

Assessment of the factors of influence on the formation of multifunctional complexes under conditions of renovation of industrial facilities

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Abstract:

This article examines the processes of formation of multifunctional complexes (MFCs) based on the renovation of industrial facilities and identifies and describes the following external factors influencing their formation: socio-economic, environmental, urban planning, architectural, aesthetic, and historical and cultural. It also highlights and describes internal factors: typological, functional and technological, engineering and constructive, space-planning, and architectural and artistic. Socio-economic factors are analysed by identifying factors that inhibit the development of new functions based on the renovation of stopped industrial facilities and contribute to these processes; the main objectives of the renovation of industrial facilities for MFCs are outlined. The factor of adaptability of the urban environment and renovation object located in it is considered in detail.

Keywords:

Multifunctional complexes (MFCs); renovation of industrial facilities; factor analysis

1 Introduction

The stages of development and current state of industrial architecture clearly demonstrate the change in the socio-economic structures of society, impact of scientific and technological revolutions on architectural and technological solutions, and change in the urban planning role of the industry in the development of cities [1].

Thus, the current state of the cities of Eastern Europe with a historical industrial past is characterised by the presence of problems associated with the transition of society from the industrial to the information period of development, and the cities of Ukraine are no exception. Many industrial facilities cease to exist; consequently, they turn into depressive buildings that are isolated from the social environment of the city. The decline of city-forming enterprises, unused industrial sites, and lack of architectural and aesthetic relationships with residential areas negatively affect the figurative characteristics and competitiveness of the city. Modern conditions require an integrated approach to solve the issues of the efficient use of urban areas and creation of a favourable environment.

When making decisions at the urban planning level regarding the reconstruction of stopped industrial territories, a methodology must be developed for quantitative and qualitative assessments of the functional and spatial characteristics of these territories in terms of the city [2, 3].

An important step is the development of an integrated approach at the architectural and planning level when exploring new uses for stopped industrial facilities for various public functions [4, 5, 6].

Currently, multifunctionality is becoming the main feature of modern cities and manifests at various levels, from large districts to separate buildings. A combination of several functions is most often used in the construction of new architectural objects. This is necessary for a more successful operation of the facility from an economic point of view and for ensuring the maximum range of functions for serving the city [7, 8].

The formation of multifunctional complexes based on the renovation of industrial facilities allows to effectively solve the aforementioned problems. Furthermore, the analysis of a complex of factors influencing the formation of these objects is urgently required. The identification and study of these factors at an early stage of design contributes to the adoption of competent and effective decisions on renovation at all levels of the urban planning hierarchy.

2 Methodology

A study of the prerequisites for the renovation of stopped industrial facilities for new functions was conducted using the following methods:

The historical and evolutionary method enabled to track the development of industrial architecture and reasons for the problem of stopping industrial facilities and emergence of new functions in them in Ukraine and abroad.

The method of field surveys as part of a qualitative and quantitative analysis of the state and dynamics of development enabled to study renovated industrial facilities both in Ukraine and abroad.

To clarify the general socio-economic state, a comprehensive socio-economic analysis was performed using statistical information to study the state of change in indicators.

Factor analysis was used to study and measure the interrelationships between a set of factors that promote and hinder the development of multifunctional complexes based on the renovation of industrial facilities as well as to study goals and priorities leading to the harmonisation of the urban environment.

At the stage of searching for the influence of a complex of factors on the architectural and planning organisation of multifunctional complexes in the context of renovation, a method of system analysis was used. Notably, the factors causing professional migration in society affect functional changes in the urban supersystem, part of which is the adaptable spatial structure of the "industrial object."

3 Factors affecting the formation of multifunctional complexes on the basis of industrial facilities

The factors represent certain reasons such as the acting force of the process of formation of multifunctional complexes based on the renovation of industrial facilities and phenomena that affect their nature and characteristics.

External (exogenous) and internal (endogenous) factors are distinguished when forming the architecture of any object. External factors characterise the environment and conditions in which an object is formed, whereas internal factors influence the decision on the architecture of the building itself. Notably, the external and internal factors interact.

The study of the formation processes of the studied complexes enables to identify the following external factors influencing their formation: socio-economic, environmental, urban planning, architectural and aesthetic, and historical and cultural. Internal factors are typological, functional-technological, engineering-constructive, space-planning, and architectural-artistic (Figure 1).

Irrespective of certain conditions during different periods for different types of multifunctional complexes, the design basis is their social role and dominant functional purpose.

