utilization

Heating costs (44.6%), hot and cold-water supply (11.9 and 11.5% respectively) have the greatest weight in the utility fees. To a greater extent, the economic efficiency of eco real estate at the operational stage is caused by the energy efficiency of such facilities at the stages of the life cycle of real estate. The analysis of methods for reducing heat loss in buildings (Table 1) shows the greatest efficiency when implementing alternative energy sources or autonomous heat supply systems. Such approaches are implemented in eco-construction in contrast to traditional housing.

The key factor that can influence the customer's choice in favor of the use of eco-technologies: the return on investment indicator should be focused not on the total unit costs of the construction of an eco-settlement, but the costs associated with the operation of facilities.

The task of solving the components of the formula (2) involves the construction of a sequence algorithm for taking into account the factors of sustainable development and converting the dependence of the generalized indicator of the system performance management process into an analytical dependence.

The main methodological provisions of the formation of the conceptual model:

- adaptability of investments;
- efficiency of the organizational and economic system;
- introduction of innovative technologies;
- reduction of construction costs;
- professionalism of management during operation;
- formation of a comfortable and barrier-free living environment, etc.

The task of reconciling the conflicting interests of the main participants in financing the implementation of ICEP, organizing and managing their interaction in accordance with common goals and interests can be solved by creating an organizational and production consortium (the consortium).

The structure of such consortia is created with the involvement of state authorities, the business community, development structures, residents of the region, the banking sector, research and innovative developments of a technological, organizational, economic, and managerial nature in the field of ecology and energy conservation as the basis for improving the efficiency of decisions.

The high-quality work of the consortium requires improving the efficiency of the organizations that are part of it, managing and attracting capital investments in volumes significantly exceeding the capabilities of the regional budget.

World practice shows that an effective mechanism for solving this problem is a public–private partnership, which allows attracting the private sector for the development of public services. At the same time, it is necessary to understand that these "attraction opportunities" appear in the private sector if they are expected to receive:

- long-term profits from investments and the use of skills and abilities for the effective management of the eco-sustainable residential real estate and engineering infrastructure;
- strengthening material incentives to ensure the effectiveness of activities in the regional investment and construction complex;
- ensuring the required investments for the implementation of the project and the balanced management of such investments;
- attraction of external financial resources, etc.

The purpose of the agreement between the participants of the public–private partnership is to provide the final consumer with finished construction products and services at a lower cost and in a more efficient way than each of these structures will be able to provide independently.

The main element of the public–private partnership (PPP) is the conclusion of an agreement between an authorized body of state regional authority or local government and a private operator, which is based on the distribution of risks between the

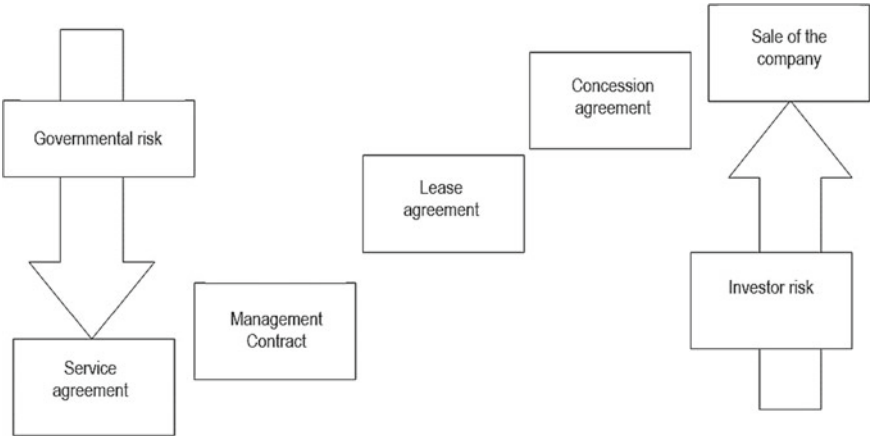

Fig. 3 The form of public–private partnership in the implementation of eco-sustainable investment and construction complexes

public and private sectors. Depending on the distribution of operational, commercial, and investment risks, a form of the public–private partnership is chosen: service agreement, management contract, lease agreement, concession agreement (Fig. 3).

The development of eco-building can be ensured only in the context of the integral reproduction of innovative and technological development of enterprises of territorial investment and construction complexes, including land development of territories, with the rational use of the organizational and production potential of the region. At the same time, the management process becomes more complex and requires the coordination of a sharply increasing number of relationships within the competence of various municipal and regional government bodies. This leads to the application of fundamentally new organizational forms of construction and approaches to the management of investment and construction processes.

4 Conclusion

1. The reproduction of residential real estate is correlated with the concept of integrated territorial development which is established in Russia and implies the creation of a market for affordable and comfortable housing with infrastructure (transport, engineering, social).
2. The model of functioning and development of the organizational and economic system of construction allows the creation of regional programs for the integrated territorial development of residential real estate to balance the effectiveness of their life cycle by increasing the productivity of the TICC and the efficiency of capital investment.

3. The implementation of the principles of eco-building makes it possible to increase the stability of the regional energy, environmental, and social clusters and the sustainable development of the regional ecological and economic system
4. Analysis of the costs of residential real estate at the stages of the life cycle showed that the cost of eco residential real estate is up to 25% lower compared to traditional housing. The main direction of cost reduction is energy and resource-saving measures. Reducing operating costs also contributes to reducing the cost of the housing and utilities sector which reduces the financial load on the population and increases the socio-economic stability of regions.

The novelty of the conducted research is the formation of the concept of integrated territorial development based on the reproduction of residential eco real estate. The mechanisms of functioning and development of the organizational and economic system of construction are formulated taking into account the existing total territorial potential.

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The Inter-municipal Ecological Park Arrangement

M. Perkova, N. Goncharova, E. Ladik, M. Monastyrskaya, and V. Onishchuk

Abstract One of the ways to preserve nature is to develop the sphere of recreation and tourism, as environmental protection can only be achieved through rational use of natural resources. Today, inter-municipal cooperation is relevant in foreign countries from the point of view of managing agents of inter-municipal cooperation. The study presents a study of the territory of settlements and the inter-settlement territory of two municipal districts and the development of a case study: "The inter-municipal ecological park arrangement". The goal is to form a continuous green area with a differentiated recreational load and various types of recreation and tourism. The natural resource potential, transport infrastructure, historical and cultural heritage, recreation and tourism facilities were studied in the study area, as well as a portrait of the consumer was drawn up. The comparative characteristics of recreation and tourism objects are given. A sociological survey of consumers of recreational areas was conducted in order to identify their preferences in transport, socio-functional, historical and cultural aspects. Measures and tactical steps were developed to solve the tasks set: renaturation and reconstruction of the natural framework; development of the tourist and recreational potential of the territory; development of transport and pedestrian infrastructure; promotion of content through the education system; branding of the territory; formation of the recreational economy was proposed.

Keywords Ecopark · Tourist and recreational area · Natural frame · Landscape · Town-planning system

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1 Introduction

One of the ways to preserve nature is to develop the sphere of recreation and tourism, as environmental protection can only be achieved through rational use of natural resources. In Russia and abroad, there is a fairly large practical experience, as well as an extensive theoretical and methodological base for creating new and transforming and preserving existing landscape and urban planning systems of urban, district, suburban and agglomeration levels of social space arrangement, recreation and tourism infrastructure arrangements both in localities. Therefore, it is in the inter-settlement territories [1–5]. It is also necessary to note the works on landscape studies of SPbSUACE I. V. Barsova, T. I. Dubyago, Yu. N. Kurbatov, Yu. N. Lobanov, V. A. Nefedov, M. E. Monastyrskaya [1], research in BSTU named after V. G. Shukhov for the formation of recreation and tourism territories, taking into account regional features [4, 5], which were the basis of our developments. Today, inter-municipal cooperation is relevant in foreign countries from the point of view of managing agents of inter-municipal cooperation [6, 7].

The research presents a study of the territory of settlements and the inter-settlement territory of two municipal districts and the development of a case study: "The inter-municipal ecological park arrangement" within the framework of the priority programs of Belgorod region "Formation of a modern urban environment in the territory of Belgorod Region for 2018–2022" and "Belgorod Region—a man-made park", as well as taking into account the regional projects "Belgorod Line", "Creation of a tourist historical and ecological zone "Krapivenskoe Gorodishche".

The problem is:

- in the presence of a disparate structure of recreation and tourism facilities in a highly urbanized area with high natural potential;
- in the low quality of the landscaping of the territory and the architectural appearance of the recreation facilities;
- in lack of route recreation;
- in the threat of loss of the natural and historical-cultural identity of the territory;
- in low interest in archaeological, historical and cultural monuments;
- in a small variety of recreation and tourism facilities;
- in lack of recreational facilities for small groups of the population;
- in the presence of uncontrolled recreational routes;
- in the presence of disturbed territories;
- in the presence of degraded meadow-floodplain areas;
- in the lack of application of IT technologies as social innovations in the arrangement of the tourist and recreational environment.

The goal is to form a continuous green area—an ecological park—with a differentiated recreational load and various types of recreation and tourism. The objectives are the regeneration of the natural framework, the formation of various types of tourist and recreational routes, the expansion of the list of tourist and recreational services to meet the needs of various groups of the population and investment attractiveness, and the improvement of the ecological culture of the population.

Method of achievement: creation of a continuous natural inter-municipal park, including linear elements (landscaping of a roadside cluster), areal elements (areas of forests of the state forest fund, nature reserves and wildlife reserves) and point elements (recreation and tourism facilities with adjacent territory. The functions of the ecological park are: regenerative, recreational, sports, tourism, educational and economic functions.

When developing the case, it is supposed to identify the landscape and ecological potential, achieve the continuity of urban development, update the existing recreation and tourism facilities, achieve maximum versatility of the continuous territory of the ecological park, in order to ensure the urban-economic and social efficiency of the investment and urban planning decisions and the results of their substantive implementation [8].

2 Methods and Materials

The study uses an integrated approach to the study of the natural resource potential of the Shebekino district based on the materials of territorial planning and the results of field surveys. Analysis of the existing use of the territory. Involvement of residents by means of a sociological survey and its analytical processing. Drawing up the characteristics of the planned development of the territory, functional zoning of a continuous natural park. Drawing up a list of land plots for the placement of planned functional zones and capital construction projects in order to attract investment (by the type of permitted use of the land plot according to the planning and development of territories). The ecosystem approach is also applied, which includes: the formation of ecological cores on the basis of nature reserves, wildlife reserves, specially protected natural areas and buffer zones around them; ecological corridors along riverbeds; zones of recreation of the natural framework on the basis of gully terrain complexes and zones of advanced development.

3 Results

There are more than 30 archaeological sites on the territory of the Shebekino district. The tribes of the pit and catacomb cultures left their mark here in the Bronze Age, in the early Iron Age—Scythians, Northerners, Proto-Slavs (Krapivenskoe gorodische), Alan-Bulgarian tribes of the Khazar Khaganate (Dmitrievskoe gorodische). In this regard, the preservation of the natural and historical and cultural identity of the territory comes to the fore. Belligerative forms of relief also have important cultural and historical value: the remains of the Belgorod Zasechnaya line of the XVII century, craters from ammunition explosions, the remains of military fortifications, trenches, dugouts, etc.—the memory of the battles during the Great Patriotic War. These specific landforms can become part of cultural and educational tours. The historical and cultural structure of the territory of the inter-municipal ecological park in the Belgorod and Shebekino districts makes it possible to offer several types of routes: historical and educational, pilgrimage tourist, rural tourist and ecological routes.

Architectural and religious objects are the basis for the development of religious tourism and pilgrimage tourism. Pilgrimage tourism in the Belgorod and Shebekino districts can be developed on the basis of the following cultural and historical sites: Holy Trinity Church (Murom village, 1836), the Church of the Resurrection of Christ (1913) in Zimovenka village, the Church of the Holy Apostles Peter and Paul (Neklyudovo village, 1870), the Church of St. Michael the Archangel (Churaevo village, 1892), the Wooden Church of Demetrius of Solunsky (Dmitrievka village, 1878). These monuments, being part of the religious landscape, are also of interest from an architectural point of view, as they are architectural monuments of the XIX–XX centuries.

The starting point of the rural tourist route of the inter-municipal natural park is the town of Shebekino and follows in several directions to the Gremyachy farm, the “Krapivinskoe gorodische” (an unknown ancient Russian city of the IX–XII centuries), the center of traditional culture and the museum of the village of Kupino, as well as the archaeological complex “Dmitrievskoe gorodische of Saltovo-Mayak culture” (VIII–X centuries) in the village of Dmitrievka.

Surface water resources are widely used in tourism activities. Water recreation, namely its bathing and beach aspect, is best implemented in the studied territory, because the nature of the bottom and the shore are relatively favorable for the organization of this type of recreation, both long and short-term. On the territory there are 12 places of mass recreation on reservoirs (within the boundaries of the Belgorod district: the beach “Central”, “Peskaryer”, “Azure”, etc., within the boundaries of the Shebekino district: near the village of Maslova Pristan, near the river Nezhegol, etc.). This number includes both independent well-maintained beaches, and those related to recreation centers, children’s health camps and sanatoriums. It is worth noting that the geochemical composition of the mineral deposits common in the region makes Belgorod region promising for the development of territorial recreational systems and health-improving recreation.

In the study area, the objects of both recreation and tourism were studied (Table 1) and a portrait of the consumer is drawn up. The recreational framework of the territory includes 11 recreation centers, 9 children’s health camps and 2 institutions of sanatorium-resort treatment. Within the Belgorod reservoir, several recreation areas are formed within 1–1.5 h of accessibility from the city of Belgorod. It is preferable to develop family water tourism here, because the presence of natural formations, archaeological sites, historical monuments contributes to its development and the development of water routes. Currently, the water area is used for arranging and conducting various types of recreation: boating, jet skiing, motorboats, water skiing, etc. There are also 20 fish farming facilities on the territory, which provide conditions for fishing.

Table 1 Comparative characteristics of recreation and tourism facilities in the study area

Name	Amount, in %
Children's bases and health camps	16
Recreation centers	20
Health resorts	4
Parks	7
Places of mass recreation on reservoirs	21
Nature reserves, natural monuments	18
Fishing spots	32

Entertainment recreation includes 4 parks: the rope park "Skala Park" in the village of Dubovoye, Belgorod district, Picnic Park (which includes: provision of pavillons, rope park, children's playground, shooting range, laser tag, airsoft, bicycle rental, etc.), a recreational area in the village of Bolshetroitskoye and a park of culture and recreation in the city of Shebekino. In addition to the existing types of entertainment recreation, less standard and well-known objects can also be arranged on the designated territory. For example, corn mazes are very popular all over the world—a type of family entertainment that has existed in the world for more than one decade. It is planned to create a corn agricultural park with quests. It is proposed to supplement the recreational recreation of the studied areas with the development of local recreational zones of various functional purposes (a golf club in the Shebekino district, an agricultural park, a pet park in the city of Shebekino, the development of geocaching.

During the study of the transport infrastructure of the districts, the schemes of personal and public transport were analyzed and the problems of access to the projected recreation and tourism facilities were identified. To assess the transport accessibility of recreational facilities on private and public transport, the technology of geoinformation analysis was used using the OpenStreetMap public resource. All routes of movement on private or public transport with their characteristics were plotted on the maps, and accessibility isochrons were built using the technology of building transport accessibility isochrons using GRASS and GIS QGIS [9]. Recreational infrastructure facilities in the territory under consideration mostly have satisfactory accessibility by private transport, few or no parking spaces. Public transport routes need to be optimized by adjusting the intervals of movement to recreational facilities at the local and municipal levels in the spring and summer time period and arranging additional public transport stops [10]. The location of the recreation area should provide transport accessibility for visitors with a minimum load on the natural framework. Near recreation areas, the case is supposed to provide for the construction of open parking lots. Parking lots must be at least 100 m away from the boundaries of recreational areas [10]. Floodplain and agricultural areas have a high potential for development and are a priority for the formation of a buffer zone of specially protected natural areas on their basis [2].

A sociological survey of consumers of recreational areas was conducted. It included 8 questions for respondents to identify preferences in transport, socio-functional, historical and cultural aspects (Table 2).

4 Discussion

The territory of a continuous inter-district ecological park is a harmonious integration of tourist and recreational facilities and the resource potential of the territory in order to achieve the stability of the natural framework and ensure a high level of living environment, as well as quality recreation for residents and guests. The territory of the Belgorod and Shebekino municipal districts is characterized by a high level of urbanization with a rich natural potential [11]. It gives an impetus to the development of recreation and tourism areas. A special feature is the relief, which is represented by a gully terrain network. On their basis, they can form natural cores, create ecological parks. The root system of the trees will protect the land from further erosion, and the residents of the suburbs will receive recreation areas within walking distance [12].

The perspective of the development of the resource potential of the territory is as follows:

1. In the arrangement of route recreation (cycling, motobike, water, hiking, horse-drawn) [10].
2. In the arrangement of air recreation (skydiving, paragliding).
3. In the development of water recreation (water skiing, wakeboarding, parasailing, flyboarding).
4. In the development of recreational activities (dog park, cat park, safari park, golf club, nature museum).
5. In the arrangement of educational recreation (“green” schools, inclusive “green” schools, festival grounds, children’s historical and cultural center).
6. In the arrangement of the recreational economy (“Green” offices, farmers’ eco-markets “field-shop”).

Measures and tactical steps were developed to solve the set tasks (Table 3).

5 Conclusion

As a result of the research, the case “The inter-municipal ecological park arrangement” was developed.

The result of the implementation of the case should be:

- sustainable development of the territory as a whole;

Table 2 The results of the sociological survey

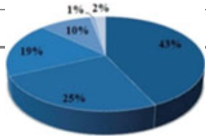
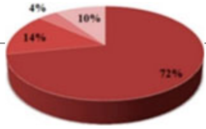
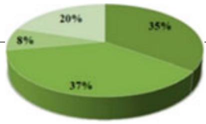
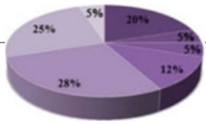
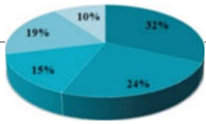
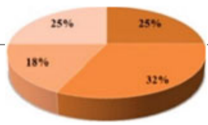
Question	Answer option	Amount (%)	
How do you assess the overall state of the Belgorod and Shebekino districts?	Excellent	43	
	Good	25	
	Satisfactory	19	
	Neglected	10	
	Extremely neglected	1	
	Difficult to answer	2	
How do you feel about the idea of forming a natural park on the territory of the Belgorod region?	Positively	72	
	Neutrally	14	
	Negatively	4	
	Difficult to answer	10	
What type of transport would you like to use to get to the park?	Bicycle	35	
	Car	37	
	Taxi	8	
	Public transport	20	
For what purpose would you like to visit a nature park?	Rest	20	
	Communicating with people	5	
	Physical education and sport	5	
	Games with child/children	12	
	Cultural and entertainment events	28	
	Crossing the park by bicycle (and other) routes	25	
	Bring visiting guests to the park	5	
Which of the suggested routes do you find most interesting?	Bike route	32	
	Motobike route	24	
	Horse-drawn route	15	
	Water route	19	
	Walking route	10	
Which of the proposed types of tourism do you consider the most attractive?	Rural tourism	25	
	Historical and educational tourism	32	
	Pilgrimage tourism	18	
	Eco-tourism	25	

Table 3 Development of measures for the inter-municipal ecological park arrangement

Event blocks	Tactical steps
Development of the tourist and recreational potential of the territory	1. To form multifunctional nodes of the tourist and recreational framework 2. To strengthen the links between them with the help of tourist routes of various types 3. To expand the list of tourist and recreational services to meet the needs of various population groups and investment attractiveness 4. To develop the information environment of the tourist and recreational complex 5. To increase the ecological culture of various groups of the population 6. To create tourist clusters based on the preserved elements of the Belgorod line (banks and ditches) with the reconstruction of historical and cultural objects 7. To develop rural, pilgrimage, historical and educational, ecological, and sports tourism
Renaturation and reconstruction of the natural framework	1. To create buffer zones between protected areas and urbanized areas 2. To recreate previously existing natural landscapes (gully forests, forest-steppe landscapes) 3. To carry out renaturation of the natural landscapes of the riverside territories of the Nezhegol and Seversky Donets rivers, Koren and Korocha 4. Recultivate and/or socialize disturbed areas (chalk and sand quarries)
Development of transport and pedestrian infrastructure	1. To create walking routes of varying difficulty 2. To create bike routes of various lengths 3. To create motorcycle routes (based on paved trails) 4. To create horse-drawn routes (based on two existing equestrian complexes)
Promotion of content through the education system	1. Creation of educational recreation facilities: “green” schools, inclusive “green” schools 2. Creation of children’s cultural and historical centers 3. Arrangement and holding of historical and event festivals “Belgorod line” 4. Development of tourist routes for children and adults
Territory branding	Use of hidden potential. For example, these are the brands “Belgorod line”, “Chalk Cave monasteries”

(continued)

Table 3 (continued)

Event blocks	Tactical steps
Formation of the recreational economy	1. Design and construction of "green" offices using additive technologies 2. Creation of eco-markets "field-shop", based on the use of IT technologies

- regeneration of natural landscapes in the adjacent parts to the basins of the Nezhegol and Seversky Donets rivers, Koren and Korocha, as well as in disturbed areas (chalk and sand quarries);
- arrangement of a single space for recreation and tourism with alternating types of recreational areas through pedestrian, bicycle and transport links;
- creating a comfortable environment and meeting the diverse needs of the population in year-round recreation and tourism;
- development of various types of recreation and tourism (routing, historical and cultural, pilgrimage, educational), as well as the development of economic recreation.

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Theoretical Experience of Restoring the Wooden Temple of Our Lady of Kazan in the Village Pokrovka, Borsky District of the Samara Region

Denis Litvinov, Natalia Kosenkova, and Yelizaveta Kosenkova

Abstract The key aspects of the Russian wooden temple architecture are considered. By the method of comparative analysis according to the selected criteria, the wooden churches of the XVIII–XX centuries of the Samara region are considered. Examples of surviving temples that have had a great influence on the historical and cultural heritage of the region are given, many of which have the status of cultural heritage sites. A project is proposed for the restoration of the wooden church of the Kazan Icon of the Mother of God in the village of Pokrovka. In order to identify the lost elements of the temple, an analysis of archival data and similar wooden temples of the Samara region was carried out. Similar temporal, stylistic, constructive, planning features of temples are considered. Based on the analysis, a model of theoretical and graphic reconstruction of the temple of the Kazan Icon of the Mother of God in the village of Pokrovka was built. The main characteristics are revealed and the role of the Russian Orthodox wooden architecture in world culture is determined.

Keywords Wooden architecture · Wooden churches · Reconstruction · Restoration · Architectural heritage

1 Introduction

Russian architecture has long been famous for its wooden buildings. Until the eighteenth century, the vast majority of buildings were wooden—simple residential buildings, outbuildings, mills, palaces of princes and churches. Over several centuries of intensive development, wooden architecture in Russia reached a high level and unique artistic expressiveness. Wooden churches of the north of Russia are distinguished by special skill of execution and exterior stylishness [1].

For example, the Church of the Nativity of the Blessed Virgin Mary in the village Peredki (Novgorod region) was built in the first third of the sixteenth century (Figs. 1 and 2). The church has a cruciform plan and two side chapels. A tent with a dome

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Fig. 1 Church of the nativity of the blessed Virgin Mary in the village of Peredki (1530s)

Fig. 2 Church of the nativity of the blessed Virgin Mary in the village of Peredki (1530s). Roof

represents the closure of the temple; small tents are located above the side cuts. The church is distinguished by a complex spatial organization; the main volume of the temple is surrounded by a gallery around the perimeter and placed on a basement. During reconstructions in the nineteenth century, the tents of the church were replaced with domes; the height of the log house was reduced. The church functioned until the beginning of the XX century and was closed in 1937 [2]. In 1967, it was taken to the Vitoslavlitsy Museum-Reserve, where it was restored according to the canon of the seventeenth century.

Many unique wooden temples have been lost. Abandoned temples are dilapidated and without receiving proper care, are gradually destroyed under the influence of external conditions. The Church of the Holy Prophet Elisha in the Podporozhsky district of the Leningrad region is located on the shore of Lake Sidozero (Fig. 3). It was built in 1899 and has a ship-shaped plan. The wooden building with stone

Fig. 3 Church of the Holy Prophet Elisha in the Leningrad region (1899)

foundations is very bright and expressive; it belongs to eclecticism. The church was closed in the 1930s and is currently under restoration (Fig. 4) [2].

There are also many examples of wooden temple building on the territory of the Samara region. Thus, in the Pestravsky district of the Samara region, in the village of Vysokoe, there is the Church of the Archangel Michael (Figs. 5 and 6). The church was built in 1854 and has a compact plan with a pronounced transept [3]. The facade of the church is planked, the church is painted blue. The decorative elements are highlighted in white. Cupolas of various sizes represent the completion of the church.

Fig. 4 Church of the Holy Prophet Elisha in the Leningrad region (1899). Development

Fig. 5 Church of Michael the Archangel in the village of Vysokoe (Pestravsky district, 1854)

Fig. 6 Church of Michael the Archangel in the village of Vysokoe (Pestravsky district, 1854). The east façade

In the Borsky district of the Samara region, in the village of Zaplavnoe, there is a church of Our Lady of Kazan (Figs. 7 and 8). It was built in 1907–1910 on the site of a previous unheated church of a smaller size built in 1837. The temple has an extended plan, the bell tower and naos are crowned with domes. The unusual shape of the metal domes and the white colour of the facade make the appearance of the temple holistic and harmonious. In 1937, the church was closed, and in 1947, the

Fig. 7 Church of Our Lady of Kazan in the village of Zaplavnoe (Borsky district, 1907–1910)

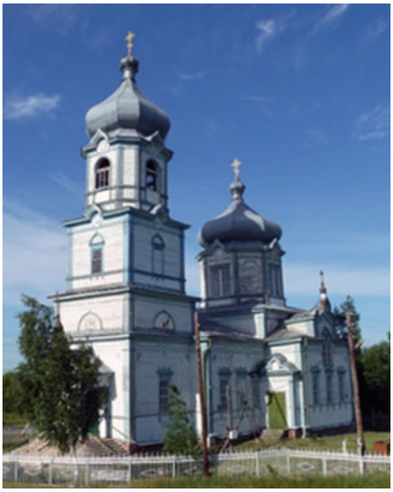

Fig. 8 Church of Our Lady of Kazan in the village of Zaplavnoe (Borsky district, 1907–1910). The bell tower

building began to function again [4]. In 1953, the renovation of the church began; new icons appeared in the church. Currently, the building has not lost its expressive appearance, but it needs renovation.

The Church of Michael the Archangel was built in the village of Pavlovka, Sergievsky district in 1855 (Figs. 9 and 10). It has an elongated plan; the end of the bell tower is hipped. The temple was built near a cemetery [4]. In the 1930s, the church priest was killed and soon it was closed. The church did not open again; the temple is destroyed at the present time. Most of the temple cover has collapsed, while inside the church unique wall paintings have been preserved.

Fig. 9 Church of Michael the Archangel in the village of Pavlovka (Sergievsky district, 1855)

Fig. 10 Church of Michael the Archangel in the village of Pavlovka (Sergievsky district, 1855). The altar

The Orthodox architecture of provincial cities has not been studied as thoroughly as the Orthodox architecture of metropolitan cities. The history of the cult architecture of Orthodoxy covered mainly the period of ancient Russian architecture of the X–XVI centuries (described by P.A. Rappoport, P.D. Baranovsky, A.A. Tic, N.I. Brunov, A.N. Komech, G.K. Wagner, V.V. Kostochkin, H.H. Voronin, K.K. Romanov, et al.). The immediate historical past of the XVIII–early XX centuries was touched upon in a few scientific works (by Yu.S. Ushakov, N.F. Gulyanitsky, T.A. Slavina, T.F. Savarenskaya, I.J. Buseva-Davydova, E.I. Kirichenko, M.B. Mikhailova, et al.). In many of these works, the methodology of studying Orthodox church building is of an art criticism nature.

Thus, knowledge about the Orthodox church building of the Middle Volga region is fragmented and has the character of historical information about the temples of Samara and the monasteries of the region, the church building of other settlements in the region remains poorly studied.

2 Research Methods

Wooden churches of the Samara region form a unique historical appearance of the province. They keep the memory of the values of a bygone era, the everyday life of the ancestors and their destinies, the joys and losses of the past. Harmonious, expressive, skilful creations of the masters of the eighteenth–nineteenth centuries reflect the regional identity of the Samara region and need to be preserved. Many churches in the region are recognized as cultural heritage sites and are gradually being restored, but some of the unique churches are in desolation, and some have already been lost.

Thus, within the framework of the diploma work at the Department of «Reconstruction and Restoration of Architectural Heritage», АСАСамГТУ, a project was carried out for the restoration of the wooden church of Our Lady of Kazan in the village of Pokrovka, graduate student E.V. Kosenkova, scientific adviser, Ph.D. in architecture, prof. D.V. Litvinov.

Little was known about the Church of Our Lady of Kazan in the village of Pokrovka, Borsky District, Samara Region, at the time of work on the diploma.

The temple was built in 1898, in the register "Objects of Cultural Heritage" of the Samara region; it belongs to the newly identified objects of cultural heritage [5]. Research carried out in the archives of the Department of State Protection of Cultural Heritage Sites of the Samara Region made it possible to collect additional information about the temple.

Field studies made it possible to study the architectural, constructive and planning features of the temple.

The Church of Our Lady of Kazan is located in the geographical and social center of the village of Pokrovka, next to former school and administration buildings. It is an architectural dominant, as it is the tallest and most artistic and expressive building of the village, the temple is clearly visible on any panorama of Pokrovka (Figs. 11 and 12). The temple of Our Lady of Kazan includes four sequentially connected volumes. Those are a four-tier bell tower, a refectory, the main volume of the temple (naos) and an apse with two aisles. Each of the spaces is one floor, with the exception of the bell tower. The space of the naos is double-height. The temple was cut down "in the paw". From the outside it is sheathed with planed boards, the logs from the inside are hewn. The seams between the logs are made with tow to provide thermal insulation.

The interiors of the temple did not survive, information about them was not been found either. According to historical information from the archival fund of the Central State Archives of the Samara Region, it was revealed that the first church in the

Fig. 11 View of the Church of Our Lady of Kazan (Borsky district, 1898) from the panorama of the village of Pokrovka

Fig. 12 View of the Church of Our Lady of Kazan (Borsky district, 1898) from the panorama of the village of Pokrovka. The ruined bell tower

village of Pokrovka dates back to 1859. Consecrated in the name of Our Lady of Kazan, the church was wooden and had a wooden fence. In 1884, a parish school appeared, housed in the church gatehouse. In 1885, the church owned a plot of 49.5 dessiatines. There were no attached and house churches or chapels in the parish. The new building of the Church of Our Lady of Kazan was built in 1898. The wooden church accommodated up to 1500 people and was surrounded by a brick fence with a metal lattice. The throne was consecrated on September 28, 1899. It is also known that in 1915 the parish school was located in a separate building that belonged to the church (Figs. 13 and 14). The visual analysis and research of the preserved part of the temple revealed the following; the frame of the bell tower is composed of several crowns. On the fours of the lower rims of the bell tower, the upper rim—an octagon—rises. A plinth made of ceramic bricks with lime mortar supports the bell

Fig. 13 Church of Our Lady of Kazan (photo from the 1980s)

Fig. 14 Church of Our Lady of Kazan

tower. The foundation is strip, shallow, composed of bedded rubble. The maximum span length is 12.6 m. The floors are made of wood and are arranged along the beams. The floor beams are cut into the outer walls. Partitions are made of boards. Two bowstrings, steps and railings represent flights. The ends of the bowstrings are cut into the platform beams. Flights and platforms below are hemmed with slats. On the roof of the house there are onion domes with a "checkerboard" roof made of steel sheet, the bell tower covering is hipped, octagonal. The rest of the coverings are pitched [5]. In the construction of the roof, a wooden rafter system and a wooden frame of the domes were used.

The work uses the method of scientific analysis existing experience in the reconstruction of temples. A comparative analysis of analogs determines the characteristic features of projects. Photofixation, measurements and visual analysis were carried out as part of a full-scale survey of the territory. The study of the territory and the search for archival data about the object allowed us to obtain information for the design. Based on this information, spatial modeling, design of the reference plan, dimensional drawings and other projections are performed. The analysis of the ecological situation, research on architectural physics and design and planning solutions are also carried out. The design was carried out in computer BIM programs.

3 Results of the Study

According to the technical conclusion of LLC "ExpertStroyProekt" for 2016, vertical and oblique cracks in the plinth made of stone were recorded in the temple. The masonry was partially destroyed by corrosion. The bearing capacity of the foundation structures is exhausted [6]. The walls of the naos above the +5.900 mark and the bell tower eights above the +15.000 mark are mostly collapsed. The best-preserved fragment deviates from the vertical. Some of the walls have collapsed completely (Figs. 15 and 16).

In the preserved sections of the walls, putrefactive damage and desiccation were noted. Fragments of the cladding of the facades are warped, and bulging of the walls is also noted in some areas. The slabs and the coverings of the building collapsed partially or completely (Figs. 17 and 18). All these destructions are associated with the loss of the building's original function, adaptation to a grain storage facility in Soviet times and its desolation in the future. It is known that in 1951 the temple was in good condition. In the 1990s, the temple was plundered, the foundations were dug, and therefore the building's coverings began to collapse. The interiors of the temple did not survive, since the coverings had completely collapsed. The property of the temple in 1936 was at the Pokrovsky village council, now part of this property, as

Fig. 15 Church of Our Lady of Kazan (September, 2019)

Fig. 16 Church of Our Lady of Kazan (September, 2019). The altar

Fig. 17 Church of Our Lady of Kazan (September, 2019)

well as individual elements of decoration and historical photographs of the temple, is collected from residents of nearby houses [6].

In the course of collecting information on the temple, the identical analogue of the Church of Our Lady of Kazan in the village of Pokrovka was identified. It was the temple of the Archangel Michael in the village of Krasnye Kluchi (1897, Figs. 19 and 20). This temple is located in the Pokhvistnevsky district of the Samara region. The church is located north of the centre of the village. It has an elongated rectangular plan in the shape of a “ship”. The church is planked and painted blue [2]. Facade decoration and trims are highlighted in white. The roof of the church and the dome are emerald. Five domes on a quadrangle and a tent with a small dome above the bell tower represent the completion of the church.

Fig. 18 Church of Our Lady of Kazan (September, 2019). The ruined bell tower

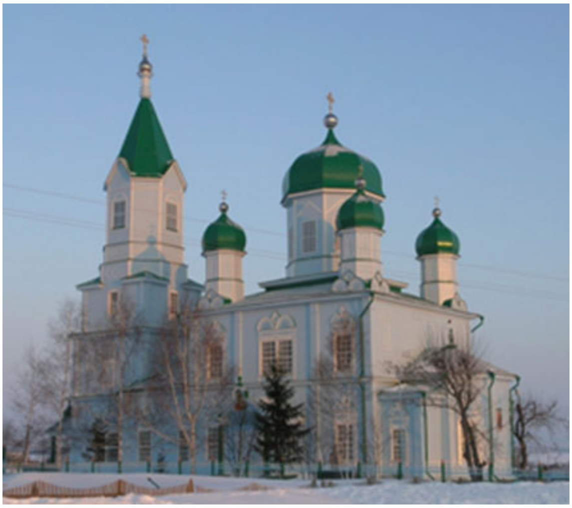

Fig. 19 Church of Michael the Archangel in the village of Krasnye Kluchi (Pokhvistnevsky district, 1897)

The Church of Michael the Archangel in the village of Krasnye Klyuchi has almost the same plan with the temple of Our Lady of Kazan; decorative elements also coincide.

The shapes of the domes and the tent over the bell tower differ from the church in the village of Pokrovka, which is probably due to the later reconstruction of the temple in the village of Krasnye Klyuchi.

The technical documentation, as well as drawings for the Church of Our Lady of Kazan in the village of Pokrovka, did not survive, including the documentation for the Church of Michael the Archangel in the village of Krasnye Klyuchi. In this regard, for a given historical period (XIX century) in the Alekseevsky district of the

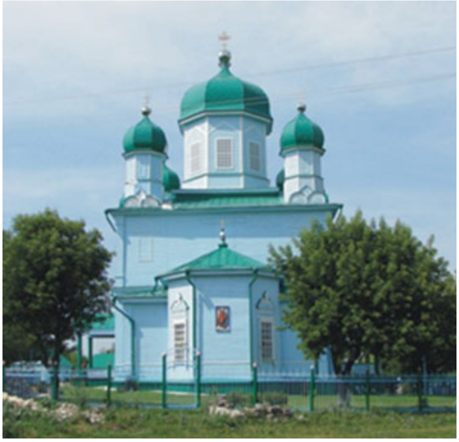

Fig. 20 Church of Michael the Archangel in the village of Krasnye Kluchi (Pokhvistnevsky district, 1897). The altar

Samara region, the Church of the Most Holy Theotokos was identified in the village of Gerasimovka (Figs. 21 and 22). The church has a plan structure and a constructive system similar to that of the church being restored; a set of drawings has also been preserved for it [2]. It helped to recreate the drawings of the church of Our Lady of Kazan in the village Pokrovka.

During the study, it was revealed that the temple of Our Lady of Kazan in the village of Pokrovka was built according to a standard design developed for a stone

Fig. 21 Church of the Most Holy Theotokos in the village of Gerasimovka (Alekseevsky district, XIX century)

Fig. 22 Church of the Most Holy Theotokos in the village of Gerasimovka (Alekseevsky district, XIX century). The bell tower

building. In addition, in the project of this temple, the number of cupolas above the quadrangle increased from one to five [7].

In the project for the restoration of the wooden church of Our Lady of Kazan in the village of Pokrovka, it was proposed to restore the drawings of the church according to measurements and historical photographs.

The facade and space planning solution of the church were restored. The constructive solution involves strengthening the rubble foundation, restoring the walls of the log house, the stairs in the bell tower and the lost coatings of the building. The developed solution of the general plan provides for the division of the territory of the temple into several zones. In the utility and auxiliary zones, there are the buildings of the utility block and the building of the baptismal/Sunday school, respectively. The developed solution of the site plan provides for the division of the territory of the temple into several zones. In the utility and auxiliary zones, there are the buildings of the utility block and the building of the baptismal/Sunday school, respectively (Figs. 23, 24 and 25).

4 Conclusion

Russians Wooden churches are only a marker of national identity. Distinguished by special artistic expressiveness, they reflect the level of development of creative thought and skill of the international community. Thus, temple wooden architecture is a world architectural heritage. The theoretical experience of the restoration of the temple of Our Lady of Kazan is based on the collection of initial information on the object, the selection of a database of analogues and the search for identical churches (Fig. 26). The collection of initial information includes visiting the site, taking measurements, drawing up a scheme for the loss and photographing the church building, conducting a survey of local residents of the village, as well as searching for

Fig. 23 Dimensional drawing

information in the archives of the Board of State Protection of Cultural Heritage Sites and the Central State Archives of the Samara Region. The key criteria for creating a base of analogues of a historical church are the initial material of the building (wooden churches), a specific geographical position (Samara and adjacent regions, since the borders of the region have changed over time) and the historical framework (XIX–early XX centuries) [4].

The collected materials and conducted historical and archival, bibliographic studies, carried out field surveys, measurements of the cultural heritage object, collection of data on the main defects, all this work has allowed us to prepare a professional restoration project of the church of the Kazan Icon of the Mother of God in the village of Pokrovka of the Bor district of the Samara region.

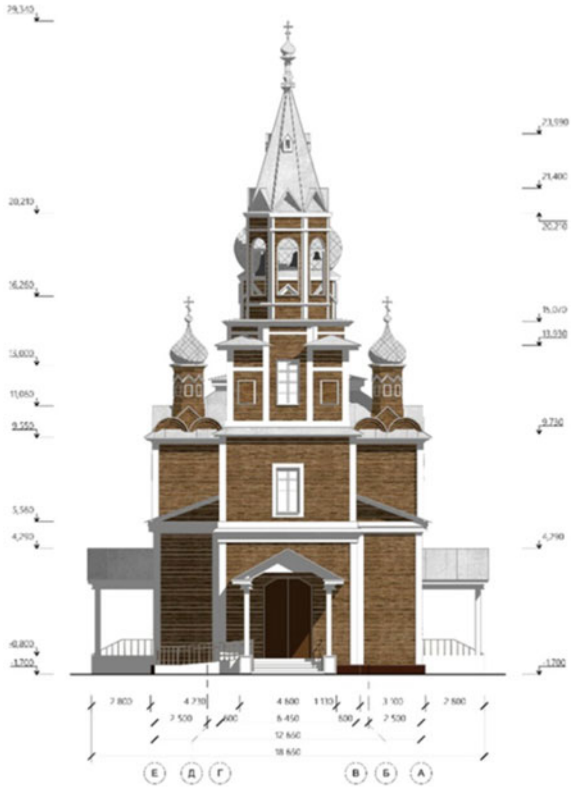

Fig. 24 Project drawing. West façade

Fig. 25 Site plan scheme

Fig. 26 Graphic reconstruction of the Church of Our Lady of Kazan in the village of Pokrovka

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International Experience of Placing Buildings with Atrium Spaces in the Urban Structure

N. Medvedeva, S. Kolesnikov, and M. Doskovskaya

Abstract The authors carry out research of the typology of atrium spaces, their inclusion in the architectural and urban environment. The experience of designing atrium buildings in the architectural concepts of the late XX–early XXI centuries, which are effectively used at the present time, is investigated. The significant aspects of designing atrium buildings for Russian cities are revealed. For the first time, the experience of designing atrium spaces in architecture of the XXI century is systematized. Under the influence of factors of scientific and technological development and changes in the highly urbanized city development, the functions and space-planning solution of atrium buildings are transformed. The development of shaping in modern architecture is accompanied by the introduction of the atrium space into the urban structure as an independent architectural object. The authors of the study use this aspect in the systems analysis of atrium buildings. The features of the position in the city structure, functional purpose, compositional and socio-economic aspects of atrium buildings are considered. The research results are presented by quantitative indicators characterizing modern architecture with atrium spaces. This study shows the interconnection of aspects of the formation of atrium space: position in the city and the radius of the building's service, tectonic-compositional and functional-compositional principles of atrium buildings. Taking into account the combinatorics of the analysis components determines the transition from the statistical assessment of the design of atrium spaces to the description of their features.

Keywords Atrium spaces · Urban structure · Public buildings

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1 Introduction

Nowadays, urbanisation of cities is characterized by a high density of development and the intensity of communication flows. International experience shows that the use of recreational and communication spaces, covered with atriums, ensures the stability of functioning and the comfort of using objects.

The aim of this study is to determine the features of the placement of atrium buildings in the urban structure.

The objectives of this study are:

- identifying the relationship between the factors of the development of modern architecture and the atrium spaces location in the urban environment;
- consideration of the influence of atrium spaces on functional processes in different types of public and residential buildings;
- consideration of atrium buildings in the architectural concepts of the late XX–early XXI centuries, relevant at the present time;
- identification of urban planning and architectural aspects of the design of atrium spaces and their impact on the design of atrium buildings in Russian cities.

The functional and compositional principles of atrium spaces, implemented in international architectural practice are structured in the article. A hypothesis has been put forward: by now, the prerequisites have been formed for the creation of atrium space design patterns in the urban structure. The variability of compositional and imaginative solution of atrium spaces and their application in all types of public and residential buildings proves this study relevance (Fig. 1).

A comparative analysis of the Russian and international experience in the design of atrium spaces revealed a variation of 10–15%. The obtained data allow the authors to generalize a number of characteristics and determine the attractors of the development of modern architecture with atrium spaces.

The subject of this research is the systematization of the features of the location in the urban structure of buildings with atrium spaces.

2 Materials and Methods

The authors of this study analyzed the international experience in the design of architectural objects with atrium spaces. More than 300 atrium buildings were examined, including the works of architectural firms: CAA Architects, UNStudio, Foster + Partners, Zaha Hadid Architects, Grimshaw, NBBJ, Pelli Clarke Pelli Architects, Neumann Monson Architects, ASADOV, MAD and others [1–9].

The transformation features of architecture with atrium spaces in a highly urbanized city were investigated by the authors on the basis of scientific works of Migayrou [10], Saxon [11], Alexander [12], Abalos and Herreros [10], Iovlev [13].

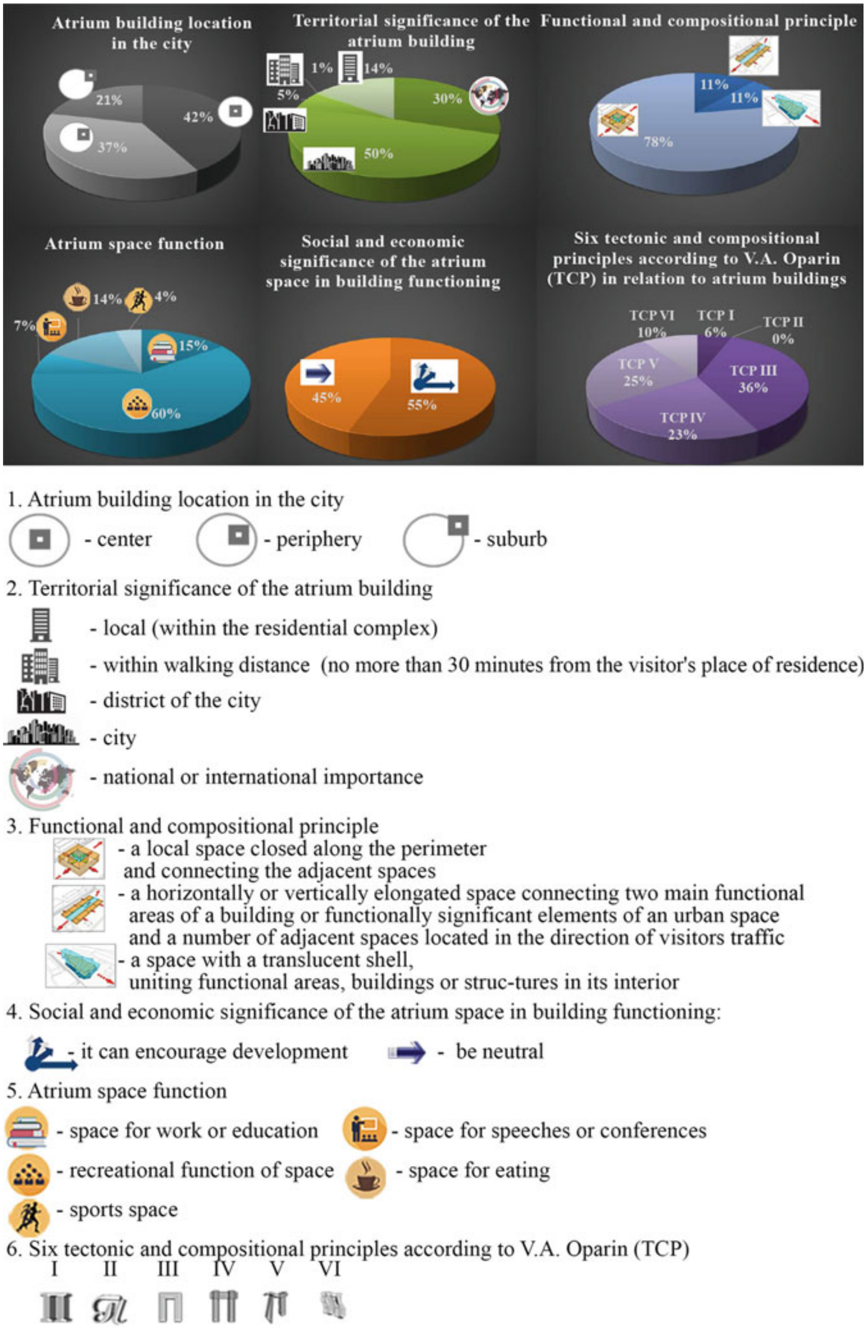

Fig. 1 Generalized complex indicators of the atrium buildings analysis

As for the typological and compositional aspects of atrium buildings, the authors considered them using the research of Saxon [11], Gelfond [14], Hung and Chow [15], Maltseva [16], Oparin [17].

