

# Sustainable urban regeneration of brownfield sites

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**Abstract.** Nowadays regeneration of warehouse zones and former industrial areas of the city is becoming one of the most relevant strategies for cities' sustainable development. The main purpose of the research is to identify the methods and principles of structural and spatial transformations of existing urban areas. The research formulates the need to rethink the attitude to urban planning in general, as well as reveals the warehouse zones' («Brownfields») potential for sustainable development while their integrated use. On the example of the industrial territory in Kazan, there were developed the principles and methods of structural-density and morphological transformations, which can be used in projects for sustainable development and transformation of existing urbanized settlements. A formalized model of study area's structural reorganization is constructed, on the basis of which the identified principles of regeneration are tested. The obtained results make it possible to formulate the basic principles underlying structural and planning transformations of warehouse zones and to create its urban planning renovation model. The developed practical methods of implementing such strategies can be applied in the further development of urbanized territories, both new and existing ones.

**Keywords:** regeneration, brownfield, densification, centrality structure, framework, structural and planning reorganization.

## 1 Introduction

Today the regeneration of the existing urban structures is becoming a key trend of urban planning in the world, and we certainly cannot ignore this process. One of the cities' smart development directions is structural transformation of existing territories, rather than the development of new ones. Urban regeneration process is based on closely integrated market conditions, public administration strategies and local communities' interests [1-3]. The key importance is given to changing the density parameters of the urban environment, while the density is considered as a tool and an opportunity to create high quality livable conditions in urbanized settlements of different levels of development [4, 5]. This is achieved through the deep integration of landscape infrastructure, structural and planning reorganization of the urban fabric and changes in the structure of urban mobility, which, in turn, implies the

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creation of a pedestrian mobility system that integrates the linear and nodal components of the spatial and planning infrastructure of the city [6-8].

There is no unambiguous interpretation of the term «urban regeneration», different authors provide a wide range of its definitions, but what unites them is an understanding of the complexity, multilevelness and scale of the processes involved in this kind of transformation. This is also the reason for the wide range of terms associated with urban regeneration, such as renovation, revitalization, structural and planning reorganization, etc. [9-11]. The use of various terminology leads to some indeterminacy, however, at the heart of all this variety of formulations is the focus on reshaping the structure and functioning of the city to improve the social, economic, morphological, transport and landscape parameters of the urban system [12-14].

As urbanized settlements of different levels evolve, attention is increasingly drawn to the former industrial and warehouse areas usually located in the middle zones of cities that are quite attractive for development. Most often, these are polluted, decayed, and even dangerous for the revival urban areas. In western practice for the definition of such territories is used the term «Brownfields» [15-17]. This term came into use in the early 1990s and, in fact, it characterizes the prospects and opportunities inherent in such urban sites. The United States Environmental Protection Agency defines «Brownfield» as a site with non-functioning properties, the further development of which is largely complicated by actual or possible pollution. As a rule, such pollution becomes the main public problem and the most serious obstacle to their return to life. Typical Brownfields include the following urban sites:

- light industry enterprises;
- gas supply facilities;
- metalworking enterprises;
- pharmaceutical plants;
- chemical and automobile enterprises.

Numerous foreign studies come to a paradoxical conclusion: Brownfields compared to Greenfields (natural areas) have a much greater potential for sustainable development, since they can use all the possibilities of existing infrastructure. Brownfields are a central factor in planning strategies to overcome urban sprawl and to preserve open natural spaces, they play an important role in reducing air pollution, stimulate reinvesting in urbanized areas, as well as contribute to achieving a balance in spatial planning strategies and urban regeneration [18-20]. Currently, the search for a strategy of creating a new and existing territories' sustainable urban environment is a priority, but the task becomes much more difficult with the reorganization of the already existing urban environment, where industrial and/or warehouse development prevails [21, 22].

The object of this study is the identifying structural and planning reorganization features of the existing urban areas with a predominance of warehouse facilities based on the results of a comprehensive analysis of the large industrial area in the Sovetsky district of Kazan current state. The urgency of the problem of this industrial territory regeneration is due to the fact that in the process of the post-industrial stage of the city's development, a significant part of its industrial functions was lost. Having a favorable site location in the structure of the city, preserving the transport and engineering infrastructure, the studied part of the city is in conflict with the adjacent areas of new development and does not provide the necessary level of comfort for the existing residential communities [23].