External factors affect the formation of multifunctional complexes based on the renovation of industrial facilities through social changes, economic and financial development, changes in environmental requirements, functional and planning changes at the urban planning level, architectural and aesthetic ties in urban structures, and historical and cultural evolutionary processes.

Multifunctional complexes are focused on the integrated implementation of the basic functions of human life associated with labour, social, and household activities, whereas socio-economic factors play a leading role in their formation, determining the demand for the functional spectrum of these type of structures.

The crisis in the industrial society of expanded capital led to a change in the social order through the transition to the information period. The process of de-industrialisation, as a result of the transition, led to a decrease in the percentage of employment of the population in industrial sectors and gross product, a financial crisis, and the emergence of depressed areas in cities. One main socio-economic task is to improve the social infrastructure to improve the psycho-emotional state of the society, create new jobs, and stabilise professional migrations in the society. The main indicators of the socio-economic state of the society are the standard of living, psychophysiological characteristics of the population, level of qualifications of labour resources, presence of long-term investments, cost of construction and reconstruction, and operating costs. The indicators of the socio-economic state of the society determine the development of multifunctional complexes based on industrial facilities.

Environmental factors influence the choice of the functional use of stopped industrial territories and facilities.

Environmental sustainability indicators are:

- Characteristics of the environment—air, water, soil, and ecosystems.
- Levels of pollution and environmental impact.
- Losses to the society from environmental pollution in the form of product losses and diseases.
- Social and institutional capacity to solve environmental problems.
- The ability to solve global environmental problems by consolidating efforts to preserve nature.

The level of pollution of the stopped industrial facility and its territory necessitates biorecoupling of the land and also indicates the variability of reuse. An assessment of the indicators of environmental sustainability of a stopped industrial area for its reuse for new purposes leads to the sustainable development of the ecological environment of the city.

Urban planning factors influence the determination of the size of the complex, choice of the dominant functional core and integrated functions, characteristics of the development,

conditions for the socialisation of depressed industrial territories into the urban environment, and choice of the type of renovation. The extensive development of cities in the post-industrial era has led to functional migration in the planning structure, which in turn destabilises the urban space. The important tasks of modern urban planning, which affect the formation of multifunctional complexes based on the renovation of industrial facilities, include the rational use of urban areas; search for functional diversity with the priority of residential, recreational, and social functions; improvement of functional ties; and renewal and activation of social life through a balanced development of the urban system.

Architectural and aesthetic factors influence the formation of the studied complexes by the presence of a depressive visual connection, “degrading industrial territory—city,” the decaying state of the monuments of the industrial architecture. The solution for important architectural and aesthetic problems, such as the creation of favourable visual aesthetic relationships and continuity of architectural images in the process of the evolution of the urban environment, contributes to the formation of multifunctional complexes based on industrial facilities.

Historical and cultural factors influence the formation of multifunctional complexes through the existing intangible features of an industrial facility (for example, special industrial “spirit” of the territory, historical and cultural value, and social status). The identification of these features and their use when introducing new functions contributes to the preservation of cultural and historical heritage and increases the prestige of the new object.

Typological factors determine the main parameters of a multifunctional complex, which is the dominant functional core, and number of integrated functions. Typological factors form the type of multifunctional complex: small, medium, large, and largest.

Functional and technological factors include the range of services of the multifunctional complex and technological scheme of each functional core included in the complex. These factors affect the conditions of people in areas that correspond to a particular functional and technological process of a particular functional core. Considering the functional and technological factors, one can determine such requirements for the formation of multifunctional complexes as the organisation of information and communication space, considering the existing technologies of each functional core, ensuring the separation of the functional and technological processes of each core, and combining them with an information and communication space.

In terms of engineering and design factors, one can single out building materials, design solutions, and engineering equipment.

Space-planning factors include the composition and parameters of blocks and premises, architectural and planning composition, and volume-spatial composition of a building, its volume parameters, and number of storeys.

Architectural and artistic factors are associated with the means of expressiveness, stylistics, preservation, and inclusion of the historical appearance in a new system to create an attractive multifunctional complex with a special image.

All the factors considered have different specifics and are nevertheless related. Thus, the peculiarities of the architectural, planning, volumetric, spatial, and constructive solutions of the renovated industrial facility and its architectural, artistic, and historical significance largely determine the decisions on the reconstruction and modernisation of the building, which in turn affects the cost of renovation work and effectiveness of the further functioning of the reformatted facility for new functions. Research and analysis of all external and internal factors and their considerations in the design allows the selection of the most optimal solutions for the renovation of industrial facilities for multifunctional complexes.