The features of modern experience in the design of atrium buildings were revealed by the method of synthesis and induction of information about the functional, compositional and urban planning characteristics of atrium spaces.

A comprehensive study of the atrium spaces of more than 300 architectural objects (built in 2007–2020) was carried out by the authors according to the following indicators:

1. Atrium building location in the city: center, periphery, suburb.
2. Territorial significance of the atrium building: local (within the residential complex); within walking distance (no more than 30 min from the visitor's place of residence); district of the city; city; national or international importance.
3. Functional and compositional principle:
   - a local space closed along the perimeter and connecting the adjacent spaces;
   - a horizontally or vertically elongated space connecting two main functional areas of a building or functionally significant elements of an urban space and a number of adjacent spaces located in the direction of visitors traffic;
   - a space with a translucent shell, uniting functional areas, buildings or structures in its interior.
4. Social and economic significance of the atrium space in building functioning: it can encourage development; be neutral; be not effective.
5. Atrium space function: space for work or education; recreational function of space; space for speeches or conferences; space for eating; sports space.
6. Six tectonic and compositional principles according to V.A. Oparin (TCP) in relation to atrium buildings: I—tectonics of vertical gravity + order; II—tectonics of vertical gravity of organisms of living and mineral nature; III—tectonics of vertical gravity + three-dimensional spatial grid; IV—tectonics of vertical gravity + multidimensional spatial grid; V—tectonics of multidirectional gravity + multidimensional spatial grid; VI—tectonics of vertical or multidirectional gravity + deformation of a three-dimensional or multidimensional space grid [17].

3 Results

3.1 Features of Atrium Buildings Placement in the Urban Structure

Based on the materials studied, data were obtained on the features of the placement of buildings with atrium spaces in the urban structure:

1. The location of atrium buildings in the city center dominates the modern urban structure (41%).
2. The territorial significance of most atrium buildings extends within the city (50%).
3. The local functional and compositional principle of atrium space, closed along the perimeter, dominates in architecture (78%). For the organization of the internal recreational space of some types of public buildings, the priority is the principles of developing the atrium composition elongated horizontally or vertically in the direction of visitors' traffic (11%) and of creation of the atrium area as an independent space with a developed internal planning structure (11%).
4. Atrium space stimulates social and economic activity of public buildings visitors (54%).
5. The atrium space has a recreational function (60%). But there is a tendency to expand its functions: it is often used for presentations and conferences (17%) and for catering points placement (21%).
6. In atrium spaces architecture the tectonic and compositional principles according to V.A. Oparin (TCP) dominate in the following ratio: TCP III (36%), TCP IV (25%), TCP V (24%).
7. The spatial solution of the atrium building is determined by the radius of territorial significance, the presence of consumer needs in the functions of the architectural object.
8. There is a development of functional and compositional solutions in atrium buildings, defined as attractors of the architecture development directions of the late XX–early XXI centuries:

   - introduction of atrium spaces—shells into transport buildings and structures;
   - introduction of atrium spaces with a developed communication structure horizontally or vertically;
   - introduction of atrium spaces with a closed space forms both local objects and nodes of the urban structure with a radius of territorial significance at the city level;
   - introduction of atrium spaces contributes to the integration of the architectural environment into the surrounding space in social, compositional and functional aspects.

9. The integration of public functions in a residential complex through an atrium space inclusion in the architectural solution increases the object prestige.
10. The typology of the building and the tectonic and compositional principles are interrelated and determine the spatial solution of the atrium space.
11. The interconnection between the typology and the TCP of the atrium building forms sustainable architectural solutions, including new current trends in architecture.

Nowadays, the urban space in Russia and other countries of the world is focused on the development of business and social relations. In Russian cities, the use of atriums is common in large architectural objects of state significance (58%). One of the reasons for limiting the construction of atrium spaces of regional and urban significance is the lack of systematization of atrium buildings by their main characteristics. The authors turn to the historical experience of designing atrium spaces of highly urbanized cities.

The processes that accompany the development of highly urbanized city structure form the directions of architecture sustainable development. At the turn of the XX–XXI centuries, the questions about the prospects for the development of architectural concepts and their practical application are the result of the bifurcation of scientific and technological development and architecture of a highly urbanized city. The use of atrium spaces in urban structure clusters is considered in this study. Atrium spaces are buffer spaces that combine functional areas and compositional elements of architectural objects. Atrium spaces are applied and transformed depending on changes in architectural trends [18, 19].

If buildings with atrium spaces serve as centers of social and economic activity, then a network of communication and information links is formed interacting in a syncopated and intermittent manner. The connections between individual elements of the urban structure and highly urbanized nodes form the scenario and the scope of the population's activities. Cartographic analysis and effective planning make it possible to identify local and global directions for the development of architecture in the considered territorial system of the city. In this article this aspect is considered in the analysis of the characteristics of the types of public and residential buildings with atrium spaces in the city.

As a result of a comprehensive analysis of atrium spaces in the architecture of the 10s of the XX century, priority functional and compositional solutions of atrium buildings in urban development were identified. Combinatorics and variability as well as «openness» of interaction form a potentially interactive space. Frederic Migayrou in his «The metropolis dictionary of advanced architecture» defines this phenomenon as «Positive synergy with the environment» [10]. The author focuses on the hidden change in the meaning of the role of the architect, which is changed already in the term: not «object designer», but rather «processes strategist». The architect becomes a mediator in the creation of the spatial organization of production and cultural structures. The functions of an architect now include all the stages of the existence of an architectural object, particularly the synthesis of an architectural solution with «environmental conditions», progressively hybridizing and multifaceted, demonstrating the diversity and heterogeneity of changing reality.

3.2 Comprehensive Analysis of the Atrium Buildings

The study was carried out on the basis of completed architectural projects with atrium spaces of well-known architectural firms. For example: UNStudio Planetarium

Phillip and Patricia Frost Museum of Science, Grim-shaw Changsha Meixhu International Culture and Art Center, Opus, Leeza SOHO, Pelli Clarke Pelli Architects Sidra Medical Research Center, CAA Archi-tects “Samsun Golf Club”, ASADOV “Scolkovo medical center”, MAD “Harbin Opera House” and others. In large architectural objects, the atrium space performs the functions of concentration and distribution of flows of people, forms new directions and nodes of business activity: UNStudio “Multifunctional Raffles City”, Foster + Partners Haramain Hight Speed Rail, Apple Aventura Mall, Zaha Hadid Architects Beijing Daxing International Airport, CitiLife Shopping District, Grimshaw Fulton Center Transport Hub, etc. Currently, there is a tendency towards the introduction of large-span, high-tech cluster formations into the urban environment. In this regard, the authors of the study pay attention to the relationship between the territorial location, compositional-spatial and functional solutions of atrium buildings.

A comprehensive analysis and combinatorics of such indicators as location in the city and territorial significance of the atrium building, functional and compositional principles and social and economic values of the atrium space made it possible to consider a number of patterns of introducing atrium spaces into the urban environment and architectural objects (Figs. 2 and 3).

Urban planning analysis of atrium buildings

The analysis of the urban planning aspects of atrium buildings revealed the following features (Fig. 4):

1. The location of atrium buildings on the periphery of the urban area with a radius of service to the population within the city is accompanied by sustainable socio - economic development:
   - architectural objects for educational purposes (62%);
   - sports, physical culture and leisure institutions (40%);
   - buildings of health care and social services (33%);
   - buildings of financial institutions (29%);
   - libraries and reading rooms, media centers (35%);
2. The location of atrium buildings in the suburbs of urban or state significance is accompanied by sustainable social and economic development of the following types of buildings:
   - transport institutions intended for direct service (50%);
   - buildings of health care and social services (25%);
   - buildings for research institutions, design organizations and offices (29%).
3. The location of atrium buildings in the city center and territorial significance within the city is accompanied by sustainable social and economic development of the following types of buildings:
   - retail and small-scale wholesale trade enterprises, catering enterprises (62%);
   - libraries and reading rooms, media centers (59%);
   - cultural and educational institutions and religious organizations (50%);

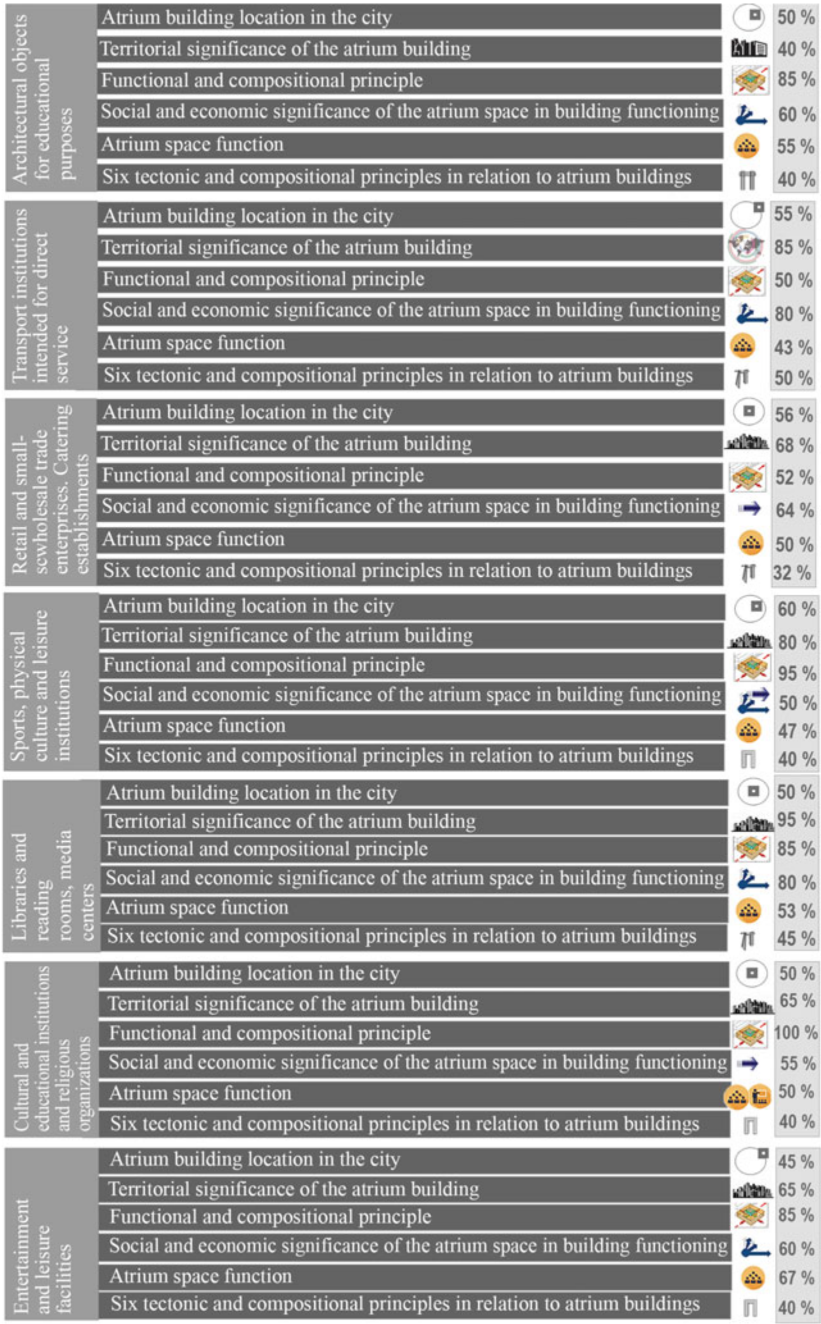

Fig. 2 Comprehensive analysis of the atrium space (Part 1)

Fig. 3 Comprehensive analysis of the atrium space (Part 2)

- entertainment facilities (31%);
- buildings of financial institutions (33%)

4. Buildings and premises for temporary residence with atrium spaces are located on the periphery (71%) and in the city center (29%).
5. The inclusion of atrium spaces in residential buildings is characterized by the localization of communication, social and economic, functional processes in relation to a residential complex or a group of adjacent buildings.

Analysis of compositional and functional features of atrium buildings

Some architectural concepts of the late XX–early XXI centuries synthesized the principle of identity with the surrounding space. A theorist of architecture, Frederic Migayrou, described this phenomenon as follows: «Modern architecture is plural, pluralistic and multifaceted; it mixes discourses, practices, and technical issues. It is effective and it embraces the industrialized world as an inexhaustible source of materials and procedures from which to draw in order to revive our relationship with the boundless urban sphere» [10, p. 60]. Frederic Migayrou's statement of 2003 about

		8	15	15	62	Architectural objects for educational purposes
17		25	17	8	33	Buildings of health care and social services
33		50	6	6	6	Transport institutions intended for direct service
8	8		8	62	15	Retail and small-scwholesale trade enterprises . Catering establishments
20	10			30	40	Sports, physical culture and leisure institutions
	6			59	35	Libraries and reading rooms, media centers
17	8	8	8	50	8	Cultural and educational institutions and religious organizations
8	15	15	15	31	15	Entertainment and leisure facilities
10	5	14	24	19	29	Buildings for research institutions, design organizations and offices
13	13	7	13	33	20	Buildings of financial institutions
71		29				Buildings and premises for temporary residence for temporary residence

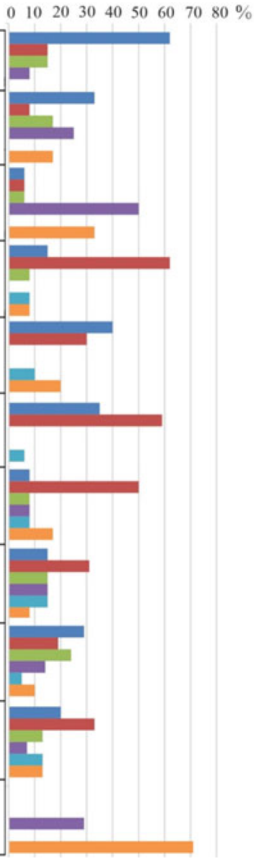

Fig. 4 Indicators of the analysis of urban planning aspects of atrium buildings

the importance of the principle of identity of architectural space and environment is confirmed in the implemented projects. The atrium spaces in the analyzed buildings and complexes demonstrate this feature of the architectural solution. Cultural, functional, aesthetic, economic, physical, energy information is synthesized with a volumetric-spatial solution and is preserved throughout the entire life cycle of an architectural object.

Tectonic and compositional principles (TCP) of architecture were identified by V.A. Oparin, PhD in architecture in 2000, in his thesis «The evolution of tectonic and compositional principles in the process of style formation in the architecture of the XX century» [17].

The research results of V.A. Oparin allow systematizing the compositional and functional features of atrium spaces in urban development. The authors of this article examine the dominant tectonic and compositional principles in public and residential atrium buildings. Systematization of 300 architectural objects with atrium spaces made it possible to identify the features of functionally stable architectural solutions of atrium buildings (Fig. 5):

1. A closed atrium space and the TCP III dominate in the following types of buildings:
   - sports and physical culture and leisure facilities;
   - cultural and educational institutions and religious organizations;
   - entertainment and leisure facilities;

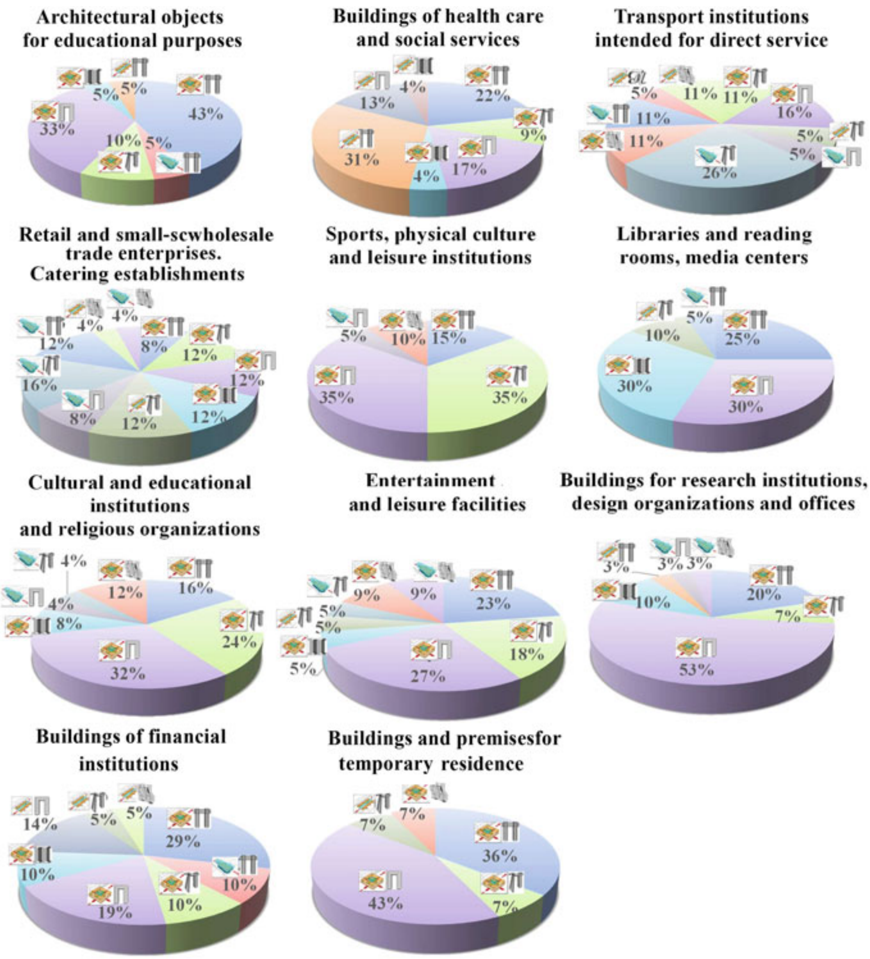

Fig. 5 Indicators of the analysis of the compositional aspects of atrium buildings

- buildings for research institutions, design organizations and offices;
- buildings of financial institutions;
- buildings and premises for temporary residence.

2. The TCP V and a perimeter-closed atrium space are common in the following types of buildings:

- libraries and reading rooms, media centers;
- retail and small-scale wholesale trade enterprises;
- catering establishments.

The expressiveness of the multidimensional space grid of atrium buildings of the TCP V is used to activate the functions of the building, to stimulate attendance. The atrium space performs the function of concentration and distribution of the flows of people, accentuates the functional and compositional solution.

1. The formation according to the TCP IV and the distribution of flows of people through a closed or elongated horizontally/vertically atrium space are characteristic for:

- architectural objects for educational purposes;
- buildings of health care and social services;
- buildings for research institutions, design organizations and offices.

Long-term stay of visitors in buildings of this type is provided taking into account recreation areas, communication, sports. The social and psychological needs of the inhabitants of atrium buildings for educational purposes and health care prove the relevance of the considered methods of shaping.

1. The TCP V and the functional and compositional principle of the atrium space in the form of a translucent shell stimulate the people and transport communication flows in transport establishments.

4 Discussion

The study analyzes for the first time the international experience of placing buildings with atrium spaces in the urban structure. The coherence of the research results with the works of Alexander [12], Migayrou [10], Iovlev [13] indicates the importance of the synthesis of urban planning functional, social, compositional, visual qualities of an architectural object in an urban environment. Atrium spaces are the elements of the prestige of an architectural object, which proves the need for an integrated approach to their design and placement in the city structure. In the XX century P. Saxon described the presented characteristics in his book «Atrium buildings. Development and Design» [11]. In this study, additional criteria for evaluating atrium buildings were introduced: tectonic and compositional principles according to Oparin [17] and functional and compositional principles proposed by the authors of the article. The introduction of these criteria for atrium spaces is justified by the need of urbanized cities in the compositional and aesthetic harmony of the architectural object and the urban environment, its attractiveness for visitors [12, 13]. The authors of the study used the typological characteristics of public buildings developed by Gelfond [14] for buildings with atrium spaces. The results characterize the specifics of the functional and compositional formation of different types of buildings with atrium spaces. The architectural aspects of atriums were studied by Province and Hung [15]. This article is aimed at considering the architectural aspects of atrium buildings relevant to the architecture of Russian cities.

5 Conclusion

The functional and compositional features of architecture with atrium spaces were revealed in the study.

A complex of characteristics of atrium buildings in a modern city was studied. The study results show that the architectural solution of buildings with atrium spaces is developing in accordance with the concepts of the late XX–early XXI centuries and it confirms the forecasts of the prospects for the urban architecture development.

Functional, compositional and town-planning atrium spaces characteristics corresponding to trends in architecture are systematized. The pattern of interaction of different factors forming the space-planning solution of a modern atrium building is revealed.

The significant urban planning and architectural aspects of the design of buildings with atrium spaces are revealed in the article. Taking into account these features of atrium buildings will allow adapting the design solution for highly urbanized Russian cities. At the stage of forming a concept or developing a technical task for a design solution with an atrium space, the results of the research allow one to:

2. determine the territorial priority of the integration of the atrium space into the structure of the urban fabric, depending on the functional purpose of the atrium building and the radius of service to the population;
3. identify a volumetric compositional solution that stimulates the attendance of the atrium building;
4. form a functional zoning of the atrium space, depending on the purpose of the architectural object;
5. choose functional-compositional and tectonic-compositional principles depending on the purpose of the atrium building.

The authors consider the information presented to be promising for further development of the principles of architectural design of atrium spaces in Russia.

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Specificity of the Airport Adjacent Areas Urbanization in Russia

Maria Melnikova

Abstract Recently, a new trend in the process of urbanization has appeared in the most developed countries: the formation of airport adjacent cities, called Aerotropolises. Initially, they were formed naturally, and in the course of development, the area of large airports influence gradually expanded, became compacted and functionally complicated. In recent years, in foreign practice, aerotropolises have started to develop purposefully according to pre-designed projects. This process occurred in Russia due to socio-economic changes. Following the Western countries, a number of Aerotropolis projects have now been developed. Their implementation is expected in the largest agglomerations of Russia. The article considers "airport adjacent areas urbanization" as a special trend of the general urbanization process with the Russian specifics. A comparative analysis of the main features and conditions of the urbanization process in Europe, Russia and the USA is presented. The real conditions of "airport adjacent areas urbanization" development in Russia at the present stage are revealed. The ways of effective planning of this process are offered.

Keywords Urbanization · Airport · Aerotropolis · Airport adjacent areas · Environmental density · Diversity of functions and structures

1 Introduction

The processes of urbanization in the modern world are an ongoing phenomenon, but with the emergence of new cities, they take on specific forms. The level of air transport development today is so high that international airports all over the world are becoming not just transport hubs, but significant city-forming objects stimulating regional development. Recently, the need to develop Aerotropolises the centers of which are large airports was understood all over the world.

The term «Aerotropolis» was introduced in 2000 by American scientist John D. Casarda. The modern airport and its work, for the scientist, are comparable to the

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"physical Internet". Airports play dual roles because they are now air highways and global–local interfaces, which turn airports into "business magnets" and catalysts regional economies as they attract, support and develop aviation and non-aviation infrastructure in their area influences [1]. Much attention was paid to the layout of the territory [2].

Spatial development of areas around airports was described by Güller and Güller [3]. The sequence of formation of aeroportocentric urbanized territories is determined by Stengel [4]. The variety of forms of airport-centric systems and their interaction with the city was investigated by Shaafsma [5].

Interest in the topic of "near-airport urbanization" has increased among Russian urban planners and economists. The increasing role of airports as nodes of the support frame was noted by Lezhava and Kudryavtsev [6]. The economic model of the consistent development of aerotropolis was proposed by Fedorova and Chizhevskaya [7]. Veretennikova has studied in detail the specifics of formation of near-airport territories on the example of number of Russian cities [8].

Currently, the regions with developed agglomerations, forming the core of the territorial organization of the country, provided for the creation of an Aerocity or Aerotropolis in their strategic documents. In attempts to adapt the scheme of the development of "air cities" developed by the American scientist J.D. Kasarda, projects for the territories planning around the international airports of Novosibirsk, Yekaterinburg, Samara, Kazan, Rostov-on-Don were proposed.

However, it must be understood that the process of urbanization is closely linked to the country's development history. The simple transfer of the principles of design and organization of such complex socio-territorial systems as aerotropolis from abroad is fraught with subsequent failures and the inefficient use of financial resources. It is essential to understand the specifics of the process of urbanization in Russia, to identify negative factors so that they can be eliminated, and to stimulate positive factors that ensure the movement forward.

1.1 The Research Relevance

The relevance of the study is due to the growing interest of Russian urban planners and economists in the process of the formation of large urban formations (aerocities, aerotropolises) that are formed on the basis of international airports. In Russian urban planning science, the process of forming urban areas around airports is called airport-centric urbanization. "Airport-centric urbanization of territories" is a process of interaction between an airport and a city, expressed in the urbanization of the territories surrounding the airport with a concentration of aviation and non-aviation activities. The form of airport-centric urbanization implies the functional-spatial organization of urbanized territories around international airports [8]. However, until now, the features of the development of airport-centric forms of urbanization in the Russian Federation, have not been discovered and formulated yet.

1.2 The Research Goal

The purpose of this study is to identify the features of airport-centric urbanization in Russia. Since we are talking about a certain stage of the urbanization process, it is necessary, first of all, to study the process history and determine what factors influenced the specificity of Russian urbanization. It is necessary to establish the patterns of further development of airport adjacent areas. When analyzing the place of Russia in the global urbanization process, it is supposed to compare it with European countries, since Russia occupies a significant part of this continent, as well as the United States, because many Russian cities in a certain historical period grew as fast as some American cities and one can often encounter similar comparisons.

2 Materials and Methods

The research methodology is due to the goal outlined in the article—to identify the specifics of near-airport urbanization in Russia. In this regard, the method of comparison was chosen as the main method, in the course of which it is possible to establish the similarity and difference between the objects of study that are in different social realities. As a result of the comparison, it is supposed to identify common (natural) features, and establish the main differences that reflect the specifics of Russian objects. Special attention in the study was paid to a comparative-historical analysis, which allows you to distinguish causal relationships, to build a logical chain.

At the same time, the object of study is quite complex, develops under the influence of external factors (society, its economy, degree of urbanization) and internal factors (economics and entrepreneurial activity of the object of study). In order to go the way of studying the object as a part of the general system and as a relatively independent system formation it is necessary to use the method of deduction and induction. The process of urbanization, as well as the "near-airport," involves the development of a territory of special quality. To identify the qualitative characteristics of the aerotropolis, it was necessary to analyze its composition and structure, comparing objects at different stages of development, and on this basis formulate conclusions, that is, use the method of analysis and synthesis.

Thus, the methodology of the study was the consistent use of three methods of scientific research.

3 The History of the World Urbanization Process

3.1 The Urbanization Process in the Antique Period

Urbanization is closely linked to social development, and the degree of urbanization is an indicator of its level of development.

In this regard, it is proposed to consider the analysis of the world process of urbanization since the formation of urban settlements, the formation of "urban relations" proper.

Urbanization in Europe. In Antiquity, the first Greek and Roman cities appeared on the coastal territories of the Black and Mediterranean Seas. It was at this time that the formation of city-states (policies), a special form of socio-economic and political organization of society, began. Greek cities became the first prototypes of cities performing administrative and commercial functions with the differentiation between public and residential urban areas. The factors for the emergence of new cities were the presence of fertile lands suitable for agriculture. To protect these lands, defensive fortifications were built. Cities formed on the banks of rivers and seas became important ports and major trade hubs.

Urbanization in Russia. In the Antique period, the process of urbanization of a part of the territory of modern Russia was of a similar nature. There was an active development of the Black Sea coast: the cities of Taman (Hermonassa), Sevastopol (Chersonesos), Evpatoria (Kerkinitida), Feodosia, formed in the image and likeness of ancient Greek cities.

3.2 The Process of Urbanization of Cities in the Early Middle Ages

Urbanization in Europe. In the second half of the nineth century, the development of late antique cities and the formation of early urban settlements in barbarian territories continued in Western Europe. Many cities were still formed as fortresses to protect lands from barbarians. Handicraft became the main element of inner city economic relations. Peasants abandoned agriculture and went to cities. This entails a gradual increase in urban population, while the cities themselves are becoming centers of new trade routes.

Urbanization in Russia. In the second half of the tenth century, northern territories began to develop in Russia. The first Russian cities appeared with their own system of trade and administration: Novgorod, Pskov, Smolensk, Murom. In the same period, the borders of Ancient Rus, which did not yet have access to the Volga and the Black Sea, were outlined.

3.3 The Urbanization Process of the Cities of the Classical Middle Ages

Urbanization in Europe. In the classical period, Western European cities became free from feudal dependence and elements of self-government arose. Cities became the "locomotives" of economic growth. Merchants and craftsmen of different cities created their own unions. The most significant association was the famous "Union of Hanseatic Cities", a trade and political union of merchants of many Germanic and West Slavic cities having several branches. It controlled the North European trade until the beginning of the sixteenth century. Trade became the basis for the development of European economic relations, which stimulated cities to grow and develop, increase the urban population, diversify urban functions into residential, administrative, trade and public functions.

Urbanization in Russia. During the X–XII centuries northern cities were actively developing in Russia. Veliky Novgorod became the first Russian city to join the famous "Hanseatic Union". However, by the thirteenth century, the process of urbanization in the country was suspended by the Tatar-Mongol invasion and the establishment of a three-hundred-year yoke in the eastern part of Russia. The southern part of the country came under the control of the Grand Duchy of Lithuania. The northern lands, where cities formed as separate principalities, were plagued by internecine wars.

3.4 The Process of Urbanization of Cities in the New Age

Urbanization in Europe. During the New History period of the early sixteenth to the second half of the eighteenth century, Western Europe there was an era of demographic growth, including the growth of the urban population. On the one hand, it was caused by the quality and availability of medical care; on the other hand—by the development of new types of industrial activity and the intensification of trade. During this period, a common European market emerged, new spheres and methods of exchange, means and ways of communication appeared (steam engine, steam locomotive). Production and trade were concentrated in specific centers. The population of cities in Italy, Netherlands, France, England, Portugal, Belgium, reached 80 thousand people and by the end of the period reached 400 thousand people (Paris). In 1700 the share of urban population in Italy and Spain exceeded 20%, in Belgium it was 30%, and in the Netherlands it was close to 40% [9]. Thus, in Europe in the 16–18 centuries, there was a process of densification of the urban environment and the concentration of the economy of the countries in large cities. Cities became centers of education, commerce and urban culture.

Urbanization in North America. In 1607 the first English colony, Virginia, arrived in North America and founded the first city, Jamestown. By 1700, the population of the thirteen British colonies along the Atlantic coast east of Appalachia was 2.5 million. The process of urbanization in the United States was very rapid. One of the reasons was the development of the territory by adapted and enterprising townspeople looking for ways to develop independently. By the end of the seventeenth century, cities with the population ranging from 4000 to 16,000 had been formed in the United States (Philadelphia alone was the largest city with about 40,000 inhabitants). The proportion of the urban population in the eighteenth century was 5%, and by the beginning of the twentieth century it had increased to 39.6% [10].

Urbanization in the Russian Empire. While the territory of Western Europe became "compact" and differentiating itself both socially and functionally, the Russian state was expanding its borders, including new territories of eastern lands. To capture and maintain control of the new lands, the key factor was to focus on the quantitative factor of cities rather than the qualitative one. Russia's first strongholds gradually turned into new cities, the number of which grew vigorously. New cities were populated by peasants who migrated from the European part of the country and who had cultural values and lifestyles that were not typical of city dwellers. By the beginning of the nineteenth century, the urban population of the Russian Empire accounted for only 5% of the population [11].

The development of rail transport played a decisive role in urban development in the second half of the nineteenth century. Cities that were not connected to the railroads faced stagnation. This happened with a number of Russian cities with a deep history (Suzdal, Rostov Veliky).

3.5 The Urbanization Process of Cities in the IXX–XX Centuries

Urbanization in Europe. The urban population became predominant in a number of Western European countries, such as Belgium, Great Britain, by the beginning of the twentieth century. The Industrial Revolution radically changed ideas about the norms and standards of the lifestyle and quality of life of citizens, their culture, income, and the state of the urban environment. By the end of the twentieth century, on the territory of Western Europe, there was a transition from point towns to a system of urbanized settlements connected by a network of highways, agglomerations and conurbations.

Urbanization in North America. In the United States, the process of urbanization was especially noticeable, caused by powerful industrial development. The positive consequences of the industrial revolution had a particularly strong effect on the development of urban settlements. By the end of the twentieth century, this led to the formation of "metropolitan areas", an urbanized area around one or several large core cities with a high population density and close economic ties [12].

Thus, the highly developed urbanistic systems of Europe and the United States were the result of systematic evolutionary development, where the urban population with the corresponding cultural values and lifestyle predominated, and diversification of urban functions took place.

Urbanization in Russia. The events that took place in the early twentieth century in Russia slowed down the current process of urbanization: the civil war, then the restructuring of the economy, the creation of a form of economic development still unknown to the world, the economy of socialism. In the 1920s and 1930s, a peasant country set a course for industrialization and the development of new territories. The newly formed cities were filled with populations, mainly peasants. The formation of urban civilization lagged catastrophically with the growth of cities [13]. Urbanization in Russia became a by-product of industrialization. The cities with different levels of development received equally distributed resources, and the main vector of the country's development was aimed at militarizing and developing industry, rather than urban areas.

A significant damage was caused by World War II: most of the historic cities were severely damaged. The evacuation of enterprises from the European part of the country has increased the movement towards the east.

The new wave of urbanization in the 50–70s of the post-war period differed little from the first in terms of qualitative characteristics. Mass construction and its high rates led to austerity of funds, which in turn led to the unification of design solutions, types of houses, methods of spatial organization of cities. This is how a miserable urban typical environment appeared in the country, where one city differed little from another. A limited number of people (enterprising citizens) have formed who were able to organize their business and fill the urban environment with various types of activities, able to diversify the economy, social structure, and create conditions for the formation of an urban lifestyle.

Thus, as a result of the historical and political events that took place in Russia, the natural course of the urbanization process was disrupted and acquired specific features. For a long time, the main factor in the emergence and development of Russian cities was their artificial formation on the basis of the construction of industrial enterprises. Almost a third of Russian cities appeared artificially, near factories, during the construction of railways, ports, etc. An artificial city is usually monofunctional, aimed at solving one problem, the production. There is no organic diversity created by long evolutionary development and economies of scale work to a greater extent for production [14]. The assimilation and development of industry in sparsely populated areas led to the emergence of many single-industry towns, the centers of which were not a historically established urban structure, but industrial enterprises, in parallel with which public and residential areas were formed.

The same principle is still used in the design of new forms of modern urbanization, airport urbanized formations within the radius of influence of large international airports.

4 Functional-Spatial Formation of Airport Adjacent Urbanized Formations

4.1 Peculiarities of the Formation of Airport Adjacent Areas

Airport cities (aerocities, aerotropolises) in foreign practice develop in highly urbanized, economically developed countries with a wide range of international relations and the presence of international-class airports with a multimillion passenger traffic (over 50 million people) and cargo turnover (over 2 million tons of cargo), which are major transport hubs, combining water, rail and road transport.

The ideology of socialism in Russia until the 1960s considered urbanization to be a process unique to capitalism. Artificial restriction of the growth of major cities was taken as control of the urbanization process.

By the end of the second millennium, only about 20 developed agglomerations had emerged in Russia's vast territories. Five of them needed to create aerotropolises that could stimulate the process of development of these agglomerations. Many Russian scientists and planners have searched for the most successful forms of airport adjacent areas development, which has led to the emergence of aero-city projects for major urban agglomerations and conurbations. As already mentioned, projects of aero-city were received by Novosibirsk, Sverdlovsk, Samara-Togliatti, Kazan, Rostov agglomerations, the basis for them were developed by American scientist J.D. Kasarda, who spoke about the cluster placement of functional areas with the center-airport.

According to J. Kasarda, different sectors of the economy and infrastructure are attracted in different ways on the territory near airports. Some infrastructure sectors, such as transport and logistics functions and warehouses, trade and hospitality services are most associated with passenger air travel and cargo delivery. Other sectors of the economy (e.g. production) may not be so functionally connected to air transport, but have a significant relationship with suppliers or consumers who also require air transport services [15].

However, it is worthwhile mentioning the high degree of specificity of the development of urbanized territories in Europe, the U.S. and Russia, which indicates that the mere application of foreign experience in its territory will inevitably lead to inefficient use of the resource potential of airports.

4.2 Functional and Planning Organization of Russian and Foreign "Air Cities"

The design stage is always preceded by a pre-project analysis of foreign experience, where quantitative rather than qualitative indicators are taken for comparison. Such analysis was carried out by the design institute of Rostov-on-Don, where the architects attempted to apply successful foreign experience in the development of "air cities" for the formation of the airport adjacent areas of Rostov-on-Don. Quantitative factor related to the characteristics of the airport itself (passenger traffic, cargo turnover, distance to the city, etc.), not to the size and population of the urban agglomeration was considered. In this case, the airports of Frankfurt am Main (Germany) and Memphis (Tennessee, USA) were taken for comparison as the closest to Rostov agglomeration in terms of the population size of urban agglomerations where they are located [16].

In a market economy, the airport is not only a route point. Today it is not only an urban object, but also an object of entrepreneurship, developing according to the economics laws. The success of the airport determines its budget and the share of aviation and non-aviation revenues in its structure, which, in turn, depends on a number of other factors. Earlier the author gave a list of factors which influence the development of the airport as a business object (aero-city) and which should be considered in a comparative analysis. The author identifies the following factors:

- The area of the passenger terminal.
- Distance to the nearest city.
- The area of the airport territory.
- Number of runways.
- Number of directions of air departures.
- The area of storage facilities.
- The number of retail and service facilities.
- The number of hotels at the airport.
- Number of parking lots [17].

4.3 Comparative Analysis of Rostov-am-Don, Frankfurt-am-Main and Memphis Airports

By the example of the colleagues from Rostov, the author conducted a comparative analysis of the territories of the three airports, taking into account not only the population of the agglomeration, but also key factors of the airports themselves: passenger traffic, cargo turnover, number of air departures, and distance to the city.

Comparative analysis of Rostov-am-Don and Frankfurt-am-Main airports

The comparative characteristics of agglomeration population and urban density in Rostov-am-Don and Frankfurt-am-Main are similar indeed. But the quantitative parameters of the airports themselves are strikingly different. The passenger traffic of the latter is more than 90% higher than that of the Rostov airport, the cargo turnover is 100 times greater and the route map of the airport is much wider and more diverse than that of the Platov airport. Frankfurt-am-Main Airport itself is located 11 km

Table 1 Comparative analysis of Rostov-on-Don, Frankfurt-am-Main and Memphis airports

Comparative characteristics	Platov airport, Rostov-am-Don, Russia	Frankfurt-am-Main airport, Germany [18]
Population of the urban agglomeration	2,260,787 people	1,950,000 people
Population density	3264 people/km^2	2966 people/km^2
Airport passenger traffic	3,236,000 people	70,556,027 people
Airport cargo turnover	20,000 tons	2,076,734 tons
Number of air flights destinations	50 destinations	265 destinations
Distance between the airport and the city	29 km from the city	11 km from the city

from the city center, born in 794. Hence, the formed aerotropolis included part of the urban area, which is reflected in the diversity of functional areas (Table 1).

Comparative analysis of Rostov-on-Don and Memphis airports

Comparative characteristics of agglomeration population size and population density of Rostov-on-Don and Memphis showed that both of these indicators in the American city are even slightly lower than in the Russian city. This is especially noticeable when comparing the population density of Memphis, which suggests a rather loose, low-density urban environment, not inherent in urbanized areas. We should pay attention to the fact that while the passenger traffic of the airports is quite similar, the cargo turnover of Memphis airport is many times greater than that of Platov airport. This is due to the fact that the airport has focused its economic activity on distribution and logistics operations. Memphis airport is located 16 km from its center. It specializes in cargo transportation, because it is in an ideal place for transport and trade: the Mississippi River runs west of it, it is crossed by two interstate highways of the USA, seven highways and many freight railroads. It is a major transportation hub, combining river, road, and rail transportation (Table 2).

It is also worth noting that Memphis is a relatively young city, founded in 1889. Due to the fact that American cities were formed at an accelerated pace and on free territory, their environment, like that of most Russian cities, is rather loose and low-density. But maintaining a consistent course of economic development and urbanization made it differentiated and diverse.

Table 2 Comparative analysis of Rostov-am-Don and Memphis airports

Comparative characteristics	Platov airport, Rostov-am-Don, Russia	Memphis airport, Tennessee st., USA [18]
Population of the urban agglomeration	2,260,787 people	1,341,746 people
Population density	3264 people/km^2	770 people/km^2
Airport passenger traffic	3236 000 people	3,330,000 people
Airport cargo turnover	20,000 tons	4,330,000 tons
Number of air flights destinations	50 destinations	157 freight destinations 55 passenger destinations
Distance between the airport and the city	29 km from the city	16 km from the city

5 Conclusions

As a result of the comparative historical analysis, the author established the main differences in the results of the process of European, American and Russian urbanization.

European cities developed in an evolutionary and almost natural way. Their environment gradually became more complex and differentiated, their cultural potential gradually increased. Currently, in the countries of the European Union, the cities have a high population density, but the main thing is a wide variety of types and methods of production and other types of human activity. An extensive network of road and rail transport makes it possible to fulfill an important need of a modern city dweller, the territorial mobility. In the limited territories of the European continent, airports were initially built close to cities. With the development and densification of the road transport network, the urban territory interacts with the airport territories. In this regard, European urbanization is long and consistent in the development of urbanized culture; territories near the airport have a high density and variety of functions.

American cities are younger than European ones. The process of their development was more rapid, so the structure of American cities is "loose". The area of the country is larger than the area of Europe, and therefore, in some states, the population density is slightly lower. The United States urbanization is industrial capitalist urbanization, the population of the country is represented by adapted, enterprising townspeople, due to which, despite the low density, urban areas are distinguished by a high degree of functional diversity. The vast expanses of the American continent, combined with industrial-capitalist urbanization, stimulated the development of all types of transport, which turned US airports into major transport hubs, which also diversified their economic activities, expanded their borders and entered into active interaction with other cities and countries.

Thus, the basis of American aeronautical urbanization was the need to connect a large territory of the country with economic ties during the period of rapid growth of the industrial economy. US airports are initially consciously formed as transport hubs, which become an incentive for the development of near-airport cities.

Russian urbanization, like the process of the country's development as a whole, is discrete, several times interrupted by various socio-economic and political events. Large cities are concentrated mainly in the European part of Russia and are located at a considerable distance from each other. The regulatory framework of socialist urban planning did not allow the location of airports near large cities and financial constraints led to the limited development of the transport network. In such a situation, the city is unable to participate in the development of airport adjacent territories: the main city functions are far removed, and the lack of stable high-speed transport links does not contribute to mutual development and rapprochement between the city and the airport.

The overwhelming majority of Russian airports do not have the capacity that international-class European and American airports have. The absence of a polycentric settlement system on the territory of Russia, in which important functions are concentrated only in the capital city, are not redistributed to regions, leading to the fact that international airports in large urban agglomerations do not add up to significant air hubs of the country, without which the stability of the development of an international airport is generally doubtful.

The stereotype thinking of the Soviet period regarding the formation of new cities on the basis of an industrial complex with functional zoning of the territory in the form of three zones (industrial, residential, public and business) cannot be applied to such a new urban formation as Aerotropolis for a number of reasons:

– the airport is not a city-forming base that attracts the population to the nearby territory, due to which an urban formation is not always formed on its basis;
– the airport attracts certain types of activities, the results of which need to be quickly transported to the destination;
– in a market economy, the airport has an internal economic source of development, which should be taken into account when planning airport adjacent territories [19].

Thus, as a result of the analysis, the specifics of Russian urbanization were established. These are the discreteness of the development of market relations, low density of population and urban settlements with large territories of the country and low density of transport links.

Talking about the development of near-airport territories as aerocities and aerotropolis—urban formations around airports—then the search of spatial solutions should be carried out taking into account the laws of urbanization. For urbanism, two key moments of urban formation are concentration and diversity, which are the two basic characteristics of the city [14].

The analysis shows that in the conditions of Russia it is initially necessary to rely on the American experience: the country's most powerful international airports should become hub centers. Only then to turn to the European experience means to begin to form a diverse and functionally saturated environment of their near-airport territory.

Thus, the diversification of enterprises and offices of companies ready to be located on the territory, the diversity of the formed urban environment, the high concentration of various types of transport systems and the use of the principles of economics of scale for the organization of trade, logistics and management processes, as well as the formation of a finely dispersed and variable urban environment should become characteristic features of near-aerial urbanized formations.

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Rationale for the Boundaries of Historically Valuable Comprehensive Development of the Industrial Era

N. A. Orlova, D. N. Orlov, V. A. Belkova, and D. A. Vlasov

Abstract The paper identifies an area within the city of Samara, characterized by high preservation of ensemble buildings of the period from 1930 to 1950. These buildings are of high historical value of global significance. The urban and architectural design of these districts has been preserved to the present day with minimal changes. The work is currently being conducted to identify a significant number of cultural heritage objects in the area. The paper substantiates the boundaries of the stable morphotypes of the 1930–1950 buildings and gives a brief historical background of their development. The purpose of the work is to substantiate the boundaries of the territory with a special regulation of use.

Keywords Sotsgorod · Industrial district · Architectural and planning structure · Historical settlement · Urban morphotype

1 Introduction

The center of Samara received a status of historical settlement in 2019. It was formed at the end of the XIX century, before the revolution of 1917. During the Soviet period, the economic structure and form of ownership of land and real estate changed. The new construction produced over the last century contrasts with this area. A historical settlement is a locality or its part containing within its boundaries cultural heritage objects included in the register, identified cultural heritage objects, and objects that constitute the subject of protection of the historical settlement. The status of a historical settlement is extremely important for the further development of Samara and the preservation of its historical appearance. It will allow one to preserve not only individual monuments, but also all the historical buildings, architectural and planning structure and three-dimensional composition of the city. The most important task of such project is to preserve and develop the urban environment as a holistic cultural phenomenon. Over the past century, the value of this phenomenon for the

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modern citizen has steadily increased. To date, this value is recognized not only as an object of tourist attraction, but also as a fundamental factor of regional identity. The economic structure and the institution of property changed again at the end of the twentieth century against the background of imperfect legislation and the lack of regulatory activities on the part of the reformed city government bodies have led to an obvious threat of losing the phenomenon of the historical city. Over the past 30 years, after the collapse of the USSR, as a result of private commercial activity, a significant part of the historical development was lost. This led to considerable tension in the Samara society. The adoption of the status of a "historical settlement" was a reaction to the prevailing construction practices. So far, the project has faced considerable resistance from the commercial construction lobby.