The purpose of the study was to identify the techniques and principles of structural and spatial transformations of industrial areas and to provide recommendations for urban renovation of the considered territory in Kazan.

The main objectives of the study:

1. To analyze the stages of formation, development and the current state of the territory under study with a comprehensive urban planning analysis and identification of urban development potential;
2. To identify the structure-forming principles and methods of existing territories transformation in the structure of the city;
3. To develop a conceptual model of the subdivision of the urban area based on the identified methodology.

## **2 Materials and methods**

The study is based on a comprehensive account of the influence of the most important factors affecting the identification of the territory urban development potential and includes the following methods:

- generalization of Russian and foreign experience of city's industrial and warehouse areas for urban reorganization, the study and systematization of theoretical, regulatory and literary materials, which allowed to identify current trends in the structural-planning and landscape reorganization of the considered urban environment;
- field survey, the study of graphic and cartographic materials that allowed to collect information for the analysis of the studied territory of the city;
- comprehensive factor-by-factor analysis, design and logical modeling, which allowed us to present the concept of urban planning reorganization of the municipal and warehouse zone of Kazan.

As a domestic experience of the industrial territories' reorganization following examples were considered: the island «New Holland» in Saint-Petersburg, the territory of the ZIL plant in Moscow, the territory of the AMO Automobile plant in Moscow, the VIZ complex in Yekaterinburg, the «Red Rose» factory in Moscow, the Melkovsky quarters in Yekaterinburg, the Industrial Zone «Sickle and Hammer» in Moscow, the Reconstruction of the Crystal plant in Moscow.

Foreign experience in the renovation of industrial areas is represented by following examples: the Kop Van Zuid district in Rotterdam, the Zollverein coal mine in Essen, the Tropical Islands resort in Germany, the New City in Docklands, the Renault territory in the suburbs of Paris and Battersea in London.

The results of the world experience analysis allowed to form a hypothesis of the study, which consists in the interrelated consideration of two frameworks – natural or (green/blue) infrastructure and public transport, which become a structure-forming components in existing urban areas reorganization projects development.

The scientific novelty of the conducted research consists in the development of new approaches to the identification and formation of the structure of urban areas that are being downsized, which in the future allows to form a system of the main communication and active nodes and connections. On this basis, the key aspects of the study are formed:

1. Structure-forming parameters of the transport and planning framework formation of the reorganized territory.
2. The system of basic principles underlying the structural and planning transformations of the object of study.
3. Model (concept) of warehouse zone of Kazan urban planning renovation.

## **3 Results**

The territory in the Sovetsky district of Kazan with an area of 810 hectares was chosen as the approbation of the proposed study. The plot has a triangular geometric shape and is

located on the south-eastern side of the city. It is bordered by the streets of Prospekt Pobedy, Brat'ev Kasimovyyh, Gvardeyskaya and Adel Kutuya.

According to the results of a comprehensive analysis of the considered industrial district of Kazan, it was revealed that 50 % of the territory is occupied by a warehouse zone, a significant part of which does not carry any functional load and is currently not used. The high concentration of storage facilities has an adverse effect on the image of the territory and determines its unsatisfactory condition in terms of social service opportunities. In the territory the segment of social service is insufficient and the corresponding facilities are distributed unevenly. There is lack of public spaces, which, in case of their proper development and multifunctionality, carry not only a socially significant function of providing a high-quality environment for interpersonal and cultural interaction, but also economic benefits. Nowadays, only «Gorkinsko-Ometyevsky forest» park, situated on the territory under study, can be assigned to public spaces of this type. Following kinds of transport operate on the considered territory: bus, tram and trolleybus, metro and railway lines. However, transport lines are unevenly distributed, which determines the insufficient coverage of the territory by public transport (saturation along the perimeter and complete absence in the central part of the territory). At the same time, there are residential buildings of various heights on the territory, from 1 to 16 floors with low public transport accessibility.

The territory is characterized by a fairly high level of landscaping, which contains a high potential for the development of favorable multifunctional public spaces, but there is no unified system for the location of green areas, they are randomly scattered throughout the territory. There is a lack of clear architectural, planning and artistic solutions that correspond to modern trends in the organization of urban landscapes.