New socio-economic conditions lead to extensive urban sprawl. Furthermore, a lack of complexity and balance in the new development, the predominance of point construction, and presence of depressed industrial areas are accompanied by property stratification of the urban population. These problems are typical for the former industrial cities of the countries of the former socialist bloc. Examples include Brasov and Sibiu (Romania), Lovech and Dobrich (Bulgaria), and Gaale (East Germany).

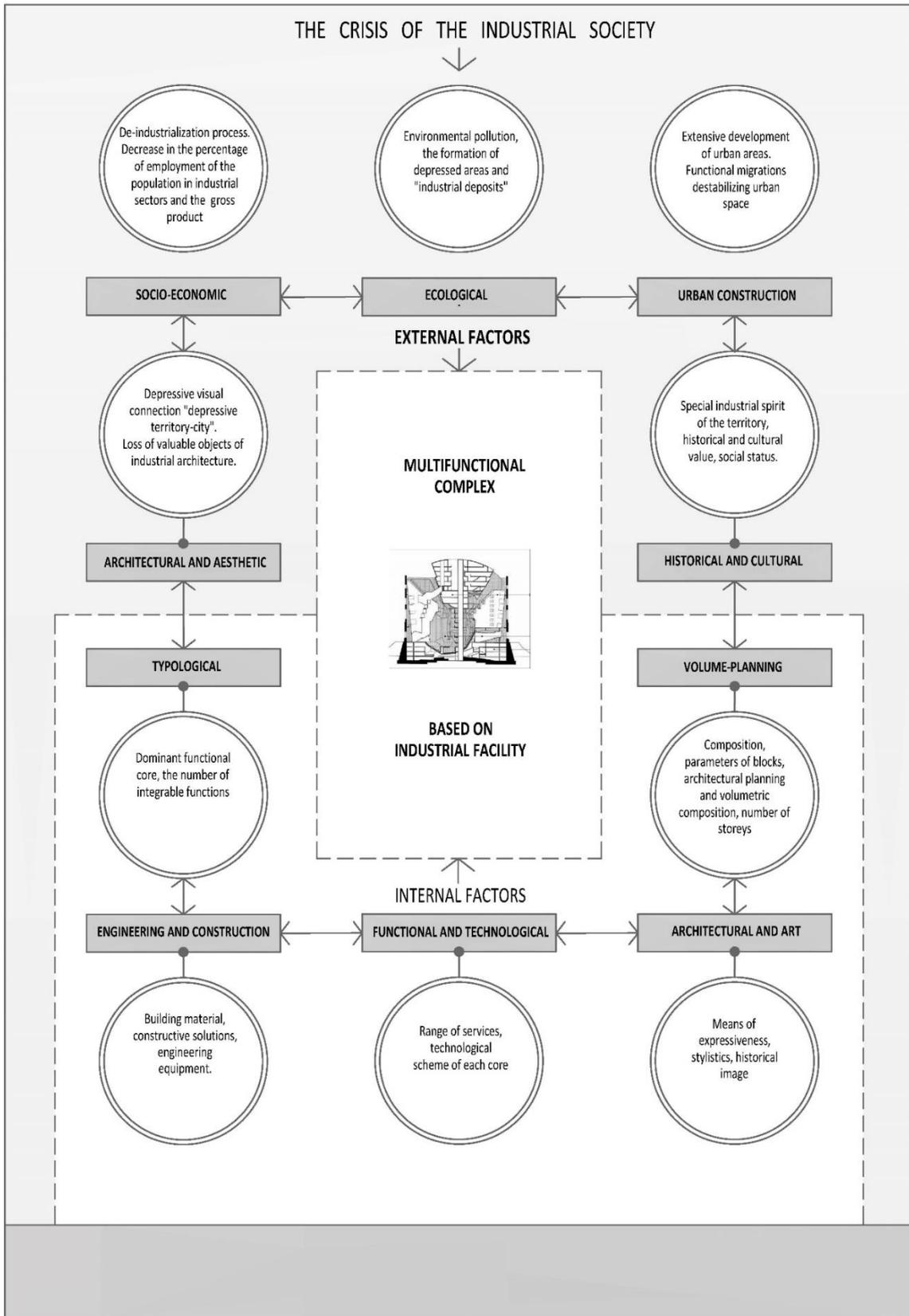


Figure 1. Factors influencing the emergence of new functions in industrial facilities (compiled by authors)

These issues are also very acute for Ukraine. The law, “On the regulation of urban planning” (2011) [9], and the resolution of the Verkhovna Rada of Ukraine, “On the concept of sustainable development of settlements in Ukraine” (1999), require more efficient use of urban areas and the creation of a favourable environment.