The value of pre-revolutionary buildings is obvious to the residents of Samara due to the maximum morphological contrast with the Soviet buildings. But even in the Soviet era, large-scale urban development projects with high architectural and environmental quality were carried out. The projects of the first half of the twentieth century have already acquired a "historical" quality. Work is underway to identify objects of cultural heritage of the Soviet period. The state register for the protection of architectural heritage already includes buildings up to the 80-ies of construction. According to Russian laws, objects older than 40 years can get this status. The specifics of Soviet construction throughout its entire period was a comprehensive approach to building. Therefore, a significant number of examples of urban planning creativity of the Soviet period have been preserved. These are large areas that preserve the original buildings, public and private spaces as they were built. The threat of losing this historical heritage is typical of a pre-revolutionary city. The awareness of the value of this development is still obvious only for specialists in architecture and urban planning. Therefore, it would be extremely important and relevant to continue the work on the study of such urban phenomena with maximum energy. The task of such study should be to identify the boundaries of the integral historical development of the Soviet era, a detailed description of its morphotypes, and the creation of regulations that allow it to be preserved and revitalized in modern conditions.

This practice of creating special regulations for the preservation and specific development of historical areas is not unique. In the United States, the first analogue of the Russian "historical settlement"—the historical district was founded in 1931 in Charleston, South Carolina [1]. Now in the United States, there are "Registers of Historic Places" at the federal level, at the state level, and local lists. In 1966, the National Register of Historic Places was established. The protection of historical sites takes into account the integrity of the heritage buildings, the urban structure of the site, the architectural environment, the landscape and the environment. Thus, the American historical site is largely analogous to the Russian historical settlement.

Similar legal norms apply in other countries, primarily in Europe [2]. In the 60s and 70s of the twentieth century, regulations for the protection of historical territories began to stand out from the general system of urban planning regulation. Currently, a lot of work is being done to form similar legal institutions around the world. Studies on the genesis and morphology of the urban territories, ways to preserve historical heritage in the process of its renewal and the search for methods of legal regulation of these practices are carried out in many countries, for example, in China, Lithuania, Poland, Saudi Arabia, Croatia, Great Britain [3–10]. With the entire regional specificity of this experience, we can talk about the development of generalizing methods [11].

In Russia, much attention is paid to research on the systematization of knowledge and experience of urban planning practices. The Soviet school of urban studies was based on the concept of social progress as a result of the class struggle. The analysis of a huge amount of accumulated knowledge with this approach was not quite productive. New studies [12–14] pay more attention to the phenomenology of the urban environment, its cultural and social significance. The concept of renewing progress has been replaced by the concept of sustainable continuity. The formation of the image of the city of the future now includes as an integral part a thorough articulation and revitalization of the city of the past.

Obviously, this is due to the process of understanding the value of the historical environment at the global human level. The process took several decades, due to the differences in the economic and political level of development of different countries. In Russia, the status of a historical settlement was first introduced in 1970 and included 115 historical sites. In 1990, it was expanded to 536 titles. In 2010, the list was reduced to 41 items. This was one of the manifestations of the threat of loss of historical heritage associated with the pressure of the commercial lobby in the context of weakening institutions of urban regulation and public control, which emerged in Russia in the context of political transformations.

Today, the tendency to recognize the value of historical heritage as the basis for the self-identification of a modern person is obvious all over the world. Modern ideas about the future of the city as the core of the material culture of mankind are not possible without positioning this phenomenon in a historical perspective. The future is a new stage in a continuous process.

2 Methods

The research method consists in determining the degree of integrity of the morphotype of the building. The morphotype implies the unity of the planning and urban planning principle of the formation of buildings and the style of the buildings that make up it.

The planning and urban planning principles include the method of forming residential groups, streets and residential courtyards. For the studied period of the 30–50s, the principle of an enlarged quarter is characteristic. It is characterized by the perimeter location of buildings along the streets. In this case, the streets form a hierarchical row, with the allocation of avenues and boulevards, ordinary streets and residential driveways. The enlarged quarter of the period under review has dimensions of about 300 × 200 m. At the same time, a typical quarter of the previous pre-revolutionary period in Samara has approximately the dimensions of 150 ×

250 m. The perimeter development of such block has gaps and always consists of separate 2–3-section houses. The inner territory of the block is not dense; as a rule, it is filled with freestanding typical 2–3-section houses. The undeveloped space of the courtyard is a well-landscaped residential courtyard without a clear division of space; it belongs to all residents of the quarter on the terms of equal use. The building is subject to sanitary standards for insolation. The pre-revolutionary quarter in Samara is represented by two morphotypes. The first of them is a manor building with 1–2 story wooden houses on the outskirts. The second is the construction of 2–6-storey stone houses with dense filling of the entire perimeter of the block without gaps and almost completely built up in the depth of the block. Pre-revolutionary quarters were formed by private ownership of land plots. In the enlarged blocks of the 30s, the perimeter of the block's development is caused only by aesthetic preferences and sanitary requirements. The perimeter development along the red lines is caused only by the need to form a traditional representative space of a city street. By the 60s, this aesthetic requirement will be removed, and the time of free planning will come. The identification of authentic fragments of the stable historical morphotype of the 30–50s is primarily based on the principle of preserving the characteristic urban structure of the quarter. The second marker is the style of the facade solution of the building. The style of the facades can be attributed to Stalinist historicism. The priority of urban planning features is due to the fact that courtyard buildings can be almost completely devoid of architectural decor. The area under consideration was not central in its status, so any rich detailing of the facades was used mainly on the main streets. The principle «all-facades-matter» is not typical for this period. The greatest detail of the facades is typical for the middle of the period under consideration. Early examples still bear the features of constructivist aesthetics, and in the most recent examples, the order details are presented more sparingly and schematically. A number of the most recent buildings, belonging to the end of the period under review, are completely devoid of order detailing. But at the same time, they retain the proportional system characteristic of the Stalinist style.

Thus, the integrity of the morphotype of the development of the 30–50s is determined primarily by the urban planning solution—an enlarged residential quarter, with a perimeter building of typical 5-storey residential buildings. At the same time, the intra-block territory is formed on the basis of the principles of free planning with the predominance of the meridian orientation of residential buildings within the block. A hierarchical system of the road network is being formed. The second feature of the morphotype is the order solution of the facades. Regardless of the presence or absence of architectural plastics, the unity of the morphotype is supported by the proportional structure of the architectural solution of the facades. The integrity of the morphotype is determined by the absence of a later development that violates these two principles.

Based on this method, schemes are drawn up that allow us to judge the integrity of the environment of a particular site. The use of this technique allowed us to clarify the boundaries of the proposed historical site.

3 Results

3.1 Historical Background

The Bezymyanka district has an important historical significance and a high architectural quality [15]. The main development of the district was in the 30s–70s of the twentieth century. Now the historical buildings are mostly in a satisfactory condition, but the problem of preservation of historical heritage does not lose its urgency. With no protective regulations, any historical building is not protected from destruction. The preservation, historical importance, architectural quality—all these factors indicate the possibility and even necessity of forming the second center of historical settlement along with the pre-revolutionary center.

In 1903, the Bezymyanka siding was created on the Samara-Zlatoust railroad, and a railroad workers' settlement with a repair plant was established near it. A cooperative village "Garden-City" was founded for the plant's employees. The village was built up first with barrack-type houses, later—with capital ones. After the revolution of 1917, there was a complete change in the entire way of life in Russia. The old forms of ownership disappeared, the laws changed, and the organization of production became different. Urban planning, despite its natural inertia, has changed several different approaches in a short period of time. The concepts of a garden city, a working settlement, urbanization and deurbanization were replaced by the concept of a «Socialist city». Its implementation was one of the main factors in the implementation of the industrialization program developed in the second half of the 1920s in the USSR. The principle of rigid attachment of the labor force to the places of application of labor, on which the concept of the «Socialist city» was based, was a crucial condition for the implementation of the state's production program.

The settlement was built in several stages, in the second half of the 20s; the development was based on the Sotsgorod concept. This approach persisted until the 50s, when the formation of Bezymyanka, which is the industrial district of Kuibyshev, was completed. The presence of such residential area contributed to the further development of this territory. In the mid-1930s, it became the location of new industrial enterprises. The formation of a large industrial area near the station "Bezymyanka" began. This was reflected in the general plan of Kuibyshev in 1935–1937. A new urban-planning formation—an industrial and residential zone in 1939—was transformed into the Molotovsky district of Kuibyshev.

By the 1940s, aircraft production facilities, as well as the USSR NKVD Department of Special Construction and the Bezymyanlag, were located in the new district. To supply the new production facilities with energy, the Bezymyanskaya CHP plant was built. The Bezymenlag provided the new construction with free labor.

At the beginning of the Great Patriotic War, due to the threat of Hitler's invasion, some of the defense industry enterprises were evacuated from the western regions of the USSR to the Bezymyanka area. The choice of this location was due to its convenient transport accessibility, the availability of spatial reserves and the sufficiency of labor, energy and natural resources.

After the end of the Second World War, most of the production facilities evacuated to Kuibyshev were repurposed from the production of military products and continued their development. By the time Soviet architecture made a sharp turn to modernism, which is associated with the personality of Nikita Sergeyevich Khrushchev, the Bezymyanka district was almost formed. Therefore, the new policy of urban planning affected it only in the form of a rejection of the classic order detailing on the most recent residential buildings.

Thus, the area has an important historical significance:

- during the Great Patriotic War, by decision of the State Defense Committee, the rear city of Kuibyshev was designated as the reserve capital of the USSR. Industrial plants from various cities of the USSR were relocated to the Bezymyanka territory. Kuibyshev became one of the centers of the industrial plants evacuation, which determined the material basis of victory in the Great Patriotic War;
- Bezymyanka is an example of implementation of the Socialistic City concept, which has planning, architectural and historical value, as a monument of the industrialization period;
- some of the residential buildings on the Kirov highway were awarded prizes for high quality of architectural and construction work at republican architectural competitions in 1945 and 1946.

3.2 Defining the Boundaries of the Bezymyanka Historical Settlement

As a hypothesis, the boundaries of the study area are taken within the XXII Partsyezd Street, Karl Marx Street, Alma-Atinskaya Street and the railroad. This choice is justified by the fact that in informal toponymy and phenomenology, the territory within the proposed boundaries is traditionally perceived as an integral part of the city. Further research to clarify the boundaries will be conducted by identifying the morphotype, according to the criteria specified above. In the study area, all the signs of a classic «Socialist city» have been completely preserved. It is a residential area spatially linked to a large industrial area. In such settlement, there are practically no production or service enterprises with the exception of basic social infrastructure facilities. These facilities include small shops within walking distance, schools, kindergartens, and post offices. Almost all of these enterprises have retained their functions to our time.

The Bezymyanka district borders on a large industrial area. The Bezymyanka district borders on a large industrial zone, in which enterprises related to the aviation and rocket and space industries, as well as heavy machinery, are located (see Fig. 1).

The clear quarter structure of the district corresponds to the development plan, which was prepared by Gosproektstroy according to an American pattern. Initially, the street network was marked by numbers instead of words, as it is common in the United States.

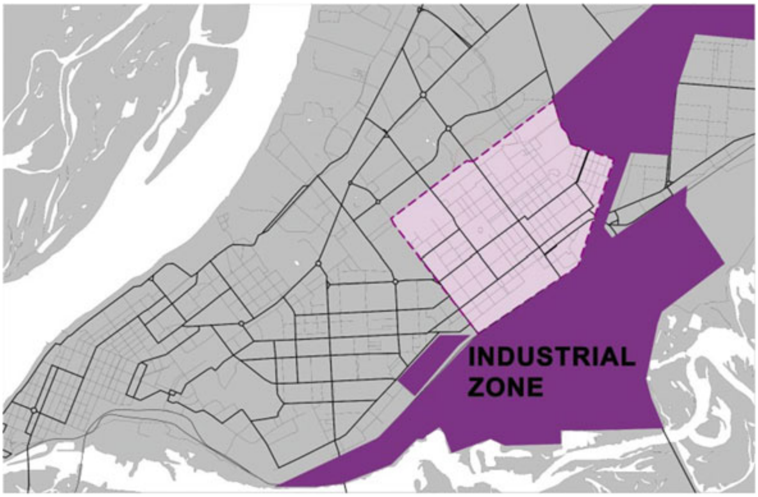

Fig. 1 Location scheme of industrial facilities in relation to the study area

There are two large parks in the district—the 50th Anniversary of October Park of Culture and Leisure and the Molodezhny City Park of Culture and Leisure. They are connected by the Alley of Labor Glory. The Alley features monuments in honor of the city's plants and enterprises. The same trend is observed on Metallurgov Avenue. Mochalov Square and the park at the Samara Metallurgical Plant are also connected by an alley.

The main pedestrian traffic is currently concentrated on Kirov Ave., Yunykh Pionerov Ave., Pobedy St., Novo-Vokzalnaya St., as well as on Fizkulturnaya St., Volskaya St. and Metallurgov Ave. It can be concluded that the urban structure of the territory is well preserved and has changed little since the mid-twentieth century.

Most of the development in this area dates back to the 1940s–1960s (see Fig. 2).

The analysis of morphotypes showed that most of the buildings are "Stalinki" and "Khrushchevki" (see Fig. 3). In the western part of the district there is a zone of private development, stretching from the street of Soviet army to Kirov Avenue.

This territory does not correspond to the characteristics of the declared morphotype. Accordingly, it should be excluded from the borders of the historical settlement "Bezymyanka". However, it is necessary to take into account the impact that this territory may have on the territory in question. In the case of its development in accordance with modern practices. A sharp increase in the population density on this territory is unacceptable, as this can lead to an imbalance, the load on the street and road network and social infrastructure facilities. Construction in these areas should begin with the development of projects for the planning of the territory, taking into account the proximity to the zones of protection of the integral architectural environment. It advises to recommend development projects for these areas that correspond to the principle of integrated development of the territory. It is unacceptable to shift part of the transport and infrastructure load to the areas of the protected morphotype.

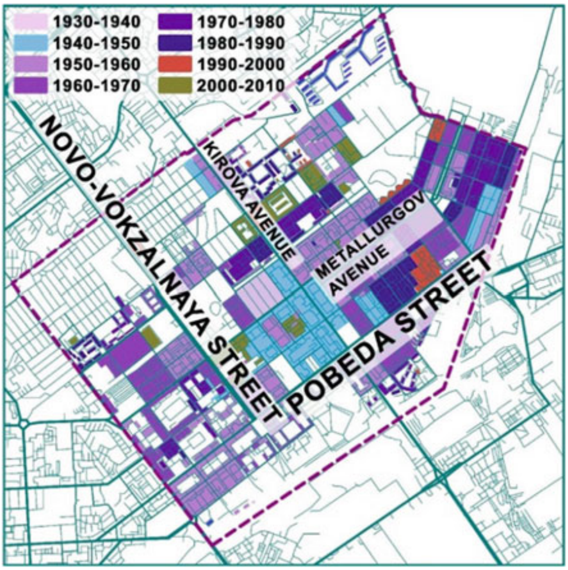

Fig. 2 Morphotypes of buildings in the study area by time of construction

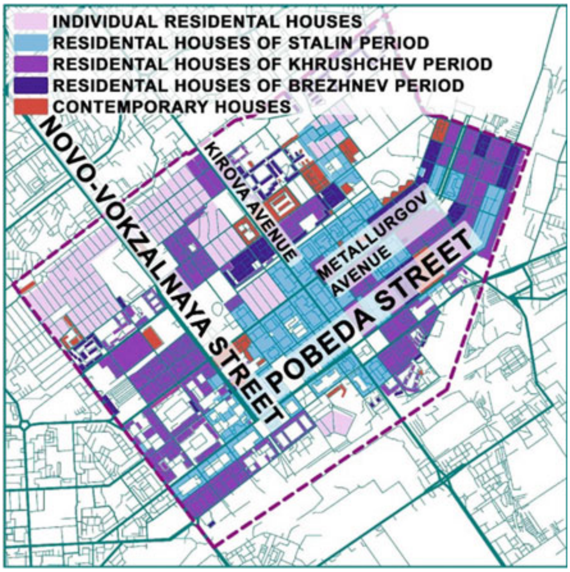

Fig. 3 Morphotypes of buildings in the study area by style

The correct way to solve this problem would be to develop special use regimes for the territories bordering the historical settlement.

Figure 4 shows buildings with the status of objects of cultural heritage, as well as newly identified monuments. Most of the objects of cultural heritage are concentrated on Pobedy St. and Metallurgov Ave. The work is currently being done to research

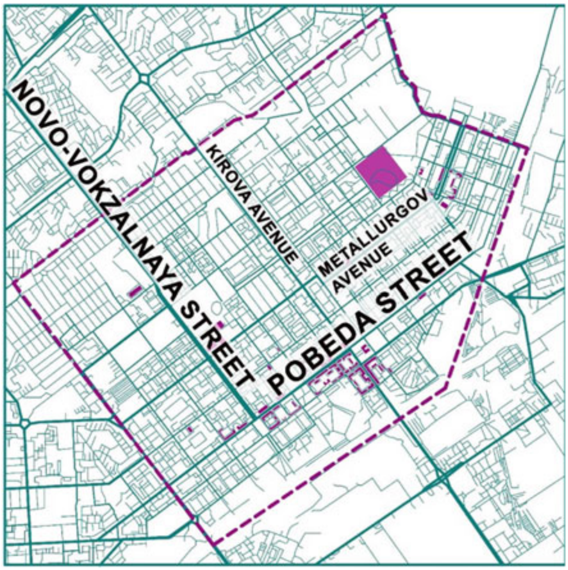

Fig. 4 Valuable elements of buildings and urban environment. Buildings included in the register of objects of architectural heritage

and identify objects of cultural heritage. The realization of the historical and cultural value of the buildings constructed in the 30–50s came recently. Therefore, this work is far from being completed. It was recently announced on February 28, 2021 that new monuments have been identified: the residential house of Engine plant No. 24 named after Frunze, which is located in 100 Pobedy St.–5 Voronezhskaya St. and the residential house of Aircraft plant No. 18 named after Voroshilov, which is located in 107 Pobedy street and was built in 1952 according to the project by architect Kuznetsov. We consider it expedient to form a comprehensive protection zone for the entire group of identified cultural heritage objects in this territory upon completion of the work on the identification of cultural heritage objects. The development of projects of such zones for each monument, as is now customary in Samara, would be impractical. Such a protection zone and regulatory zone could be defined for the entire identified territory as a single object of protection.

On the 1967 plan, we identified areas where a characteristic urban environment in the Stalinist Empire style had been fully formed by that time. By the mid-50s the construction of buildings in this style was discontinued. Therefore, these are the areas expected to contain objects of cultural heritage and valuable city-forming objects (see Fig. 5).

The boundaries of two zones can be distinguished (see Fig. 6). We included objects of cultural heritage, monuments and other objects of historical, architectural, urban planning, aesthetic, scientific and socio-cultural value in the first zone. In this zone, the regulations aimed at the preservation of cultural heritage objects and the historical environment are assumed to be in effect. The second zone is a development regulation zone. New development in this zone must not have a dissonant impact on the area delineated as the first zone.

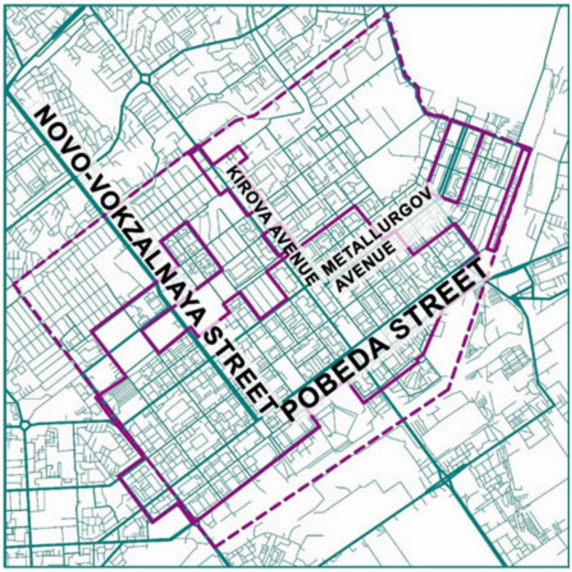

Fig. 5 Valuable elements of buildings and urban environment. Elements of urban planning and development structure formed by 1965

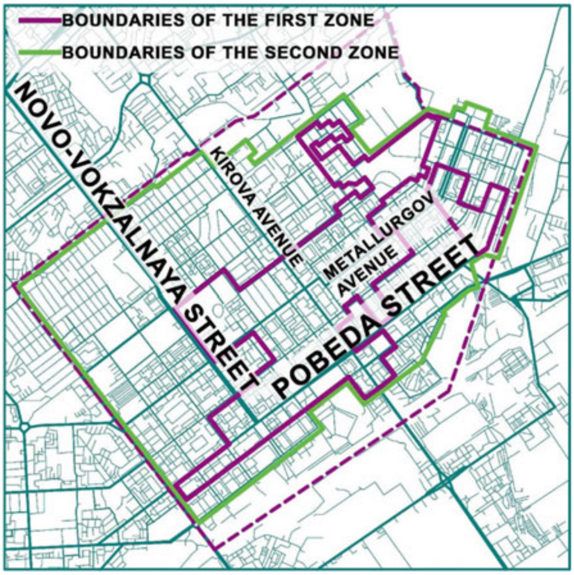

Fig. 6 The proposed boundaries of the Bezymyanka historic settlement and the regulatory zones

4 Discussion

Figure 6 shows the result of analytical work to identify the boundaries of the territories, the corresponding features of the morphotypes stated in the research methodology. The identified areas correspond to the principles of the formation of an enlarged block and have a development characteristic of the period of the 30–50s. It should be noted that the identified border does not correspond to the hypothetical one. The feeling or phenomenal perception of the territory is not entirely based on the morphotype of its development, but also depends on other factors. Nevertheless, the areas corresponding to the claimed morphotype represent a large complex spatial formation, characterized by a high degree of preservation of its morphological integrity.

5 Conclusion

Thus, it can be concluded that the assignment of a status to the territory in question, implying a special regulation of use aimed at preserving stable historical morphotypes of development, is not only possible, but also necessary.

The development of this area has high architectural and environmental qualities, and the value of the buildings is only increasing over time.

The district also has an important historical significance: it is an example of an almost completely preserved integral ensemble environment, which keeps the memory of the 30–50s, the time of industrialization and World War II.

Thanks to the use of methods of analysis of the architectural environment based on the identification of the morphotype of the building, it was possible to justify the boundaries of sites with high preservation of the studied morphotype. The boundaries did not coincide with the hypothesis based on the established stereotypes of perception of the environment. The updated boundaries of the historical territory allow us to confidently and reasonably speak about the exact correspondence of the actual state of the building to historical data. The territory within the identified borders is characterized by the correspondence of the two markers of the desired morphotype in the presented method and is based on a priori historical data. The study area is represented by characteristic enlarged blocks with perimeter open buildings and a free layout of courtyards. The buildings on the territory under consideration are subject to a general style corresponding to the period of the 30–50s. Temporary layering in this area is minimal. Thus, we can talk about identifying the boundaries of the territory of the integral development of the 30–50s, which has a high architectural, environmental and historical value. It is necessary to insist on the development of regulations for the preservation and development of this territory as an integral and integrated object of cultural heritage. We can talk about this territory as the second focus of "historical settlement" on the territory of the city of Samara, or about giving this territory the status of a place of interest. It is provided by No. 73 of the Federal Law of the Russian Federation "On objects of cultural heritage (historical and cultural monuments) of the peoples of the Russian Federation".

As a continuation of the study, an in-depth study of the style of buildings within the identified boundaries is expected. With more accurate and fractional dating and identification of time layers. It is also necessary to study the changes that have occurred in the functional content of the preserved buildings, including in order to identify the resources for the development of this territory that do not contradict the principles of preserving cultural heritage.

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Development of Complex Territories Building Considering the Elderly Needs

I. A. Saenko, O. R. Tolochko, and A. V. Sharopatova

Abstract The article presents offers for the development of integrated development of urban areas, considering the elderly needs. In the conditions of modern industrial cities, the desire of consumers to live in an area that combines a developed social and environmental infrastructure is growing. The living environment is a place with a comfort zone that significantly exceeds the boundaries of the apartment, entrance and courtyard territory. At the same time, there is a progressive updating of the legislative framework, which shifts the focus from the development of the investment and construction sector in cities to the development of integrated urban building, taking into account the satisfaction of residents' various needs. In this connection, the development priority for the investment and construction sector of cities is shifted to the development of integrated development of urban areas. At the same time, the demographic situation suggests that there is a specific weight redistribution in the share of different age groups from the total urban population in favor of increasing the share of the elderly population. The article contains a number of proposals for the creation of a multifunctional comfortable urban environment and the integration of elderly people group into it, which include the expansion of the typology of housing and residential complexes; decentralization of infrastructure, etc. The proposed urban planning and management solutions based on the analysis are designed to increase the comfort of the living environment and fully implement in practice the main goal of a complete construction project—to provide a comfortable stay, absolutely for all citizens based on their needs and regardless of age gradation.

Keywords Urban areas · The elderly needs · Industrial cities · Environmental infrastructure · Courtyard territory

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1 Introduction

The most important task for government authorities, modern urban planners, architects, designers, investors and other representatives of the investment and construction sector is the desire to create a full-fledged living environment for a person living in an urban industrial environment [1]. At the same time, the living environment is a space with a comfort zone that significantly exceeds the boundaries of the apartment, entrance and courtyard territory, which determines the priorities for the development of the investment and construction sector [2]. This is happening because of the growing population desire to live in a territory that combines a developed social, engineering and environmental infrastructure, which in turn causes changes in the regulatory framework. According to the new federal law No. 494-FL of 30.12.2020" one of the goals for integrated development of territories is to ensure a balanced and sustainable development of settlements, urban districts by improving the quality of the urban environment and improving the appearance, architectural, stylistic and other characteristics of capital construction objects [3]. This law shifts the focus in urban planning to ensuring the integrated development of territories, considering the various needs of residents. Here we can see the classical scheme of participants' interaction within the system of forming a comfortable living environment, so the relationship of developers, authorities and the population in the formation of a comfortable living environment. Each of the participants in this system influences each other by virtue of their capabilities, which contributes to the development of the process for forming a comfortable environment. The population has needs that form the demand for construction products. The authorities, in turn, develop national, other projects and strategically, regulatory documents based on the needs of the population to ensure a comfortable living, which determines the activities of builders in accordance with the political and social course of the government, and the dissatisfaction of the population with construction products generates a new round of this system development.

A number of demographic trends indicates an increase in the share of elderly people in the structure of modern industrial society. It suggests that in order to bring the system of forming a comfortable living environment to a new stage of development, it is necessary to pay attention to the needs not only of the villages as a whole, but also to concretize the needs of elderly people as an increasing separately emerging group of consumers.

The purpose of this study is to form offers for the development of integrated urban territory in relation to the elderly.

The object of the study is the comfort of the living environment for elderly people at housing construction sites in Krasnoyarsk.

The subject of the study is tools for creating a comfortable living environment for the elderly.

2 Materials and Methods

The methodological basis of the study is an integrated approach and a systematic analysis for the problem of creating a comfortable living environment for the elderly, the use of detailing and cartography, a tabular method of reflecting data, methods of comparing and summarizing information, as well as project analysis. In the work of the author it is noted that «…in order to ensure the well-being of the elderly, it is psychologically necessary for the elderly to continuously activate in the process of producing and consuming spiritual, intellectual and material goods» [4].

When talking about creating comfort in a residential environment for the elderly, it is worth emphasizing the principle of individualization: for each category of elderly people, it is necessary to propose different strategies for the formation of urban infrastructure facilities. Within the general age group, older people are divided into different categories, considering their socio-functional activity. According to it, there are three main categories: active, weak, and infirm [5, 6]. For the first category of active people, only enhanced outpatient supervision and compliance with the recommendations of specialists are needed, and for non-working people—institutions of a health-improving, leisure, amateur and entertainment nature. For the second category, in addition to public institutions and service enterprises, it is proposed to form a network of social service facilities that are as close as possible to their main places of residence. When organizing an environment for the infirm, the category of senior citizens should not live without inpatient living conditions in specialized social service institutions.

We understand the residential complex as a system of real estate elements and infrastructure elements interconnected with each other, but when talking about housing for the elderly, it is especially important to have the idea that this housing is a system that should interact with various elements of the urban environment. Hence the separation of the typology of housing systems for the elderly into open and closed systems.

It is obvious that the closed system represents typical specialized and isolated nursing homes and residential homes both within and outside the city. And this means limited contacts with the outside society, hence the isolation of citizens, which does not contribute to the formation of active longevity in this category of the population. The open system is aimed at integrating specialized housing into urban building. Examples of an open system are cottage settlements in Norway or a social town Borisovichi in the Pskov region. The project implemented in the Pskov region is experimental for the Russian Federation. The space is a complex of low-rise apartment buildings, as well as a number of infrastructure facilities. It is assumed that a project of this kind will be able to provide elderly people with comfortable and safe living conditions that will be similar to home. At the same time, the main thing is to improve the quality and accessibility of social services for elderly citizens. Including through the use of modern social work technologies.

In the works of the authors M.E. Troyan, W.K. Hughen and D.C. Read the differences in the approach to the formation of urban building in relation to the elderly in European countries and in the Russian Federation are presented [7, 8]. The separation and remoteness of specialized educational institutions from the city center in Moscow and especially in Krasnoyarsk indicates their isolation and attitude to a closed system. Such "homes" for the elderly have a place to be, but should exist only for a small proportion of elderly people who need special medical care and inpatient stay, since these institutions can not be fully a home.

Based on this information, the authors believe that it is necessary to synthesize closed and open systems into something average, so the most optimal and cost-effective system of housing organization for the elderly, namely: a mixed system.

Since the most promising and feasible format for organizing residential development today in Russian cities, including Krasnoyarsk, is building complex, it is most promising to try to integrate a mixed housing system for the elderly into building complex projects.

The issues of new approaches to the formation of an urban environment that is able to respond to the needs of residents and meets the requirements of the modern economy, the interests of business and government are dealt with by the consulting bureau of KB "Strelka". Planning and spatial solutions based on the standards of building complex can bring us closer to the goal of comfort improving the living environment [9].

In the realities of modern post-industrial society, the option of implementing specially equipped premises in residential buildings of the city for living and servicing the elderly, directly with the participation of medical and social workers, does not seem out of the ordinary, it does not destroy the usual way of a person life, contributes to maintaining a sense of independence in a person [10–12].

3 Results and Discussions

In modern urban planning terminology, it is customary to apply such concepts as a residential complex, a residential quarter, a residential area. A residential complex is defined as a primary element of residential development, since it includes not only residential buildings, but also institutions for everyday use: a kindergarten, a school, a store, green areas, public service facilities, etc. It is important to note that all these elements should be connected together by a common functional and composite structure, engineering equipment, a system of pedestrian paths and entrances, and landscaping. The origins of such a building complex lie in the variety of the population life spheres, from which a whole set of diverse needs appears [13–15] (Fig. 1).

Within the framework of modern integrated development, basic living conditions and economical, rational, as well as effective use of the city (quarter) territory are provided [1, 16–18]. The purpose of the building complex is to provide a comfortable living, absolutely for all citizens, based on their needs and regardless of age gradation.

Based on the presented statistical data, the aging trend of the population in the Russian Federation as a whole, including the Krasnoyarsk Territory, is obvious, in which over the past 5 years the share of the elderly population (from 65 to 69 years)

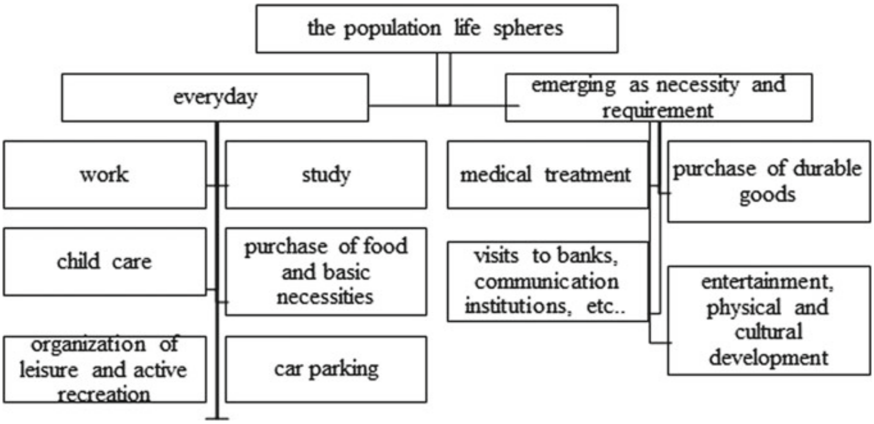

Fig. 1 Population needs scheme

has increased by 1.5%; stable dynamics is observed in the number of citizens from 60 to 64 years; the number of citizens aged 55–59 years has decreased by 0.4%. Thus, there is a redistribution of the specific weight in the share of different age groups from the total urban population in favor of increasing the share of the elderly population. It is also obvious that different age groups of people have different needs and requirements for the level of comfort in the living environment, which means that when developing integrated development projects, it is worth paying attention to all age groups. At the same time, as a growing group of consumers, the needs of older people deserve special attention [19, 20].

Modern social, demographic, economic and other changes help to form a number of proposals for the creation of a multifunctional comfortable urban environment and the integration of an elderly people group into it [5, 21]:

- to provide for the typology expansion of housing and residential complexes, considering the needs of older people;
- to create new types of organization for the living environment for the community of older people;
- to provide for measures to decentralize the infrastructure for the elderly, provided that the criteria for evaluating the territory and algorithms for its search are used;
- to create new types of housing for several generations due to structural changes in the family structure;
- to ensure the variability of space-planning solutions, which will help the integration of housing for different age groups of the population;
- to create standard projects and carry out the construction of standard facilities for social service organizations, including medical services;

In addition, the main tasks in the development of documentation on the planning of territories, in order to form the living environment of the population, considering the needs of the elderly, should be considered [1, 4]:

- the definition of a rational planning organization for the cities territories and other settlements;
- the complex system solution for social facilities of various typological affiliation;
- ensuring the accessibility of the entire urban infrastructure for the elderly;
- creating an ecologically friendly environment.

In recent years, the practice of integrated territorial development projects has found its application in various cities of the Russian Federation. But to what extent do they consider the needs of older people? Consider the state of this issue and the possibility of solving the problem on the example of the project of the residential complex (RC) “Preobrazhensky” being implemented on the territory of the city of Krasnoyarsk. The builder positions this project as a “new city”, since such large-scale projects with a single concept have not yet been built in Krasnoyarsk. Expressive architecture, a complex of public spaces, a large area, a variety of functional areas, self-sufficient modern infrastructure—all this distinguishes the residential complex “Preobrazhensky” from other offers.

However, according to the authors of the article, the residential complex will become completely comfortable for the population only if it is possible to organize a social space for the elderly. We believe that it is necessary to place premises on the first floors of residential buildings for the purpose of social services for the elderly. Currently, the code of rules (CR 141.13330.2012) provides only a standard: the specific indicator of the total area for social service facilities is 341 m^2 per 1000 people with limited mobility [22]. However, not all elderly people who need such social services belong to this category of citizens. Based on the data in Table 1, we understand that in the Krasnoyarsk Territory, the share of people over 60 is about 15% of the total urban population of the region. The total population of this residential complex implies a number of 16,600 people, therefore, the approximate number of people over 60 years old in the future may be 2490 people. The above-mentioned CR implies an indicator for low-mobility groups of the population, but the total number of low-mobility citizens in the residential complex is not possible to estimate, while people over the age of 60 years are referred to this group by regulatory sources, which seems logical against the background of physiological changes with age. Consequently, almost two and a half thousand people in the future on the territory of the residential complex will have the right to implement their social security (Table 2).

In the case of the residential complex “Preobrazhensky” chosen as an example, we will consider the implementation of the solution proposed above.

Figure 2 shows the plan of the 1st floor in one of the residential buildings in the residential complex “Preobrazhensky”, with allocated unoccupied areas for their implementation on a commercial basis, broken down by premises that can be partially used as social services for the elderly. In order to organize such institutions, it is advisable to use public–private partnership mechanisms at the stage of attracting investment in such projects.

Table 1 Structure of the urban population by age group in the Russian Federation and in the Krasnoyarsk Region (percentage)*

№	Age groups	The Russian Federation						The Krasnoyarsk Region					
		2015	2016	2017	2018	2019	2020	2015	2016	2017	2018	2019	2020
1	0–4 years	6.1	6.3	6.4	6.3	6.2	5.9	6.9	7	7.1	6.9	6.6	6.3
2	5–9 years	5.2	5.4	5.6	5.8	6.0	6.1	5.1	5.2	5.3	5.4	5.6	5.8
3	10–14 years	4.6	4.7	4.8	4.9	5.1	5.3	4.9	4.8	4.8	4.9	5	5.2
4	15–19 years	4.5	4.4	4.4	4.5	4.6	4.8	6.7	6	5.6	5.4	5.1	5.0
5	20–24 years	6.6	5.9	5.4	4.9	4.7	4.5	9	8.8	8.5	8	7.4	6.8
6	25–29 years	9.0	8.8	8.5	8.0	7.3	6.7	8.8	8.9	9	9.1	9	8.9
7	30–34 years	8.7	8.7	8.9	9.1	9.1	9.0	7.8	7.9	8	8.2	8.5	8.6
8	35–39 years	7.7	7.9	7.9	8.1	8.3	8.6	7	7.1	7.2	7.3	7.5	7.6
9	40–44 years	7.1	7.1	7.2	7.3	7.4	7.5	6	6	6.2	6.2	6.5	6.7
10	45–49 years	6.2	6.2	6.3	6.5	6.7	6.8	7.3	6.9	6.4	6.1	5.8	5.7
11	50–54 years	7.3	6.9	6.5	6.2	6.0	5.9	7.2	7.3	7.3	7.2	7	6.8
12	55–59 years	7.3	7.4	7.4	7.3	7.1	6.9	6.2	6.3	6.3	6.4	6.5	6.5
13	60–64 years	6.3	6.4	6.5	6.5	6.6	6.7	3.9	4.5	4.8	5	5.2	5.4
14	65–69 years	4.5	5.1	5.3	5.4	5.6	5.6	2.3	2	1.9	2.3	2.7	3.3
15	70 years and more	8.9	8.8	8.9	9.1	9.3	9.7	6.9	7	7.1	6.9	6.6	6.3

*Data of official statistics on the numerical composition of the population in the Russian Federation https://rosstat.gov.ru/

Table 2 Main parameters of the RC "Preobrazhensky"

Parameters	Meaning
Square	42.8 ha
Number of houses	21
Population	About 16.600 people
Altitude	14 houses–5-storey; 7 houses–25-storey
Educational institutions	3 kindergartens, 2 schools, 1 clinic
Public spaces	Pedestrian avenue and circular bike path
Shopping and entertainment centers	Lenta Shopping Center, Planeta Shopping Center, Arena-North sport complex
Completion of construction	2023 year

The proposed practice of creating a residential environment is aimed at integrating older people into the overall structure of the residential complex, which in general will help it to be self-sufficient and cost-effective, and for older people to improve the quality of life and, if desired, expand the range of social contacts, that is, will contribute to their longevity.

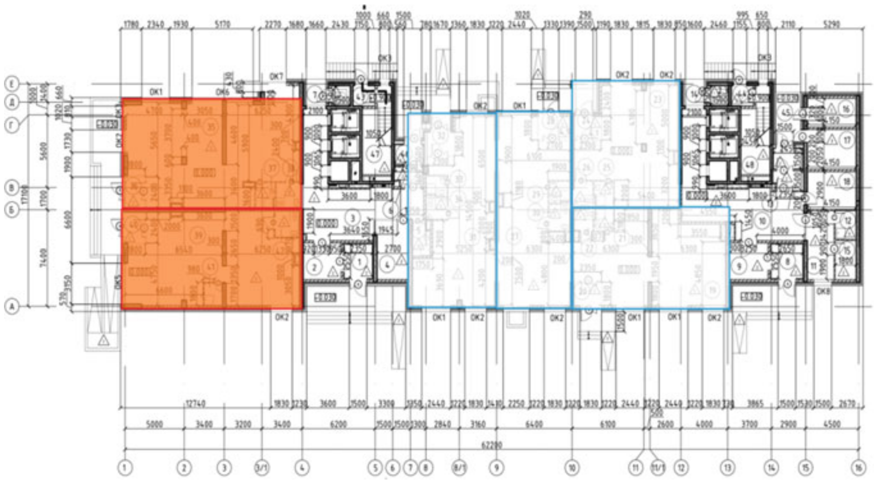

Fig. 2 Plan of the 1st floor of a residential building in the residential complex "Preobrazhensky"

4 Conclusion

It is necessary to comprehensively improve the mechanisms for implementing specific directions of the state social policy, which refers the citizens of the older generation to a special socio-demographic group and considers the specifics of their life activities. We are talking about the integration of social policy into the housing policy of the state in order to form the correspondence of the living environment to the needs of the elderly. In particular, to develop mechanisms of public–private partnership in the formation of a comfortable living environment for the population, since at this stage the society is moving from the classical scheme of participants' interaction within the system of formatting a comfortable living environment, mentioned in the article earlier, to a new and more expanded scheme. A new participant appears in it—this is a private business. The tasks of attracting private business to the provision of social assistance services to the population can just be implemented through the principles of public–private partnership and municipal-private partnership. In particular, to develop mechanisms of public–private partnership in the formation of a comfortable living environment for the population.

It is necessary to consider the needs of older people in integrated development projects, in order to first of all meet the goal of integrated development, which we discussed at the beginning of the article, and this is to ensure a comfortable stay, absolutely for all citizens, based on their needs and regardless of age gradation.

A proposal to improve the comfort of the environment for the elderly through the development of organizational and managerial solutions in the social sphere: to strengthen the partnership of state authorities and local self-government bodies with public associations, especially charitable organizations, and to assist them in providing services to older citizens, protecting their rights and interests, and increasing social activity.

Proposals for improving the comfort of the environment for the elderly based on the development of organizational and management solutions in the urban planning sphere:

- Creation and support of competitions for the best projects of development of residential buildings, planning of residential premises.
- Revision of the regulatory framework for the design of residential areas in terms of the norms for the mandatory area of functional zones in order to increase the comfort and compactness of the development of territories.

Improving the life of older people affects the life of all groups of the population. A city designed to meet the needs of older people and young people with prams is a city that is convenient for everyone. This fact directly determines the choice of alternative social models of the living environment for all categories of the population.

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Analysis of Sustainable Development Trends in Improving the Universities Architectural Environment

Tatiana Ya. Vavilova and Daria S. Kaiasova

Abstract The practice of implementing sustainable development technologies into promotion programs and projects of university buildings and complexes is considered. They are part of the general worldwide process covering the educational, organizational and scientific activities of higher education. Such approach is in line with the new guidelines for the development of life. The object of study was the universities included in the Top 200 QS World University Rankings in 2020. The purpose of the study is to identify modern tools of the architectural and planning organization that ensure the implementation of the principles of sustainable development in their activities. In the course of the work, the tasks of studying and collecting experiences in the development of their infrastructure were solved. The analysis of numerous examples revealed the relationship between the greening of the educational process and scientific research with such key trends in improving urban planning and architectural solutions as the modernization and construction of new buildings based on resource-saving technologies, as well as the verification of university campus facilities for compliance with environmental certification criteria. The buildings that received the relevant documents were investigated more thoroughly. The conclusion about the close dependence of the university's successes on the quality of the university environment was made. In Russian universities, educational, scientific and laboratory infrastructure should be developed and modernized in accordance with the principles of sustainable development.

Keywords Architecture · University · Sustainable Development · "Green" Standards

1 Introduction

By the beginning of the 90s of the twentieth century, the formation of the methodological foundations of the sustainable development theory (SD) contributed to the

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understanding of the need for practical implementation of its ideas. The process was based on the integration of economic, political and institutional mechanisms at the international and national levels. In 2000, at the World Education Forum in Dakar, modern education was recognized as the key to SD, peace and stability within and between countries. The years 2005–2014 passed as the UN Decade of Education for Sustainable Development, and in 2011 the following two main approaches to the implementation of these tasks were identified: general and professional. The most important role of the professional sector was noted, as the training of leaders who can navigate environmental and social issues will be up to date.

Currently, universities are facing new challenges in the field of sustainable development of the architectural environment. Therefore, in the course of this work, the dissertations of Russian scientists were systematized. It was found that in most works the problems of sustainable development and related environmental, social and economic innovations are considered fragmentary. Basically, the issues of improving the quality of the architectural and spatial environment of universities and improving their infrastructure were considered (Skakova A. G.—2003; Yankovskaya Yu. S.—2006; Liluyeva O. V.—2011; Puchkov M. V.—2011, 2020; Khrustalev D. A.—2011; Isakova S. A.—2012; Ryabova E. K.—2012; Chernenko G. N.—2012; Gazaryan R. K.—2013; etc.). It is absolutely clear to us that aspects of sustainable development almost did not affect the adjustment of the principles proposed by scientists for the design and modernization of different university buildings, including educational and research facilities.

2 Materials and Methods

The main method of research was a content analysis of the websites of foreign and Russian universities included in the Top 200 QS World University Rankings in 2020, as well as the websites of a number of leading Russian state universities located in the Volga Federal District.

At the first stage of the work, data on infrastructure, development programs, educational and scientific activities were collected. The key evaluation criteria (indicators) were compliance with the UN Sustainable Development Goals, namely Goal 4—"Quality education" and Goal 11—"Sustainable cities and communities".

At the second stage of work, attention was paid to university infrastructure facilities that built or modernized in the twenty-first century. For this step, both data from university websites and illustrated articles from specialized Internet portals were used—ArchDaily.com, Archi.ru and others. The information was also received from the websites of architectural and engineering companies engaged in the design or modernization of facilities. The most important criterion was the compliance of design solutions or already constructed facilities with national or international systems of environmental certification of buildings.

All the data was accumulated in Excel spreadsheets and then sorted.

3 Results

3.1 Key Aspects

One of the problems of promoting the ideas of sustainable development in Russian higher education is related to the lack of buildings and premises that are necessary for effective practice-oriented training of students and for conducting various research works using modern methods and technologies for scientists. Meanwhile, the basis of the development policy of the most successful higher education institutions in the second half of the XX century was the recognition that the formation of the mentality and knowledge of future bachelors and masters, as well as the effectiveness of scientific research depend on the conditions created for this. Unfortunately, today the functional and spatial qualities of the majority of research facilities of the Russian higher school do not correspond to the modern tasks of innovative technological breakthrough.

At the beginning of the twenty-first century, with the support of the UN, the introduction of SD technologies became a global strategic reference point for universities after the Rio+20 Forum in Rio de Janeiro (2011). Higher education institutions' commitments to sustainable development practices should cover all major areas. These include the learning process, scientific research, the content of practices and extracurricular activities, and, most importantly, the modernization of the architectural environment of universities. The international community was able to concretize a number of important measures contributing to the promotion SD ideas in higher education. These are the following areas:

1. inclusion of disciplines related to sustainability issues in the core curriculum;
2. promotion of scientific research and innovative technologies for sustainable development;
3. modernization and construction of new buildings and facilities in accordance with the principles of the ecological balance maintaining;
4. combining the efforts of universities, local authorities and citizens for the purpose of social integration and improvement of the ecological state of the habitat;
5. development of international cooperation.