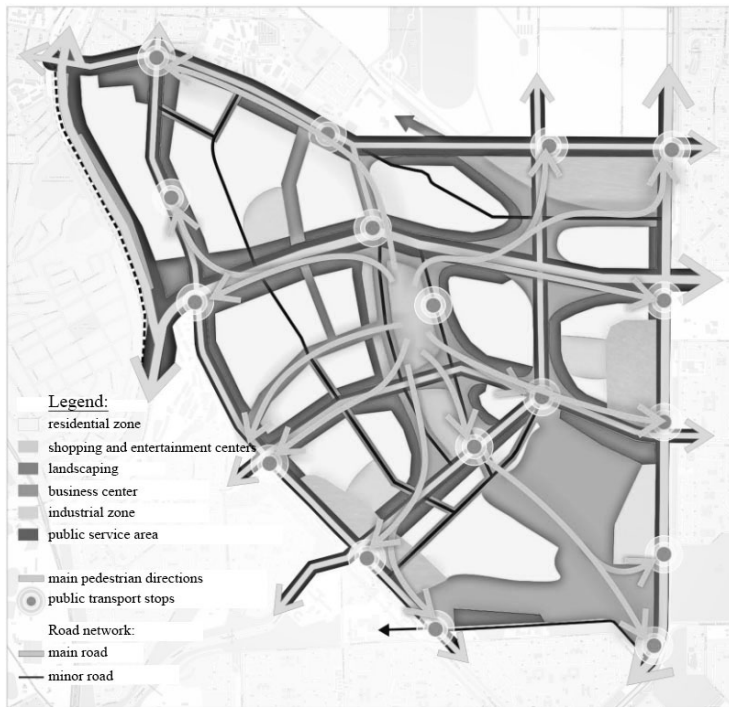
According to the results of the SWOT analysis, an equal ratio of strong and weak characteristics of the territory under consideration was revealed. At the same time, the range of opportunities that can be realized through the transformation of this site is 3 times higher than the list of potential threats in case of design solutions implementation.

In the process of research hypothesis forming, the starting point was the understanding that when creating a sustainable environment, the landscape planning aspect implies not only the preservation and restoration of natural systems, but also a change in the structure of mobility, including public transport infrastructure and improving the quality of communication spaces [24-26].

The formalized model of the structural organization of the territory under study was formed on the basis of combining two frameworks:

- landscape and ecological structure of the district;
- an integrated mobility system that forms the infrastructure of the area's activity and includes nodal objects (centers) around which it is possible to increase the density parameters of the environment, and linear spatial structures that closely interact with the environment taking into account the use of the landscape component.

In this context, the landscape-urban approach is used to overcome the opposition between transport and landscape and to combine morphology, natural and engineering systems into a single infrastructure using hybrid solutions.



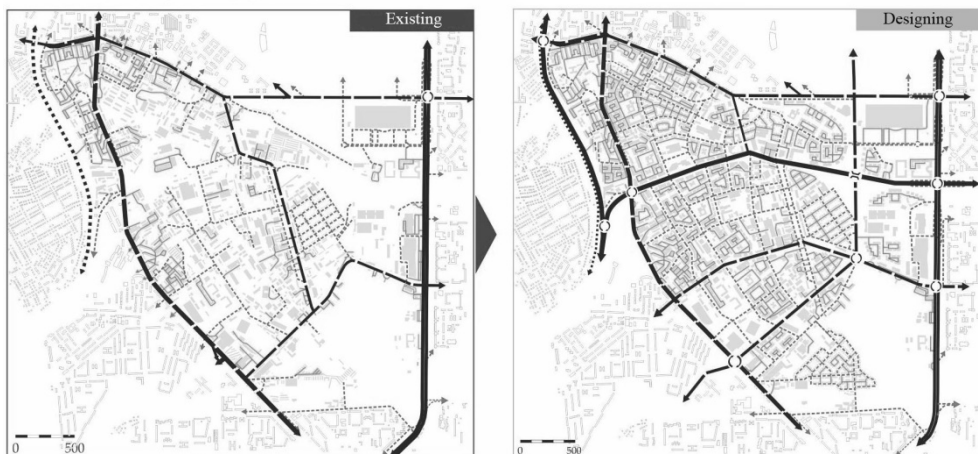
**Fig. 1.** Conceptual model of spatial and structural reorganization of the studied territory.

A comprehensive proposal for the functional and planning reorganization and development of the territory was formed on the basis of the following principles:

1. Creating a centrality structure, including:

- compaction of the building front through the regeneration of its structure;
- organization of mixed functional use, creation of new jobs, cultural opportunities and other activities;
- promote the use of public transport.

The compaction of the building front is due to the modernization of residential buildings, the elimination of dilapidated and unused buildings and the transformation of the urban structure.