The processes taking place in the industrial sector of the city of Odessa, which is a large economic centre in the south of Ukraine, clearly demonstrate similar processes taking place throughout the country.

In the industrial complex of Odessa, problems are caused by the following factors:

- Lack of modern technologies, equipment, production infrastructure, insufficient capacity of the financial and credit system, heavy tax burden, and imperfect regulatory and legal support.
- Insufficient solvent internal market of industrial products.
- The rise in energy prices significantly affects the financial performance of machine buildings and metallurgy enterprises and competitiveness.

For example, in 2011, compared with 2010, the volume of industrial products sold in Odessa decreased by 40,8 %. This reduction is because of the fact that almost half of the city's industrial production was provided by the “Lukoil” refinery—Odessa oil refinery. In October 2010, the company stopped refining oil, leading to a significant decrease in industrial production in Odessa. The decrease in the volume of industrial products sold also affected the loss of the city's position in the regional results [10]. Currently, the situation is worsening.

Notably, a significant part of the city's industrial potential was lost in the 2000s of the last century. In 1990, approximately 180 industrial enterprises were operating in Odessa; in 2008, 135 were operating; as of February 1, 2013, 89 were operating; in 2016, approximately 70 were operating; and in 2019, approximately 40 were operating, 97 % of them were in private hands and operated at minimal capacity [11].

Since the end of the 90s of the last century, a point renovation has been taking place in the city of Odessa.

Evidently, in modern conditions, when humanity is on the verge of transitioning to a new technological order (that is, nanotechnology, solar, and nuclear energy), reviving industrial facilities is inappropriate, the technological chains of which correspond to the technological order associated with an internal combustion engine.

A priority task for the development of the Ukrainian industrial complex should be its inclusion in the main direction of the country's socio-economic development for the development and implementation of new technological processes in industrial production and construction of modern high-tech industrial facilities, which will ensure the growth of domestic production, export potential of large Ukrainian cities, and state immunity.

Stopped industrial facilities and their territories should be comprehensively studied, and objects among them that require their introduction into the status of monuments of architecture or history must be identified. These facilities should be protected by law. The fulfilment of this issue is extremely important for Ukraine and several other Eastern European countries.

Furthermore, currently, numerous positive examples of the renovation of stopped industrial facilities in Eastern Europe exist, the experience of which is worth studying.

For example, an exemplary example of renovation is the former textile factory, “Manufatura,” in the Polish city of Lodz. This factory was considered one of the largest textile enterprises in Europe. When it closed in 1992, the 9 ha area and surrounding neighbourhoods froze. However, the shopping and cultural and entertainment centre Manufatura, which opened there in 2006, became a place for recreation for residents of the city and competed with the main tourist street of the city.

A similarly successful solution was the renovation of the Rotermann quarter in Tallinn, Estonia. There were factories that produced starch and alcohol, sawmills, pasta factories, bakeries, mills, and salt warehouses. For many years, this has been an ordinary industrial quarter in the city centre near the port. Currently, the quarter is recognised as the cultural and historical value

of the city. It includes a Coca-Cola Plaza multiplex with 11 screens, the Museum of Estonian Architecture in the building of a former salt warehouse which is considered the best limestone building in the entire country, cafes, restaurants, boutiques, offices, and residential apartments for rent.

In the course of the described renovations, multifunctionality plays a primary role.

Thus, the stopped industrial facilities and their territories, in the context of the restructuring of the urban fabric within its own borders, act as a territorial capital, the transformation of which into multifunctional structures will solve the problems of the master plan for the development of cities and contribute to their sustainable development.