Unfortunately, there is also no experience of environmental certification of university facilities in Russia. Therefore, the primary attention in the study was paid to the consideration the real practice of greening the best universities in the world. Many of them post this information on official websites. The websites of reputable architectural magazines and specialized designers have become important resources for obtaining a reliable picture of trends in the use of sustainable development technologies. Also, a significant number of scientific publications of researchers from different countries were studied.

3.2 Sustainable Development Strategies and Long-Term Action Plans

At the beginning of the twenty-first century, the experience of the most prestigious universities in the world in changing the guidelines of spatial development and improving the architectural environment is of particular interest. The majority of these universities have purposefully switched to the development of strategies or long-term action plans based on SD principles. The modern technologies of greening and humanization of the educational and architectural environment began to be introduced there [1, 2]. The relevant plans include sections devoted to the design, construction and modernization of the functional and spatial structure of campuses, the street and road network, landscape design and landscaping, buildings and their engineering systems, as well as the development of underground space. The use of a synergetic approach is aimed at reducing anthropogenic pressure on the environment, optimizing social and functional processes and reducing operating costs. Very often, planning is based on the elaboration of special documents used. For example, the University of Nottingham (UK–China–Malaysia) implements an environmental protection strategy. This applies to all areas of education and management. In particular, the procedure of environmental certification of buildings according to the BREEAM standard (Building Research Establishment Environmental Assessment Method, Great Britain) is being actively used, the network of bicycle services is being expanded and the extensive Nottingham Park owned by the university is being maintained [3].

At the same time, it is a very important fact that at present, in the universities of all progressive countries that are part of the "Bologna Space" are persistently studying disciplines that use the theory and applied technologies of SD and are guided by the 17 Sustainable Development Goals. For example, already in 2006, sustainable development became the basis for cooperation between universities that joined the International Alliance of Research Universities (IARU) [4], and in 2011, the process of implementing SD technologies also affected the training of future architects. Four universities from Portugal, the Czech Republic, the Netherlands and Spain have submitted Master's degree programs in Sustainable Buildings (IMoSB) to the European Commission [5]. In connection with these and other circumstances, the inclusion of Russian universities in the greening process is becoming an increasingly urgent task.

Therefore, the subject of the presented research was a set of methods that meet the Goals of Sustainable Development and contribute to improving the quality of the architectural environment of universities.

3.3 Infrastructure for Promoting Sustainable Development Science and Practice

Another notable trend of the era of SD is the orientation of higher education activities towards the technological renewal of national economies. Special attention is paid to practice-oriented training, as well as to the development of the infrastructure of buildings and complexes for conducting scientific research. Their typology in the twenty-first century is diverse and is subject to industry characteristics when solving scientific problems. Today, innovation development centers, research centers, laboratories, testing centers and scientific and information centers for the development of applied methods of sustainable development, especially those related to the resource conservation, have become the most common facilities in engineering universities [6]. In this regard, the experience of the University of Cambridge, where the Institute for Sustainability Leadership was established, as well as Nanyang Technological University (Singapore), where the activities of six innovation centers are focused on sustainable development issues at once, is also interesting.

To conduct unique research and experiments in a single complex, it is possible to integrate scientific departments of several universities, as well as cooperation between universities, academic and commercial institutions [7]. One of the first examples of such facilities was the “Triangle Universities Nuclear Laboratory”, built on the campus of Duke University (1969, USA). For several decades, platforms for successful cooperation of about 100 scientists from four of North Carolina state universities have been created in this place every year [8].

The next trend of multisectoral optimization of university infrastructure in the context of SD, which appeared at the beginning of the twenty-first century, is the design, construction and modernization of facilities. Such buildings are designed both for the study of ecological and social systems (“nature–society”, “man–society”), and for educational activities. This role is performed by university libraries, museums, and visitor centers attached to research institutions. For example, to enhance the importance of the Botanical garden of the University of Copenhagen (2012, Denmark, authors—Lundgaard and Tranberg Arkitekter и Claus Pryds), by 2024 it is planned to build a new museum of natural history in the city center in accordance with the project of its phased reconstruction and expansion. At the same time, a significant part of the new premises will be located underground. This method will ensure the best preservation of collections. All conditions for transit to the botanical garden and autonomous use of the museum without disrupting the educational process will be created [9].

A combination of research and educational activities is considered to be one of the characteristic techniques that contribute to increasing the prestige of the university. Examples are the most prestigious universities, such as the Massachusetts and California Institutes of Technology, Harvard and Stanford Universities (USA), Cambridge and Oxford Universities (UK), Tsinghua University and Peking University (China), etc. Extensive areas of social interaction are included in the structure of campuses and individual buildings to implement this idea. Their task is to strengthen scientific relations between various departments of the research institution, as well as with foreign partners [10].

The most common trend that corresponds to the SD goals is the use of "green" standards in the design, construction and reconstruction of university campuses. Firstly, it is embodied in the modernization of existing facilities and in the design of new buildings, and, secondly, it is reflected in the themes of innovative developments [11]. In architectural and construction solutions, with the help of the latest achievements of the engineering industry, optimal microclimatic parameters are maintained and a psychologically optimized environment is formed. Staying in such buildings helps students, teachers and staff to realize the importance of SD processes and to understand the tasks of humanization and greening of life better [12, 13]. Obtaining a certificate of compliance with environmental protection requirements is considered the highest achievement. The certificate becomes the pride of the university, and the information about it is advertised on the official website. For example, on the website of the MIT Office of Sustainability (Massachusetts Institutes of Technology), we can find information about the implementation of the Zero-Carbon Campus and 2019 Climate Action Plan Update principles, as well as about university buildings that comply with sustainable development strategies.

SD technologies are most fully implemented by universities in the construction of infrastructure facilities for scientific research. For example, in the Hardiman Research Center and the National University of Ireland's Biomedical Research Center (2013, architectural design—Payette), the main attention was paid to light comfort and natural ventilation of premises [14]. In the United States, the external parameters and microclimate of the premises of the ten-story multifunctional building of the Rice University Biological Research Association were coordinated using monitoring systems (2009, designer—SOM) [15]. And in Canada, a similar process is being carried out at the Center for Interactive Research on Sustainability (CIRS) at the University of British Columbia (2011, architect—Peter Busby—FRAIC, Perkins + Will, Canada) [16]. In the building of the Advanced Energy Research and Technology Center at the American State University of New York at Stony Brook (2011, developed by Flad Architects) methods of introducing renewable sources into construction, engineering and industrial technologies, the use of solar energy, the collection and reuse of rainwater, the processing of building materials, etc. are being studied [17]. All the mentioned North American facilities have successfully passed the LEED environmental certification (Leadership in Energy and Environmental Design, USA).

The process of invention and implementing sustainable development technologies is rapidly spreading to the architecture of laboratories. They are key elements of the research infrastructure of universities. For example, in China, the Green Energy Laboratory of Shanghai Jiao Tong University (2012, Archea Associati project) studies low-carbon technologies for construction and housing. Photovoltaic panels are installed on the roof of the building, experiments with which allow optimizing energy consumption modes [18].

The experience of modernizing the laboratories of Yale University (USA), which is considered one of the most authoritative in the world, also deserves attention. Since 2010, a large-scale modernization of laboratory and technological equipment and engineering support systems has been carried out here. In 2013, a Sustainability Supplement to the Campus Planning Structure was introduced. As a result, by 2020, the conditions for conducting most scientific research have improved significantly. There are 27 facilities that have received LEED certificates (in different categories) to significantly reduce the negative impact on the environment [19].

The study of best practices and a thorough content analysis of open Internet resources have shown that progressive transformations in Russian universities, corresponding to global trends, have already been outlined. In recent years, in the curricula of Russian universities more and more attention has been paid to the issues of resource conservation and environmental protection. The interest in promoting the ideas of SD is most clearly manifested in the criteria and results of the rating assessment of the sustainability of the world's universities—UI GreenMetric World University Rankings [20]. It has been arranged by the University of Indonesia since 2010. By 2020, the total number of participating countries had reached 84, and the number of universities will grow from 95 to 912. A large group of 51 universities from Russia participated in the latest ranking, which is partly due to the emergence in 2017 of the All-Russian youth movement—The Environmental Association of "Green" Universities of Russia. Familiarization with data on the official websites of Russian universities has shown that various aspects of sustainable development are very rarely included both in student training programs and in the subject field of scientific research.

4 Discussion

There is a link between the quality of education received and the effectiveness of scientific research. It is clearly reflected in the statistics of the Nobel Prize. To confirm the previously expressed results, the lists of laureates were compared with the QS World University Rankings for 2007 [21] and 2020. The analysis revealed that countries with a large number of "best" universities are stable "suppliers" of laureates. Moreover, this trend is most pronounced in the statistics of the post-industrial period—that is, from the 1980s to the present, as shown in Table 1.

It should be remembered that in 2007 none of the universities in Russia was included in the list of the top two hundred best, and in 2020 only one was included. A significant reason for the insufficiently high international positions of Russian universities is the overall low level of product innovation. Their development requires the creation of buildings with new properties, for example, the ability to adapt to specific tasks. This trajectory has been chosen by many countries in which scientific developments of universities are carried out by orders of manufacturing companies and actively implemented in practice, for example, in Germany, China and South Korea.

Table 1 Comparison of the assessment dynamics of the academic level of universities in the Top-200 QS World University Rankings

Country	2007		2020		Total number of Nobel Prize winners for 1980–2020	Rating
	Number of universities	Rating	Number of universities	Rating		
USA	57	1	45	1	198	1
UK	32	2	26	2	40	2
Australia	12	3	11	4	6	10–13
Germany	11	4–7	12	3	24	3
Canada	11	4–7	7	7–10	14	6
Netherlands	11	4–7	9	6	5	14
Japan	11	4–7	10	5	20	4
China	6	8	7	7–10	4	15–16
Belgium	5	9–11	4	15	2	19–23
France	5	9–11	5	11–14	19	5
Switzerland	5	9–11	7	7–10	9	8
Hong Kong	4	12–13	5	11–14	1	24–…
Sweden	4	12–13	5	11–14	13	7
Denmark	3	14–15	3	16–18	2	19–23
New Zealand	3	14–15	2	19–29	–	–
Austria	2	16–23	2	19–29	3	17–18
Brazil	2	16–23	1	30–33	–	–
Israel	2	16–23	1	30–33	6	10–13
Irish	2	16–23	2	19–29	2	19–23
Italy	2	16–23	3	16–18	3	17–18
South Korea	2	16–23	7	7–10	1	24–…
Singapore	2	16–23	2	19–29	–	–
Finland	2	16–23	2	19–29	2	19–23
Spain	1	24–28	2	19–29	1	
Mexico	1	24–28	2	19–29	2	19–23
Norway	1	24–28	2	19–29	4	15–16
Taiwan	1	24–28	2	19–29	–	–
South Africa	1	24–28	–	–	6	10–13
Malaysia	–	–	5	11–14	–	–
India	–	–	3	16–18	8	9
Saudi Arabia	–	–	2	19–29	–	–
Chile	–	–	2	19–29	–	–
Russia	**–**	**–**	**1**	**30–33**	**6**	**10–13**
Kazakhstan	–	–	1	30–33	–	–

One of the main reasons for the lag is a significant reduction in the volume of new construction and modernization of existing buildings over the past 40–50 years. According to the Federal State Statistics Service for 2020, the degree of depreciation of fixed assets for professional, scientific and technical activities amounted to 46.1%, for education –48.3%, which is significantly higher than the average industry values in the country.

5 Conclusions

In the course of the work, the tasks of studying and summarizing the experience of the world's leading universities in implementing of the principles of sustainable development were solved. Since the adoption by all UN member States of 17 Sustainable Development Goals (2015), Russian architectural science had not dealt with these issues. Meanwhile, they are very important for the Russian Federation, since the National Project "Science and Universities" is being implemented in the country. It ensures the development and updating of the university's infrastructure in accordance with modern requirements for training, research and interaction with partners.

Content analysis of the websites of universities included in the Top 200 of the QS world university rankings in 2020 made it possible to see that the principles and goals of sustainable development proclaimed by the UN are being actively implemented in all the main areas of activity of the most prestigious foreign universities. They cover the educational process, scientific research, the content of practices and extracurricular activities. In parallel, in accordance with the new guidelines, work is underway to improve the architectural environment of educational institutions. The functional and engineering consumer properties of the facilities included in the infrastructure, during new construction and modernization changed taking into account new tasks—environmental, social and economic. It was revealed that the programs of many universities identified measures to reduce the impact on the environment, which ensured the implementation of the principles of sustainable development.

The analysis of numerous examples revealed the following trends:

- many prestigious universities located in different countries of the world are aimed at developing strategies or long-term plans that ensure sustainability;
- there is a close relationship between the greening of the educational process and scientific research with ways to improve urban planning and architectural solutions;
- modernization of existing facilities and construction of new buildings on university campuses is carried out on the basis of "green" technologies and verification of architectural solutions for compliance with environmental certification criteria.

In the era of globalization, turning to sustainable development technologies is a necessary condition for the continued existence of Russian universities. Their implementation will contribute social and environmental responsibility of universities, as it is a guarantee of safety, creating comfortable conditions for students to study and improving the effectiveness of pedagogical and scientific work of teachers. This makes it possible to bring closer the international recognition of the Russian higher school and its scientific achievements.

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Problems of Optimization of Design Solutions of Residential Structures and Their Elements

Yuliya Yankovskaya and Alexey Merenkov

Abstract The COVID-19 pandemic gives us a reason to once again draw attention to the problems of optimal functional and spatial organization of residential structures (traditional and mixed types of residential buildings and complexes) and of their basic elements—accommodation units. In the article the authors try to summarize the results of numerous progressive developments in architecture and construction in recent decades. The main problem of creating a comfortable living environment and its elements is that high-quality and proven architectural and planning solutions are often neglected for the sake of short-term economic benefits or considered outdated. The authors focus on optimizing the design solutions of residential cells (as the basic elements of residential structures) in terms of various functional scenarios of their use, as well as their comfort and environmental friendliness. The article provides examples of experimental design developments carried out under the guidance of the authors and awarded at International competitions. The novelty of the proposed recommendations is due to the construction of a system of principles, techniques and means of organizing housing adequate to the needs of society faced with a pandemic.

Keywords Residential structures · Accommodation unit · Comfortable housing · Environmental aspects of design

1 Introduction

In this article we will consider the main problems of formation of a modern living environment which were clearly highlighted by the COVID-19 pandemic. We will allocate the basic means of solving these problems at two structural levels: formation

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of the residential structure as a whole and of its basic element—accommodation unit. The urban planning aspect of building development remains outside the scope of this work.

The relevance of the study is determined by the critical discrepancy between the bulk of the planning solutions of residential structures and the residential cells that make up their basis, the requirements imposed on them in the conditions of the COVID-19 pandemic. This is expressed in the fundamental inconsistency of most modern functional and spatial solutions of residential premises with the requirements imposed on the conditions of long-term isolation of the family and its individual members. There are no separate rooms for each family member, there are no isolated communications leading from the entrance to the apartment to these isolated rooms. This happens in the absence of spatial resources for the organization of isolated work areas necessary for remote operation, both in separate rooms and in family-wide premises; in the absence of spatial resources for the organization of contact with the natural environment within the capabilities of residential cells and residential structures as a whole.

The novelty of the recommendations proposed in the study is due to the construction of a system of principles, techniques and means of an adequate and effective response from the architectural community to the strategic request formulated by the community of consumers put in distress by the results of the irresponsible activities of the organizers of the Russian construction complex in recent years. We are talking about the practical elimination of the system of central and zonal research institutes of standard and experimental design, generalizing and promoting the best practices of domestic and foreign science and practice in the standard of design and construction in the USSR. Currently, in the construction complex of Russia, not representatives of the professional architectural community are at the head of the processes of formation of the residential environment, but builders and developers who are not burdened with relevant knowledge and care about the consumer qualities of housing.

The provisions put forward by the authors have been tested in the scientific and design developments of the last decades, but they need to be generalized and comprehensively presented.

2 Materials and Methods

The materials and methods are determined by the typological approach and traditional views on the functional and spatial organization of the dwelling. The importance of this topic is confirmed by a large number of new scientific publications devoted to the structural organization of housing at different levels [1–7].

The structural method became fundamental for this work. The problem of optimization of housing design solutions is considered at different structural levels. The residential cell and its structural and functional organization are considered as the basic element. Next, the organization of the residential structure as a whole is considered; such consideration seems to the authors more correct within the framework of this study.

The materials of the study are both design developments in the field of housing, and realized objects. In addition, the article presents experimental projects that demonstrate and confirm the propositions put forward by the authors.

The sequence of presentation of the material goes from the basic element to the formation of the residential structure as a whole.

2.1 Accommodation Unit

We adhere to the traditional interpretation of the term "accommodation unit" considering that a residential cell is a set of functionally and spatially interconnected individual and common zones. The accommodation unit is a basic structural element of the living environment, and its comfort determines the quality of the architectural and planning organization of the dwelling.

Problems, challenges (COVID-19 problems). The main problems of the organization of accommodation units highlighted by the COVID-19 pandemic:

- fundamental inconsistency of most of the modern functional and spatial solutions of accommodation units with the requirements for the conditions of long-term isolation of the family and its individual members;
- lack of spatial resources for the ultimate organization of work areas in individual rooms and in family spaces;
- lack of spatial resources for ultimate communication with the natural environment.

Special measures for the organization of accommodation units are aimed at solving these problems, which are summarized in the design principles and planning tools updated by the authors [8].

Basic principles of designing and planning means of their application. Principles of designing accommodation units: a unified approach to the formation of all types of apartments; functional zoning into public and private zones; the device of a developed entrance area (hallway-hall); arranging a well-developed entrance zone from the hallway-hall entrance to the living room. They also include organization of separate entrances from common apartment communications to all rooms; exclusion of "pass-through" rooms; arranging spatial interconnection (transformable partitions) between the living room and the breakfast zone of the kitchen.

Recommended planning techniques and means of organizing accommodation units (see Figs. 1, 2 and 3) are:

- mandatory adherence to the rule of differentiating public and individual zones, starting with the entrance hall (distribution hall);
- following the rule of placing a guest sanitary unit in the entrance area of the apartment (hallway);

Fig. 1 Apartments of the experimental residential district of Severnoye Chertanovo in the 1980s; architects are M. Posokhin (head), L. Dubek, A. Shapiro, L. Misozhnikov, A. Kegler [9]

Fig. 2 Olympia Center in Chicago, 1986. A fragment of a typical storey of a residential area. Business class apartments [10]

- excluding solutions with walk-through living rooms, combined kitchen and living rooms;
- providing an entrance from the hallway or distribution hall directly to the kitchen room;
- planning spatial isolation (separate entrances, stationary or transformable fence) and divided kitchen and living room functions;
- using planning tools that provide possibility of adapting groups of rooms to changing functional requirements—transformable fences, etc.;
- providing possibility of allocating a special area for placing various types of transformers designed for performing work at home in spatial organization of individual and common premises;

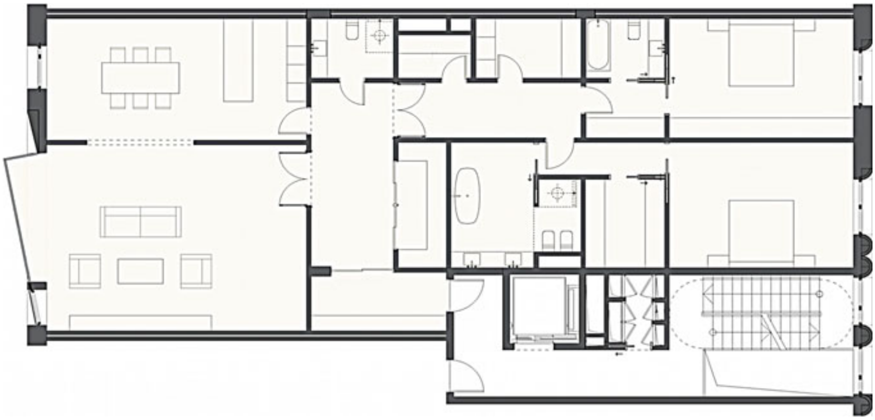

Fig. 3 Multifunctional complex development on the Sofia embankment in Moscow. 3-room business class apartment. Architectural Bureau of Sergey Skuratov, 2015 [11]

- providing specialized premises for home work (offices, studios) in the spatial organization of business-class apartments, placing them near the entrance to the apartment;
- equipping spousal bedrooms of business class apartments with a separate sanitary unit and a dressing room (dressing rooms).

Separately, one may allocate means that ensure interaction with the natural component [8, 12, 13] in the accommodation unit (see Fig. 4):

Fig. 4 Arranging developed (glazed and open) summer rooms for each individual apartment. Berlin, city villa

- to reconsider the point of placing summer premises in residential cells to ensure their optimal use as of recreational premises and equipping them with plants and of their spatial parameters;
- to consider construction of specialized premises (green rooms, winter gardens) in business—class apartments to ensure the possibility of all year-round communication with developed natural forms;
- to consider construction of two-level apartments with built-in courtyards in business class houses.

2.2 Residential Structure

In this section, after analyzing the main requirements and techniques for implementing various life scenarios in residential cells, we consider it necessary to highlight the main points related to the formation of comfortable residential structures. The term "residential structure" in this case seems to us more correct, since we are talking about the basic elements and the most characteristic connections.

The main regulations of the space-planning arrangement of comfortable residential structures. Here are the most significant regulations in the authors' opinion that determine the priorities of the structural organization of housing [8]:

- when forming the structure of multi-apartment residential buildings of various classes and types, the principle of maximum approximation of the functional capabilities and parameters of their residential cells to the functional capabilities and parameters of residential cells of individual residential buildings should be followed;
- in frames of mass urban housing construction to give preference to medium-rise residential buildings, to housing that is more environmentally perfect due to greater inclusion in the natural context (housing at the level of tree crowns);
- to provide individual apartment courtyards for apartments located on the first floor;
- to provide a penthouse area for placing apartments with individual pre-apartment terraces in the structure of residential buildings;
- to provide greening of roofs of residential buildings and their use for recreation;
- to provide developed landscaped all-weather yards equipped with appropriate infrastructure designed to serve a certain number of apartments in the structure of multi-storey residential buildings.

Implementation of the stated regulations in formation of the residential environment. The European experience of organizing a comfortable living environment shows us the approbation of the provisions stated in the previous section (see Figs. 5 and 6).

Fig. 5 Paris. Residential buildings of medium height (housing at the level of tree crowns) with developed summer premises, apartment courtyards and penthouses

Fig. 6 Oslo. Green public spaces on the roof of a residential building

3 Results and Discussion

The main results of the presented research and design study consist in summarized, systematized and emphasized number of significant regulations for the design of comfortable residential structures and their basic elements—accommodation units, meeting various life scenarios (including those associated with long-term forced isolation at home). The article clearly shows the usage of the proposed provisions in the world practice of home design and construction.

Let us summarize the main points that ensure the comfort of a long stay in a home:

- orientation to the maximum use of medium-storey residential structures;
- approximation of residential cells to the parameters of individual residential buildings;
- introduction of a «green component» into the structure of the dwelling through summer open spaces/winter gardens/apartment courtyards, landscaping of exploited roofs, the formation of all-weather courtyards into groups of quarters;
- mandatory clear functional zoning of an accommodation unit and organization of a place of work at home.

We will demonstrate how these provisions are implemented in experimental projects carried out under the guidance of the authors for Russian conditions (see Figs. 7, 8 and 9).

The project "Panorama" is an illustration of the proportionate inclusion of comfortable summer rooms in the premises of apartments and public recreational areas of a residential building.

The experimental project for the city of Ekaterinburg provides for the organization of a system of developed green recreational spaces organically connected with residential apartments.

Fig. 7 An experimental project of a medium-storey residential structure "Panorama" (the city of Sysert). An architect is E. Asmolov, leaders are A. Merenkov, N. Doronina, N. Lamekhova

Fig. 8 The plan of the seventh floor with a “green component” and the plan of the apartment. The project of a medium-storey residential structure “Panorama”. An architect is E. Asmolov, leaders are A. Merenkov, N. Doronina, N. Lamekhova

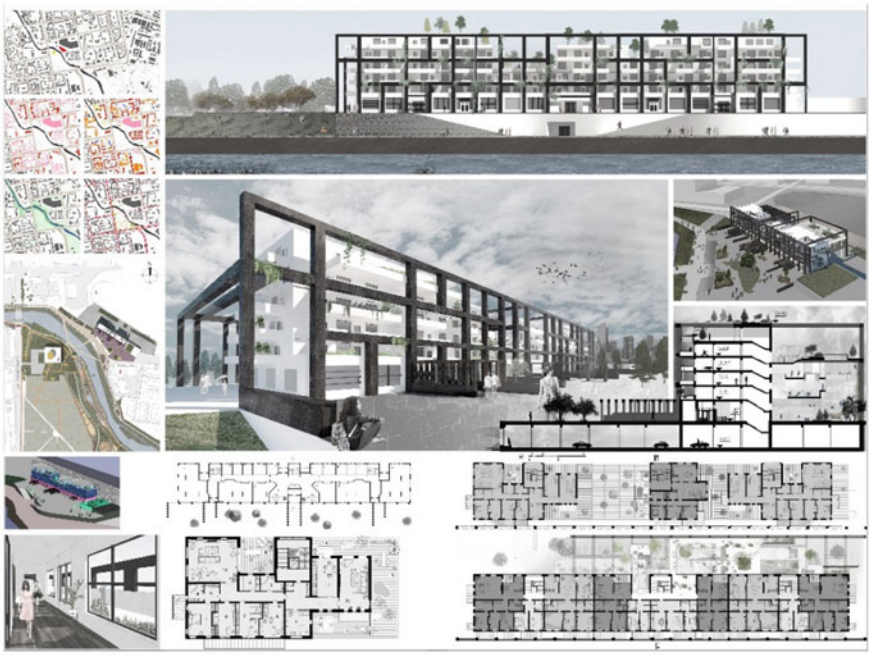

Fig. 9 An experimental project with developed open apartment spaces for the city of Ekaterinburg. An architect is K. Yshakov, leaders are M. Mamveev, T. Matveeva A. Merenkov

Next, we will demonstrate how the methods of organizing medium-storey residential structures are adapted for high-rise buildings while maintaining a high level of comfort (see Fig. 10).

The project of a complex of apartments for the city of Ekaterinburg serves as an illustration of the formation of a system that ensures the vertical distribution of well-maintained public spaces that are rationally close to residential cells.

Fig. 10 The project of a complex of apartments for the city of Ekaterinburg. An architect is A. Alyakritskiy, a leader is A. Merenkov

In conclusion, we present a project for the harsh climatic conditions of the city of Nadym, adapting the declared provisions in the form of a residential structure isolated from external influences with an internal all-weather courtyard (see Figs. 11, 12).

The project of a public-residential complex for the city of Nadym demonstrates a developed public space with favorable microclimatic parameters, serving residential and public structures.

Fig. 11 Pilot project of a public-residential complex for the Far North (Nadym city). An architect is E. Denshchik, leaders are A. Merenkov, N. Lamekhova

Fig. 12 First and second floor plans. In the central part of the building, there is an all-season courtyard with public infrastructure. The pilot project of a public-residential complex for the Far North (Nadym city). An architect is E. Denshchik, leaders are A. Merenkov, N. Lamekhova

4 Conclusion

The article highlights the principles, techniques and means of designing accommodation units and their structures that ensure comfort even with a forced long stay in a dwelling. Let us list them. First is a unified approach to the formation of all types of apartments; functional zoning into public and private zones; the device of a developed entrance zone; the organization of a well-developed entrance zone from the hallway-hall to the living room. There is also compliance with the rules for placing a guest bathroom in the entrance area to the apartment; the organization of separate entrances from the common communications of the apartment to all rooms; the exclusion of “walk-through” rooms. This involves providing an entrance from the hallway or distribution hall directly into the kitchen room, excluding the combination of kitchen and living room functions; organization of spatial interconnection (transformable partitions) between the living room and the kitchen breakfast area. Then there is allocation of a group of private rooms in the form of bedrooms and bathrooms (bathrooms) serving them into an autonomous group of rooms with independent access from the hallway (distribution hall); the use of planning tools that make it possible to adapt groups of rooms to changing functional requirements—transformable fences, etc. Providing the possibility of allocating a special zone for the placement of various types of transformers designed to perform work at home in the spatial organization of individual and common rooms; providing specialized rooms for homework (business class), placing them next to the entrance to the apartment are also included. Equipping the marital bedroom of business-class apartments with a separate sanitary unit and a dressing room (dressing rooms); equipping business-class apartments with developed summer rooms of various kinds, including apartment courtyards designed for ground-level apartments, terraces for apartments of the "penthouse" type and similar solutions are provided for. The inclusion in the multi-storey residential structures of landscaped multi-level courtyards designed to serve a certain composition of apartments, for which they can serve as a well-maintained and equipped with the necessary infrastructure recreational area.

The provisions about the competent functional and spatial organization of residential cells and specifics of the structural organization of residential buildings put forward in the article can be used in experimental and mass design of a high-quality, eco-friendly, comfortable and humanistic living environment of a modern city.

All the provisions stated in the article have been successfully tested in experimental design and have received high awards and reviews at international professional competitions.

All the presented experimental projects were carried out at the Department of Architectural Design of Ural State University of Architecture and Art.

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Architectural Organization of Public Spaces in Coastal Areas

Tatyana Zhuravleva and Mikhail Zhuravlev

Abstract This article examines the architectural means of organizing public spaces in coastal areas. The presence of a natural reservoir in the city is a great value, which determines great responsibility for coastal areas organization. Water has always been the center of attraction for people; therefore it is necessary to include embankments in the structure of the city. More and more cities are reorganizing industrial zones that were previously located on the banks of rivers in favor of a human-friendly environment. This determines the relevance of the study of architectural means of creating public spaces in coastal areas. The research methodology involves the selection of modern efficient public spaces of coastal areas with an aesthetically high quality environment. Selected objects are considered for functional zoning, typology of spaces, types of landscaping, the presence of small architectural forms. For each subsection, based on the results of the analysis, the main functional zones of public spaces are determined including the conditions of their efficient functioning; the main space types necessary to ensure a comfortable stay of visitors are indicated; types of landscaping are considered; and a classification of small architectural forms is provided.

Keywords Coastal area · Embankment · Public space · Urban environment

1 Introduction

The public space of a modern city must meet the requirements of safety, accessibility, and environmental friendliness. One of the most important demands is the creation of such an environment that meets the actual needs of society. This entails the creation of a large amount of functional areas. The above-listed characteristics determine the necessity of urban public space, its durability and efficiency [1]. The relevance of this study is determined by the need to develop the concept of sustainable development

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of urban public spaces. An integrated approach is needed to identify architectural methods for organizing public spaces in coastal areas.

A distinctive feature of the public spaces organization in coastal areas is the presence of a natural water body as the main element. Water is the center of the volumetric-spatial composition. The original function of the embankment is to provide bank protection, for example, to prevent the coastal development from flood destruction. This issue was especially acute for cities on the banks of rivers with cascades of hydroelectric power plants. The embankment is also very often combined with port facilities. The modern embankment includes recreational, entertainment, sports functions, and thus one of the most important tasks is to arrange them properly [2]. In a broader sense, the contact between the city and the water body is ensured by means of the public space organization of the costal area. The increased attention to the zone of this contact prompts a deeper study of the patterns of coastal territory development and the architectural methods of organizing public spaces.

Urban public spaces have been studied by researchers such as K. Lynch ("The Image of the City"), Jane Jacobs ("The Death and Life of Great American Cities"), William H. Whyte ("City: Rediscovering The Center"), Jan Gehl, Ray Oldenburg, Anna Gelfond ("Public Space Architecture"), Vyacheslav Glazychev, Alexey Krashennikov, Alexey Krasheninnikov. Currently, the topic of public spaces is disclosed from the perspective of urbanism, sociology, and perception of space. However, the public space of the embankments is a special case in the structure of the city. The embankment is the place of contact between the city and nature. The formation of the public space of the coastal territory is carried out taking into account the reservoir as the main compositional and specific element. The issue of organizing the public space of coastal areas is currently not fully disclosed and requires special attention.

The purpose of this study is to identify and systematize the architectural means of organizing public spaces in coastal areas. The object of the research is landscaped public spaces of coastal areas (embankments) of large cities in different countries, demonstrating effective functioning and aesthetically high-quality environment. Research objectives are:

- sample of realized public spaces of coastal areas;
- analysis of selected objects for functional zoning;
- analysis of selected objects for the typology of space;
- consideration and systematization of types of landscaping by the example of selected objects;
- consideration and systematization of the types of small architectural forms used in the selected objects;
- presentation of the results of the analysis in the form of functional diagrams and tables.

2 Methods

The identification of architectural means of organizing public spaces of coastal territories is carried out by analyzing the existing embankments. For this analysis, we have selected public spaces of coastal areas of different structures, located in different countries and demonstrating effective functioning, as well as an aesthetically high-quality environment. The selection of objects is carried out according to the following criteria: the completed project; the location of the coastal area in the city; the presence of several functional areas; variety of types of space; the presence of landscaping; aesthetically high quality environment.

All selected objects study is based on the following architectural means of organizing public spaces of coastal areas:

1. Functional zoning.
2. Typology of spaces. The quality of the urban environment largely depends on the set space types it contains. Small secluded areas, linear communications-corridors, spacious areas for mass events differ significantly [3, 4].
3. Landscaping is one of the means of organizing public spaces, which include the geometric appearance of the form, size, mass, texture, position in space, color and some other features. The space of the embankments belongs to the coastal areas for recreational purposes, landscaping in various ways is one of the most effective methods of creating a comfortable and human-friendly public space [5]. In most countries, the amount of greenery in cities is currently being standardized in one way or another, but special attention is paid when it goes to embankments for they are considered to be especially valuable territories.
4. Small architectural forms. An increasing number of studies confirm that the requirements for the public space of modern society are changing [6]. An open area is not enough for a city dweller; he needs a place for rest, food, street cinemas, and sports grounds. Public space today is an urban "guest-room" where people come to relax after work. The saturation of the environment is gained by a system of pavilions, small architectural forms, the visual appearance of which should reflect the trends in architecture and design of the architectural environment.

Based on the results of the analysis, the main functional zones are determined, used space types and landscape types are found, and the classification of small architectural forms is given.

3 Results

The analyzed objects represent territories with a complex structure of functional zones. The main functional areas present in each object, as well as secondary ones, providing an expanded program of activities on the territory, have been identified.

3.1 Functional Zoning

Sandgrund Park, Thorbjorn Andersson and Sweco Architects, 2008. The public space of the Sandgrund Park embankment has the following functional areas: a terrace that provides contact with the water; promenade; street scene; berths; landscaping and natural relief; a place for holding mass events; sand beach (see Fig. 1) [7].

Paprocany Lake Shore Redevelopment, RS and Robert Skitek, 2014. The coastal area of the lake has a recreational function; the following zones are present here: beach; promenade; terrace that provides contact with water; outdoor sports ground; terrace for relaxation (see Fig. 2) [8].

Vestre Fjord Park, ADEPT, 2017. This design solution assumes the following functional areas: playground; promenade; terraces providing contact with water, an amphitheater (see Fig. 3) [9].

Zhangjiagang Town River Reconstruction, Botao Landscape, 2013. The main goal of the reconstruction of the city river embankment in Suzhou was to create an oasis in the city. Therefore, the following functional areas have become the main ones:

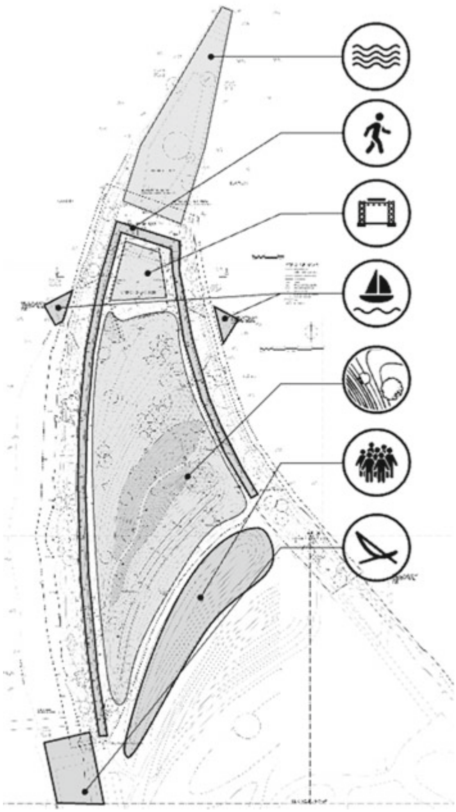


Fig. 1 Sandgrund Park Embankment Functional Zoning Scheme, Sweden, original work

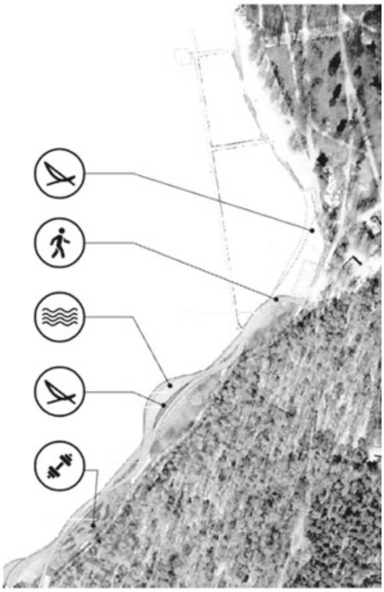


Fig. 2 Paprocany Lake Shore Redevelopment Functional Zoning Scheme, Poland, original work

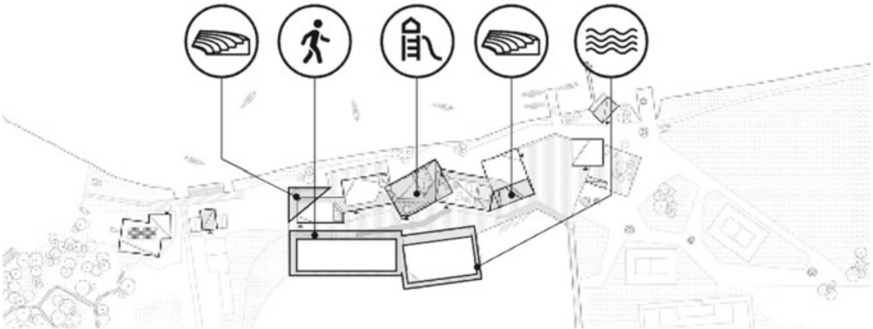


Fig. 3 Vestre Fjord Park Functional Zoning Scheme, Denmark, original work

promenade; terraces that provide contact with water; amphitheater; landscaping area; catering (see Fig. 4) [10].

Samara embankment, The First Stage. The functional program of the Samara embankment includes: promenade; landscaping; outdoor sports grounds; playgrounds; beach; pier; catering points (see Fig. 5).

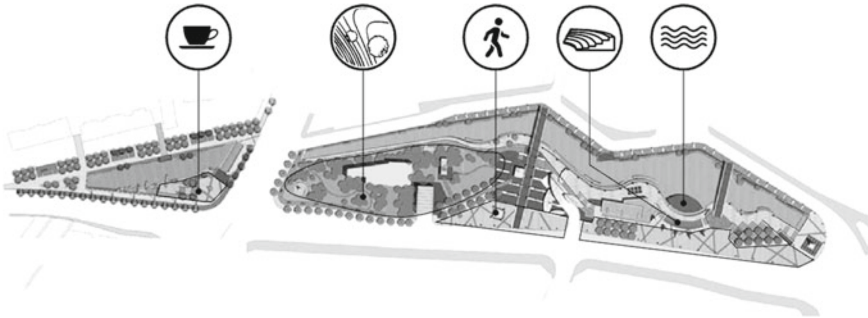


Fig. 4 Zhangjiagang Town River Functional Zoning Scheme, China, original work

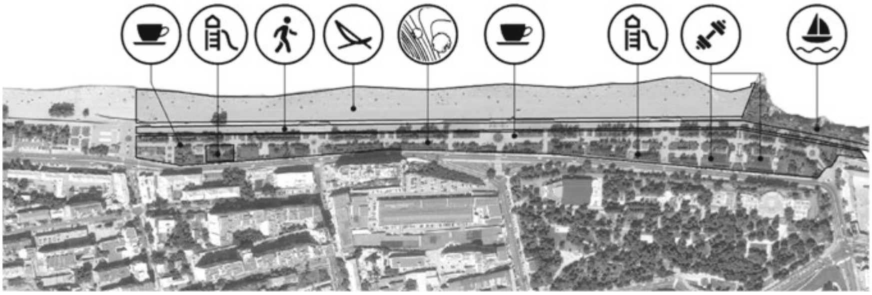


Fig. 5 Samara embankment Functional Zoning Scheme, Russia, original work

3.2 Typology of Spaces

The public space of modern coastal territories was analyzed for the presence of various types of volumes and spaces in it: linear connections; open flat areas; volumes formed by landscaping and natural relief; volumes formed by artificial relief; compact closed objects. The analysis results are presented in Table 1.

3.3 Landscaping

The following types of landscaping are used when organizing public spaces of embankments: flat gardening; landscaping with freestanding trees and shrubs; trees and shrubs group compositions; ordinary arrangement of trees and shrubs (see Table 2).

Planar landscaping is the most common type of landscaping. This includes a lawn, planting tall grasses, flower beds. The current trend is the planting of filtration landscaping for the purification of polluted waters (e.g. the embankment of the Kaban lake system in Kazan [11]).

Table 1 Space types of coastal areas

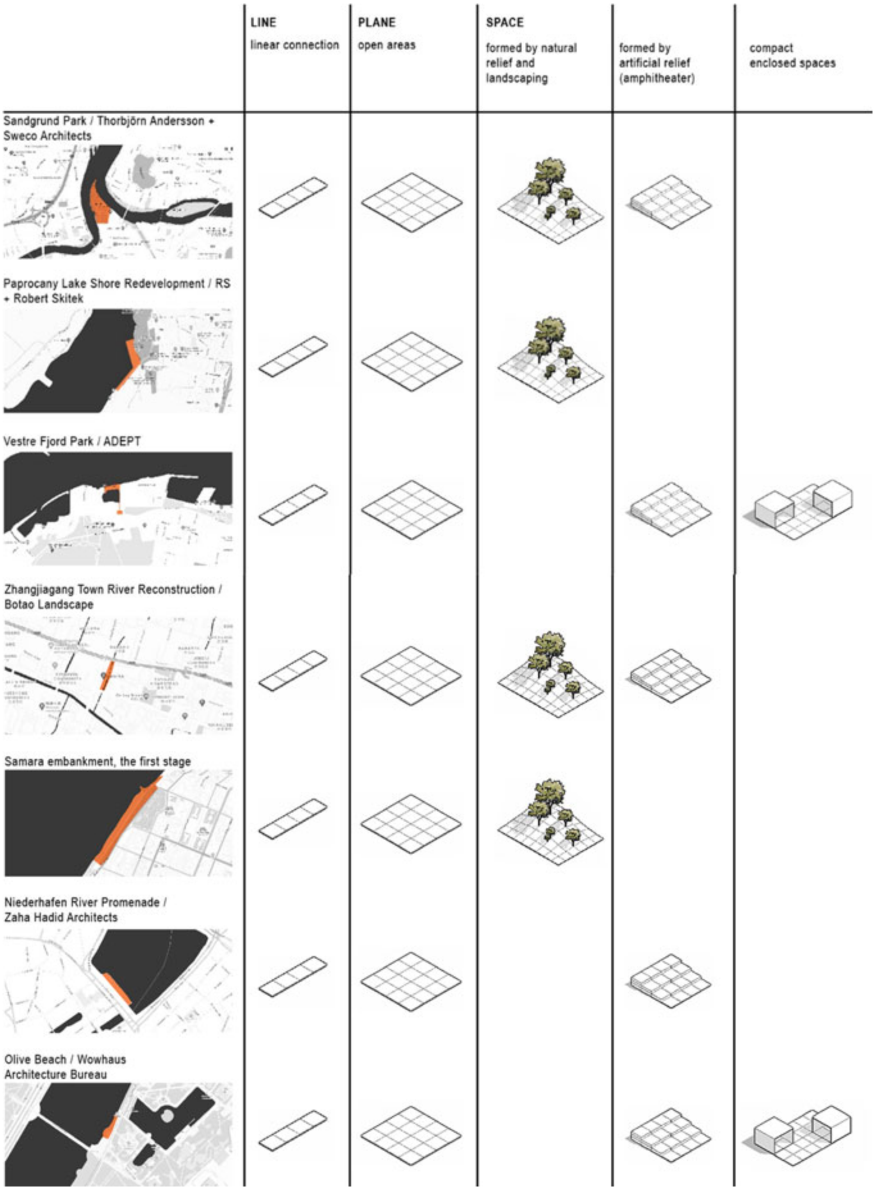
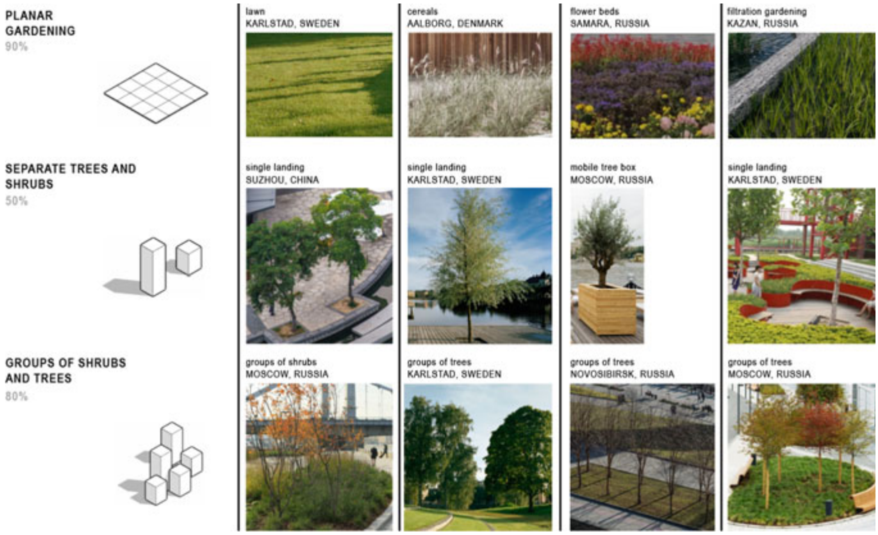


Table 2 Types of landscaping of coastal areas



The feature of public spaces of coastal areas is the prevalence of a linear direction; therefore, one of the main methods of landscaping in this case is the alley or in-line planting of trees and shrubs. However, it should be noted that in modern embankments there is a tendency towards more natural landscape arrangement. The regular arrangement of elements is mostly rejected nowadays. Thus a more natural public space environment is achieved [12].

Based on the considered objects, the following conclusions can be drawn. Landscaping is completely absent in 10% of the total number of analyzed projects of organizing public areas; planar gardening is used in 90% of cases. Volumetric landscaping with large trees and shrubs was carried out in 70% of the total number of analyzed territories.

3.4 Small Architectural Forms

Small architectural forms are the means of organizing public space. The main tasks that such objects solve are: functional program expansion of public space; visual environment content; stylistically established environment updating; provision of the necessary space for holding mass events. The small size of such objects makes it possible to create a human-scale environment, to orient him in the public space of the coastal territory.