**Fig. 2.** Existing and designing road network schemes of the territory.

A variety of functions allows people to live, work, relax, shop in one place, which then becomes a place of activity for people from other areas, hence it can increase its economic viability and security by growing number of people on the streets and in public places. A variety of functions helps to reduce the traffic load due to the increased pedestrian accessibility of places of employment and a decrease in the number of trips by private cars. Public service facilities are distributed and concentrated along the main planning axes and pedestrian links. Sports, cultural, leisure and medical facilities are interconnected with the green areas and the transport system of the district. In addition, public and business functions are located at the intersections of existing and newly created transport corridors, commercial and trade territories are formed. The saturation of the ground floors with various additional functions in the context of reconstruction and new development contributes to a change in the monotonous, uniform nature of the streets, enriches and makes the life of dormitory areas diverse. The integration of additional functions will attract a greater number of different social groups, determine the variety of walking routes and high social intensity of use of the territory, and, consequently, social control.

2. Regeneration and renovation of existing buildings, including:

- using various techniques to change the housing development;
- formation of compact semi-public and residential spaces;
- using of diverse building typologies.

The development of the micro-district is represented by individual, blocked, medium-storey sectional and high-rise point residential buildings. According to the project, the existing residential development is preserved, thereby preserving the historically developed peculiarity of the development of the district. The composite drawing of residential blocks is aimed at creating semi-enclosed courtyard spaces, inside the blocks there are sections of schools and children's institutions with stadiums and sports grounds. A variety of categories and types of residential buildings, structural and planning solutions of the housing stock meets the interests of different groups of the population. On the projected territory there are 6 types of residential development: perimeter, estate, line, carpet, group and free. According to the project, it is planned to build up the territory with the following types of buildings: private buildings of 1-2 stories high, residential sectional houses with a height of 5 and 9 stories and point houses with a height of 12-16 stories. High-rise buildings are supposed to be located along the main streets, thereby providing the soundproofing of the area.

3. Creating a comfortable living environment, including:

- high density of the environment, along with a diverse social composition of the population;
- attractive and diverse public spaces;
- high level of neighborhood accessibility;
- formation of a continuous system of landscaping of the territory using green corridors and boulevards.

The project consistently implements three key techniques: increasing connectivity, activating and saturating various types of spaces with functions and changing the structure of mobility in favor of public transport. The variability and multifactorial nature of the density concept is also actively used, which in fact should become a tool for managing not only quantitative, but also qualitative parameters that affect the formation and regeneration of the morphology of the area's development.



**Fig. 3.** The formation of territory’s dense development due to the liquidation of dilapidated buildings.

Due to the discrete nature of the existing green areas, with the help of designed green corridors, boulevards and squares a continuous system of landscaping of the territory is formed. The boulevards are oriented to the planned central zone of the micro-district, where a zone of commercial and business activity is provided, and to public transport stops. There is a recreation and park area around the pond. The new pedestrian directions are aimed at providing the shortest and most comfortable connections between significant objects of the neighborhood and public transport stops [27].

## 4 Conclusions

As a result of the study, in order to identify the methods and principles of structural and spatial transformations of urbanized territories, the stages of formation, development and the current state of the territory under study are analyzed with a comprehensive urban planning analysis and identification of its urban planning potential.

There have been developed the following principles and techniques of structural-density and morphological transformations, which can be used in projects of sustainable development and transformation of existing urbanized settlements:

- creating a centrality structure;
- regeneration and renovation of existing buildings;
- creating a comfortable living environment.

A conceptual model of the urban area subdivision is constructed on the basis of the identified methodology. The developed practical methods of implementing such strategies can be applied in the further development of urbanized territories, both new and already established.

In Western practice regeneration is considered as a modern and integrated approach to solving urban problems, which leads to sustainable development and improving the economic, structural, social and landscape conditions of the territory [28, 29]. This definition implies a departure from the concept of «priority of property» in development, to a more balanced concept of sustainability (economic, social and natural landscape), strategic vision and partnership. This makes it possible to approach the problem of structural and planning transformation of urbanized territories as a multi-level process, in which the regeneration of a separate site should lead to a change in the nature of the city as a whole. In this case, the processes are not considered in isolation (regardless of the scale of

the changes and the territory), but in an integrated way with the aim of becoming «drivers» for further development [30, 31]. Today, the city becomes a kind of mosaic of projects and transformation processes initiated by private investors, the state or their partnership.

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