4 Analysis of socio-economic factors and the main objectives of the renovation of industrial facilities for multifunctional complexes

Socio-economic factors that influence the development of multifunctional complexes based on industrial facilities can be divided into two groups:

- 1) Factors contributing to the formation of multifunctional complexes based on industrial facilities: stopped industrial facilities—a resource of urban land and fund of historical buildings, the presence of developed engineering communications, special “industrial spirit” of objects and territories, favourable location in urban areas, architectural and planning solutions (large-span, frame system, and high floor height), transport accessibility of territories, high level of identity of the established territory, and preservation of historical memory.
- 2) Factors hindering the formation of multifunctional complexes based on industrial facilities: the consequences of de-industrialisation in Ukraine—limited budget funds; an unfavourable investment climate in the state; unfavourable environment for business development; uncertainty in the direction of specialisation of the former industrial cities of Ukraine; low living standards of residents; an ambiguous attitude of society to the possibility of using industrial facilities for residential, public, and recreational functions; and a lack of interest at the state level in the preservation of industrial heritage.

The study of the aforementioned factors allows to highlight the main goals and priorities of renovating industrial facilities for multifunctional complexes.

1. The renovation project should be included in the city development strategy.
2. Activities related to renovation should positively affect the image of the city, make it more comfortable, and expand the range of its activities.
3. The new life of an industrial facility will become a new point of attraction in the urban system of socio-economic relations.
4. Securing the continuity of the historical stages of the urban planning chronicle by the method of functional migrations in a separate territory.
5. Stabilization of the urban space by integrating multifunctional structures into existing buildings.
6. The mission of multifunctional complexes based on industrial facilities is to improve the quality of the urban environment.

5 Factor of adaptability

An important factor influencing the formation of multifunctional complexes based on industrial facilities is the factor of adaptability of the urban environment and renovation object located in it.

Mobility is an important characteristic of the habitat, which is expressed in the dynamism of object-spatial and organizational forms and states, as well as in the purposeful or involuntary transformation of the conditions for the perception of the environment and the human reaction to these changes. In the design culture, this phenomenon is called “adaptability” and implies,

in the general case, the property of the material and intellectual-sensory environment to change its parameters in accordance with the tasks of its optimal state [12, 13].

The main meaning of any adaptive action is to change the initial characteristics of the habitat in such a way that they ensure the optimal performance of life processes, and the essence of the design efforts that implement these changes is the continuous search for principles, techniques, and technologies that change the environment in accordance with human needs. [12].

Adaptation is the ability of any system to receive new information and bring its structure closer to the optimal state.

Global changes have affected the emergence of functional migration in urban environments. The city, as a supersystem, includes a set of systems and subsystems that change under the constant influence of certain factors. The change in the social structure led to a decline in industrial production based on the principles of an industrial society. Functional and planning connections in the urban structure associated with production are losing relevance, and buildings and territories are emptying. The need for the application of labour in the field of industry is disappearing, and priority is being transferred to the fields of trade, business, tourism, education, and the provision of various services. The emergence of professional migrations in the society causes functional migrations in the urban environment, destabilising it (for example, "industrial deposits" and disruption of functional planning links).

The renovated industrial facility and its territory can be considered as an adaptable spatial subsystem (Figure 2).

An adaptable spatial system "industrial facility" is an architectural and urban planning space that has the potential to adapt to functional migrations and changes in the life of the city to achieve optimal compliance of that space with new requirements and stabilise the urban environment.

The following factors have potential for adaptation: the town-planning location of the industrial facility, volumetric-spatial structure, constructive solution, architectural and social status, and degree of preservation of the facility.

Renovation, in this context, acts as a tool in the development of the potential of an industrial facility and its territory and is a multi-stage process. The renovation process is a system of design solutions and practical actions that changes the existing characteristics of the renovated object in accordance with the requirements

of the new function. The following factors and indicators affect the renovation process: the adaptability of the renovation object (material and metrological components), architectural and social status, and accepted methods of renovation (algorithm of actions).

The measures of adaptability of the "industrial facility" subsystem to the algorithms of changes (renovation) include compliance with the requirements of the new function, the measure of permissible changes (partial renovation, complete renovation, and conservation), and complexity of the transformation processes (at the constructive and space-planning levels, legal level, economic level, and socio-cultural level).

Thus, adaptability is the internal quality of a renovated industrial facility based on its potential, and renovation acts as a tool with which these qualities receive new meanings and development.