Volumetric-spatial configuration can be expressed in the following types (see Table 3):

Table 3 Types of volumetric configuration

TYPES OF VOLUMETRIC CONFIGURATION	COMPACT Final Wooden House Sou Fujimoto Architects	LINE King's Garden Pavilion Krupinski Arkitekter	VOLUMETRIC Pavilion of Reflections Studio Tom Emerson
			

Table 4 Types of functional purpose

FUNCTIONAL PURPOSE	SCULPTURE Broken Landscape NFO	ONE FUNCTION The Oasis OBBA	MULTIFUNCTIONAL Collapsible Street Cinema Omri Revesz
			

- compact object, which is a small structure with a clearly defined internal and external space;
- linear object. Small architectural objects of this type are associated with the organization of flows with a pronounced direction. Objects of this type also serve to delimit space, to create the boundaries of different functional areas;
- deep spatial object. It is a structure with a combination of different space types and the absence of a clear boundary between internal and external space.

In terms of functional purpose, objects are classified below (see Table 4):

- sculpture;
- monofunctional object. Such kind of a small architectural object is intended to contain one process and does not imply a detailed use case;
- combination of several functions in an object. This kind of structure contains several processes that implies either the spatial delimitation of the object into two zones, or the transformation of the object for each functional process, that is, the organization of processes in time.

4 Discussion

4.1 Functional Zoning

Based on the analyzed modern public spaces of coastal areas, the following functional zones can be distinguished: a promenade, a zone of landscaping and natural relief, a pier, view terraces and playgrounds, an amphitheater, a beach, a sports ground, a playground, a catering area, an area for holding mass events, a quiet recreation area. The more of the above functions the embankment includes, the more effective the use of the coastal territory will be, in case the zones are correctly distributed relative to each other. According to the study, which was published in the journal "Ocean and Coastal Management" [13], this classification complements and expands the classification of coastal areas proposed in the study.

4.2 Typology of Spaces

Based on psychological research on the perception of public spaces in the city [14], it can be argued about the need to observe the diversity of types of spaces from the point of view of configuration, openness, size.

Most of the analyzed coastal public spaces mainly consist of a combination of linear links (promenade) and open planar objects (terraces, observation decks). In many cases, the coastal zone is located on a steep relief, which determines the presence of amphitheaters and slope-terracing devices, which fact in turn sets the special character of the public space. Considering public space as a compositional object, we can conclude that landscaping acts as the main volumetric element.

The presence of closed local spaces is not common in existing embankments, but their presence can visually enrich the environment and positively affect the perception of public space by visitors.

4.3 Landscaping

Landscaping is one of the main traditional means of organizing public spaces in coastal areas [15]. It can be argued that the perception of the geometric characteristics of landscaping (size, color, shape, density) occurs inseparably with the emotional perception of landscaping as a natural object, which contributes to the formation of a human-friendly environment, as stated in the study "Underlying relationships between public urban green spaces and social cohesion: A systematic literature review" [16]. It defines the configuration of the space, separates the functional areas, sets the basic color scheme. In view of existing environmental trends, one of the demanded types of landscaping is the planting of filtration plants capable of purifying contaminated water.

4.4 Small Architectural Forms

Small architectural forms can significantly expand the potential of the public space of coastal areas. Firstly, the functionality of the embankment is increased with the help of such objects, which is necessary during mass events for example. Secondly, the use of a system of small architectural objects visually enriches and saturates the environment [17]. Thirdly, different-scale architectural forms are able to create different levels of perception of the environment, allowing you to orient yourself in the public space of coastal areas more effectively.

5 Conclusion

Coastal territories in the city are special zones, a place of contact between urban development and nature, therefore the architectural organization of the public space of the embankment is an important element in the life of the city. Separately, it is worth noting the replacement of the functional purpose of such zones for cities over the past 50 years: from an industrial function to a recreational one. This determines the relevance of this study, since more and more modern cities are trying to get rid of inactive factories in coastal areas in favor of organizing comfortable and comfortable public spaces. The results of this study are the identification and systematization of the means of the architectural organization of public spaces in coastal areas. The results of the study can be used to form a systematic approach to the design of embankments, which contributes to the creation of a high-quality and efficient environment.

Today, along with the traditional functions of embankments, there is a need for an expanded functional program of public spaces in coastal areas. This requires the organization of various space types, the inclusion of the embankment in the city structure, the formation of a visually comfortable environment that meets the needs of all categories of the population. The study of the means of the architectural organization of public spaces of coastal territories on the basis of the accumulated experience will allow one to form the environment of the embankments in the conditions of sustainable development, taking into account the trends in architecture, design of the urban environment and ecology.

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Special Features and Development Prospects of Social Rental Housing in Russia

Elena M. Generalova and Viktor P. Generalov

Abstract The article deals with modern trends in the design of rental houses in the framework of an integrated approach to the development of housing construction as a market for comfortable and affordable housing for all social groups of people in the Russian Federation. The goal of the research is to study the process of forming a civilized rental market in Russia and compare the results with the best international practices. The research methodology is based on a systematic analysis of pilot projects of social rental housing and design guidelines developed by DOM.RF, including design standards, nomenclature and options for apartment design planning concepts. The negative trend of the predominance of small-sized apartments in the completed projects of social rental housing is considered. The study highlights the extremely important role of forming the typological diversity of rental houses and apartments, taking into account the differentiated approach to the needs of different social and demographic categories of the population.

Keywords Housing construction · Rental housing · Social rental housing

1 Introduction

In Russia rental housing is considered to be an upcoming trend for the development of the housing sector. This is evident from some facts and documents. On July 21st, 2014 Article 91.16 Hired House was introduced into the Housing Code of the Russian Federation. In the «Strategy for the housing sector development in the Russian Federation for the period up to 2025» [1] (key developers: the Ministry of Construction of Russia and DOM.RF—integrated housing development institution, 2017) it is noted that the formation of a civilized rental housing market is one of the most effective tools to meet the basic needs of people, that is the need for housing. In 2019, the book «Principles of rental housing in the Russian Federation» (developer—DOM.RF) was published [2].

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In the Housing Code of the Russian Federation, a rented house is treated as a building that is the property of one person, all apartments in which are intended to be provided to citizens for living under rental contracts. The development of modern, high-quality and affordable rental housing is considered in two directions—commercial and non-commercial rental housing. Thus, rented housing in Russia can be of two types: **social rental housing and commercial rental housing**. It is specified that in a social rental house, some apartments can be provided for commercial rent, but their share should not exceed 50%.

Social rental housing is of the greatest interest for the study as, according to DOM.RF experts, this format of housing is able to solve the housing problems of socially priority categories of citizens. It is emphasized that social rental housing is a real opportunity to solve the housing problem for families that do not fall under the category of the poor for since their income exceeds the minimum one, but at the same time with the available funds they cannot afford taking out a mortgage.

Statistics in the housing sector in Russia show that the population owns 90% of the housing stock; the rental housing share is small and does not exceed 8% of the housing stock. Comparing the ownership structure of housing with developed western countries, it can be concluded that the share of rental housing in developed western countries is much higher [3–9]. For example, in Germany it is 54%, of which social rent is only 4%; in France it is 39%, including 17% of social rent; in the UK it is 36%, where private and social rent represents equal shares.

However, before turning to the best foreign experience, it would be good to have a better idea about the characteristics of the so-called new format modern rental housing in Russia. This problem is extremely relevant and still is not solved for Russian citizens, so it requires a comprehensive study, including the analysis of the accumulated domestic and foreign experience [10–12]. This is necessary for forming a modern, scientifically based, relevant and promising architectural typology of rental houses, identifying their functional-planning and space planning characteristics, as well as structural and technological features related directly to economic efficiency and viability.

2 Materials and Methods

The object of the research is social rental housing. Research objectives are analysis of the current situation with rental housing in Russia, including: regulatory and legislative framework, design experience, problems, development prospects. The purpose is to give an example of best practices in the development of public rental housing abroad. The chronological boundaries of the study are the twenty-first century. Typological boundaries of the study are architectural and planning features of public rental housing.

The theoretical basis of the research is analysis and assessment of the development of the rental housing market in the regions presented in the works of the following authors: Skubriy V. S., Bryantseva I. V., Kulumbetova D.B., Davletkalieva K. B., Kalugin V. A., Korolkova D. I., Ganush G. I., Chirich A. V.

Priority directions and prospects for the development of rental housing for social use for the conditions of the Russian Federation are considered in the works of the following authors: A. V. Antyufeev, G. A. Ptichnikova, O. V. Koroleva, D. V. Papyan, O. M. Pyrkova, Pliev Kh. M., Belyakov S. I., Sirazetdinov R. M., Larionova Yu. V., Kubasova T. I., Kaverzina L. A., Makarova G. N.

The economic aspects of the development of rental housing in Russia were studied by: Vyunov S. S., Gareev I. F., Bryukhova E. V., Gasilov V. V., Sitnikov A. G.

The features of the formation of the rental housing market abroad are considered in scientific articles of the following authors: Petrukhina E. A., Chistyakova Yu. A., Abramova N. V., Khodov L. G., Gasilov V. V., Polshchikov D. V., Serebryakova E. A., Zakharzhevskaya A. Yu., Arshkenova A. M., Fedorov A. V., Leonova L. B., Cherny T.

The study of the theoretical base showed that there are no studies of the typological features of rental housing for the conditions of Russia. A systematic approach to studying the features of the emerging new market of high-quality rental housing is fundamental to this study. The methodology is to summarize scientific research in the field of the regulatory and legal framework, urban planning and architecture of buildings. The analysis is based on the database of pilot projects and the recommendations of DOM.RF [2]. The above-mentioned book «Principles of rental housing in the Russian Federation» lists the main principles aimed at forming the most effective approach to the design, construction and operation of rental housing throughout a building's life cycle. It is proposed to rely on the following principles [2]:

1. «Principles of the house» (architectural and space-planning concepts; common facilities; engineering systems; energy efficiency; environmental friendliness, etc.).
2. «Principles of residence premises for citizens, including flats and apartments» (materials; equipment and furniture; technical equipment; safety, etc.).
3. «Legal principles» (legal documents; procedure for booking rental premises; booking conditions, rights and obligations of the parties; procedure for signing a rental agreement; rental conditions, rights and obligations of the parties; the rights of the Owner in case of the Tenant's rent default and others).
4. «Service principles» (basic services; additional services).
5. «Principles used in realizing legal rental relationship» (rules for living in a rental house; organization and work of the homeowners' association; maintenance of premises; maintenance of common facilities and surroundings).

The study was complicated by the fact that the database of pilot projects built in Russia on the basis of these principles is extremely small. The first pilot project of commercial use was successfully realized in the Russian Federation as part of the rental housing development program DOM.RF. It was a rental house on the basis of «Liner» (Moscow)—a multifunctional complex with the developed infrastructure.

In the future, it is planned to launch new rental houses in Moscow and other regions of the Russian Federation, including the following residential complexes such as «Symvol»; «Serdtse Stolytsy»; «Park Legend»; «Oktyabrkoe Pole»; «Match Point»; «Level Amurskaya».

The number of pilot projects for social rental housing is even fewer. Only two examples were considered in the study—a rental house in the residential complex «Sovremennik» (Voronezh) and a rental house located in building 2, 3 Eremeyeva str. (St. Petersburg).

The authors believe that the lack of sufficient analytical material is not a reason for postponing a comprehensive study of this issue. On the contrary, the analysis of pilot projects by identifying positive and negative trends will allow correcting in time the development course chosen for such an important housing sector as rental housing. This is especially true for social rental housing which is able to solve the housing problem of 11 million Russian families that need to improve their living conditions.

3 Results

To date, quite a lot has been done in Russia in legal regulation especially to promote the idea of forming a civilized market for social rental housing. For example, in St. Petersburg, the registration requirements for obtaining an apartment in a social rented house are stated clearly in the regulatory documents. Let's list the key requirements the applicant must meet: live in St. Petersburg for at least 5 years; need residential premises, i.e. occupy residential premises less than the accounting norm of 9 m^2 of the total area of residential premises for living in separate apartments and 15 m^2 for living in communal apartments. One must live in residential premises unsuitable for living or a communal apartment; suffer from severe chronic diseases or have no housing; not be poor and have an income of at least 2 and no more than 5 subsistence wages for each family member.

Despite the availability of legal regulation tools, the analysis showed that the typology of rented social houses in Russia is in its infancy and is mostly absent in the modern rental market. Only a few pilot projects for the construction of non-commercial rental houses have been completed. By 2023, it is planned to build about 10 rental houses with reduced rental payments. The first Russian state supporting the social rental housing project was completed in Voronezh (see Fig. 1).

It should be noted that no special project was developed for the design assignment for this house construction. One of sections in the comfort-class residential complex «Sovremennik» was allocated for rented housing (Voronezh, bldg. 3, 68/2, 9 January str.). In general, the residential complex is located on a plot of 13 hectares and includes residential tower type (17 storeys) and multi-section buildings of variable number of storeys (from 14 to 25 storeys), as well as social infrastructure facilities, underground parking and guest parking. DOM.RF bought from the developer JSC «DSK-1» one tower (165 apartments and 40 parking spaces in the underground

Fig. 1 General view of the «Sovremennik» residential complex in Voronezh, 2020. General view and the facade partial elevation of a rented house [13]

parking lot). Monthly rental cost varies from 14,600 rubles (for a studio) to 41,000 rubles (for a 3-room apartment). However, only 41 apartments were allocated for social rent where tenants should pay not more than 30% of the real rental cost. The number such apartments is only 25% of the total number of residential apartments in the house that does not meet the norm (at least 50%) prescribed in the Housing Code. Thus, unfortunately, this house cannot be fully called a social rental house.

In a number of publications, it is noted that the apartments in this rented house are made according to the standards of DOM.RF that are the same for all rental housing of the company. The provision of this standard can be found in the book «Principles of rental housing in the Russian Federation». Here are the main directions of architectural and planning concepts for a rental house that include: (1) architectural, economic and design solutions; (2) configuration of rooms, number of windows, height of interior doors, ceiling height, etc.; (3) expected nomenclature of apartments: type, purpose, area; (4) minimum permissible availability of elevators; (5) number of apartments on every floor; (6) efficiency evaluation of planning concepts; (7) organization of entrance groups, reception areas (if such a zone is introduced in the concept); (8) format of the planning concept (application of BIM technologies); (9) materials used; (10) options for placing balconies; 11 – facade concepts; (12) engineering support; (13) architectural and planning concepts for public areas, including possible design options [2].

Recommendations are given on the planning concepts of apartments, including the area and proportions of the premises [2]: the area of the bathroom is at least 4 m^2; the area of the only room in the apartment is at least 14 m^2 with a width of at least 3 ^{m} and the area of each subsequent room in a multi-room apartment is at least 8 m^2; the area of an isolated kitchen is 10 m^2; the configuration of the rooms should be much similar to a square shape; the minimum ceiling height in the finished apartments is 2.8 m. The layout of the rental block in the «Sovremennik» residential complex is the example of using abovementioned recommendations (see Fig. 2).

The offers made by DOM.RF on rented houses' apartment structure are given in Table 1 and raise a number of doubts. In this study, the attention should be drawn to the only one very important fact: there is still a high percentage of apartments intended

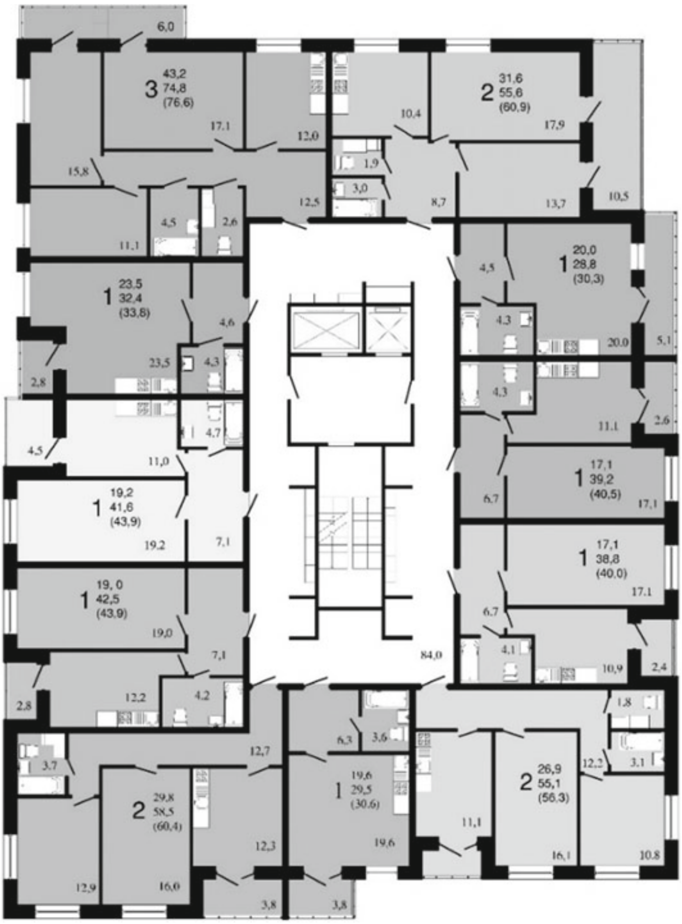

Fig. 2 Options for planning concepts of apartments in a rented house of the «Sovremennik» residential complex in Voronezh [13]

Table 1 The nomenclature of apartments for a rental house, depending on the area and the number of people living [2]

Apartment type	Number of residents	Area, m^2	Percentage of quantity, %
Studio	1–2 persons	20	15–25 (on average 20)
1–2—room apartment	1–2 persons	40	20–30 (on average 25)
2—room apartment	2–3 persons (1 bedroom)	60	25–35 (on average 30)
3—room apartment	2–3 persons (2 bedrooms)	80	10–20 (on average 15)
4—room apartment	4 persons (3 bedrooms)	100	5–15 (on average 10)

for 1–2 persons (45%), and the share of 1- and 2-room apartments is recommended to be maintained at 75%. This is despite the fact that the predominance of 1- and 2-room apartments, which currently make up 63% of the housing stock of the Russian Federation, is presented in various analytical documents of DOM.RF as a negative trend in the development of housing market in Russia.

It should be emphasized that the trend of designing apartments in which in fact, one room or even a single room (in the case of a one-room apartment) is both a common space for all residents and a residential (personal) territory for a part of the family is completely unacceptable for social rental housing. This is because a significant part of families that belong to a socially priority category of citizens and need to improve their living conditions and are families with two or more children. Table 2 is a clear illustration of the negative trend of the predominance of small-sized apartments in the pilot projects of social rental housing. In addition to the rental housing block in «Sovremennik» residential complex in Voronezh (17 floors, 165 apartments), this table shows the structure of apartments by the number of rooms in the first social rented house in St. Petersburg (15 floors, 178 apartments). In both projects, 1-and 2-room apartments make up 84% of the total.

Table 2 Apartment structure in the pilot project of social rental housing

Rental house	Studios and 1-room apartment, quantity/share of total quantity, %	2-room apartment, quantity/share of total quantity, %	3-room apartment, quantity/share of total quantity, %
Voronezh, 68/2 bldg. 3, 9 January str., residential complex «Sovremennik»	101/61	37/23	27/16
St. Petersburg, 2 building, 3, Eremeyeva str	116/65	33/19	29/16

4 Discussion

Raising the issue of the inadmissibility of the predominance of 1-and 2-room apartments in social rental housing, the best practices of Singapore should be referred to once again. Singapore has great achievements in the development of public housing typology (HDB) [14–19]. In Singapore, the modern typological range of HDB apartments includes 6 types: «2-room Flexi flats» (36.0 and 45.0 m^2; one bedroom) (see Fig. 3); «3-room flats» (60.0–65.0 m^2; two bedrooms) (see Fig. 4); «4-room flats» (about 90.0 m^2; three bedrooms) (see Fig. 5); «5-room flats» (about 110.0 m^2; three bedrooms and the possibility to allocate an office or an additional bedroom in the living room) (see Fig. 6); «3 Gen flats» (115.0 m^2; four bedrooms, two of which are en-suite) (see Fig. 7); «Executive apartments» (about 130 m^2; three bedrooms and the possibility of arranging a more spacious dining room). The layouts of «2-room Flexi flats» and «3 Gen flats» should be focused on.

The «2-room Flexi flats» layout is designed to meet the needs of the elderly or young couples. Approximately 40% of apartments of this type are reserved for the elderly. This housing is fully ready for occupancy. Kitchen and plumbing equipment is installed; there is a built-in wardrobe in the hallway; all rooms are finished taking into account the needs of the elderly (non-slip flooring, no floor level differences, bathroom equipment with special equipment for the disabled, an emergency alert system both in the apartment and in the elevator lobby on each floor, etc.).

The «3Gen flats» layout is an extremely interesting type of apartment. These apartments are designed for families consisting of three or more generations living together, as well as for large families that need an additional en-suite. This type of

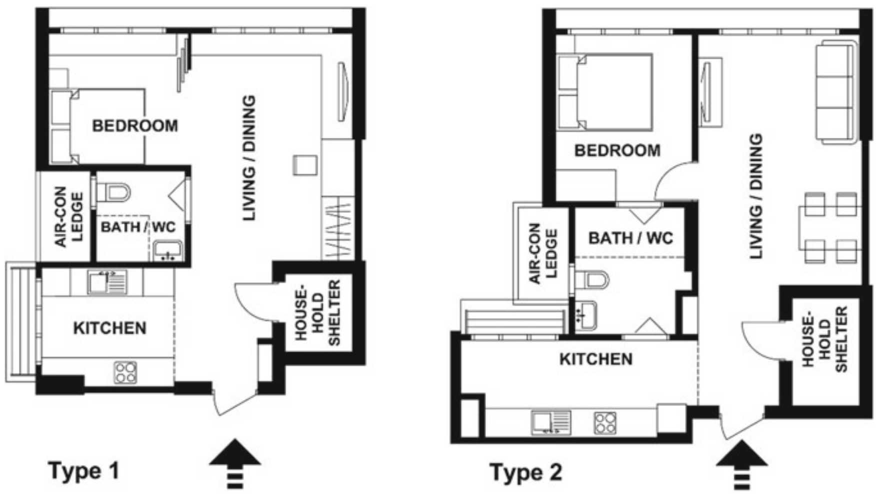

Fig. 3 Types of HDB flats in Singapore—«2-room Flexi flats» (Type 1—36.0 m^2; Type 2—45.0 m^2)

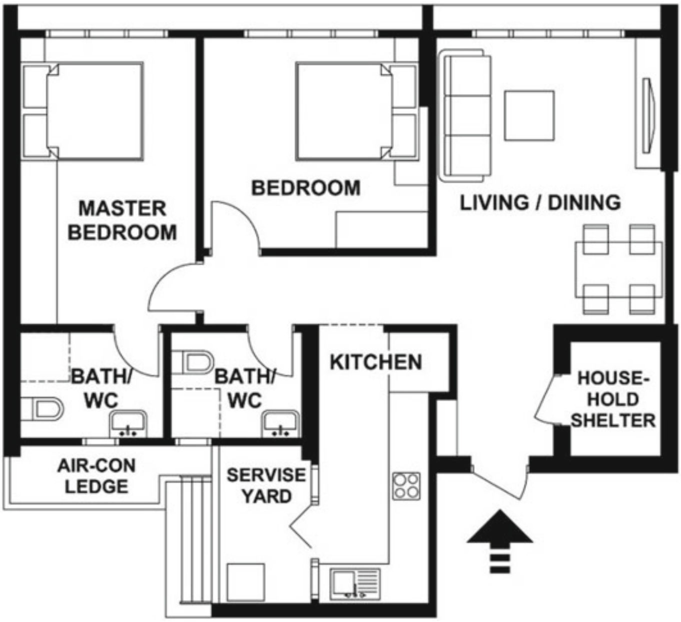

Fig. 4 Types of HDB flats in Singapore—«3-room flats» (60.0—65.0 m^2)

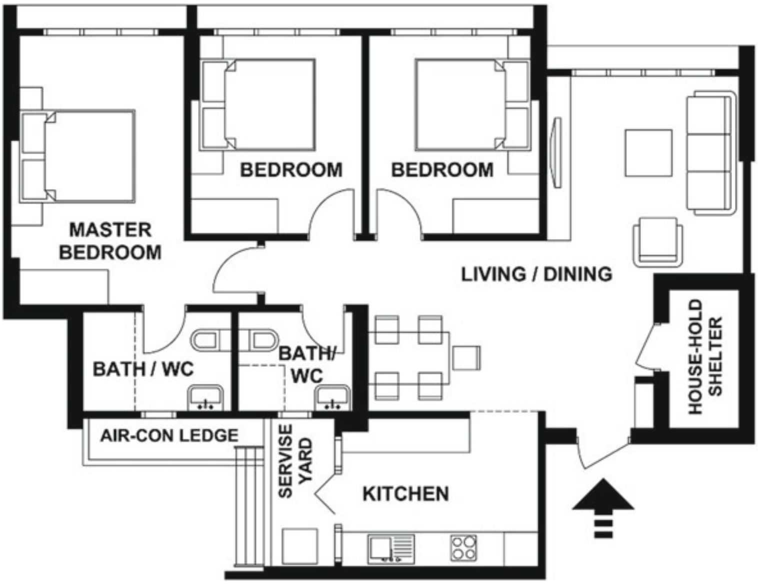

Fig. 5 Types of HDB flats in Singapore—«4-room flats» (90.0 m^2)

Fig. 6 Types of HDB flats in Singapore—«5-room flats» (110.0 m^2)

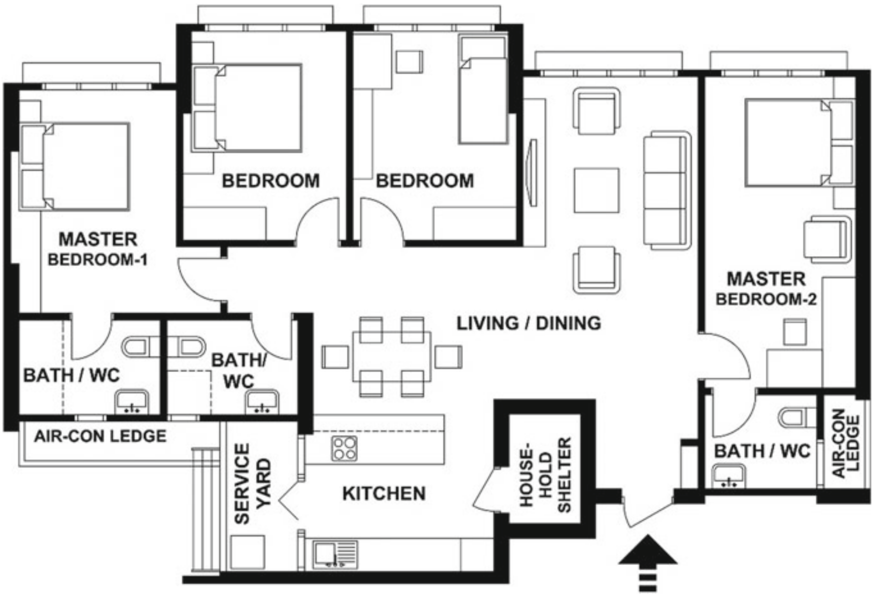

Fig. 7 Types of HDB flats in Singapore—«3 Gen flats» (115.0 m^2)

apartment is actively introduced, gets various very interesting planning options and allows preserving extremely valuable and important intra-family ties of generations.

In Singapore «The Housing & Development Board» (HDB) set up in 1960 is responsible for public housing management. As the result over 80% of Singapore's resident population live in public housing that amounts over one million apartments. Such an indicator as «HDB Resident Population by Flat Type» that means the distribution of HDB residents by flat type is of great interest. According to the statistics of 2018, the majority of residents lived in four-room apartments («4-room flats»)—31.7%; in five-room apartments («5-room flats»)—23.2% and in three—room apartments («3-room flats»)—17.6%; two-room apartments («2-room Flexi flats»)—only 6.1% of HDB residents. This ratio indicates that the population of Singapore has the future, i.e. there are families with two or more children. They do not live in 2-room apartments, but in 4- and 5-room apartments. All countries in a demographic crisis, including Russia, should strive for this.

5 Conclusions

The formation of a civilized rental housing market is an actual and promising direction for the development of the housing sector in the Russian Federation. There is much about the need to develop a mechanism for the state support of non-commercial rental housing construction, as well as the development and taking measures for stimulating the attraction of funds from private investors to the construction of non-commercial rental housing. At the same time, the need for a scientifically based approach to the formation of the space-planning structure of rental housing is completely overlooked, both at the level of the house as a whole and at the level of planning the apartment typology.

The most important conclusion of this study is the following. Today in Russia in case of social rent, the state buys out residential buildings from private developers. This is a dead-end path of development. Since the planning characteristics of these residential buildings and apartments do not meet the specific requirements of people and families in need of rental housing for social use. These include large families, the elderly, the disabled, etc.

According to the authors, a differentiated approach to the development of methodological recommendations for rental housing of social and commercial use is extremely important. These recommendations should be based on a comprehensive study of the demographic structure of the population interested in renting residential housing. Several stages of further work can be distinguished: classification of social and demographic groups for rental housing for social use; identification of their needs related to the parameters and functional organization of the dwelling (from an apartment to a residential complex); formation of a typological range of apartments; assessment of their economic efficiency. At that, it is necessary to rely on the world experience accumulated in the formation of a typological diversity of housing for a socially priority category of the population.

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Methodology for Assessing the Level of Architecture of an Industrial Enterprise in the Context of Digital Transformation

S. K. Kochina, E. V. Osychenko, and N. V. Ovcharova

Abstract The relevance of the article is due to the fact that the architecture of an enterprise is one of the tools for assessing organizational changes in an industrial enterprise. The shared vision created by the enterprise architecture allows for a unified design of business processes that are consistent positions of achievement of objective of the organization and the external environment, and capable of interoperability and integration where necessary. The purpose of the article was to defining entity and composite elements architecture of an industrial facility and analyze its level. The authors define enterprise architecture as an area of knowledge about the functioning of individual parts of a business structure, taking into account the changing conditions of a new technological paradigm—digital transformation. An enterprise architecture helps an organization leap forward by making its core business processes function as efficiently as possible within an efficient IT environment and modern digital tools and technologies. The methodology for assessing the level of enterprise architecture, proposed by the authors, involves the analysis of three main components with a certain set of parameters. This approach will allow enterprise managers solve existing problems effectively, improving the functioning of the existing architecture. The authors demonstrated the calculation of the integral indicator of the level of architecture of an industrial enterprise using the example at CJSC Architectural and Construction Association "Intex" is given.

Keywords Industrial enterprise architecture · Architecture level · Enterprise architecture components

1 Introduction

Digital transformation is a collection of multifaceted, comprehensive and complex changes for the entire business community. To understand the transformation object, you need to describe it, i.e. the current position of the organization, as well as the

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future state that needs to be achieved in the process of implementing the development strategy. In the current socio-economic and financial-production environment, there was an urgent need to develop tools for the comprehensive diagnosis of business processes, to link the many requirements and requirements of business structures with the elements of digital infrastructure, which was realistic to ensure by creating a co-temporary architecture of an industrial enterprise.

Enterprise architecture is a specific area of knowledge about the organization of individual parts of business structures, and the most different and absolutely all parts: systems, processes, people, infrastructure, data, goals, mission, development strategy, tasks, requirements, etc. For the last decade, we perceived organization only through the prism of business processes or the introduction of another complex system (CRM, BPMS, EPR) [1]. The architecture looks at it differently: the goals must coincide with the resources of the enterprise for the production of products (services), the products must address the customer's values, consumers interact with the enterprise through their preferred channels, the channels are supported by processes, the processes are provided by IT systems and platforms in turn, systems require a specific infrastructure.

Thus, we see an expedient, organized system of relationships between consumers, manufacturers and partners, using a set of decisions and corrective actions focused on the digital transformation process and taking into account its new trends [2]. The enterprise architecture is designed to help in choosing certain actions, to structure this relationship properly.

In 1987, an article "A framework for information systems architecture" was published by business and IT consultant J. Zachman, thanks to this article the formation of modern methods of enterprise architecture design began. Then S. Spivak in 1992 published a work entitled "Enterprise Architecture Planning", in which the term "enterprise architecture" was first introduced into scientific circulation [3].

There are several approaches to defining the concept of "enterprise architecture" (EA), here are some of them [4]:

(1) S. Spivak writes that the architecture of an enterprise is the most general and comprehensive representation of an organization as an economic entity focusing on operational and strategic development plans emanating from the mission, the strategy, resources and perspectives required to achieve results, as well as the well-established "rules of the game" of the main activity.
(2) The Institute of Electrical and Electronics Engineers (IEEE) interprets EA as a set of all components of an enterprise, their relationship with each other and with the external environment of the enterprise, as well as management decisions and principles that determine their creation, application, interaction and development of these key components.
(3) The Klinger/Cohen Law (1996) states that enterprise architecture is a management and engineering discipline that represents a multi-dimensional view and research of an organization, including strategic and organizational planning, management of interactions, improvement of business processes, retrieval and management of information, knowledge and operations.

Initially, the term "enterprise architecture" was associated only with the IT environment, IT technologies and Internet projects. In the future, other areas of activity and business processes of the enterprise began to be included in this concept. In its development, the concept of "enterprise architecture" has passed several stages (see Fig. 1).

As we can see, in the beginning, the architecture of the enterprise was equated with the technological processes of the organization. Then it was identified with the information technology EA, which, in turn, consists of application architecture, information and technology. In the 2000s, a business architecture was added to the already selected elements of the EA, considering the goals of the organization, its organizational structure and existing business processes. In the 2010s, business architecture receives an expanded list of components (knowledge, business model, performance indicators, services, etc.).

But the modern conditions of socio-economic, innovative, technological and technical development of business entities dictate different rules: you need to focus on digital transformation. In this regard, we propose the following definition of EA:

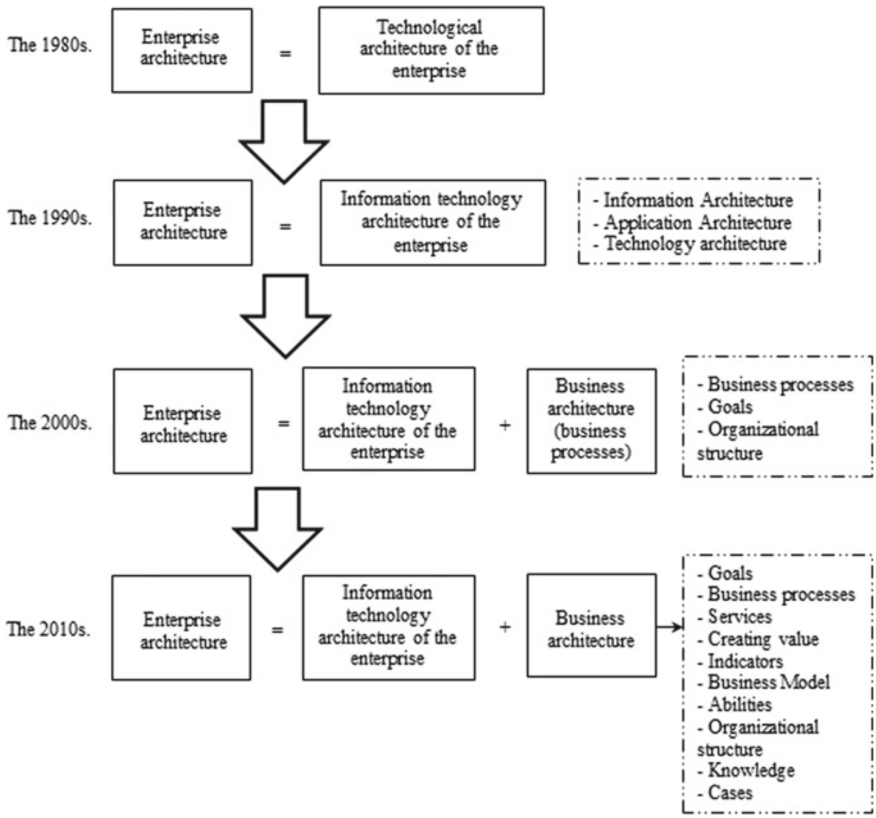

Fig. 1 Evolution of the concept of "enterprise architecture" [5]

The architecture of an industrial enterprise is a multidimensional process of a qualitative transition from the presentation of a business strategy to an effective change in the organization through the formation, assessment and improvement of key competencies of activities, principles and models, also by focusing on changes in the parameters of the digital infrastructure, which, ultimately, will ensure the high competitiveness of the enterprise, improve its image, improve financial performance, cover new market segments, strengthen the gained positions in the functioning industry market, etc.

The architecture of an industrial enterprise as a complexly structured process consists of the following layers (see Fig. 2). Let's take a closer look at these layers below.

Context Architecture determines the goals, objectives, mission, motives for the operation of an enterprise in a given industry, as well as factors influencing it, which, as a result, will allow the development of projects for the development of this business structure.

The layer "Action Architecture" contains a set of methods, values and models of relationships between the enterprise with consumers, suppliers, partners, potential investors (i.e. platforms, information, distribution channels, etc.).

Data Architecture structures the entire amount of information that an enterprise has with the help of various modern tools (for example, Big Data) [7].

Infrastructure Architecture forms the so-called EA application layer. It is a set of tools such as cloud services, artificial intelligence technologies, CRM, EPR.

The complex of existing equipment, workshops, production sites, etc. forms such a layer as Manufacturing Architecture.

The works of such authors as Bogomolova M. A., Gritsenko Yu. B., Lukyanov B. V., Peshkova O. V., Zinder E. Z. are devoted to the problems arising in the study and assessment of enterprise architecture [8, 9], but this aspect remains unexplored to the end.

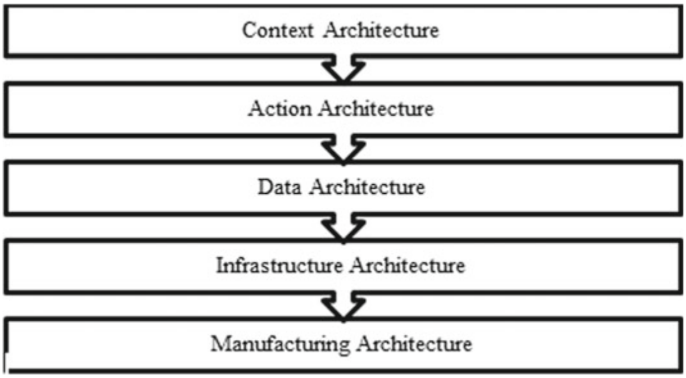

Fig. 2 Representation of the architecture of an industrial enterprise, as a multi-layer process [6]

2 Methods

In order to present a methodology for assessing the level of EA, it is necessary to determine first its constituent elements (components).

During the period of digital transformation, we believe that the following composition of components of the architecture of an industrial enterprise, which is presented at Fig. 3.

Consider the content of each component of an enterprise architecture:

- EA of business processes contains and explores the relationship of key business processes of the business structure, aimed at achieving the goals and objectives, implementing the strategy in the long and short term, the object of study will also be the innovation process implemented within the production strategy of the enterprise [10];
- Technological architecture is the basis for the operation of the entire complex of information technologies and enterprise resources. It also includes application systems that ensure that business processes are carried out in accordance with today's digital transformation requirements. The main goal of this component is to provide and ensure the stable operation of IT services and platforms [11];
- Digital architecture is a set of digital techniques, methods and tools for the implementation of production and other types of enterprise activities, which will increase competitiveness in the national and world markets [12].

In our opinion, this list of components of enterprise architecture evaluates and analyzes quite fully the activities of an industrial enterprise in modern economic and technological conditions.

Each of the declared components has a certain set of parameters that will be used for further research of the enterprise [13]. For example, it is advisable to analyze the architecture of business processes must be considered from the point of view of speed of adoption and the effectiveness of management actions; when assessing the technological architecture, it is necessary to consider the quality and availability of software; digital architecture—from the standpoint of providing (and the level of use) with modern Internet technologies, tools and resources.

Based on the foregoing, we propose the following stages for assessing the level of architecture of an industrial enterprise:

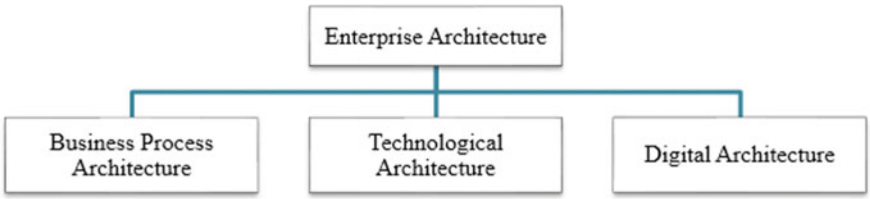

Fig. 3 The structure of the architecture of an industrial enterprise. *Source* compiled by the authors

- systematization of homogeneous parameters of the level of architecture of an industrial enterprise;
- obtaining the necessary information in relation to the investigated enterprise;
- determination of the rank of parameters for each component of the EA, using method of expert assessments;
- analysis of an industrial enterprise according to the selected indicators;
- payment an integral indicator of the level of enterprise architecture;
- interpretation the results obtained and compiling recommendations for improving the architecture of an industrial enterprise.

The use of such a category as "architecture of an industrial enterprise" at any level of management processes, as well as in appropriate strategic and operational decisions, is quite multifaceted. There are certain scenarios (situations, problems) in which the structure, improvement and diagnosis (level assessment) of the EA will allow you to effectively manage this organization and solve the corresponding problems.

The initial scenario for using the enterprise architecture can be considered a plan for leveling the business and IT sphere, which was proposed in 1993 by J. Henderson and N. Venkatraman. This has become a kind of starting point for the subsequent development of the definition of problem situations and scenarios in which schemes for creating and evaluating EA can be applied, as well as a certain range of problems are solved. The above-mentioned scenario is especially relevant in modern socio-economic conditions, when there is a rapid development and a comprehensive impact of digital transformation on the activities of enterprises of any scale.

Let us present a list of scenarios for the application of the enterprise architecture, as well as a set of tasks to be solved:

1. Enterprise transformation. The tasks are as follows:

    - encouraging the emergence of various types of associations and acquisitions with market partners (and competitors);
    - changing the business model;
    - creation and implementation of the selected strategy;
    - strengthening competitive positions;
    - find the best organization management model.

2. Develop a holistic mechanism for effective communication and management action. Tasks:

    - reducing risks and losses;
    - provision of variability of management decisions;
    - assessment of the feasibility of actions taken;
    - focus on strategic development.

3. Business and IT sphere integration:
   - digital transformation;
   - substantiation of the need to use IT technologies for the efficient operation of the organization;
   - formation of a “communication channel” between business and IT sphere;
   - ensuring strategic prospects for the development of the IT sphere.
4. Operational improvement:
   - reducing the number of duplicate rights and powers;
   - creation of an optimal (simplified) organizational structure;
   - following to the planned development strategy;
   - increase of competitive advantages;
   - the use of effective outsourcing;
   - reuse architecture elements at all levels.
5. Capitalization growth and compliance with the requirements:
   - increasing the goodwill of the organization;
   - creating a high reputation in the investment market;
   - achieving compliance with the norms, standards and requirements of the external and internal environment;
   - formation of a transparent management process;
   - formalization of the business model, strategic development of the organization’s activities.
6. Application of accumulated world experience, benchmarking:
   - use of management practices and techniques adapted to the specifics of this organization;
   - identification of weaknesses and vulnerabilities in business processes;
   - search for reserves for improving activities;
   - conducting a comparative characteristic with market leaders.
7. Complexity management and risk reduction:
   - division of the organizational system into key subsystems;
   - diagnostics and refactoring of spontaneously formed structures (or layers of architecture);
   - reduction of risks and losses associated with incorrect design and use of elements of the enterprise architecture;
   - specification of knowledge about the organization’s structure.

Thus, we see that the formation of the enterprise architecture can solve the structural and organizational problem of the enterprise, reveal the shortcomings and inconsistencies of the organization’s work, and the EA can also be applied at any stage of the subject’s life cycle.

3 Results and Discussions

To calculate the integral level indicator of an industrial enterprise architecture, it is required to determine the rank of the parameters included in the components of the EA, using the method of expert assessments, attracting highly qualified experts, analysts on this industry market and the object under study.

In connection with the above, the following parameters can be used to assess the level of enterprise architecture (see Table 1).

To assess the level of architecture of an industrial enterprise, we propose to calculate the integral indicator for each component according to Formula 1:

$$I_j = \frac{\sum_{i=1}^{n} g_i \cdot r_i}{n_i}, \tag{1}$$

where I_j—is the integral indicator of the j-th group of components, g_i—is the relative value of the i-th parameter, r_i—is the rank of the i-th parameter, n_i—is the number of parameters in the group of components.

Further, on the basis of the obtained integral indicators for each component of the EA, a general integral indicator (as an arithmetic mean) is calculated for the entire enterprise, which will reflect the level of the organization's current architecture (see Formula 2).

$$H_{\mathrm{EA}} = \frac{\sum I_j}{m}, \tag{2}$$

Table 1 Parameters for evaluating the components of an industrial enterprise architecture

Enterprise architecture components	Parameters (values from 0 to 5)	Rank
Business process architecture	– the level of corporate management; – innovation process and potential; – organizational and management activities	0.3 0.3 0.4
	Total:	1.0
Technological architecture	– hardware, system and software; – availability of a single platform for the purposeful work of all departments; – security services	0.3 0.3 0.4
	Total:	1.0
Digital architecture	– Internet access; – availability of digital marketing, e-commerce; – Database; – applications, cloud services, platforms, 3D modeling programs, virtual reality, the presence of an ERP system (enterprise resource planning system), etc	0.2 0.3 0.2 0.3
	Total:	1.0

Table 2 Analysis of the level of enterprise architecture CJSC architectural and construction association "Intex" for 2019

Architecture components enterprises	Integral metric of enterprise architecture components	Enterprise architecture level
Business process architecture	1.0	0.98
Technological architecture	1.0	
Digital architecture	0.93	

where H_{EA}—the level of architecture of an industrial enterprise, m—is the number of components.

According to this approach, the following levels of industrial enterprise architecture can be distinguished:

- from 0 to 0.5—initial;
- from 0.5 to 1—medium;
- from 1 to 1.5—advanced.

Based on the above methodology, we will calculate the level of architecture of an industrial enterprise CJSC Architectural and Construction Association "Intex" (large Russian architectural and construction holding) for 2019 (see Table 2).

Thus, the architecture level of the object under study is 0.98, which is defined as the average level. Of all the analyzed components of the enterprise, "digital architecture" in relation to others has the lowest level—0.93, which, of course, is not critical.

To grow the level of enterprise architecture CJSC Architectural and Construction Association "Intex" management needs to pay due attention to problem areas of the functioning of business processes, to strengthen the work digital marketing, introduce modern digital technologies and strengthen the work of an existing set of such tools, develop an innovative process, attracting foreign and domestic partners.

4 Summary

In modern conditions, the assessment of the level of architecture of an industrial enterprise can be considered a significant task in the construction, diversification and analysis of the functioning of entrepreneurial activity. This is especially true in the period of digital transformation.

Our proposed methodology for assessing the level of architecture of an industrial enterprise makes it possible to comprehensively analyze the activity of the object under study, namely, from the standpoint of three components: the level of existing business processes and innovative potential; system and software activities; application of digital technologies. Ultimately, the results of such an analysis will be the identification of problem areas in the activities of the enterprise, their analysis and interpretation, as well as recommendations for improving the functioning of the production facility, which will allow the business structure to reach a new level, increase competitiveness, and apply more competently digital technologies in certain business processes, use the innovative and technological potential for appropriate purposes.

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Green Technologies of Wooden Building for Arctic

Alexander Kuzmenkov, Gennady Kolesnikov, and Zahar Voronin

Abstract The article presents the results of the development of space-planning, structural and construction technological solutions of an experimental wooden building. The construction of two identical laboratory buildings in Murmansk and Petrozavodsk has been completed. The identity of the objects will allow us to evaluate the effectiveness of the use of the same structures in different climatic conditions. The purpose of the work is to assess the energy efficiency of a wooden house and its microclimate in the conditions of regions with a cold climate. In order to substantiate the relevance of the topic, to analyse aspects related to the history of wooden house construction; to develop and implement a method for monitoring humidity and temperature in the material of wall structures, as well as temperature and humidity inside and outside the house, we based on the results of monitoring to form a database to use it to substantiate recommendations related to increasing the resistance of wooden structures to the effects of humid air. Attention is focused on the use of "green" materials and technologies for the construction of wooden houses in cold climates.

Keywords Green building · Wooden house construction · Northern and arctic territories · Energy efficiency · Sustainable development

1 Introduction

The construction sector of the world economy is a large consumer of natural resources, the processing of which requires high energy costs. The growth in resource consumption in construction is proportional to the damage to the environment, which gives rise to a set of urgent problems of sustainable development and environmental preservation. As a result of studying these problems, developed and improved global, national and local programs based on the concept of green building [1, 2].

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The practical implementation of green building is associated with the development of resource-saving technologies covering the entire life cycle of an object, including its construction, use, repair, modernization and disposal. The problems of green building are relevant, first of all, for the Arctic region, the definition of which is given in [1]. However, the problems of green building are no less relevant for other regions [3, 4]. At the same time, regardless of the region, attention is focused on the problem of energy conservation at all stages of the life cycle of a construction object (from design to disposal) [3, 5].

Green building technologies require careful consideration of a large number of factors at the design stage, and therefore it is necessary to use BIM technologies (Building Information Modeling). The use of BIM makes it possible to improve the quality of projects taking into account construction technology, management, economy and social environment [6]. In this case, it is possible to search for optimal options [7].

This paper discusses the technical and technological aspects of the use of wood by the example of two experimental objects.

Within the framework of this study, the results of the design and construction of two identical experimental buildings (model objects) on the territories of the Murmansk region and the Republic of Karelia are presented [8]. The aim of the study is to identify materials and construction technologies that most fully represent the concept of "green building" [9]. Model objects are designed for research and development in the field of green technologies and energy efficient construction. Buildings in Murmansk and Petrozavodsk are designed in the same space-planning and structural solutions.

Based on the results of previous studies [10, 11], it was decided to consider in more detail low-rise buildings, depending on the main structural material of the walls. The current study relates to low-rise buildings made of timber. Wood and wood-based materials are the most popular in the construction of individual housing projects. The authors substantiated the expediency of conducting a study on the basis of an experimental object, the parameters of which are as close as possible to the parameters of an individual residential building. The use of wood as the main structural material was also justified.

Wood and wood-based materials meet most of the criteria for "green" construction:

- environmental friendliness and minimal negative impact on the environment;
- reusability;
- it is a local and naturally renewable resource for the regions of the North and North-West of Russia;
- the properties of the material allow you to create a comfortable microclimate inside the building (breathable material).

The obvious disadvantages of wood are low fire resistance and susceptibility to decay and insect attack. The disadvantages are compensated for by preliminary treatment with special compounds.

The development of wooden housing construction is also due to additional factors justifying the need for the development of this type of construction. Wooden house building is receiving close attention from both federal government bodies and government bodies of the constituent entities of the Russian Federation. The Ministry of Industry and Trade of the Russian Federation positions wooden housing construction as a tool for the development of the timber industry complex in Russia.

2 Materials and Methods

The object of research in this work is a one-story wooden experimental building built in the city of Petrozavodsk [8]. A similar object made of the same materials, as noted above, was built almost simultaneously in Murmansk. The design of two objects was carried out by the same organization [9]. The construction of the facilities is carried out using the same technologies. Identical methods and devices are used to monitor the state of objects [11]. Monitoring of the condition of these facilities continues from January 2020 to the present (October 2021). Project documentation and monitoring of the condition of two similar facilities built in Murmansk and Petrozavodsk allowed us to obtain a large amount of new data for the study of some features of wooden house construction in the northern regions.

The methodological approach to the study is to consider various structures of buildings built in two regions with a cold climate [8, 9]. In this article, the methodological approach is understood as the application of a knowledge base, including both new and well-known knowledge in the literature, to consider the problem of wooden house construction from specific points of view. Namely, attention is focused on methods of remote measurement of temperature and humidity of wall material. The use of these data at the design stage of new buildings will improve the thermal insulation characteristics of wooden wall structures. In addition, the use of the same data is necessary to substantiate recommendations related to increasing the stability of wooden structures in conditions of high humidity outside the building.

3 Results and Discussion

Using the methodological approach defined above (Materials and Methods section), we will consider issues related to the energy efficiency of wooden house construction from specific points of view. The first part of the current section contains brief historical references and explanations. The specific results of the performed research are discussed in the final part of the section.

The most energy-efficient building shape is the dome or hemisphere shape. This form of buildings has long been known to mankind. Initially, interest in domed houses was manifested only due to the original shape of the building, but the idea has not received widespread acceptance to this day. The main advantages of a hemispherical building are:

- originality and aesthetic appearance;
- strength and reliability, good aerodynamics and seismic resistance;
- shape of the hemisphere does not allow snow to accumulate in winter;
- low weight of the structure;
- the need for building materials is 25–30% lower;
- relatively high construction speed;
- smaller outer surface area.

The latter ensures high energy efficiency of domed buildings. Hemisphere-shaped buildings also have a number of disadvantages:

- structural elements require higher manufacturing accuracy and quality, especially in the interfaces, which puts forward increased requirements for the quality of the initial building materials;
- increased consumption of lumber and additional costs in the production of non-standard elements of domed structures;
- the need to use non-standard window and door blocks, as well as furniture elements;
- the need for a more thorough study of the internal layout and arrangement of furniture, as well as the difficulty in placing standard furniture;
- the round shape of the building requires a detailed development of the master plan of the site;
- increased requirements are imposed on waterproofing coating materials and interface devices.

The next most energy efficient building shape is the cube shape. It should be noted that historically the poorest strata of the population in the northern regions of Russia built their houses with a square shape. Basically, these buildings were one-story, in rare cases—two-story (for the wealthier). As the main reason, it can be assumed that the poor people lacked funds for heating, and therefore chose a more compact form of their dwelling. In terms of the ratio of volume and surface area (enclosing structures), the cube is close to domes.

At the initial stage of our research, a variant of an experimental building in the form of a cube was considered. At the same time, the constructive solution for each wall was supposed to be different: frame, wooden squared beam with external insulation, double wooden log and glued beams. However, this solution does not make it possible to objectively assess the energy efficiency of various wall structures due to the stationary orientation of the building relative to the cardinal points. This option is supposed to be considered separately using the example of a scale model of a building, which will be able to change the orientation of the walls during the study. As a result, the shape of a rectangular parallelepiped was chosen for the experimental building. This shape of the building is most widely used in the design and construction of buildings in northern conditions. From the point of view of the energy efficiency of the form, the northern territories buildings are more characterized by a simple form, without a large number of protruding and recessed building parts.

Currently, in the territories under consideration, two types of constructive and technological solutions for wooden low-rise buildings are widely used—frame and with the use of solid wood elements.

The construction of residential buildings from solid wood is traditional for the northern territories of Russia. The oldest log buildings in world history, discovered during excavations, date back to an approximate time period of 550–400 BC. The earliest mentions of log buildings on the territory of Russia are found in the chronicles of the fifth century, and already from the tenth century, chopped structures were massively used in Russia for the construction of religious, residential and utility buildings. The northern territories of Russia are widely known for monuments of architectural wooden architecture. With the development of industrial methods of wood processing and lumber production, wood has become more widely used for building buildings. In the post-war years, buildings made of wooden squared beams became widespread in rural areas and are still being built.

The basis of a log building is a cage of logs or squared beams connected at the corners of the building. There are more than fifty known ways of connecting logs and squared beams to each other. The most famous ones and used for logs are: "in the bowl" and "in the paw", for the timber—"in half a tree", "on thorns" and "in the paw". To insulate the grooves at the joints and joints between the rows (crowns) of logs or squared beams, both traditional materials are used—moss, linen tow, felt, and modern—jute-based tape heaters. Lumber walls are additionally reinforced with dowels, which are installed in pre-drilled holes in a checkerboard pattern through several rows (crowns) of logs. Currently, the construction of a log house from profiled beams has become widespread. In the places where the rows (crowns) dock, the profile of the bar has a "groove—ridge" connection, which eliminates the main disadvantage of the wooden log cabin—blowing between the crowns. The planed surface of the profiled timber eliminates the need for wall surface finishing and increases the aesthetic qualities of the building.

The traditional single log structure of a log house in modern conditions cannot fully satisfy the regulatory requirements for heat transfer, since the thickness of a dense layer of wood should be about 40 cm. Logs and squared beams of this thickness are almost impossible to find today. An exception is made of glued laminated timber, but the price of glued structures is very high. Single log cabins are actively used for the construction of buildings for seasonal residence and baths. When building a residential building for year-round use, log houses with a single log structure must be additionally insulated.

Considering the above, a technology is of interest, which would allow satisfying modern heat engineering requirements and preserving the characteristic traditional appearance of a log building. Such technology can be the technology of "double timber" ("log house in log house") or "double log". Initially, the "double log" technology appeared in Austria, and then it was applied in Germany and, later, became widespread in Finland. In Russia, this technology is positioned as Finnish and began to be applied relatively recently—in the late 90 s, early 2000s. In the traditional version of the structural solution of the wall, a profiled beam is used, from which two layers of the wall are formed—an internal and external one. The cavity between them is a heat-insulating layer, for the implementation of which various materials can be used. In this study, it is proposed to consider the design of a double log house with the use of rounded logs. The reasons for this choice are as follows:

- the round log is a classic element in terms of aesthetics, appearance and northern architecture;
- for the manufacture of rounded logs, wooden raw materials can be used in the form of thin logs (average diameter of a log is 200–250 mm);
- wood waste in the production of rounded logs is less than in the production of profiled timber.

Timber frame structures also have a fairly long history. Europe is considered to be the birthplace of frame buildings. In the XII century in many countries of Central and Northern Europe, houses became popular, the basis of which was a system of posts, crossbars and braces, made of oak or larch—a wooden fachwerk (German Fachwerk) or frame. The sections of the wall between the elements of the frame system were filled with a mixture of manure, lime and straw, and later with clay, brick or stone.

Frame technology was further developed after 1833 in the USA. In 1833, St. Mary's Catholic Church was built in Chicago by Augustine Taylor. Instead of massive wooden elements, smaller boards were used during construction, spaced at a certain (rather frequent) step from each other, which were connected at the nodes with nails. Professional carpenters of the time did not appreciate Taylor's design and coined the name "balloon frame" for it, hinting that it could be blown away by a light breeze like a balloon. However, the proposed solution was cheaper, faster to implement, and required less material costs and fewer workers. A serious drawback was the high fire hazard of such buildings, which was confirmed by the fires in Chicago in 1871 and in San Francisco in 1906. This was the first experience of using frame house building technologies in the modern sense of timber frame construction. Wooden frame houses were widely used in the USA and Canada after the Second World War, with the simultaneous appearance and distribution of panel materials for frame cladding. The frame technology was further developed on the territory of the Scandinavian countries of Europe in the form of the "Platform" technology.

In the Soviet Union, frame technology was actively used in the post-war years for the construction of typical 4, 8 and 12 apartment residential buildings with up to 3 stores high. Basically, frame sheathing technology and backfill thermal insulation materials (disposed slag) were used. In some cases, frame-shield or frame-panel versions of structures were used with the use of slag and glass wool slabs as an insulating layer.

In modern conditions in Russia, timber frame houses are gaining more and more popularity. The relatively low cost of construction and rather high heat engineering parameters take precedence over the prejudice formed from the operation of frame houses of the Soviet period and the "insufficient" solidity and safety of the frame building. Currently, several options for the construction of a wooden frame house have become widespread:

- fabrication of frame elements from sawn timber in a construction site with subsequent assembly of frame structures;
- assembly of the building frame from prefabricated and cut to size frame elements (prefabricated house kit assembly);
- assembly of pre-fabricated elements of frame walls (shields) or panels (frame-panel construction).

Most often, there are proposals on the market for the construction of a wooden frame house using the second option—prefabricated house kit assembly. This option allows you to more flexibly make space-planning decisions, while with the frame-panel or panel version, many decisions depend on the standard sizes of the shields or panels. The rigidity and immutability of the frame structure are provided in two ways. In the first case, along with the system of racks and crossbars, a set of struts is used, which are installed in key places: in the corners, at the junction of the walls, near the openings. In this case, wooden board materials (block house and lining), panels and siding systems can be used as cladding. In the second case, to ensure rigidity, plate sheathing is used, and the number of struts is reduced at the same time. OSB, plywood and gypsum plasterboards are most often used as slab cladding in this embodiment. Decorative cladding, however, can be any.

Thermal insulation materials for the experimental buildings were also selected based on their compliance with the principles of "green" construction in the conditions of the northern territories:

- environmental friendliness;
- resource efficiency;
- energy efficiency;
- production at the territory of use;
- availability of material in the area of application;
- assembly adaptability in northern conditions.

The model object is a one-storey building with dimensions in the plan in the axes of 12.45 $\times$ 5.5 m with a pitched roof with a slight slope. The height of the building along the highest roof part is 4.3 m. The building consists of two square premises connected by a vestibule-corridor. The right and left parts of the building have the same area of premises and the same internal volume, which is necessary for further research and comparison of the two applied design solutions of walls and construction technologies. The building plan is shown in Fig. 1.

For both parts of the building, the structures of the roof, floor and foundations are the same. Foundations are concrete, from concrete blocks. The lower overlap is made of wooden beams, and insulated. The total thickness of the bottom overlap is 465 mm, including the thickness of the heat-insulating layer—300 mm. The composition of the structural layers of the bottom floor structure is shown in Fig. 2. The roof is gable, insulated. The supporting structures of the roof are represented by a system of rafter legs supported by longitudinal walls and a ridge girder. Roof covering material is metal. The total thickness of the roof structure is 450 mm, including the thickness of the insulating layer—350 mm. The structure of the roof structure also includes

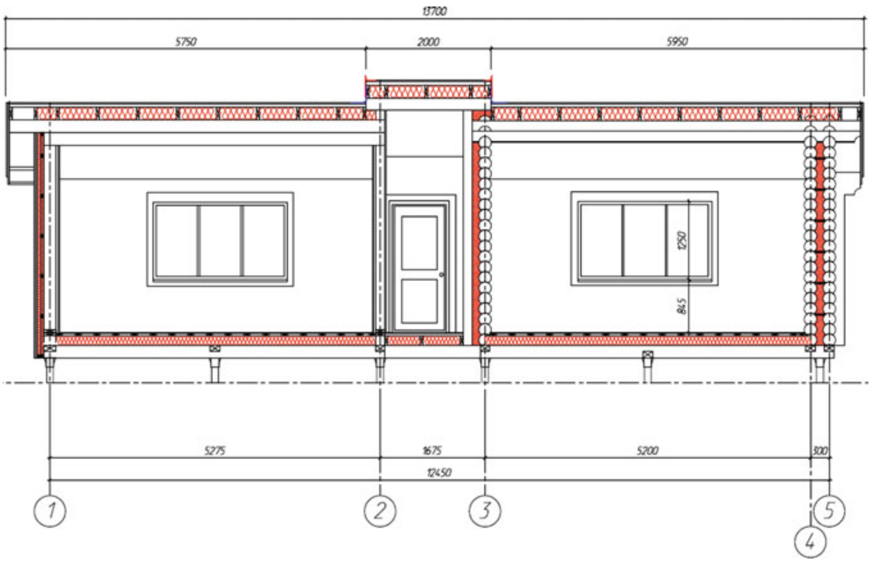

Fig. 1 Longitudinal cross section of the experimental building

- *Floor elements - 15 mm*
- *Logs - 40x100 mm*
- *Vapor barrier*
- *Cross beams – 50x150 mm + Insulation – 150 mm*
- *Moisture and wind protective layer*
- *Beams – 50x150 mm + Insulation – 150 mm + Sub floor construction – 50 mm*

Fig. 2 The composition of the structural layers of the structure of the lower floor

wind-waterproof and vapor barrier layers. The composition of the structural layers of the roof structure is shown in Fig. 3. Mineral wool insulation "ISOROC Super Warm" was adopted as the main insulation material for the roof construction and for the construction of bottom overlap.

The structures of the external walls and the technology of their construction are different for the parts of the building. The structures of the walls of the building parts are made according to two different technologies: one part using frame technology, the second one using double log technology. The total thickness of the wall frame structure is 350 mm. The supporting frame is represented by uprights with a section

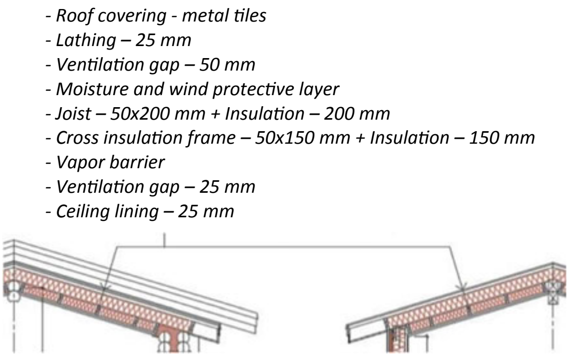

Fig. 3 The composition of the structural layers of the roof structure

of 50 × 200 mm, crossbars of the same section and a system of struts. Along the supporting frame in the horizontal direction, the frame of the cross layer of insulation with a thickness of 50 mm is made. The total thickness of the insulating layer is 250 mm. Mineral wool insulation "ISOROC Super Warm" was adopted as the main insulation material for the frame wall. The material belongs to the group of non-combustible materials. On the outside of the insulation layer, a wind-waterproof layer of Izospan AM membrane film is provided. On the inner side of the heat-insulating layer, a vapor barrier layer is designed from the Izospan B membrane film. The composition of the structural layers of the frame structure of the wall is shown in Fig. 4. As the outer finish of the frame part, a sheathing of a planned grooved board with a thickness of 20 mm along a lathing with a section of 50 × 50 mm. The cladding is treated with an antiseptic compound for outdoor use. The cladding of the inner surfaces of the walls of the frame part, and the filing of the ceilings are

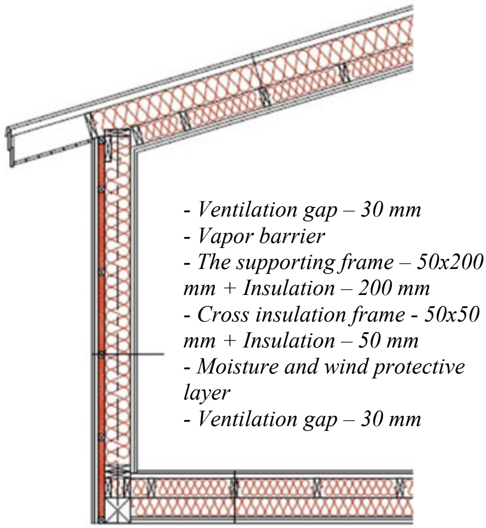

Fig. 4 Composition of structural layers of a frame wall

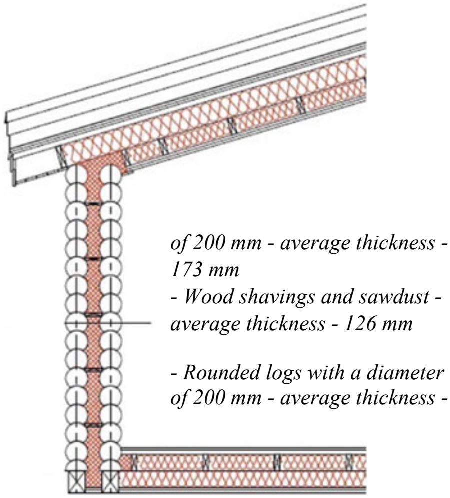

Fig. 5 The composition of the structural layers of the wall made using the double frame technology

made of 12 mm thick coniferous plywood. For the object in Murmansk, the interior decoration of the walls of the frame part, and the filing of the ceilings, is provided from the lining.

The average thickness of the wall structure made using the double log technology is 472 mm. The insulation layer thickness is 126 mm. As the main heat-insulating material, shavings and sawdust are taken, which are waste in the production of log elements. To compensate for the possible settling of the backfill insulation, membranes from a board 25 mm thick are provided in the wall structure. The composition of the structural layers of the wall structure, made according to the principle of a double frame, is shown in Fig. 5. Outside, the log part is treated with weatherproof antiseptic Tikkurila Valtti Log after preliminary mechanical cleaning and polishing. Indoor log surfaces are treated with matt acrylic lacquer Tikkurila Paneeli Assa.

One of the conditions for the comparability of research results in different climatic zones is the same orientation of the experimental buildings on the ground. The blank wall of the building should be oriented to the north, both in the city of Murmansk and in the city of Petrozavodsk. At the same time, the north-facing wall is divided into three zones in each part of the building. In each zone, a separate type of alternative heat-insulating material is used. For the frame part of the building, alternative heat-insulating materials are: natural insulation Flaksan Breeze (fibrous material made from dried seaweed and hemp (85%) and lavsan (15%)), ecowool and linen mats. Linen mat is an alternative thermal insulation material for a double log wall. The third zone in the wall of a double log house is represented by an air gap without additional insulation. The location of zones with additional types of heat-insulating materials for a frame wall and a wall from a double log house are shown in Figs. 6 and 7, respectively.

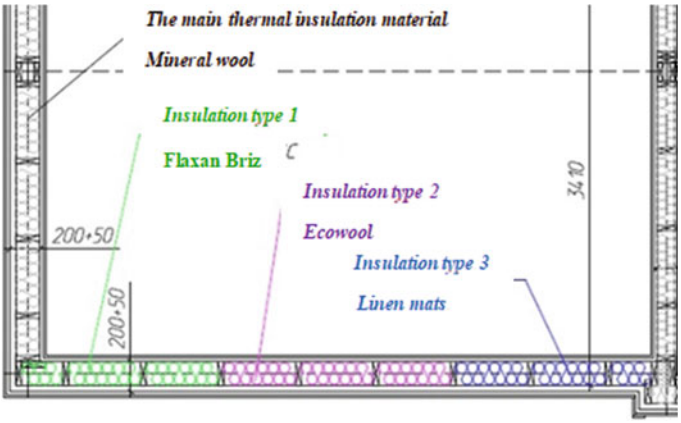

Fig. 6 Placement of zones with additional types of heat-insulating materials in the frame wall

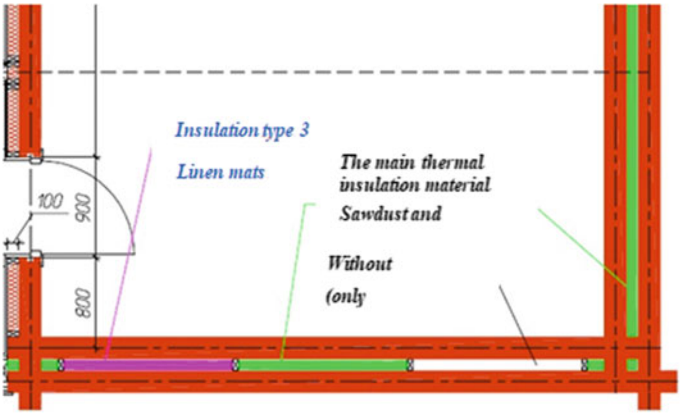

Fig. 7 Placement of zones with additional types of thermal insulation materials in a double frame

The thickness of the insulating layers is calculated in accordance with the climatic conditions of the city of Murmansk. As a result of the design, a general energy efficiency class for the entire building was achieved—A (very high).

As a filling of window openings, window blocks made of PVC Halo profile 72 mm thick with a double-glazed window unit with the formula 4i-12a-4-16-4 are provided. The entrance door is made of metal, insulated with expanded polystyrene sheets. Internal door blocks are made from MDF (Medium Density Fiberboard).

For the manufacture of elements of both house kits, the same wood was used, which was harvested in the Prionezhsky central forestry (compartment 19, unit 23) of the Prionezhsky district of the Republic of Karelia. Timber was harvested from December 15 to December 31, 2019. The logs were debarked and laid out in a cage for atmospheric drying for 5 months—from January to June 2020. After atmospheric drying, and the moisture content of the wood was 20–30% (air-dry wood).

The experimental buildings (Fig. 8) are equipped with a set of engineering systems (power supply, heating, ventilation [12] and electric lighting) necessary to ensure the standard indicators of the internal microclimate and conduct further research standard indicators of the internal microclimate and conduct further research, including using well-known methods of multi-purpose optimization of design solutions [13].

In summary, we note that our article focuses on the technical and technological aspects of experimental buildings (Fig. 8) construction. A similar but larger study of four construction options in Switzerland [14] also demonstrates the environmental and socio-economic benefits of using locally sourced timber.

For example, a hybrid structure (concrete and wood) has been shown to have clear environmental benefits in terms of greenhouse gas emissions and energy consumption compared to the reinforced concrete alternative. Undoubtedly, taking into account

Fig. 8 Experimental laboratory buildings in Murmansk (up) and in Petrozavodsk (bottom)

climatic and socio-economic differences between regions will lead to some correction of the conclusions of [14]. However, the adjustment will not be drastic, since according to the criteria of CO_2 emissions and CO_2 storage, the use of wood and wood waste [15] in construction has advantages [16]. And therefore further research in this area is advisable in the interests of the socio-economic development of the regions [17].

At the same time, it should be taken into account that all the advantages of wood construction can be realized if locally produced wood is used [14], since imports from outside the region create economic leakage that reduces economic benefits [18]. In addition, it should also be taken into account that the growth in the volume of wooden housing construction gives rise to the problem of Recycling of Wood Waste [19], which also requires further research, for example, by analogy with work [20].

In the future, on the basis of the considered experimental buildings, it is possible to conduct various studies in the field of resource conservation and energy efficiency of low-rise wooden buildings. For example, determining the locations of "cold bridges" and thermal energy leaks through the building's enclosing structures in order to substantiate recommendations for their elimination and thereby increase the efficiency of using wooden structures in the construction of buildings.

4 Conclusion

1. In this paper, in order to substantiate the relevance of the topic of the presented research, the analysis of aspects related to the history of the use of wooden structures is carried out. Explanations directly related to the research topic are given.
2. A method of synchronous monitoring of humidity and temperature of wood in the wall structures of two objects built simultaneously in two different regions (Murmansk and Petrozavodsk) is proposed. At the same time, various thermal insulation materials are used in the wall designs of each of the buildings to justify the choice of a more efficient design. The criterion of efficiency is thermal insulation characteristics and resistance to operation in conditions of high humidity outside the building.
3. Based on the results of monitoring, a database of temperature and humidity was created, both inside the building and in the material of wooden walls, as well as outside the building. All measurements are made using sensors and are automatically recorded on electronic media with an interval of 15 to 30 min. Monitoring has been carried out since January 2020.

Thus, the above stated goal of the work has been achieved, and the research tasks have been solved.

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Urban Environment: From Non-fragmentation to Integration of Localities

Valentina Melnikova and Tatyana Filanova

Abstract The problems of the urban environment quality in Russia have been discussed for many years, but since 2018 they have been raised to the state level. One of the trends of the country development, adopted by the Russian Government, is the Housing and Urban Environment National Project. To implement the project, all its participants use foreign experience, the recent experience of the most developed countries. At the same time, neither the specifics of Russian development, nor the specifics of constructing the actual environment of cities, artificially created socio-territorial entities, the specifics of the repeatedly changing social reality are taken into account. At the same time, the solution to the problem of the environment quality, its formation, taking into account the needs of the population of Russia were known in the 70 s of the twentieth century. However, this method either is forgotten or acquired a kind of author interpretation without taking into account its origin and references to the founder. The article presents the domestic experience in solving the problems of urban environment quality, demonstrates its approbation. The results of the study changed the direction of development of a particular city, opened the way to solving the problems of reconstruction of Russian cities, revitalizing their environment.

Keywords Urbanization · Urban environment · Urban culture · Kogan method · Local socio-territorial entities · Local center

1 Introduction

It is obvious that the problems of the urban environment, with its inherent asceticism, causing discomfort among the citizens, emerged in the countries that "skipped through" the period of mass formation of medieval cities and faced high rates of

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"industrial" urbanization. American scientist, writer-journalist, urban planning theorist Jane Jacobs wrote in her book "Death and Life of Large American Cities", published for the first time in 1961: "A big city cannot be a work of art" [1]. The environment of the historical cities of Europe is distinguished by an abundance of architectural monuments, cozy streets with well-kept houses and many flower beds, and a "human" scale. Jacobs suggested looking at the city through the eyes of a city dweller, thereby prompting two areas of urban planning thought and activity—"New Urbanism", appealing to create in cities conditions for a person, comfortable stay and "Participatory Design" as a new design method by involving the interested population in the process.

Currently, a certain experience has been accumulated in both areas: by the end of the twentieth century, the Charter of New Urbanism was issued, which pointed out the basic principles for creating cities that can improve the quality of life of the population living in them; at the beginning of the twenty-first century, many publications appeared. The authors provide the methodology and experience of involving citizens in the urban planning procedure. In 2015, UN-Habitat, the leading organization coordinating human settlements development in the United Nations system, was focusing on the development of urban "public spaces" [2].

In the early 1990s, the interest of researchers of various disciplines (sociologists, geographers, political scientists, architects, philosophers) in such object of research as "public space" was revived [3]. Within the framework of urban design, there is a growing understanding of the close relationship between social, economic, political, management processes and the creation of public spaces [4]. With the increase in the intensity of the use of public spaces, it became necessary to coordinate mass events. The experience of managing public space is described in the works of Carmona and De Magalhges [5–7]. An experimental approach to managing the development of the city as a whole and its elements has become widespread [8]. For this purpose, various "urban living laboratories" are being formed, the activities of which solve the problems of management of three levels: state and regional–strategic, municipal–civic and local–organic [9].

In Russia, under the influence of these processes, the quality of the urban environment improving is likely to become a national problem. In May 2018, the President of the Russian Federation signed a decree on national goals and strategic objectives for the development of the Russian Federation for the period up to 2024, establishing and approving national projects in Russia, including the national project "Housing and Urban Environment" [10]. The key objectives of this project are providing the population with affordable housing, increasing the volume of housing construction, increasing the comfort of the urban environment, creating a mechanism for direct participation of citizens in the formation of a comfortable urban environment, ensuring a sustainable reduction in the housing stock unsuitable for living [11].

To implement the project, the regions have developed by State programs "Comfortable urban environment", municipalities worked out Municipal programs "Formation of a comfortable urban environment". The Ministry of Construction of Russia, together with the Agency for Strategic Initiatives, developed and approved the Standard for involving residents in solving issues of urban environment development

[12]. To assess the quality of the urban environment, the Ministry of Construction of Russia with the direct participation of JSC DOM. RF "and KB "Strelka" developed and approved an index of the quality of the urban environment [13].

The relevance of the topic chosen for the article is due to this general interest in the problem of creating comfortable living conditions both in the cities in Russia and abroad.

A good tradition has developed in Russia to be guided by the high standards of the most developed countries of the modern world. However, in our opinion, one should take into account the difference in social realities, and not abstract from the domestic experience. Those scientific developments that have developed taking into account the specifics of the development of our country, including the specifics of the formation of the environment in Russian cities. "Russian Urban Studies" emerged much earlier than such institutions as DOM. RF and KB "Strelka" [14]. This article is devoted to one of such areas of "Russian urbanism", methods of creating a comfortable urban environment with the population participation.

The research goal is to introduce the domestic experience of interaction between the creators and consumers of the urban environment, to demonstrate the testing of the developed method and prove the advantage of its use at the present time.

2 Methods

2.1 Formation of the Urban Environment by the Method of Rationing and State Regulation

The overwhelming majority of Russian cities appeared in the socialist period associated with the industrialization of the 20–30 s and the restoration of the national economy after the war of 1941–45. The cities were formed as centers of industrial complexes by the state order and at the state expense. The accelerated pace of industrialization required an appropriate pace of construction while simultaneously cutting down the capital investment as much as possible. To solve this difficult task, scientific and design institutes were created that develop a regulatory framework, standard designs of buildings and structures, principles of planning organization of cities and methods of building urban areas. Typical planning organization, construction of typical houses, created according to uniform standards, made the new cities similar to each other. The socialist state committed itself to providing the population with housing, free education, medical and cultural services, and even guaranteed a sufficient number of jobs. The role of the city dweller in organizing the environment of his life was excluded.

Since the first wave of "industrial" urbanization of the 1920s and 1930s took place in a peasant country, the territory of the new cities of Russia was inhabited by the first generation townspeople who moved from the surrounding villages with the appropriate skills and level of ambitions. The ideological orientation towards universal equality with an almost complete class, socio-professional and cultural homogeneity of the social component of the urban organism, which is still manifested in monotowns, determined the monotony of the social structure of the city in terms of activity and mentality. The state concern for the needs of the people formed the attitude towards "dependence", and did not induce to engage in entrepreneurial activity, characteristic of a city dweller of a European city, starting from the Middle Ages. *The homogeneity and indivisibility of a socialist city is the specificity of Russian urbanization at the beginning of the twentieth century.*

The second wave of "industrial" urbanization of the post-war period put the historically formed cities into a particular position. Many of the cities located in the European part of Russia received a new development impetus in connection with the evacuation of enterprises and their workers from the border zone of the country. We are talking primarily about those cities that developed in the pre-industrial period and used to be provincial centers. Having received an industrial impulse, they began to grow and develop rapidly, despite the restrictions on their growth, undertaken by the state.

The cities developed in the pre-revolutionary period, survived or rebuilt after all social collisions, turned out to be the owners of a "historical" environment, the one that was formed in the pre-revolutionary period. We cannot say that with the understanding of the difference between the emerging, modern environment, there was an awareness of the value of the "historical" environment. On the contrary, often with a large scale of new construction, the question of demolishing old buildings was raised, but this turned out to be a troublesome and costly affair. It is much easier to build up vacant territories, as Russian cities became wider. We should say that this tradition has not yet been lost.

The rapid growth of cities in Russia during the war, and especially in the post-war period (50–60 years of the twentieth century) aroused interest in the process of urbanization of a number of specialists in various scientific fields and directions. It is believed that since the publication of L. B. Kogan and V. I. Loktev "Some sociological aspects of urban modeling", the city sociology appeared in our country [15], the publication of A. S. Akhiezer, L. B. Kogan, O. N. Yanitskiy. "Urbanization, society and scientific and technological revolution" is the theory of urbanization developed [16]. The first publication aimed at considering the city in 4 aspects that characterize the main directions of its modeling: building-functional, social-informational (the mechanism of interaction between the social and material-spatial environment), ecological and historical-genetic (the mechanism of continuity in the development of the urban structure). The second generally proposed to consider urbanization as a social phenomenon, as "an increasingly important part of the society development", since its driving force is "practical life activity", all the variety of forms of which is concentrated and intensified in the largest cities, then "urban culture is transmitted to the countryside".

2.2 Formation of the Urban Environment "By the Method of L. Kogan"

On the basis of these new theoretical views in the second half of the twentieth century in the Group of Sociological Problems of the Central Research Institute of Urban Development, headed by L. B. Kogan, a new trend in domestic urban planning science is emerging called "Social and functional studies". Despite this fact their theoretical basis remained the theory of urbanization, which by the end of the 70 s was already openly interpreted as a process of increasing the role of cities, urban culture, urban relations in the development of society. And its two-phase mechanism was known: the concentration of the culture of society in the largest cities with the subsequent spread of its samples to the periphery. In foreign science, the essence of this process reflects the "center-peripheral model" of economic development [17–19].

Socio-functional studies emerged at the junction of urban planning and sociology, where the city is considered as a social-spatial organism capable of self-development and self-improvement. The material-spatial environment of the city is transformed under the influence of life processes, which in turn is determined by the urbanization degree of the urban organism, the level of development of urban culture. ***An important component of urban planning-sociological research is the methodology for conducting them, which allows obtaining objective data in the course of studying the subject's activities***. ***The method of such research***, let us call it the "Kogan method" by the author's affiliation, ***consists in a sequential transition from a theoretical analysis of the problem, the construction of a hypothesis of the study, to the study of functional processes, through a specially set survey, and from them to determining the direction of spatial planning changes, solving urban planning tasks.***

Applying this method to cities at different stages of development, L. Kogan formed a theoretical model of the natural transformation of the spatial structure of a city in the process of its development, its gradual differentiation into zones differing in the urbanization degree (maturity of cultural potential). They are *the central zone* with historical depth, functional richness, density of functions and compactness of planning structures; *the middle zone*, which has a wide range of places of employment, large service facilities; *the peripheral zone* is mainly a residential area with utilitarian service functions [20].

2.3 Approbation of the "Kogan Method" by the Example of Samara

The first study using the "Kogan method" in Samara was carried out in 1991 as an alternative to the master plan of the city developed by the order of the municipality, according to which the city center was supposed to be developed in the geometric center of the urban area. The historical part of Samara, formed in the place the confluence of the Volga and Samara rivers in the first half of the nineteenth century, remained on the periphery and was supposed to be transformed. During the war of 1941–45, the development was received by the south-western territories remote from the historical part of the city. In subsequent years, the territories located between the developed western and eastern parts of the city were built up.

The results of the study showed that residents of all districts of Samara actively use the historical part of the city, considering it to be its urban center. The vast majority of citizens noted the historical environment as the most attractive, and its reconstruction was considered a priority event. Therefore, the idea of moving the citywide center to a new territory turned out to be not viable. Samara's master plan had to be adjusted. The center-peripheral model set the direction of the city's development (Fig. 1).

Over the course of a number of years, Samara has repeatedly been subjected to urban planning and sociological research. In 1991, the country was in the stage of restructuring the socio-economic structure, but it was still a socialist state. In 2002, market relations were consolidated in Russia; the spheres of everyday life and trade were privatized, which led to a sharp increase in the number of objects in these spheres on the territory of Samara. At the same time, some industrial enterprises, concentrated in the southeastern part of the city, ceased their activities or underwent reorganization. These changes redirected labor, cultural and leisure flows to the central and middle zones of the city. In 2017, a new survey was carried out as part of the development of the city's master plan. Its results showed that the process observed in 2002 intensified

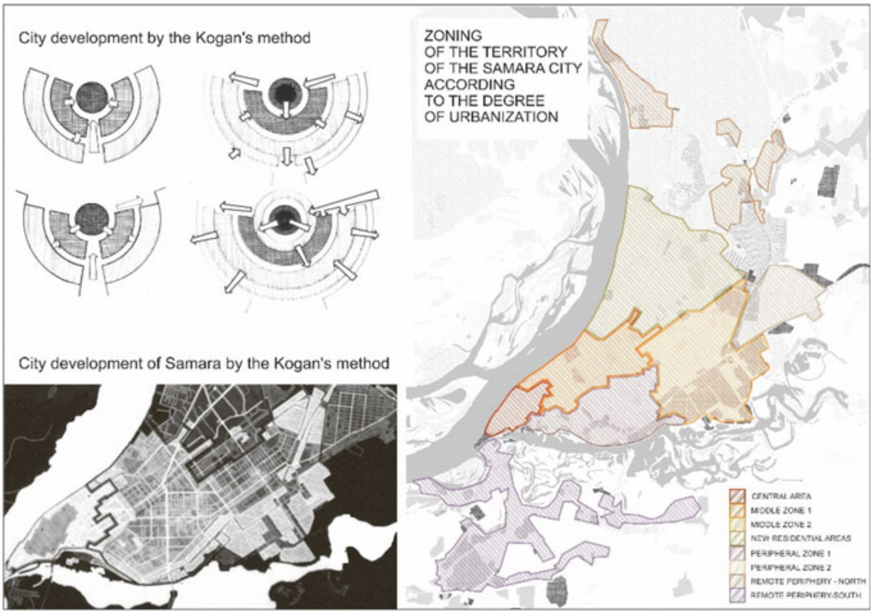

Fig. 1 Center-peripheral model of urban development (1991, V. Melnikova)

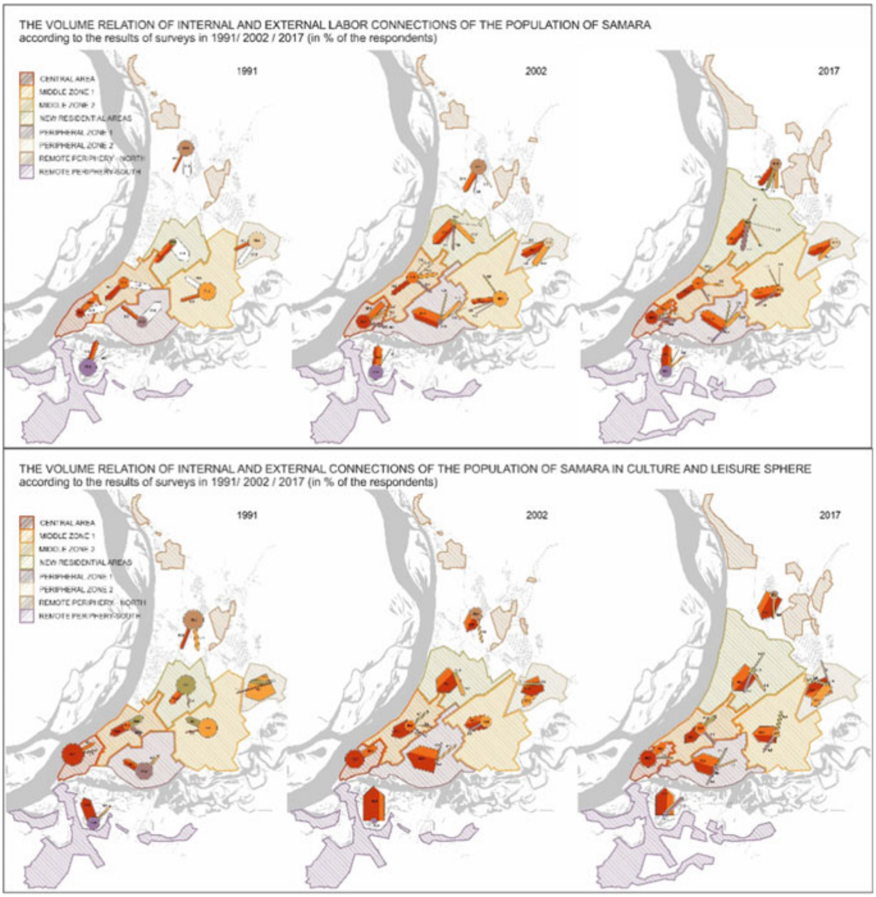

Fig. 2 Dynamics of the urban zones transformation (V. Melnikova, T. Filanova)

and strengthened. The spatial structure of Samara is gradually acquiring the outlines of a forecast model formed in 1991 on the basis of the "Kogan method" (Fig. 2).

Thus, the "Kogan method" was tested by the example of one city that has been developing for 25 years, which proves its objectivity and expediency of using it in practice.

3 Results and Discussion

In 2003, Russia passed a law on the organization of local self-government. The territory of Samara was divided into local formations (territorial public self-government) at the discretion of the city administration. For a number of years, the usefulness of such a division and the activity of territorial public self-government functioning has not been noticed. In this regard, the authors of the article in 2009 proposed a new version of dividing the territory of Samara into local formations using the "Kogan method" [21]. The analysis of social systems showed that social integration is based on the social nature of the realization of the individual needs of people. According to Kogan's theory, utilitarian life-supporting functions are centrifugal, while unique sociocultural functions are centripetal. Consequently, the integrating basis for the natural association of city dwellers at the local level is the local centers, within which the daily life of the urban population is realized. The location of local centers and the areas of population gravitation towards them were established by the method of urban planning sociological research—the "Kogan method", on their basis, the boundaries of local socio-territorial formations capable of solving problems of the local level were determined. It should be noted that the zones of influence of local centers were studied not only from the point of view of real functioning, but also at the level of the respondents' consciousness, their perception of space, which they consider "theirs". Also, an indispensable condition for the study was to take into account the characteristics of the material-spatial environment, the degree of its urbanization Fig. 3.

By the time of the development of the general plan of Samara in 2017, the issue of the location of the city center and the presence of local centers with the aim of forming "public spaces" were actualized.

As it could be expected, in 2017, citizens again pointed out the historical part of the city as Samara center, the intensity of use of which significantly increased compared to the results of the 1991 study. In 2009, when it was necessary to establish the

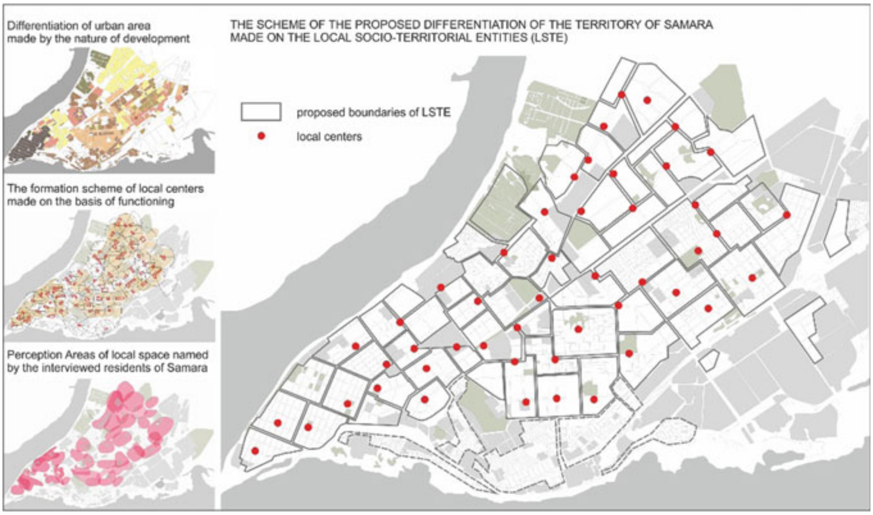

Fig. 3 The method of differentiation of urban territory made on the local socio-territorial entities (2009, T. Filanova)

Fig. 4 Identification of local centers in the urban area (2017, V. Melnikova, T. Filanova)

location of the centers of local urban communities, the places of concentration of social functions that ensure the realization of the utilitarian needs of the population were identified. In 2017, the question was to identify Samara citizens' awareness of the very presence of a local center on the territory of residence with a proposal for its name, if the respondent believes that such place exists. The results are shown in Fig. 4.

In urbanology, public space should be understood as a part of an urban (or rural) territory visited by residents on an ongoing basis with different goals and frequency, with any form of interaction between different partners. Simply put, public space is a place of social activity of various social groups of the urban or rural population, depending on their belonging to a certain type of settlement. Public space should have at least one quality that is attractive to a certain group of the population. To become a public space on the scale of a large city, a part of the territory claiming the status of a public space should possess a number of such qualities.