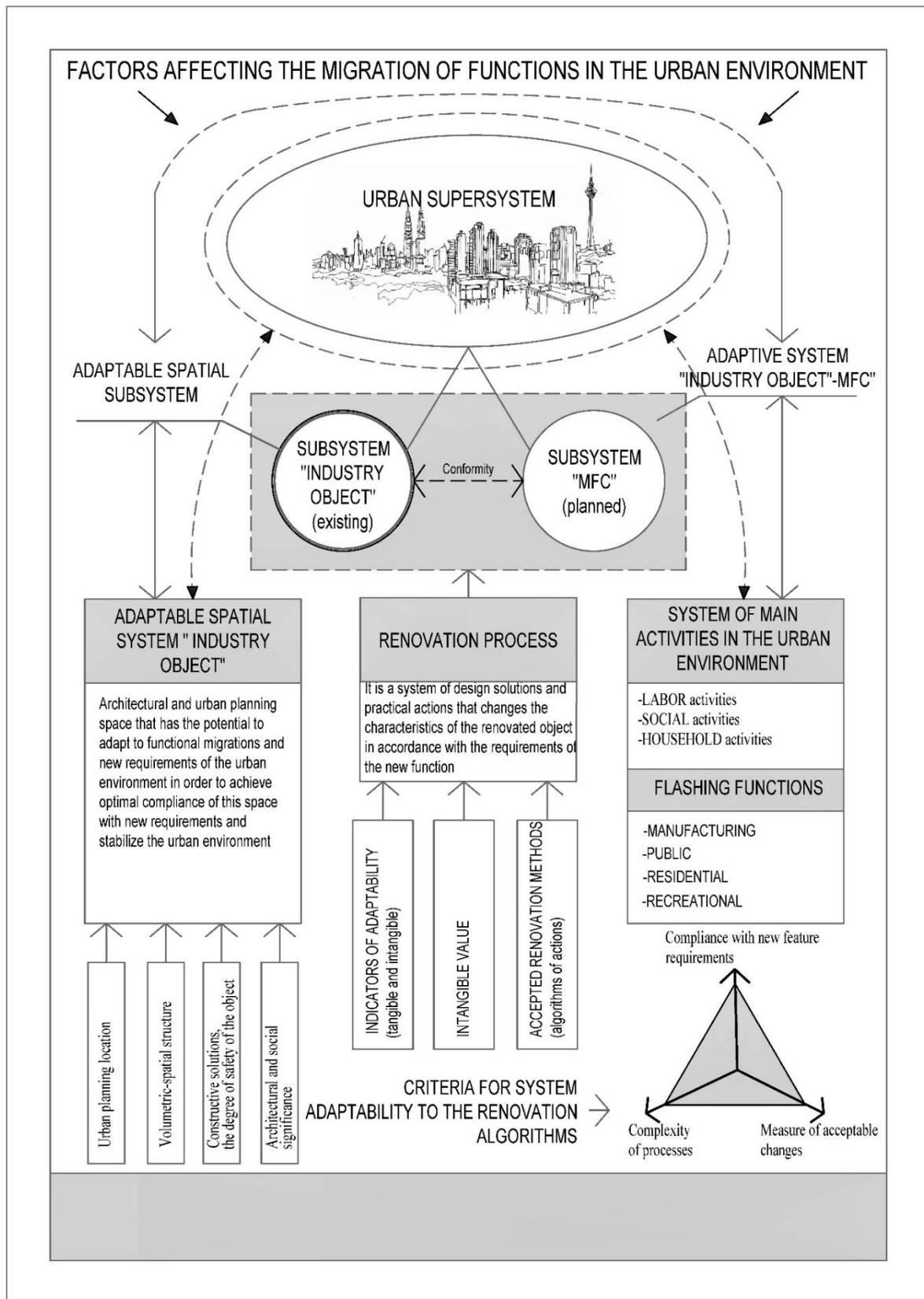


Figure 2. Adaptive system “INDUSTRIAL FACILITY–MULTIFUNCTIONAL COMPLEXES” in the city system (compiled by authors)

6 Conclusions

Currently, developing a systematic approach to the transformation of stopped industrial facilities and territories is necessary. This is important not only for the preservation of industrial architecture and implementation of the principles of environmental sustainability, but also for the humanisation and social orientation of renovated facilities, as well as to maintain a balance between natural and anthropogenic components to meet the needs of large cities. For morphological infrastructure, in which the main subsystems have already formed objectively and historically before starting the design, a complex of studies must be conducted concerning the renovated industrial facility to determine the algorithm for renovation actions. The assessment and analysis of factors influencing the formation of multifunctional complexes based on the renovation of industrial facilities is the most important stage in this process. This will contribute to the development of a city development strategy without violating its architectural and spatial integrity, while simultaneously improving the quality of the urban environment.

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