In order to identify public spaces on the territory of Samara, the following qualities were proposed that are most appreciated by the citizens:

- the most visited territories indicate and characterize the intensity of it use and the degree of mobility of the population;
- territories that are perceived by the population as central, they are already by definition a place of social activity;
- the most attractive territories for residents, where they are especially pleased to be; as a rule, it is these places that become generators of social interaction;
- territories that are most often used to meet with friends are the main communication partners of a city dweller.

When combining the information received, it was found that some territories endowed by the citizens with the status of "public space" have several qualities Fig. 5.

In order to create an integral frame of public spaces on the territory of the city, we analyzed those elements that are potentially ready to be included in the general system of socially demanded places, of course, subject to their improvement and appropriate functional saturation (Fig. 6).

So, over a number of years, the "Kogan method" was used in different works carried out in Samara for different purposes, but the end result is supposed to identify the places of various social activities, when comparing the data an interesting result was obtained. In the overwhelming majority of cases, almost complete or partial coincidence of the location of social activities, on the one hand, is another fact of approbation of the Kogan method. On the other hand, it confirms the reliability of the data obtained in 2009 concerning the reality of the existence of local centers capable

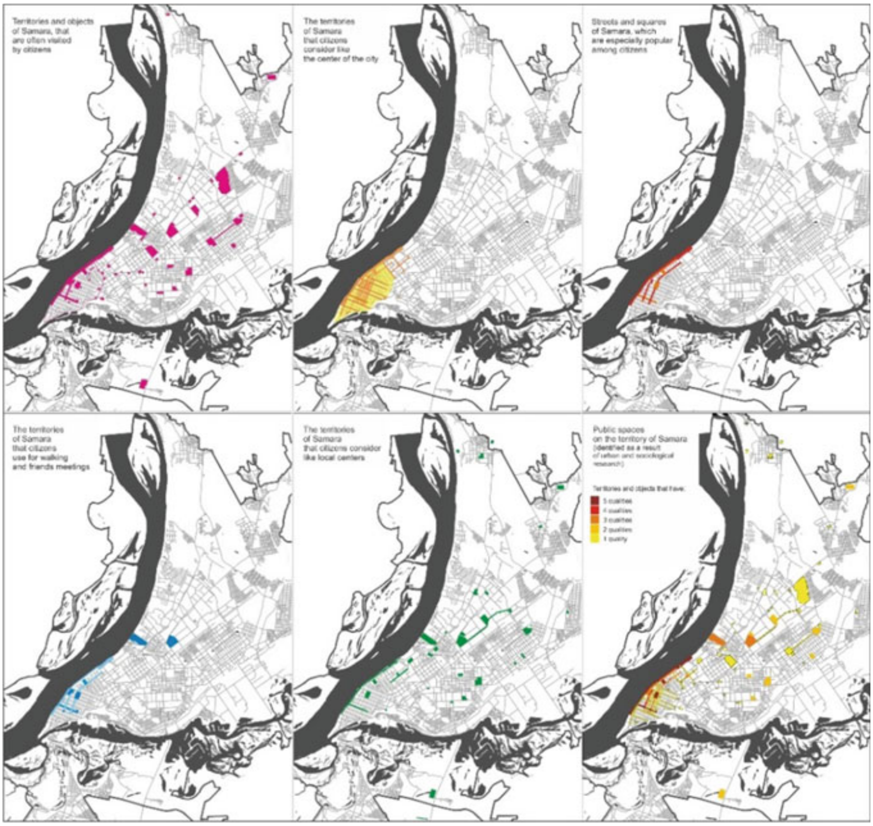

Fig. 5 Analysis and project proposal on the formation of a system of public spaces (2019, V. Melnikova, T. Filanova)

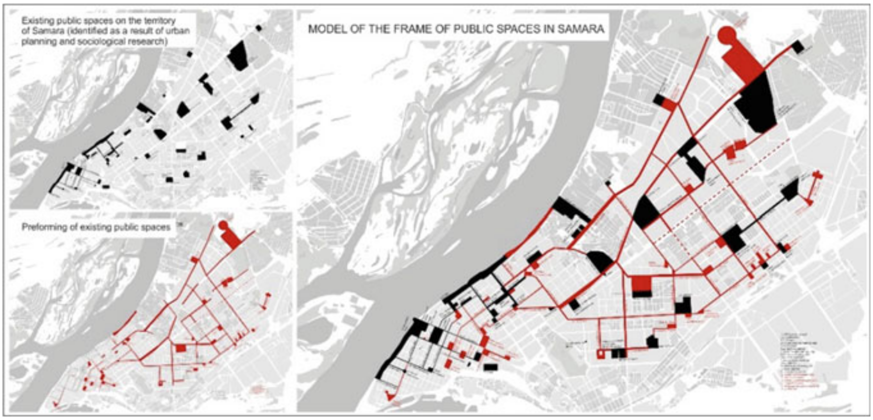

Fig. 6 Project proposal on the formation of a system of public spaces (2019, Research and Development Department of SSUE «TerrNIIgrazhdanproekt»)

of ensuring the integration of society to solve problems in their local territory related to the provision of the comfort of the environment (Fig. 7).

Thus, a close relationship between a certain territory and the social life of the people living in this territory has been discovered. It is necessary to strengthen this interrelation. Local centers with the most laconic equipment could turn into places of interaction of citizens of a single consumption area on a constant basis to solve their actual problems. Such interaction would create the conditions for a partnership between small businessmen and contribute to the identity development. It is possible to create places that naturally and harmoniously fit into the urban canvas,

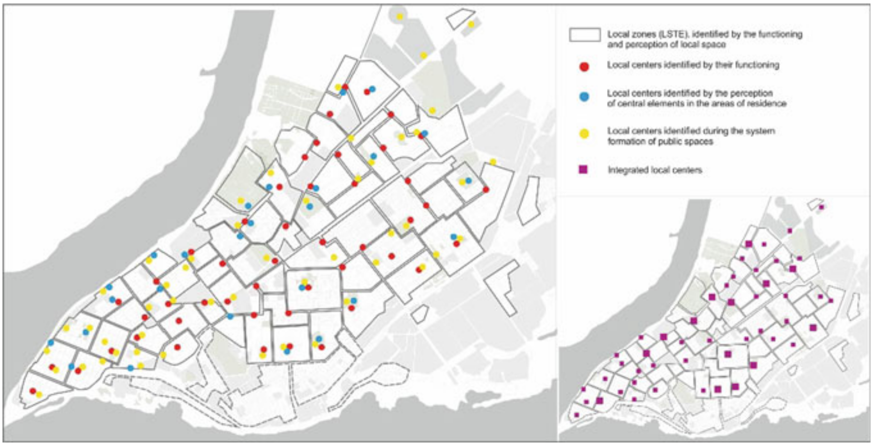

Fig. 7 Integration of localities (2020, V. Melnikova, T. Filanova)

giving the urban environment a unique diversity. The creation is based on knowledge, opportunities and ideas of the local community.

Now let us compare what results we can get using today's method and the "Kogan method".

As we have already noted, the method used today is essentially the method of the state, the method of the standard of the population involvement in the design, and the standard by which the quality of the environment is evaluated. We note that it is assessed not by the residents, but by the state standard and state agencies. Developed options for landscaping, recognized as successful, are replicated and contribute to the environment unification. The community involvement standard gives the opportunity to choose the area to be improved, but only from the options offered by the administration of the municipality. Among those involved in the design process proposed by the standard, there are social groups who are in the proposed area, but they are forced by the standard to take part in the judgment on its equipment and make a decision.

As for the "Kogan method", it is focused on the actual consumer of the urban environment at all design stages, regardless of the scale of the socio-territorial entity, whether a point object, part of the city, the city as a whole or even the region [22].

4 Conclusion

Urban planning-sociological research, conducted by one of the authors of the article in Samara in 1991, attracted the attention of planners and managers to the historical part of the city, which helped to save it from destruction. Kogan's theoretical model was first introduced into the design practice and was used to correct the general plan of Samara. All subsequent design developments have maintained the trend outlined in 1991. In December 2019, the historic center of Samara was granted the status of a historical settlement of regional significance.

Urban planning-sociological research of subsequent years has demonstrated the realization of the 1991 model. The central zone of Samara is consistently gaining greater social significance. The peripheral zone (PZ-1) adjacent to the historical center is intensively transformed and saturated with central functions. The median zone, remote from the center (SZ-2), on the contrary, loses its former importance, the rank of its environment decreases.

The local centers identified in the course of urban planning-sociological research in 2009 and 2017 are actually functioning public territories of local urban communities that meet the requirements of an urban lifestyle. As a result, new qualities that public spaces must have in order to receive the status of "public space" were established. These are intensity of use, centrality, attractiveness, but most importantly, they must become a place for friendly meetings of citizens.

Urban planning-sociological research (Kogan's method) is a set of explanatory theory, methodology for conducting a full-scale survey and spatial-planning interpretation of the data obtained within the framework of the theory. The use of the method of urban planning-sociological research opens the way to solving the problems of the reconstruction of Russian cities, the revitalization of their environment; the formation of a variety of "public spaces" in full accordance with the needs of the population, activates the participation of citizens in transformative activities to improve the quality of the environment. The only condition for obtaining positive results is strict adherence to the methodology. Deviation from it can turn into self-deception.

The method used today, in essence, is the method of the state, the method of the standard defined by it for involving the population in design, and the standard defined by it, according to which the quality of the environment is assessed. The developed landscaping options, recognized as successful, are replicated, which leads to the unification of the environment. The standard of population involvement gives the opportunity to choose an area to be improved, but only from those options offered by the municipality administration. It should be remembered that legislative activity, which does not rely on research of real processes, turns into a screen for arbitrariness.

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Peculiarities of the Spatial Development of a Region in Conditions of Urban Planning Conflicts

K. M. Mishina, N. A. Goncharova, M. E. Monastyrskaya, and A. Y. Perkova

Abstract The problems of settlements' spatial development in the conditions of new approaches to organizing the life environment cause the occurrence of city-planning conflicts. The transition from the functional model of urban-planning activity to the social-spatial-oriented one is highly relevant. The purpose of the article is to identify the peculiarities and approaches of spatial planning and determine the mechanism of resolving the city-planning contradictions that arise in the territories' development process. The city-planning conflict resolution method is the leading approach to investigating this problem. City-planning conflicts inevitably occur due to the different motivations of the participants in the city-planning process. It is an analysis tool and is intended to solve the problems of harmonizing society's interaction, territory urbanization, and the environment. It has been determined that there are no research works or project designs in regional territorial planning. The basis of decision-making would be the analysis of the causes of the contradictions at the territory. The research work suggests a methodology of settling city-planning conflicts as a mechanism of resolving urban-planning contradictions. The developed theoretical and methodological basis for territorial planning would allow providing the rational utilization of natural resources, settling the conflicts of various land uses, resolving modern housing conflicts and the historical and cultural legacy.

Keywords Spatial planning · Regional settlement system · Conflictological approach · Urban planning conflicts · Land use

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1 Introduction

Historically, various spatial forms present the population's settlement with the functional, and environmental diversity of settlements according to the countries' geographical and sociocultural peculiarities [1]. The regionalisation processes should preserve the local originality, the uniqueness of cultural peculiarities and traditions [2], and the territories' social and economic development [3]. The essence of regionalisation consists of understanding the significance of the place, evaluating, transforming with time and how it exists now, and preserving its originality through federal and regional programs and strategies [4]. New approaches of the human environment organising and implementing the innovative methods of economic development inevitably provoke urban-planning conflicts. The urban planning conflictology has not been yet formed as a field of research. This field of study is at the intersection of urban planning [5] and conflict management. Its purpose is the interpretation of spatial systems at the conflictological level, and the search of options to solve the conflicts between the motivations of the participants of urban-planning activity.

The research aims to identify the distinguishing characteristics of spatial planning [6] in some countries [7] and determine the mechanism of urban-planning conflicts, which occur in the territory's development [8]. The objectives of the study are: the features consideration of spatial planning in a number of countries in order to identify approaches to spatial planning, determining the role of urban planning conflictology in the regional settlement systems development in Russia and abroad; development of a methodology for resolving urban planning contradictions as a theoretical and methodological basis for territorial planning.

The conflict-related subjects in the urban planning theory have been studied for not a long time, the search for balance between the concerned parties in the process of territorial transformation is conditioned by the urban planning conflictology [9–11]. Several works deal with studying a conflict in sociology, psychology, and politic studies. V. Svetlov, in his work, formulates the basic definitions of conflict and a conflict-free situation and describes various models of conflict. G. Edelman, B. De Melder described the experience of planning in post-conflict and post-emergency situations. L. Wirt, E. Burgess studied the spatial aspect of conflicts. M. Castells devoted his works to the conflict basis in city territories development. G. Edelman and J. Forrester's works are devoted to the management strategies of city-planning activities including the organisation of the negotiation process at making decisions.

In the Russian urban planning theory, urban development contradictions received little attention due to the predominance of the functional paradigm. However, we can single out specific points of view and renderings of conflicts in urban planning. A. Krasheninnikov concludes that the main causes of conflicts, associated with land use, are the incompatibility of crowded and individual activities; lack of area for car parking, games, avocations; inefficiency of borders. V. Glazychev considers conflict as a subject of organisational activity within the framework of participation technology, one of the purposes of which is resolving the conflict of interests of a small circle of development project initiators and a wider community of residents. E. Eschina in the context of studying democratic procedures in urban planning activity regards the «NIMBY syndrome»—a specific form of social-spatial conflict. NIMBY («not in my backyard»). A. G. Bolshakov considers the universal types of city planning activity motivations, the main groups of conflicts between them and the design methods of their resolution [12]. E. O. Freidin describes the urban-planning conflictology as a method of interpretation of city-planning activity and conflictology [13].

However, these research works have no unified theoretical and methodological apparatus yet, borrowing it from sociology, political science and psychology. In this regard, it is supposed to determine the up-to-date approaches to solving the problems of urban regulation, to study the process of territorial planning in terms of resolving contradictions in various countries, to identify the place of urban-planning conflictology within the territorial planning system and to suggest the methodological sequence of resolving city-planning contradictions in this research.

2 Methods and Materials

The primary approach to territorial planning is sustainable development. It also becomes the basis of network systems stability [14–16]. Lately, the researchers have been paying attention to the methodology, which should be used for the quantitative evaluation of stability both in cataclysms, and in the peacetime. It is the authors' opinion that the sustainable development of the regional settlement system is a result of the stability of the network nodes, the degree of spatial connections density, the amount of the involved natural resources, and should be aimed at resolving the conflict of interests between natural, economic, and social subsystems [17].

The second approach consists of developing a polycentric settlement structure. Polycentric spatial structure is used at various levels. The concept of polycentric spatial development was first introduced within the ESDP program framework and is essential for territorial development in the EU. Polycentrism contributes to sustainable territorial development and reduces territorial disbalance [18].

The third approach is the ecological-environmental one. The modern urban regulation lies between two polar processes: on the one hand, there are high spatial designing and organisation technologies, the improvement of life comfort, environmental health monitoring and control, and environmentally friendly architectural solutions, on the other hand, there is the intensive market relations development, which drains the resources, hazardous production facilities and technologies, the continuous environmental pollution and degeneration, the rapid growth of urbanisation. The research of the spatial planning system to determine the mechanism of resolving city-planning conflicts, has shown that certain attempts are made to consider the ecological-economical aspect and resolve the participants' contradictions in spatial planning.

Integrated planning (unlike the sectoral planning) is future strategic planning with administrative division, resource distribution and the producing sector organisation. The integrated planning acts as a coordinating centre in initiatives advancement and resource distribution. Participatory planning is a specific form of planning activity, used by governmental bodies at the local level, making it possible for the citizens to participate in the planning process. The most popular form of integrated planning is public hearings concerning the projects before their official sanction. Such procedures allow reducing the number of potential conflicts, resolving them at the approval stage.

Therefore, at the first level of spatial planning in European countries, a comprehensive plan is strategic planning, intended for a long-term perspective and includes analysing the territory's available potential. The objectives of territorial planning are solved according to the relatively conventional established scheme to involve the urban planning regulation population. The conflictological approach as an instrument of pre-project analysis is not used; the conflicts are partially resolved in public hearings at taking decisions.

The authors of this research consider it expedient to use the methodology of identifying the existing urban-planning conflicts and forecasting the potential conflicts at the stage of analysing the existing problems and evaluating the territory's potential to create the favourable environment of social and economic development and environmental safety.

As a result, the urban planning activity faces some problems, of which a group of urban-planning conflicts can be singled out. As a basic definition «urban-planning conflict», we suggest considering an articulated adverse reaction of the urban community's various representatives to the others' city-forming activities. The conflict structure also includes a spatial element that is a particular part of the territory planned to undergo this change. An urban-planning conflict begins where one or more functional groups (subjects) of architectural and city-planning processes create the environment, adverse to the other subjects in specific parameters. Each subject has its ideas about how and for what purpose this territory should be utilised. Analysing the compatibility of some aspects of the situation and determining its state allows us to conclude a conflictual or conflict-free state of a city-planning situation. The conflict participants are the administration, business structures, citizens, and professional associations.

An urban-planning conflict arises based on contradictions concerning the use (development, formation, and transformation) of the urban environment by opposing parties. The collision of interests of two or more activity participants occurs, at which the transformations of physical (territorial) and semantic resources of a city takes place. The larger is a construction object or an object of urban environment transformation, the more citizens can take part in an urban-planning conflict.

The urban-planning conflicts can also occur at the reconstruction of the already existing built-up environment with the subsequent change of the functions of a real estate item or a particular territory, creation of infrastructure facilities or significant buildings or the inexpedient use of territories, these results in the increase in the number of problems in the city's general social and engineering infrastructure, transport, ecology, and demography [19].

The urban-planning conflicts arise at the active intervention of new buildings and constructions into the existing urban-planning system, which increases anthropogenic properties of the territory; creates transformations in architectural and planning, volumetric and spatial functional features of the urban environment, disrupting the settled system. This creates the change of spatial-planning conditions of livability and active alteration of the structure of the territory itself.

The main reasons for urban conflicts are progressing contradictions between the processes of territories development and the processes of territories' uniqueness preservation; progressing contradictions between the economic development and ecological sustainability of the territory; contradictions, which arise at the usage of territories by the population for the satisfaction of their needs; contradictions in determining the guidelines of a city's spatial development; maladjustment of the regulatory and legal framework in the sphere of natural resource management and urban planning; non-coordination of land and property complex management and city-planning activity; local errors in urban territories development made in a particular period.

Most of these conflicts are due to the contradictions about treating the available territory. An essential thing for studying the connection between the territory and the outcome of the conflict is the fact of the environment (urban-planning situation) change in the process of social subject interaction, for example, acts of war result in the change of administrative divisions of territories between adversaries; disasters and natural calamities in physical changes of the environment; land-use conflicts in alterations at the level of zoning and development potential of the area.

The function conflict arises when various social groups claim the same territory with opposite motivations. In this case, the task of urban-planning activity is resolving all types of spatial conflicts.

The conflictological approach, aimed to determine the contradictions in the use of the urban environment by the opposing parties, was used by the authors to identify contradictions in the transport infrastructure development of the large city agglomeration of the Russian Federation.

3 Results and Discussions

The overall result of this research is developing a methodology of detecting the urban-planning contradictions, which would contribute to the sustainable city-planning development of the regional settlement system and its elements by up-to-date imperatives: balanced social and economic development, which would not destroy the natural environment and would contribute to the social progress. The suggested methodological sequence of identification and resolution of city-planning conflicts was developed based on principles of the territory's sustainable development regulation; analysis of the territory's resource potential; determination of the identity «code» of the territory; identification and classification of the areas of city-planning conflicts; methods of city-planning conflicts resolution (Fig. 1).

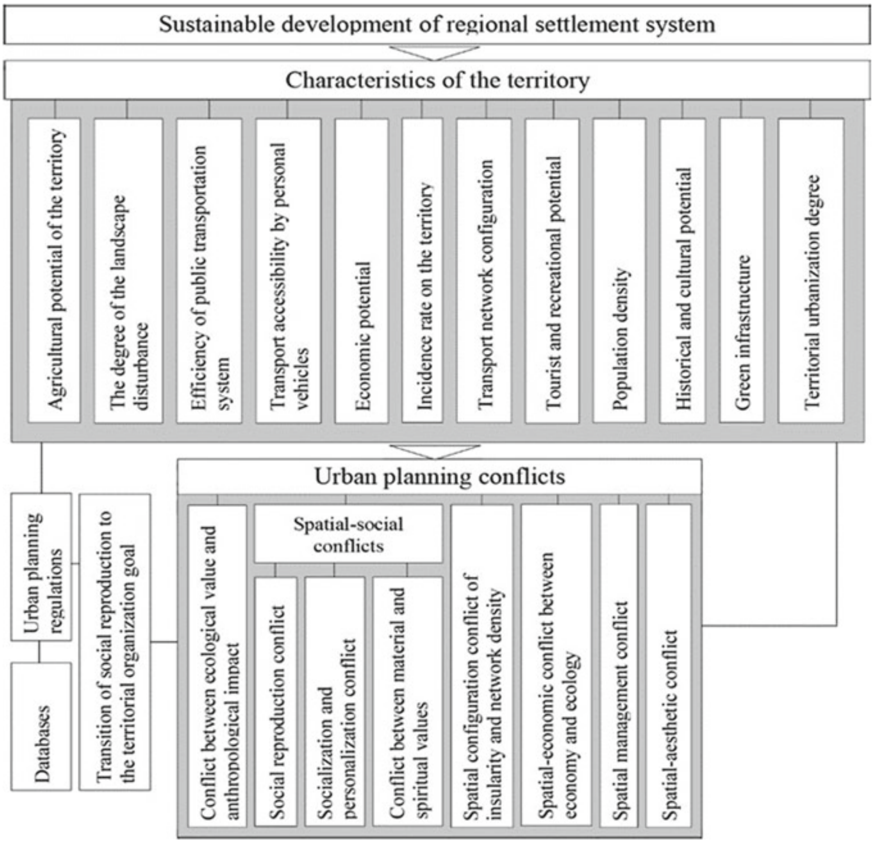

Fig. 1 Methodology of development of the existing regional settlement system and types of urban planning conflicts

As an example of an urban planning conflict, the authors consider the development conflict of suburban areas of the Belgorod agglomeration, Russia. The Belgorod agglomeration feature is its powerful belt of suburbs, consisting of neighbourhoods with areas of low-rise housing construction, which developed in the early 2000s due to the regional program's introduction support individual housing construction, launched back in 1993. The critical factor in the development of suburbanized territories in the Belgorod Region is creating the Belgorod Mortgage Corporation, which issues land plots for low-rise housing construction on preferential terms.

The natural boundaries of the territories of low-rise residential buildings are ravines and beams, reservoirs, and forests. The expanded areas of new low-rise buildings are several times larger than the original settlements in the area, often merging with other settlements and Belgorod. Unlike the historically established rural development, personal subsidiary farming does not become a specialization of the suburbia population since the inhabitants of these territories are the urban

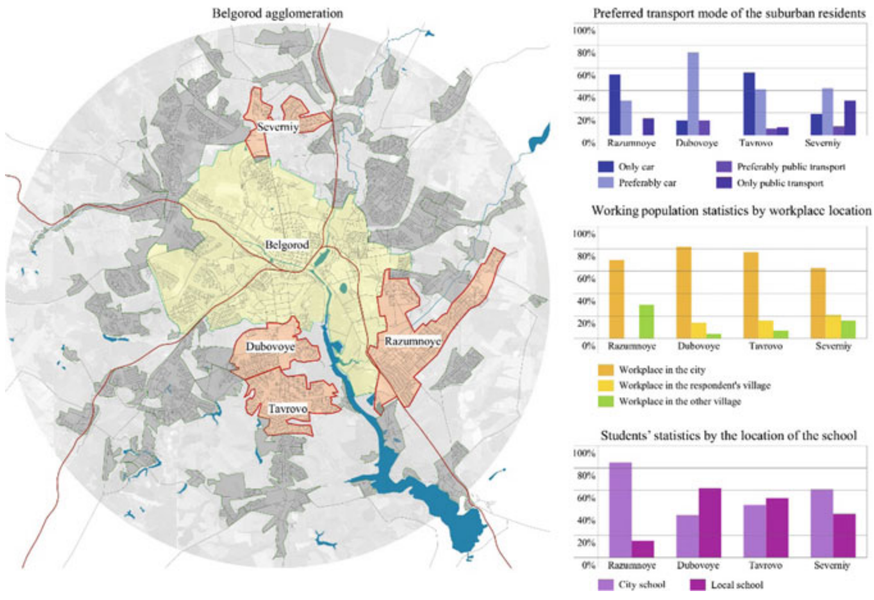

Fig. 2 Urban planning conflict of Belgorod agglomeration

population. The lack of places of employment forces the population to make daily commuting. The suburbs' low density does not contribute to the development of public transport, which leads to an increase in the need for a private car among the population (Fig. 2). The results of the suburban population survey are presented in Table 1.

The developed methodological sequence for territorial planning, based on resolving city-planning conflicts, would allow providing the rational use of natural resources and its replacement, providing the environmentally sustainable development of various parts of the territory, settling conflicts between different types of land use and building concerning valuable landscapes, and settling conflicts between modern housing and the task of preserving the historical and cultural legacy.

The transition of the system from a conflictual state to a qualitatively new conflict-free one improves the condition of human environment. Using conflictological approach in spatial planning at all levels of projecting the regional settlement systems, from development strategies to the plot plans of settlements, would allow the sustainable development of the territory and preserve its natural structure.

The existing types of spatial planning in various countries and various urban regulation processes include to this or that extent the attempts of resolving contradictions and searching for optimal decisions with an account of all the participants' interests. Comprehensive spatial development approach considers a fair amount of factors, which can influence the spatial development of a specific territory regardless of their character: natural factors (climate changes or natural calamities), human potential, investment attractiveness, public policy. Special attention is paid to the

Table 1 Survey results

Question	Answer	Razumnoye (%)	Dubovoye (%)	Tavrovo (%)	Severniy (%)
What is your preferred transport mode?	Only car	53	86	58	19
	Preferably car	32	7	31	41
	Preferably public transport	0	7	5	6
	Only public transport	15	0	6	34
Where is your worplace locaed?	Workplace in the city	70	83	78	62
	Workplace in the respondent's village	0	15	17	21
	Workplace in the other village	30	2	5	17
Where is your school located?	City school	85	38	47	61
	Local school	15	62	53	39

coordination of state policy in various spheres concerning a particular territory to ensure territorial unity and prevent the uneven distribution of resources and production. Nevertheless, identifying the evolution of various natures' conflicts as a factor of territory development is not noted in public documents and strategies.

During the pre-project analysis stage at evaluating a territory's resource potential, it is crucial to study the evolution of the arising and development of urban-planning conflicts and resolve the contradictions concerning the territory's current use. At any contradictions, that may occur, the primary focus should be on the natural structure's interests and preserving the ecological balance. It is feasible to detect and forecast urban-planning conflicts at every hierarchical level of spatial planning (region, district, settlement), which considerably increase the risks for implementing this or that spatial program or territory development strategy. An essential characteristic of this process is solving the land-use conflicts to search a compromise to the benefit of the well-being of people and the sustainable environmental state in the first place, not the sectoral interests.

Based on the designed map charts and the identified urban-planning conflicts, the methods of resolving conflicts are developed with an account of the regional specifics: ecological, spatial, social, and economic. This would allow considering all the interests and values of a certain territory with the purpose of its balanced development.

4 Discussion

It can be noted that in the existing types of spatial planning in different countries and urban regulation processes, there are, to one degree or another, attempts to resolve contradictions and the search for optimal solutions is carried out taking into account the interests of the parties involved. For example, when developing a master plan, public hearings, debates with the participation of the population are held, which allows resolving potential urban planning conflicts at the planning stage. The Comprehensive Spatial Development Approach takes into account many factors that can affect the spatial development of a certain territory, regardless of their nature: natural factors (climate change or natural disasters), human potential, investment attractiveness, public policy. Special attention is paid to the consistency of the state (sectoral) policy in various areas on a certain territory to ensure territorial cohesion and prevent uneven distribution of resources and production. However, the identification of the evolution of conflicts of a different nature as a factor in the development of the territory is not indicated in publicly available documents and strategies.

At the stage of pre-design analysis, when assessing the resource potential of a territory, it is important to study the evolution of the emergence and development of urban planning conflicts and resolve existing contradictions in the modern use of the territory. At the same time, in case of any contradictions that arise, the interests of the natural framework and the preservation of the ecological balance are of paramount importance. It is advisable at each hierarchical level of territorial planning (region, district, and settlement) to identify and predict urban planning conflicts that significantly increase the risks in the implementation of certain spatial programs and strategies for the development of territories. An important characteristic of this process is land use conflicts in order to find a compromise in favor of human well-being and a stable ecological state, rather than an industry position.

5 Conclusion

The mechanism of urban planning conflicts arising based on different participants' views of the on the territories development was determined by the authors of this study. The conflictological approach aims to provide the rational use of natural resources; providing the environmentally sustainable development of various parts of a territory; regulating the human-induced impact; restoring the production culture; settling the legal relations. In spatial planning, it is necessary to consider the participants of city-planning activity, the conflicts between their interests, the social groups, and their positions, oriented to changes, social-spatial connections, and correlation of the project with the conflict dynamics. Ecological and city-planning conflicts can be caused by the high concentration of material, energy and human resources, the waste products at a limited territory, combined with the imperfections of life environment organisation. The questions of detecting and resolving the urban-planning conflicts in spatial planning and management system should come first in program documents, determining the prospects of city-planning development with an account of the already existing regional context.

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"Pilot Projects" for the City in Educational Design

V. L. Pastushenko and O. S. Rybacheva

Abstract The method of diploma design on complex city-forming sites is considered. The problems of the relationship between construction and design practice are outlined. Possibilities of forming urban spaces, alternative to real design practice, are revealed by the example of "pilot" projects. Three main thematic areas for design in problem areas of Samara city are formulated. An overview of projects in each of these areas is given. The role of experimental design in the framework of the educational process at the Faculty of Architecture to determine the ways of the future development of problem areas of the city in terms of reconstruction and renovation of the urban environment is indicated.

Keywords Pilot project · Renovation · Inactive industrial enterprises · Reconstruction · Historical quarters

1 Introduction

Renovation of historic urban areas is one of the key issues in international architectural practice [1–5]. The construction practice of recent decades is associated with the intensification of the use of already developed urban areas, namely, with the reconstruction and compaction of buildings. A particular actual topic is the necessity for renovation and re-profiling of former industrial enterprises, built on the peripheral urban territories at the end of 19th-first half of the twentieth centuries and, at present, surrounded by residential areas. This problem became especially acute in the post-industrial time in all big cities with developed industry. Samara, as a developed industrial city, is a bright example of this typology.

In modern Samara a lot of industrial enterprises, ranging from pre-revolutionary ones located on historical quarter borders to the large enterprises of the Soviet period (SBF 4, Maslennikov factory, Tarasov factory, Klapanov factory, etc.) located outside of the city, found themselves surrounded by a new residential building.

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Since at present there is no clear long-term urban planning for the development of the city and its fragments, construction is carried out according to the rules of the market: commercial profit becomes the only criterion for construction. Generally, such construction is carried out without taking into account the harmonious development of the urban environment, rational functional and planning organization of the city's territories, without taking into account any contextual architectural and planning continuity of the development. In the current situation of a shortage of urban planning concepts, it may be advisable to turn to the potential of the Faculty of Architecture for the implementation of various search and forecast project proposals, especially in the framework of final qualification works in the areas of baccalaureate and grad school degrees.

Designing within the framework of the educational process is not associated with targeted funding programs and the interests of specific customers, therefore it makes it possible to look at the development of the territory more broadly, taking into account the context of the architectural and planning structure of a district or city. In this sense, educational projects can act as an alternative to competitive design, since they solve a similar problem, namely, an analytical study (examination) of urban planning conditions, urban planning justification, variant design, and space-planning modeling of the urban environment. In the process of developing educational projects, all problematic areas of the city's development are touched upon—from the reconstruction of the planning structure to the design of objects on complex and important city-forming sites [6]. Unfortunately, until recently, this huge potential of alternative design as problematic and significant areas have not been used in the interests of the city.

Design practice is always associated with a large volume of paper design, during which investors explore the potential of promising areas for the development of public and residential buildings and complexes. In this situation, the projecting architects collect up-to-date information on potential construction sites. One of the directions, within the framework of the educational process, is alternative experimental design on these forward-looking sites. Such projects can be called "pilot". Such projects can be called "pilot". The goal is to demonstrate possible options for the development of individual territories and fragments of the urban environment in the broader context of city development without reference to a specific design assignment, which gives a certain freedom in decision-making of demonstrating alternative development scenarios. The task of the "pilot" projects is to offer new social and functional content for the development of complex, problematic in terms of urban planning, territories, and on this base to create options for project proposals for the subsequent professional and public discussion of the prospects and strategies for the development of these territories.

2 Pilot Projects Methods

The following research methods were used in the "pilot" projects:

- System-structural analysis—presentation of the design object with the identification of structural links.
- Historical and genetic analysis—the development of an object in time with the identification of stages of formation.
- Evolutionary urban planning analysis—identifying the most stable elements of the architectural and planning structure in the process of its development.
- Contextual method—the study of an object in relation to the urban context.
- Diploma design related to problem areas of the city can be divided into several main thematic areas:
- renovation of the territories of former industrial enterprises;
- design of objects on empty, difficult to implement sites in the existing urban development;
- design of facilities in the context of the reconstruction of historical quarters.

The territories of former industrial enterprises, which are surrounded by residential areas and have lost their status as a result of economic transformations, are reserved for the development of the urban environment [7–9]. Renovation of such territories and the placement on them of large public multifunctional objects with an accessible environment and the required number of service facilities create new places for the application of labor, restore the imbalance of the urban fabric. Currently, the renovation of former factories is solved in a rather monotonous manner through the construction of commercially viable housing projects. There are no comprehensive projects for the development of territories; construction is carried out on local fragments without understanding the final result.

The topic of renovation of inactive industrial enterprises within the framework of the educational process makes it possible to develop comprehensive master plans, taking into account the balanced functional use of the territory. Currently, many reconstructed industrial enterprises in Samara, as a rule, are surrounded by residential areas with undeveloped social infrastructure. Therefore, the diploma projects offer options for the development of former factory sites with the placement of public recreational spaces and city-wide facilities in combination with housing. The tasks of the design of the extended perimeters of the facades facing the citywide highways are being solved, architectural visualizations of pedestrian zones are proposed, the concepts of unique public complexes are being developed.

3 Results

3.1 Pilot Projects of Renovation of the Industrial Enterprises

As an example of a project on the renovation of an industrial enterprise in the current urban environment, we will consider two concepts for the development of the territory of the A. Tarasov factory on the Moscow highway in Samara. The first project is the graduation work of E. Lebedeva—"Rehabilitation of the territory of the A. M. Tarasov factory" with the development of a concert hall in Samara, leaders are professor V. L. Pastushenko, associate professor O. S. Rybacheva (see Fig. 1). The territory of the A. M. Tarasov factory is located in the Industrial District of Samara and goes to two highways of city-wide significance: Moskovskoe highway and Novo-Sadovaya street. The extended territory of the factory is surrounded by residential quarters and divides a large residential formation into two autonomous parts. The micro districts adjacent to the plant were formed as monofunctional (sleeping) zones without comfortable public spaces and the social infrastructure. The concept of the complex development of the territory of the former plant consists in the formation

Fig. 1 Rehabilitation of the territory of the A. M. Tarasov factory, E. Lebedeva

of a public pedestrian park connecting Moskovskoe highway with Novo-Sadovaya St., hosting the Concert Hall, which includes two concert halls, a hotel with a media center, and a music school. The community center divides the territory of the former factory into two parts: northern and southern, where residential buildings (micro districts) are located in the form of mid-rise blocks (6–12 floors), built up along the perimeter. It is proposed to use the development of micro districts overlooking the city-wide highways as office and retail spaces. Residential quarters on the north side in the north–south direction are divided by a pedestrian boulevard.

The second project is the diploma work of M. Kartasheva "Public and business center Samara-City" in the conditions of renovation of the territory of the A. M. Tarasov factory in Samara, professor V. A. Samogorov, professor V. L. Pastushenko (see Fig. 2). A multifunctional business complex with a developed social function has been designed in the selected area. The prevailing buildings are office blocks of

Fig. 2 "Samara-City" in Samara, renovation of the A. M. Tarasov factory, M. Kartasheva

various configurations. The public and business center includes the exhibition center area. The residential function with the permanent and temporary residence of residents is also presented. Retail spaces are predominantly located on the ground floors and open up to pedestrian spaces. There is a well-developed cultural and educational center with auditoriums of various capacities. The concert hall is for 1500 people. The project provides for a transport hub with a service function. The development of the complex is organized by 8-storey buildings with a high-rise dominant. The multifunctional high-rise office and recreational complex are a complex compositionally organized volume, consisting of 6 towers, united at the 40th-floor level by a bridge structure. The height of the towers is 247.65 m; the spatial uniting platform has a height of 3 floors. The location of the citywide public and business center in the middle zone of Samara redistributes the functional load on the historical center. The proposed transport structure makes it possible to organize a system of interchanges for the distribution of traffic flows.

3.2 Pilot Projects on the Vacant Urban Areas

The following two works are examples of design solutions in the existing urban development on empty sites that are difficult to implement. The first of them is the graduation work of E. Negodyaeva: "Reconstruction of Komsomolskaya Square with the expansion of the railway station in the city of Samara", managed by professor V. L. Pastushenko, associate professor O. S. Rybacheva (see Fig. 3). Modernization of Komsomolskaya Square as the central transport hub of the historically formed part of the city is necessary due to the increased traffic load on the streets of the historical center, the lack of parking spaces, and the lack of organized safe pedestrian flows. The railway station is a "landmark" object of Komsomolskaya Square; it plays an important city-forming role, being the main "gates" of the city. At present, only the first stage of the station building has been completed, as a result of which the perimeter of the building of the square is torn apart, which violates the integrity of the compositional perception of the interior of the square. In the diploma project, the station building is developed in the form of a horizontal building and, thus, the integrity of the inner space of the square is replenished. The functional reconstruction program provides for the expansion of waiting areas, a restaurant, a business center with meeting and conference rooms, commercial space with shops and exhibition halls. The project proposal proposes the active use of underground space, which makes it possible to distribute urban transport and pedestrian flows by levels, provide a solution to streamline passenger flows of the station, separate the movement of public and private vehicles, and create additional areas for parking spaces. The territory of the square itself is freed from the open parking of cars and becomes a landscaped city square. The space under the square on the first underground floor is designed as a public and commercial complex. The second and third underground floors are proposed to be used as public parking. Thus, an integrated approach to the design of the station building and the station square will help to solve the problems

Fig. 3 Reconstruction of Komsomolskaya Square in Samara, E. Negodyaeva

of organizing the transport infrastructure, and the proposed multi-level structure of the facility and the transfer of the parking lot to underground levels make it possible to fully connect the station building to city life and return Komsomolskaya Square to residents.

The second work is the project of graduate student I. Nekrasov on the theme "City-wide cultural center in the Strukovsky garden in Samara", managed by professor V. L. Pastushenko, associate professor O. S. Rybacheva (see Fig. 4). The cultural center is designed in the historic city park of Samara–Strukovsky Garden. The territory of the park is located on a slope and adjoins the Volga embankment. When locating the facility, one of the main design tasks was to minimize the impact on the existing natural environment and preserve visual connections from the park to the river. The building is tactfully inscribed in the relief of the slope, and the ground building of the concert hall is proposed to replace the currently non-functioning summer stage structure. Two functional blocks of an acoustic concert hall and a museum of modern art are connected by an underground floor with a parking lot. The connection of the cultural center with the park, the embankment, and the river is realized in the project at several levels: the park space flows along a wide staircase to a mini square, where the main entrances to the concert hall and museum are located. A pedestrian bridge connects the lower alley of the park with the embankment; visual corridors have been formed thanks to orderly landscaping elements and tree planting. The entire inner space of the cultural center is maximally open towards the Volga. The skylight system gives the interior of a slope-submerged object an interesting interior light and shadow environment. The proposed design solution does not violate the established

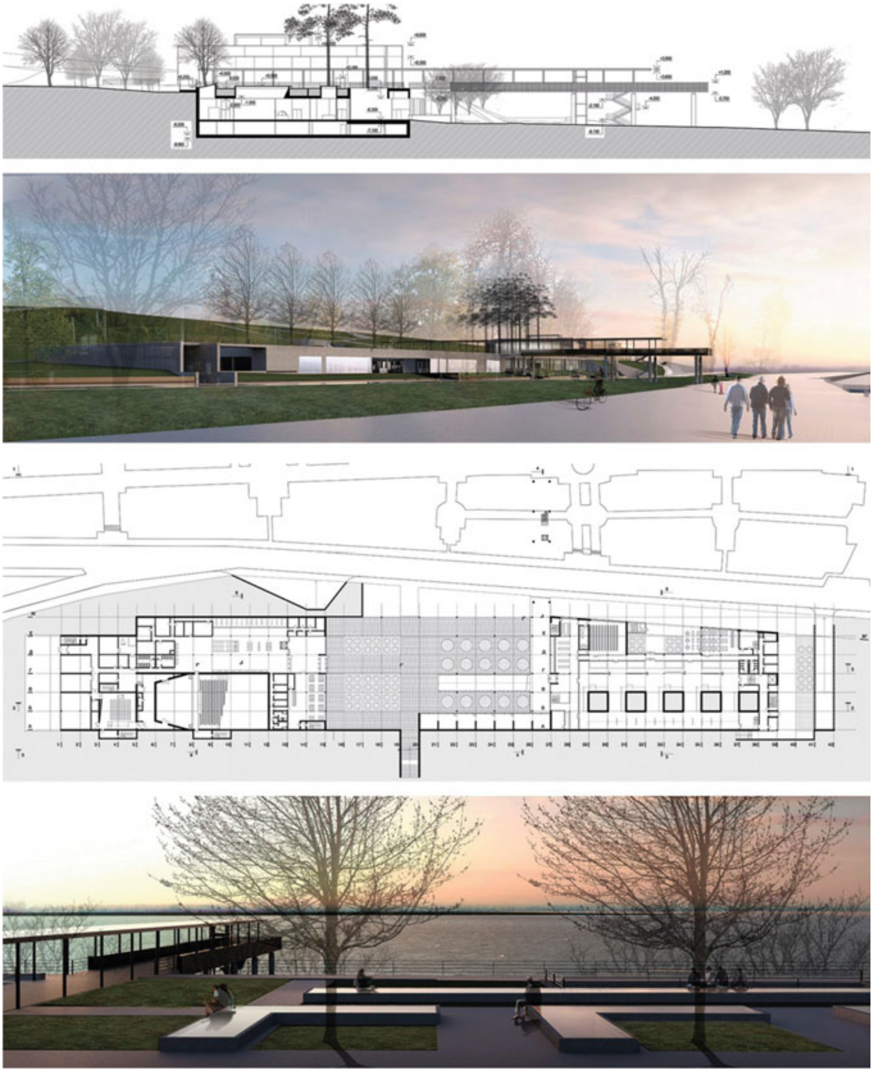

Fig. 4 City-wide cultural center in the Strukovsky garden in Samara, I. Nekrasov

recreational spaces of the Strukovsky Garden, and the functional space is filled with new cultural sites. Additionally, a system of organized pedestrian connections is being formed that unite the city park with the embankment into a single recreational system.

3.3 *Pilot Project of Reconstruction of the Historical District*

Designing an object in the context of the reconstruction of historical quarters is associated with several urban planning restrictions. The architectural and planning environment of the historical center is distinguished by a fine-meshed structure. The territorial boundaries of the development in the center of Samara are determined by the orthogonal grid of streets and land plots formed by the historical surveying of the quarter [10, 11]. The historical context, the presence of valuable buildings, monuments of architecture, and history dictate the scale of new objects and their delicate inclusion in the surrounding buildings. During the industrialization period, large public buildings and industrial enterprises were built into the historical urban fabric, which defined a new scale of the urban environment and public spaces [12, 13]. One of such sites in Samara is the territory of the Klapanov factory in quarter No. 2. This site was chosen for the thesis by K. Akhmetshina "The concept of the development of the pedestrian zone of the historical core of Samara. Reconstruction of the grain area", managed by professor V. L. Pastushenko, associate professor O. S. Rybacheva (see Fig. 5). Previously, the first square of the city, Khlebnaya Square, was located on the territory of Quarter No. 2; its interior was formed by the quarter buildings along the perimeter and the three main churches of the city, now lost.

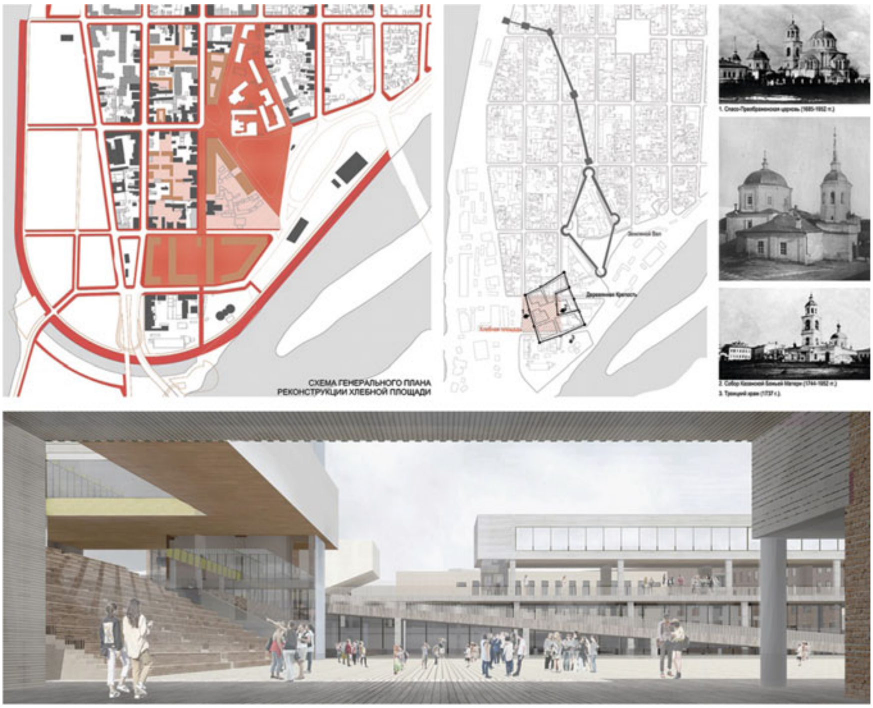

Fig. 5 The concept of the new pedestrian zone of the historical Samara, K. Akhmetshina

The project proposed the formation of a pedestrian zone between the main objects of the city center: Kuibyshev Square, Revolution Square, and Khlebnaya Square. The unifying route was chosen along the streets of Molodogvardeyskaya, Leningradskaya, and Kuibyshev. The key final object of the pedestrian route is the community center at Kutyakova street—at the site of the Klapanov factory and the site of the original location of Khlebnaya Square. The main concept of the reconstruction is to turn the factory area into a citywide recreational space and link the proposed walking route along the streets of the historical center with the newly designed embankment along the Samara River. To solve this problem, a system of open public squares, interconnected by passages, has been designed. Topographic conditions, a relief difference of 10 m, determined the planning solution of the object in several levels. The project excludes the intersection of pedestrian routes and traffic flows due to the organization of traffic at different levels. The functional content of the object is determined by the task of increasing the status and social significance of the projected territory in the structure of the historical center and includes the following groups of premises: a concert hall, a hotel, a museum, exhibition, and lecture spaces, trade pavilions, an amphitheater, creative workshops of the "Art-play" type. The proposed concept for the development of a pedestrian route in the historical center of Samara, together with the program for the development of the territory of the Volga and Samara rivers spit, proposes approaches for transforming historical buildings. They include its new functional content, a new structure of public urban spaces and pedestrian connections, as well as solving the problems of the transport framework.

4 Conclusion

By the example of the presented "pilot" projects, project proposals are demonstrated for the development of complex problematic fragments of the urban environment in the context of reconstruction and renovation of historical quarters and the development of vast territories of former industrial enterprises in Samara. The novelty of the work done lies in the creation of promising models for the development of fragments of the urban environment in accordance with the changed socio-economic conditions. A certain freedom of action, which is provided in the framework of the implementation of educational projects, allows a broader look at the prospects for the development of individual territories in the structure of the city and offers original scenarios for their reconstruction and renovation. In addition, the methodology of educational design assumes, as a mandatory stage of the project, and analytical study of urban planning conditions, options for conceptual pre-design solutions. During the implementation of the educational project, the study is carried out in several directions: the town-planning situation, the functional structure and town-planning context, the topography of the site, pedestrian and transport connections are assessed, the morphology of the building is analyzed, the features of the visual and emotional perception of the surrounding space are studied, the planning constraints of the design object are revealed, and much more. In the process of real design, there is no such analytical stage of work; design is carried out, as a rule, in order to obtain the highest possible commercial indicators. Thus, in the absence of a generally accepted practice of competitive design for all areas significant in urban planning, exploratory design at the Faculty of Architecture, as part of the development of baccalaureate and grad school degree projects, becomes the only alternative proposal.

The purpose and objectives of the "pilot" projects are implemented in several directions: to identify problem areas in the structure of urban development; to make pre-design analytical studies of the projected territories with a technical and economic justification for renovation; to develop options for design solutions ("pilot" projects) of renovation. Public presentation of "pilot" projects creates an opportunity for professional and public discussion ща the prospects of problem areas development of the city and the urban environment in general. In practice of "pilot" projects, often there is a situation when potential construction sites identified in studying projects are used later by investors.

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Globalization of the Research and Educational Centers' Modern Architecture in the Processes of New Construction and Reconstruction

Timur V. Radionov and Konstantin A. Marenkov

Abstract The key priority areas for the architectural formation of buildings and structures of the research and educational centers in the conditions of globalization processes are represented in the paper. Analyzed modern trends indicate that the new educational technologies require creation of self-regulating spaces for their full functioning and development. It is motivated by the new architectural forms of objects in scientific and educational areas. The architectural scripts for the organization of the modern research and educational centers are proposed. These scripts are important for the implementation of subsequent design, experimental and research solutions aimed at the organization and development of the objects in scientific and educational areas.

Keywords Architectural dynamics · Globalization · Research and educational center · Development · Reconstruction · Self-regulatory architectural and urban planning system · Improvement · Organization

1 Introduction

Process of formation and development of the architecture of scientific and educational centers is the most important mechanism based on the development of the system of innovative education in the Russian Federation, as well as in the countries of near and far abroad. This is due to the fact that the objects of the scientific and educational sphere must take into account the development trends of the cities of the future, in which the newest system of new educational values will be concentrated. When creating scientific and educational centers, an important condition, according to the research results Korsakova and Korsakov [1], it should be considered that a person's ability lies in the ability to change circumstances. And first of all, this can be applied in the scientific and educational sphere, when architecture changes

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with the process of improving the educational and scientific potential. It becomes more enriched, integrates into the environment. Forms new true values of society, which take into account the strategic concepts of sustainable development of the scientific and educational process in the Russian Federation and in other countries. Assessing the importance and need for the formation of scientific and educational centers, one should pay attention to the experience of Montenegro, and directly to the study of Perovic S., which draws attention to the fact that the architecture of educational institutions should be considered on a transdisciplinary platform, which is an important condition for creating a sustainable and developed educational environment enriched with modern methods and approaches for its development [2]. Considering the problem of the formation of the architecture of scientific and educational centers in an integrated format, it is necessary to agree with the opinion of Ajupova A., Mikhailova R. Mullanurova A., which indicate the need for interaction between research and educational centers with industrial clusters [3]. This will make it possible to significantly increase the level of science and education in the centers and significantly improve the architectural concept, which directly depends on the functional and technological capacities of scientific and educational centers.

Designing the contemporary architecture of the research and educational centers requires increased attention. The necessity of the most important scientific-applied problem-solving is closely related to the development of the scientific capability of the region with consideration for the educational area's improvement. This process comes through establishing of a scientific and educational (diversified cluster) state aimed at solving the national economic problems. Thus, one should investigate the existing experience in the development of design solutions, including experimental ones. They should be related to designing the architecture of the research and educational centers. The classic formula for the usage of the research and educational centers indicates that such institutions are a complex that combines diversified processes of researching with staff training in promising areas from various branches of science and technology. The functional certainty of the research and educational centers is based on several specific issues. First of all, how should such a building (or a complex of buildings and structures) look like. The second thing is the basis for the creation of ideological and figurative architecture, stylistic affiliation, compositional significance and expressiveness, as well as a dynamic predisposition. Above mentioned factors allow the object under consideration to change in time and space, namely in the process of new construction and under reconstruction conditions. Therefore, the current issues relating to diversified the research and educational centers require increased attention. Since objects of such importance can be considered in the light of the interests of all branches of science and technology, the fundamental significance to a scientific and educational institution will be given. Such kind of institution can represent the system of creating objects of a new generation for new achievements and global scientific and educational results aimed at increasing the international educational level of society. Based on this assumption, attention should be paid to the Flores E., Xu X., Lu Y. "A Reference Human-centric Architecture Model: a skill-based approach for education of future workforce", which defines the process of modern education through a person-centered model aimed at visualizing and adapting the scenario of the educational process [4], based on the creation of the architecture of scientific-educational centers of a new generation for the development of cities of the future.

Modern educational architecture is an extremely complex area that needs considerable time and effort to spend within professional discussions and on an operational experiment. When society will positively or negatively assess the subject of its capability, relevance and importance of the formation of a self-regulating architectural environment in the scientific and educational areas. Thus, it is necessary to clarify the definition of the modern research and educational center given by the authors of the paper.

The work of the research and educational center is focused on a wide audience of students and employees. The younger generation gets the opportunity to attend extracurricular activities according to their interests. The peculiarity of these activities lies in the scientific specification of research, namely in the process of creation, enhancing, developing of devices and technologies. The students who have completed the senior secondary education will be able to go into further academic study as if they enter universities and colleges. They will be able to continue their research programs as staff scientists. Moreover, everyone will have the opportunity to apply for research request.

Previously published studies of the authors of the article showed that the process of creating and implementing the architectural solution of scientific and educational centers depends on the territorial conditions and the internal space of the environment, where it is supposed to place objects of this purpose. Additionally, it should be noted that this process must be carried out in accordance with such modern trends as an open educational environment, an innovative environment, as well as transformable spaces—in a word, create a multipolar architecture aimed at enriching, primarily cultural, modern society through education and science [5].

When creating architecture of a new generation and considering scientific and educational institutions in this format, great attention should be paid to the building and finishing materials used. This issue is often neglected by many. But, the research has proven that a high-quality selection of building and finishing materials allows you to form the objective integrity of the complex being developed by the project. In some cases, a certain level of savings has been achieved due to interchangeable building materials. Giving the design object high-quality architectural and aesthetic characteristics due to the professional combination of finishing materials, which will interact with each other on two levels: architectural and artistic and operational.

The purpose of the article is to substantiate the importance and relevance of the formation and development of modern architecture of scientific and educational centers in the conditions of new construction and during reconstruction, which is achieved by taking into account modern innovative trends that determine the methodological meaning of objects of such a typology.

Based on the stated goal of the article, the following research objectives are set:

- to summarize the scientific, theoretical and practical world practice in the field of architectural formation of scientific and educational institutions;

- to reveal the methodological meaning of the formation of the architecture of scientific and educational institutions;
- to formulate and substantiate the main approaches that determine the process of globalization of the modern architecture of scientific and educational centers implemented in the conditions of new construction and during reconstruction;
- to determine the fundamental scenarios for the formation and development of scientific and educational centers in the context of the implementation of the concept of sustainable development of urban areas and spaces.

2 Materials and Methods

Defining scientific and educational centers as a new and unique system of the educational and scientific process, it is necessary, first of all, to propose for general discussion a methodological decision-making algorithm related to the formation of new cluster scientific and educational systems.

Modern methods of scientific knowledge in the field of architecture represent the fundamental cycle of the research system. This is due to the fact that each branch of science and technology is imperfect and needs constant improvement, development, addition and renewal. For this, the generally accepted and newly implemented methods of cognition of scientific and practice-oriented material reflecting the main criteria for the formation of buildings and structures in the scientific and educational sphere of activity, implemented in conditions of new construction and during reconstruction, are used and applied. Within the framework of the investigated problematic, the following methods were applied:

- method of systematic data analysis (based on the collection and processing of information reflecting the solution of pressing problems in the field of the formation of the architecture of scientific and educational centers);
- methods of theoretical modeling (used when summarizing information from domestic and foreign sources, considering the theoretical and methodological context of the formation of objects of scientific and educational orientation);
- methods of structural and logical forecasting (based on the concept of sustainable development of the architecture of scientific and educational institutions);
- methods of complex experimental design (including in their structure variable possibilities of creating architectural and spatial solutions of scientific and educational centers, implemented in two vectors: new construction and reconstruction of existing buildings for a given function).

Based on the above, special attention should be paid to the methodology for considering the problems of forming the architecture of scientific and educational centers in the scientific work of Grablera I., Taplicka P., Yanga X. "Educational Learning Factory of a Holistic Product Creation Process" in which the authors argue that with the approach of training factories, the methodological, social and personal competencies of employees (working in various branches of science and technology) are significantly increased [6]. At the same time, the term "training factory" should be understood as a very accurate algorithm of the scientific and educational process, which is aimed at the formation of the highest professional competencies in students, while an important condition is the "learning environment" and, first of all, the architectural environment that enriches the learning process and scientific knowledge.

When reviewing approaches to the creation of classical educational institutions (the implementation of which was back in the twentieth century), it is necessary to pay attention to the fact that at that time the architecture of such objects was created directly for a person, his development and professional formation. This is an important methodological condition, in the modern world it is necessary to take into account, and even more so to interpret it from the position of "Global sustainable development".

In this regard, it is worth referring to the Pereira study P., Zalenienea I., "Higher Education For Sustainability: A Global Perspective" [7] in which the methodology for finding Sustainable Development Goals is very accurate and, first of all, it is related to the search for knowledge through a scientific platform. It means that the creation of educational centers cannot be implemented without a scientific base, which means that in architecture it is necessary to consider an integrated approach that allows you to form not only new objects, but also apply the reconstruction process to existing buildings and structures that could potentially be suitable for placement. designated functional structures.

The globalization of the educational and scientific sphere of activity raises questions of an organizational nature. What is the most effective education method. What is scientifically optimal in terms of education. How is it possible to achieve high-quality efficiency in the interaction of the scientific and educational process with elements of intercultural interaction, when participants from different institutions and many countries join the process to achieve the set goals. All this has to do with scientific and educational institutions, which in the Russian Federation are, among other things, implemented and integrated in many educational and industrial sites.

Some answers to questions of a similar nature are considered in the study by Valeeva R. and Valeeva A., which defines educational vectors (methods) of productive intellectual and organizational activity in an open multicultural world [8], which makes it possible to assert with confidence: research and educational centers must be created taking into account industry specifics, intellectual demands, social relevance and production necessity.

3 Results

Studies have shown that the globalization of the modern architecture of research and educational centers in the context of new construction and reconstruction is a fundamental process that can be effective, provided that the following fundamental architecture-oriented approaches are applied:

Methodological approach—based on the use of previously obtained scientific research results in the designated branch of science by scientists whose work affects the problems of forming scientific and educational institutions;

A representative approach that forms the integrity and significance of architectural priorities in the context of new construction and during the reconstruction of existing buildings that may be suitable for the placement of scientific and educational sites;

Reproductive approach—allows, at the level of architectural and urban planning reconstruction of buildings and structures, urban areas, to return the reconstruction object to its original state, giving the building or structure its original functional purpose—if this function was previously eliminated or changed, then the question of restoring educational or scientific function in a building that can be suitable for further and safe operation;

Dynamic approach—based on a complex process of improving and developing the architectural typology of an object of the type under consideration, a potentially possible change in the functional and typological purpose, which can participate in the program for the formation of a new generation of architecture, based on the traditional principles of improving the typology of public buildings and appropriate techniques for their implementation [9].

The above approaches determine the theoretical and design-experimental mechanism for the formation of world-class scientific and educational centers. This is due to the fact that the scientific and educational type of institutions is related to the objects of the new typology—and from a scientific point of view, as well as from a practical issue of this nature, it is debatable and needs a comprehensive discussion. Nevertheless, it can be argued with confidence that the architecture of scientific and educational centers should reflect the qualitative challenges of the time, which are as follows:

- the use of innovative design solutions (a new architectural and planning structure of building complexes, a multifunctional system for the development of floor plans of floors of design objects);
- the use of complex geometric shapes, often unique, in the development of building facades, in order to form a recognizable and unique architecture);
- the formation of the integrity of the entire complex of buildings and structures due to the high-quality development of the master plan and the volumetric-spatial solution of development objects.

It has been established that today the newest concept of "cognitive architecture" has been introduced into scientific use. This term and its principle of perception are considered in the work "Reflections on dynamics, adaptation and control: A cognitive architecture for mental models" by the authors of Mentsan L., Treur J. [10], with whom it is worth agreeing, since they regard the cognitive architecture as a semantic interaction "person–environment". This is a very important observation, since the term man refers to society (society), and the term environment is close to architectural parameters, then it can be attested that the architecture of research and educational centers should be formed according to the principle of a sustainable development system with the use of innovative priorities.

4 Discussion

The ideological meaning of designing the contemporary architecture is to improve the conditions of stay in an artificial or natural environment.

Nowadays many states are aimed at improving the quality of life and living standards for the population. At the same time such kind of policy attracts professionals from all over the world. Higher educational institutions figure prominently in this process. They often function as research centers that represent knowledge and innovation. Such as finished products they form a certain scientifically enriched, culturally significant worldview, that takes into account the best and meaningful globalization manifestations in science, culture, art, etc. directly affecting the architectural and urban planning conditions.

The world-wide practice represents architectural and urban planning trends as a set of research and exploring works aimed at studying the latest trends in modern architecture. First of all, it is worth paying attention to the world-famous works of such architects as Zaha Hadid, Frank Gehry, Norman Foster, Massimiliano Fuksas, Santiago Calatrava, Jean Nouvel, Richard Rogers and many others. Their works are world famous, based on the postulates of stylistic recognition, which reconciles the usage and combination of building materials. It is necessary to pay attention to the methodology of their work, represented in the form of the most important architectural and urban planning lessons, including universal technological methods. They allow to propel architectural concepts to the completely new level of development, perception, functioning and operation in relation to research and educational institutions. Which should combine the resources and competencies of various leading industry enterprises on the region [11].

It is necessary to emphasize that in the modern conditions of the architectural science development, there is a number of fundamental scripts for the formation and development of the research and educational centers. Their existence and functioning is detectable over such systems as:

Partial implementation of the research and educational centers' functions in the existing urban, architectural planning and ideological structure of the university as part of innovative development. It is conceived as conceptual approach with elements of reconstruction actions in the structure of established educational complex [12];

Comprehensive reforming of the institutions' work-items and principles for further usage of it as a research and educational center. It is promoted with the expansion of the educational institution's territory and increasing the usable area for buildings and structures included in the available structure as well as in newly erected architectural objects [12];

The formation of a brand new complex for the research and educational diversified center and its further operating [12].

The special attention should be paid to the configuration of educational and self-regulating recreational spaces in the context of architectural and typological structure of the modern research and educational centers formation. Modern trends in exploitation of the research and educational institutions implies openness and transparency of the architectural environment, flexibility and adaptation, the usage of dynamic architecture's systems, for the convenience and the level of functioning [13].

It has been demonstrated that the most important and fundamental components of the research and educational centers including a new generation of similar establishments are, learning spaces that take into account the specifics of the educational process and technologies, spaces for research activities, for scientific and organizational activities and administrative offices.

It is proved that the architecture of modern scientific and educational centers is based on priority provisions: the nature of the location of the object (a complex of buildings and structures) in the city structure, the creation of an architectural form, the organization of the master plan.

The organization of the master plan is a special stage in the architectural organization of the object and is developed in parallel with the creation of the architectural form, since these two processes are closely interrelated. In such conditions, a qualitative distribution of the necessary functional areas is required, taking into account the identification of ways of interconnection of the main departments.

A high level of elaboration requires the improvement of the territory and the general stylistic coordination of the elements of the master plan with the architectural form of buildings and structures of the scientific and educational center.

Thus, each architectural object is designed to evoke certain feelings in the viewer. The ability to competently use the basic principles of the formation of an architectural composition will help to create a unique appearance as a scientific and educational center in particular, and to influence the appearance of the whole city. The listed criteria can be implemented and included in the program for the development of the architecture of buildings and structures of existing objects of the type under study. Determination of the position in the structure of the city plays a fundamental role in the formation of a modern scientific and educational center. It is preferable to locate scientific and educational centers in the central part of the city. However, the modern urban planning environment of each city has individual characteristic features that do not always allow to locate a bulky object in the city center. In this case, the necessary site is selected at some distance from the city center, but with the obligatory availability of high-quality transport accessibility.

The creation of an architectural form is the main property of an architectural object, which allows the viewer to understand and feel the scale of a particular idea. The form of the research and educational center is influenced by such factors as the associativity of the chosen composition, the functional purpose and design of the object.

The world around us shows that there are no regular geometric forms in nature, they are inherent only in the results of human activity. The bionic origin of the form is the most acceptable theory considered by architectural science.

It is most comfortable to be in an architectural environment, represented by bionic forms. However, in order to maximize the scientific orientation of the object under consideration, one should strictly adhere to the canons of geometric shaping, taking into account the competent selection of proportions.

Also, at the level of creating an architectural form, one should take into account such a property of architectural objects as chiaroscuro, which enhances the visual perception of the architectural form [5].

It has been established that new technological spaces should be organized within the architectural environment of the research and educational centers. It is necessary to represent the classical algorithm of the functional and typological capacity of the research and educational centers, based on the running of the following functional spaces such as:

- providing specialized education (mainly aimed at further training and skills development in a particular area);
- research work in various fields of human activity;
- providing full support in scientific research (multi-sectoral research interconnection);
- using the up-to-date technologies (including the creation of new technologies);
- organization of an open learning space (for different age categories of people);
- providing conditions for solving the main problems in research activities (learning spaces, research laboratories, production and technological platforms for research) taking into account the innovative potential that can be achieved by involving all educational institutions of the state in solving the current situation [14].

The difficulties in organization of open learning spaces are not only in the formation of a new functional organization corresponding to the diverse content of educational activities. For the most part, the difficulties lie in the development of the new principles, improvement of the methodology and norms for the design of objects and complexes of the architectural and typological purpose. An open learning environment makes a qualitatively new approach to the providing of knowledge, presented in the form of a holistic system that contributes to the development of an educational institution; in the conditions of the formation of such objects in the structure of residential, public and industrial clusters [15].

Modern research and educational centers need new spaces and new architectural forms for their full development due to modern trends. An architectural form creation is the main property of an architectural object, which allows the viewer to understand and feel the scale of a particular idea. Modern architecture includes such threads as purity of forms, functionality and laconicism, harmony with the natural world. Besides, the results of technological progress should not only use in the design and construction of an object, but also during exploitation (usage of modern technologies).

The study found that the use and application of new finishing and building materials, according to the Maywalda researchers C., Riesserb F. [16] will allow creating a new type of space: internal and external, which means that new opportunities for further development of architectural and urban planning clusters of scientific and educational centers will appear.

The fundamental values of the research and educational centers' architecture are the important part of the design process. That's why it is necessary to pay much attention to the process of creating. It is achieved through the development of design solutions in the format of new construction, as well as during reconstruction. In addition, it should be noted that the modern dynamic transformation of buildings and structures is the result of freedom from the order language in construction and reconstruction of architectural objects at the end of the twentieth century. That kind of transformation forms the integrity of the city space frame. Which in the digital era (in terms of distance learning) will create a personalized space for each employee [17].

The process of new construction of the research and educational centers is based on an exploratory design system (mainly of a new generation with a new typology). This approach allows solving the problems of forming objects of a similar typological orientation according to the classical research design algorithm, based on the development of the following solutions:

- urban planning;
- functional and technological;
- architectural planning;
- compositional and artistic;
- volumetric-spatial.

The process of reconstruction should be considered as much more complex due to the practice-oriented and research activities. It is based on the detail selection of non-functioning buildings and structures suitable for transformation into the research and educational centers. Nowadays, such trends are under theoretical and experimental development. That is why, designers should take a more global approach to the organizational problem of the research and educational centers in the context of the reconstruction of existing architecture objects as same as a new type of construction.

A presentational ability of the modern research and educational centers should be considered as the main condition of designing its architecture. It is based on the usage of pure forms, open spaces and the convenience of all communications, which determine the positive operational suitability [18].

Additionally, attention should be paid to the fact that the process of forming architectural and urban planning decisions of scientific and educational institutions should be based on the developed algorithm (sequence) for making design research and experimental decisions in relation to the formation of objects of a similar purpose.

5 Conclusion

Various research works and scientific papers represent the modern research and educational centers as a new stage in the development of educational institutions.

It has been found that the main task of research and educational centers is an ideologically new approach in providing the necessary amount of knowledge using modern equipment, as well as maintaining the creative potential of students and contributing to its development in every way.

It is proved that the process of the research and educational centers' architectural designing must be substantiated due to socio-economic efficiency and suitability in the modern conditions of the architectural science development.

It should be noted that the research and educational centers represent new research and educational platforms, which are based on the strategic cooperation of educational institutions' complexes. This is a place where practical skills are implemented and scientific competencies are formed.

The main growing areas of further design and research solutions in the field of formation of the modern research and educational centers due to modern trends are determined.

Architectural scripts for organization of the research and educational centers are proposed. These scripts are important for the implementation of subsequent design, experimental and research solutions aimed at the organization and development of the objects in scientific and educational areas.

Based on the above, attention should be paid to the fact that the scientific novelty of the research presented for discussion lies in the fact that the work for the first time identified and systematized trends indicating that new educational technologies require the creation of self-regulating spaces, dictated by new architectural forms of objects of scientific and educational areas of activity for their full functioning and development; the need for the formation and development of scientific and educational institutions of a new generation is substantiated, which, in the context of the implementation of the algorithm for the formation of objects of a new function and typology, will allow solving the most important national economic problems in each industry.

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Transport Interchange Complex Model Evolution Within the Formation Concept Framework of the Aeropolis

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Abstract The article discusses the problem of aeropolis creation on the basis of the transport and transfer functions' development in the aerodrome zone of major airports. The aim of the study is to develop an "evolution model" of the transport interchange complex (TIC)—as a kind of the airport "growth point", acting as a prototype of the "City of Tomorrow". For reasonable planning of the aeropolis growth and development, the methods of "prognostic" and "structural-morphological" TIC modeling are applied. The generalized functional-spatial structure of the transport-interchange complex is revealed; a development (diachronic) model of the given object is formed on its basis. The model makes it possible to increase the capacity of functional blocks and transport links of the transport-interchange complex with other activity centers and serves as a catalyst for the aeropolis growth gradually "in time". Intermediate (synchronous) models of the complex are proposed, reflecting the main phases of its evolution within the framework of aeropolis designing. Five intermediate architectural and typological models of the transport-interchange complex have been identified: (1) bus station; (2) bus station with a logistics center; (3) intermodal complex station; (4) transport and business center; (5) transport and public complex. Its "structural and morphological units", which include: (a) functional components (blocks) of TIC; (b) structural-tectonic "units" (skeleton) of TIC; (c) communication "framework", are described based on the method of "morphological analysis-synthesis" for each model. A similar diachronic (development) model of the transport-interchange complex ensures its phased planning, optimal functional zoning of the facility for each intermediate phase, which will allow it to be self-sustaining in the early operation stages. This approach creates the basis for the TIC "digital modeling" and the use of the aeropolis "generative design" method.

Keywords Transport and interchange complex · Aeropolis · Evolution · Diachronic model · Architectural and typological models

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1 Introduction

An important role in international practice of urban planning is played by the airports, which become not only the large transport interchange hubs, but also the “cores” of the advanced formation for the surrounding development. The forms of spatial development of the territories around the large hubs are presented in the modern concepts of megapolis development: the concept of “airport zone” [1]; “airport city”—the development of mixed hotel and business areas with high density [2]; the concept of airport city—“aerotropolis” which becomes the driver of the airport adjacent territory transformation [3, 4]. Such studies are of significant interest for the development of near-airport areas, including the large Russian cities (St. Petersburg, Samara, Yekaterinburg, Rostov-on-Don, etc.), as one of the conditions for increasing national economy competitiveness.

According to the “Strategy-2030” project, the Ministry of Construction, Architecture and Territorial Development of the Rostov Region provides for the concept of creating an “aeropolis” in the area of the new Russian airport “Platov”—as a zone of advanced development [5]. The concept includes the strengthening of the importance of the airport “Platov” in the structure of the agglomeration “Bolshoy Rostov” and the concentration of various transport and business links with the cities of the Rostov region—as a prerequisite for the emergence of the airport [6], acting as one of the forms of “Cities of Tomorrow”.

Creation of a transport interchange complex (TIC) in the near-airport area, which is a kind of the new airport “growth point”, can become a first step in the planning process and the transformation of this territory into a zone of advanced development. A transport interchange complex (TIC) in the study is understood as a multifunctional complex of buildings and structures that “performs the functions of redistributing passenger flows between different modes of transport and movement directions”, and providing a number of secondary and tertiary functions [7]. Transport interchange complexes (TIC) and transport interchange hubs (TIH) are theoretically the objects of “terminological clarifications” and are considered as a developing problem area of urban planning [8–10] today. In the Russian experience, their formation occurs mainly in the areas of land transport concentration. The placement of such objects in the aerodrome zones is a new promising area of research and is associated with the problems of long-term planning of their phased development, the formation of optimal logistic connections [10–15]; technological equipment and filling the complex with additional new functions.

As a number of studies [1–4, 8–12] and the world experience of such facilities functioning show, modern transport interchange complexes tend to be transformed into public and business centers. They become catalysts for the development of the station complex itself, logistics links, transport and pedestrian infrastructure, social and business activities. Building on the above-listed trends, it is possible to form generalized functional-spatial structure of the TIC, including railway station and public-business functions (Fig. 1).

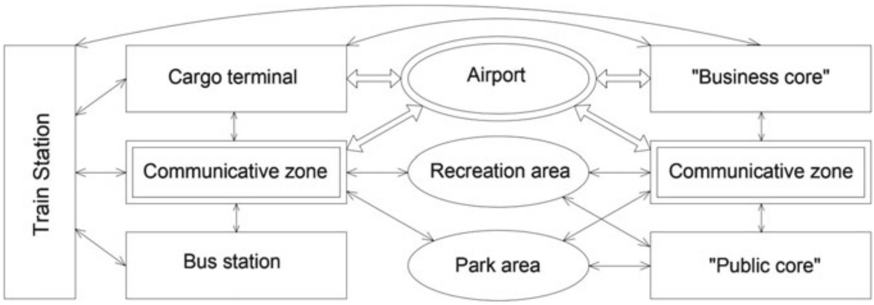

Fig. 1 Prospective functional and spatial structure of the transport interchange complex in the airport area

Taking the perspective functional-spatial structure of the TIC as a basis, it is possible to formulate the purpose of this research—the development of a specific design model of the transport-interchange complex, fixing the steps and phases of its sequential development as a "growth point" of the Platov airport.

The step-by-step achievement of this goal involves the solution of the following *tasks*:

- identification of a promising functional-spatial structure of the TIC, taking into account the "secondary" functions' acquisition;
- description of the TIC development (diachronic) model concept;
- construction of the TIC intermediate "architectural and typological models", corresponding to the stages of growth and formation of the aeropolis;
- description of the "structural and morphological units" presented by the architectural typological TIC models.

The perspective functional-spatial structure of the TIC, presented in Fig. 1, can be adapted to the urban planning features of the near-aerodrome territory of the airport "Platov" as an experiment, taking into account its transformation into an "aeropolis" in the future (City of Tomorrow, advanced development zone). The hypothesis of the experiment is the assumption of the possibility of transforming the generalized functional-spatial model of TIC into an adaptive "development" or "diachronic" model, which allows one to gradually increase the power of functional blocks and TIC transport links with other activity centers and serve as a catalyst for the aeropolis growth. The objects of the experiment are the functional-spatial structure of the TIC and sections of the aerodrome territory as potential sites for the formation of this complex and the Platov airport.

2 Method

The generalized functional-spatial model of TIC is considered under experimental conditions in the “diachronic (at different times) aspect” as developing and evolving in time. The polyfunctionality of TIC provides a “diachronic” inclusion in the complex, in addition to the “station functions” of the accompanying public and business. When forming a “diachronic TIC model”, the method of “predictive modeling”, which is based on the “perception paradigm” of the object, can be used. In this case, the “perception paradigm” refers to a set of requirements for the object (functional, planning, constructive, etc.) at each successive stage of its development—as a catalyst for the aeropolis growth. The necessary actual requirements meeting the requirements of the object perception paradigm at this stage of its development can be:

1. architectural and artistic requirements for the object, its figurative solution, taking into account the prevailing stylistic trends in architecture at this stage, new materials and technologies in solving the interior and exterior environment of TIC;
2. functional and spatial requirements of the new “development phase” (evolution) of the TIC, in terms of the functional composition of the premises, their spatial arrangement and blocking; percentage of main, secondary and tertiary functions;
3. requirements of optimal communication and technological links between TIC units (within the time limits of one phase—i.e., in the synchronous aspect) for the organization; and other requirements.

Thus, at each stage of the TIC development, functional-spatial and geometric tasks are formulated to create optimal planning, structural-spatial and functional-technological parameters of TIC, which provide clear requirements for a future object at this development stage.

Further detailing of the of multi-temporal growth and TIC development concept presented in its “diachronic” model makes it possible, within the framework of this study, to represent the growth phases of an object as a series of its intermediate qualitative states described in the form of “architectural and typological models” of a transport interchange complex, formed taking into account the given requirements. To describe and develop the TIC intermediate architectural and typological models at each stage of its development, the study proposes to apply the method of structural “morphological analysis and synthesis” [13, 16].

The method allows one to decompose the complex into initial structural components—functional-spatial blocks and units. The relationship between them is determined by technological processes and requirements for the object at each stage of its development. Thus, the TIC intermediate architectural and typological models can be represented as a collection of peculiar structural and morphological “units”, which include:

- TIC functional-spatial “units” (blocks);
- TIC structural-tectonic “units” (framing);
- communication frame elements (planning and spatial).

TIC Functional-spatial “units” include:

1. “Storing devices” (landing platforms, railway platforms, loading platforms, parking areas for private vehicles, bus stops);
2. “Junctions” (stopping points, intersections, paddings, atriums);
3. “Accumulators” (recreation for passengers, waiting areas, concourses, ticket offices);
4. Public spaces (functions of trade, entertainment, leisure, spare time, catering);
5. Business spaces (for business meetings, conferences, exhibitions, offices, business management, administration);
6. Green spaces and recreation (green galleries, vertical gardens, hanging platforms with eco-parks, recreation, green facades, exploited roofs).

Structural-tectonic “units” (framing) of the TIC includes:

1. construction frame of the transport and transfer complex (steel, monolithic reinforced concrete;
2. stiffening cores (nodal points, elevator shafts);
3. structural nets and coverings (platforms, canopies);
4. tunnels, mines—underground level; and etc.

TIC Communication framework includes:

1. ground technological connections and communications (pedestrian crossings, esplanades, travelators, access and mobile platforms, access roads);
2. underground communications (tunnels, underground levels of railway transport branches of local, regional and federal significance; interchanges and intersections);
3. overground communications (transitional galleries, escalators, branches of monorail transport).

Taking into account the designated structural (morphological) units—components of the TIC, it is possible to describe the intermediate phases of its development—as independent “architectural and typological models”.

3 Results

The use of two methods: the “predictive modeling method” for the formation of a development (diachronic) model of the transport-interchange complex and the “method of structural-morphological analysis-synthesis” for detailing the proposed model in the form of its constituent structural-morphological units gives a possibility to form a number of TIC intermediate architectural and typological models as a result acting at its development states.

Five intermediate architectural and typological models of the transport-interchange complex have been identified: (1) “bus station”; (2) “bus station with a logistics center”; (3) “intermodal complex station”; (4) “transport and business center”; (5) “transport and public complex”. These models reflect the growth points of Platov aeropolis as a significant regional project “Cities of Tomorrow”.

3.1 The First Phase of TIC Development

Model 1 “TIC bus station” reflects the first phase of the transport-interchange complex development in the airport area. The purpose of this stage is to solve the primary problem of transport accessibility of the Platov airport using ground public transport for adjacent cities (Rostov-on-Don, Novocherkassk, Kamensk-Shakhtinsk, etc.) (see Fig. 2). A bus station complex is being created for this on the eastern side of the terminal building next to the M-4 Don highway; communication with the airport building is provided using the cross-links: overhead transitional galleries, a ground travelator and mobile electric transport.

Thus, there is a provision of comfortable, safe, convenient and providing the development of the complex TIC links with the airport and the main highways (highway of federal significance “M-4 Don”, highways of regional significance and the main local highways) with the help of ground vehicles (both public intercity, suburban, rout and private cars). At the first stage of its development, TIC is a fairly compact object and includes the main functional blocks of the bus station, as well as the auxiliary ones in the form of public catering units, waiting areas with rest rooms and recreation areas (see Fig. 2).

The structural morphological units of this TIC architectural-typological model, indicated in Fig. 2, are:

(a) at the level of functional and spatial solution: main functional blocks of the bus station: 1—ticket offices with a waiting room, 2—boarding platform, as well as auxiliary ones: 3—catering unit, 4—rest and recreation rooms;

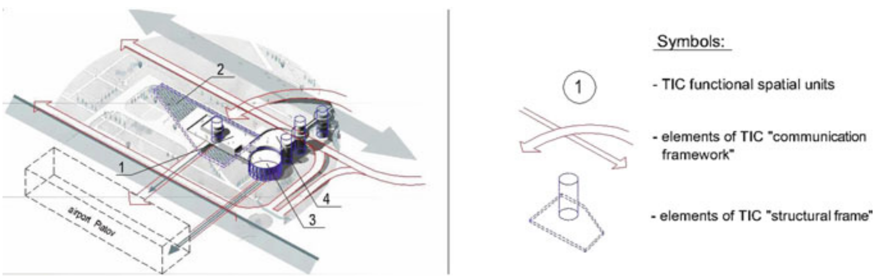

Fig. 2 Architectural and typological Model 1: “TIC bus station”

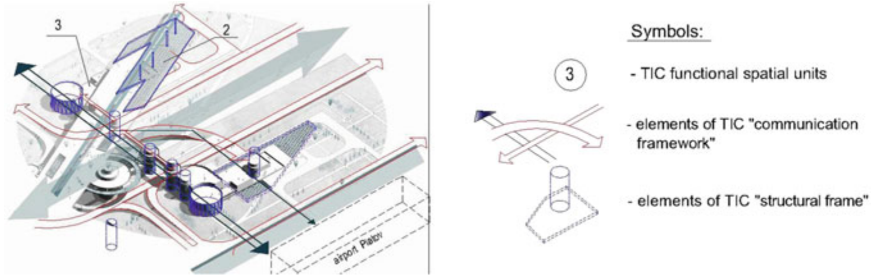

Fig. 3 Architectural and typological Model 2: "TIC bus station with a logistics center"

(b) at the level of technological links and communication framework: ground and above-ground pedestrian galleries; TIC transport links with the airport and the highway of federal significance "M-4 Don".

3.2 The Second Phase of TIC Development

For the second phase of evolution, it becomes relevant Model 2: "TIC bus station with a logistics center". The second stage of the TIC transformation envisages the development of the airport complex "Platov" itself, its cargo terminal, therefore there is a need for coordination and further redistribution of cargo flows. This stage of the transport-interchange complex formation will become the first step or catalyst on the way to the aeropolis "City of Tomorrow" creation on the basis of the airport "Platov". The self-sufficiency of this stage is ensured by the development of logistics industry as an investment attractive direction for the TIC development with a rapid growth in freight traffic. To ensure the most compact connections between the airport facilities and the transport-interchange complex (to combine them into a single complex), transitional galleries are provided above the highway (Fig. 3).

The main functional-spatial units of this model, indicated in Fig. 3, are: bus station increased in its capacity (1), cargo terminal (2), the station building of the airport "Platov" and its logistics center (3). The units of the communication frame that provide compact connections between these facilities and the airport are: traffic interchanges, transitional galleries above the highway, boarding and loading platforms.

3.3 The Third Phase of TIC Development

The next stage in transport interchange complex development reflects Model 3: "TIC intermodal complex station", depicted in Fig. 6. At this stage, a qualitative development of the TIC communication frame is taking place due to the railway transport

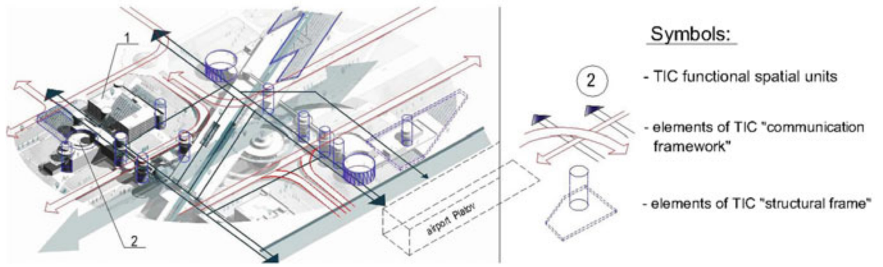

Fig. 4 Architectural and typological Model 3: "TIC intermodal complex station"

network presence in the area of the Platov airport at the ground and underground levels, including:

(a) the planned high-speed railway of federal significance "Moscow–Adler";
(b) land line of regional electric trains connecting the airport complex with the cities of the Rostov region;
(c) the underground line of the city electric train with the communication—Rostov-on-Don airport.

The functional-spatial units of the model (see positions 1 and 2 in Fig. 4) reflect two railway stations in the underground and aboveground levels, supplemented by a bus station complex and a logistics center, which makes the transport interchange complex a full-fledged and convenient object of transport infrastructure.

3.4 *The Fourth Phase of TIC Development*

A significant stage in the development of TIC and the "growth point" of the aeropolis is Model 4 "TIC transport and business center". This stage will not only give a possibility to make the complex itself more attractive, convenient and viable, but will also become the starting point for the growth of the "zone of advanced development" by creating the aeropolis "business core" as an alternative function (Fig. 5).

1—administrative center of the techno park, 2—business incubator, 3—administrative part of large production facilities, 4—exhibition complex for demonstrating innovative developments and other objects act as the TIC dominant functional-spatial "units", indicated in Fig. 5, and giving development to the "business core" of the aeropolis. A distinctive feature of the communication and structural-tectonic framework is the presence of vertical communication nodes that unite different levels of the transport-interchange complex, and create the basis for the functional build-up of these levels in the form of structural overlaps (platforms) (Fig. 5).

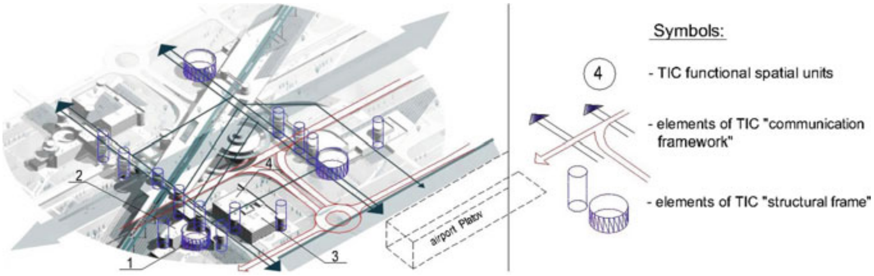

Fig. 5 Architectural and typological Model 4: "TIC transport and business center"

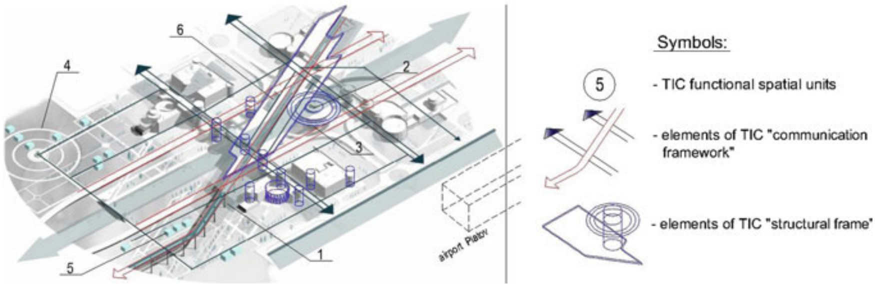

Fig. 6 Architectural and typological Model 5: "TIC public transport complex"

3.5 The Fifth and Final Phase of TIC Development

Model 5 "TIC public transport complex" is the most advanced distant. It is presented in Fig. 6. In essence, this is no longer just a transport infrastructure object, but a group of multifunctional independent objects, between some of them there is no longer such a tight connection as between the main objects of the complex. The development of additional territories occurs already at the stage of active growth and functioning of the advanced development zone—Platov aeropolis, a prototype of the City of Tomorrow.

Figure 6 shows the structural components of this model indicated as the final stage of the TIC development, which include:

(a) functional-spatial units of the formed "public core" of the "Platov" aeropolis include: 1—commercial zone; 2—recreational park area, 3—apart-hotel, 4—sports area; 5—catering area, 6—shopping and entertainment center;
(b) components of the structural framework of various functional blocks and TIC housings include: vertical stiffening cores; levels and floors adjacent to these vertical elements; structural slab "suspended park";
(c) elements of the communication frame in the form of surface and underground railway communications are supplemented by a line of overhead monorail transport serving the aeropolis (Fig. 6).

A pronounced element in the architectural and spatial appearance of an intermodal transport and interchange hub at this development stage is a public space—a "suspended park" in the form of a structural plate—a platform creating an image of the TIC sustainable architecture as a "visiting card" of the aeropolis.

4 Discussion

Comparing the obtained results and the main idea of work with a number of similar studies [1–6, 8, 9], it can be stated that for the first time the research object itself—the transport interchange complex—is considered not separately (as an independently functioning complex), but as a kind of "catalyst", the "growth point" of the City of Tomorrow—aeropolis. This thesis is adapted and experimentally correlated with the regional characteristics of Platov airport with its location, the location of the main highways, the needs of the environment. In the context of this idea, the methods of "prognostic" and "diachronic" modeling used in the study, made it possible to present an integral object—a transport interchange complex as a set of its intermediate "architectural and typological models" formed over time. This creates the basis for the regional project "Strategy-2030" implementation in the form of building a kind of "road map" for the phased creation of the Platov airport with the development of a set of requirements, technical specifications and competitive design documentation for individual phases of its development.

The diachronic (development) model of the transport-interchange complex, proposed in the study, and the "architectural-typological models" concretizing it, significantly develop the TIC "model range" in comparison with previous studies of the similar objects [3, 6, 8–12]. They also supplement and clarify the terminology [7], introduce a number of new names of the object into circulation, for example, "TIC transport and business center", "TIC transport and public complex", describing the development and evolution stages of TIC. So, in the work "Factional-Typological Models in Architecture of Intermodal Transport Hub" (Architecture and Modern Information Technologies, 2019) [6], the TIC model range is formed by the authors mainly according to the functional-spatial feature, without directly affecting the factor of time and evolution.

The methods of prognostic and diachronic modeling used in the study significantly develop the traditional, accepted in most studies, "synchronous" (non-recurrent) functional spatial model of hubs and complexes transport interchange [7, 8, 11]. Thus, the use of a similar model in the work of the following researchers Li-Ya Yao, Xin-Feng Xia, Li-Shan Sun "Transfer Scheme Evaluation Model for a Transportation Hub based on Vectorial Angle Cosine" [7] gives them an opportunity to consider the TIC changes and dynamic transformations only in the aspect of simultaneous architectural and planning reconstruction. In this study, for the first time, the concept of a TIC "evolution model" is proposed, which makes it possible to present an integral object of transport infrastructure as a set of its intermediate phases of development ("architectural and typological models").

The presented models significantly develop the subject area of the transport interchange complexes study and open up the opportunities for further promising research. The scope of the “method of structural morphological analysis” application is expanding, which is used not only to study the objects of cultural heritage and urban space (see the studies [13, 16]), but also at the objects of transport infrastructure.

TIC structural and morphological units (components) revealed on the basis of the “morphological analysis and synthesis” method create the prerequisites for the application of methods and technologies of “structural”, “digital modeling” and computer generation of the TIC architectural and spatial solution (generative design), allowing to create a field of options functional and spatial solutions. The generative design method takes into account: a) external requirements for the facility associated with the TIC general layout, the aeropolis and the aerodrome area in general; and also, b) internal requirements of the TIC functional and technological organization, the functional connectivity of its blocks [14, 15].

This method of TIC “morphological description” opens up the possibility of its generation (construction) at each development stage, using the bank of initial structural units for various levels: geometric (volumetric); constructive (tectonic); communicative (pedestrian, transport communications) and others. In this case, the following options can be generated:

- urban planning conceptual solutions for TIC placement;
- decisions on the layout and interconnection of functional areas; TIC functional blocks;
- planning solutions for individual buildings, structures and TIC premises.

5 Conclusion

In conclusion it can be stated that the conceptual research of the adjacent airport zones’ evolution and urbanization forms in terms of the transition from the airport development problems and the adjacent airport area to the transport interchange complex—as a nodal element of the future aeropolis has been further developed in the work.

The transport interchange complex adapted the evolutional model concept in the structure of the airport complex “Platov” was proposed on a regional level. The concept provides the possibility to perceive it as a kind of "growth point" of aeropolis—the city of tomorrow.

Unlike the similar research describing the development stages of airport and airport adjacent territories, the presented approach is the first to describe the phases of development and evolution for transport interchange complex and aeropolis that are presented in the research as independent architectural-typological models of TIC. Such phased increase in the capacity of the transport interchange complex will allow it to become self-sustaining at the early stages of operation, which corresponds to the principles of sustainable architecture.

The study is the first to present a TIC holistic systematic description: the study has revealed the structural and morphological components of the transport-transfer complex at the level of the functional-spatial structure, the TIC structural frame, its communication frame. Such morphological description and the TIC identified structural components create the basis: (a) for its architectural shaping with the help of functional-spatial units and geometric forms; (b) for the "generative design" of the TIC with the generation and evaluation of options for its layout based on orthogonal and nonlinear objects, unit spaces and their connections; (c) for further formalization of the object and the use of BIM-design technologies with the creation of options for standard and "nonlinear" TIC digital models.

Thus, the proposed model description of the object creates the basis for the use of information technology design based on the TIC "digital non-stationary model" and, in the future, its "digital construction" and operation. This will ensure the sustainable formation and development of the facility itself and the aeropolis in general.

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