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Key words: *methodological approach, reconstruction, urban area, objects, system-integrated urban planning education, physical deterioration, obsolescence, technical comfort, mathematical and system models*

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METHODOLOGICAL APPROACH TO PLANNING THE RECONSTRUCTION OF URBAN ENVIRONMENT

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The article substantiates the need for a comprehensive multidimensional reconstruction of the territories of cities and settlements, caused by social, urban planning and economic reasons. For effective planning of the reconstruction of sections of the urban environment, a systematic approach is proposed as a leading methodology, which allows one to design interrelated solutions for the reorganization of various objects of the urban environment in order to bring them in line with current norms and modern requirements. At the same time, sections of the urban environment are presented in the form of a complex hierarchical system - a system-integrated urban planning education - and are expressed by a subject structure with components and objects included in it. Physical deterioration, obsolescence, "technical comfort" are taken as indicators of the effectiveness of the functioning and development of a system-integrated urban planning education. Based on a systematic approach, a stratified mathematical model for the choice of options for actions, technical and technological solutions has been developed when designing the reconstruction of urban areas with minimization of resource consumption.

Key words: methodological approach, reconstruction, urban area, objects, system-integrated urban planning education, physical deterioration, obsolescence, technical comfort, mathematical and system models

INTRODUCTION

The progressive development of human society requires an increase in the corresponding level of the living environment and life activity - these are various types of buildings and structures, engineering infrastructure and other objects. The need for large-scale reconstruction of cities and settlements is caused by social, urban planning and economic reasons. These include: providing the population of the country with convenient and comfortable habitation and living conditions; improvement of buildings, streets, areas, parks, squares, adjoining territories according to the laws of architectural composition. At the same time, the solution of the listed construction and urban planning tasks should be carried out with the optimization of the consumption of material, technical, labor and cost resources. Numerous studies of a number of scientists show the feasibility [1] to [6] of a comprehensive multidimensional reconstruction of urban areas, including all the relevant infrastructure. Multidimensional reconstruction is understood as a set of actions, technical and technological solutions aimed at significantly reducing the physical and moral deterioration of buildings and structures in the urban environment. It should be borne in mind that carrying out a complex multidimensional renovation in an urban environment is a very complex engineering, architectural and social task. For example, the advanced development of residential building renovation programs, including their reconstruction with superstructure and expansion, the demolition of obsolete buildings with possible sealing development, etc., on the one hand, increases the amount of living space on the renovated section of the city, and on the other hand, it can complicate the development of engineering infrastructure due to additional requirements for the number and area of car parking lots, the need to lay additional water supply and sewerage networks, etc. Priority renewal of engineering and network infrastructure (heat supply networks, water supply, sewerage, etc.) can affect the operation of highways, the state of indoor and outdoor areas, while it is impossible to exclude the need for work in park and "green" zones of the city, which can damage its ecology. Planning a comprehensive multidimensional reconstruction of the urban environment in a generalized form involves a phased implementation of the following procedure [7]:

1. Analysis of technical and statistical, planning, structural data on the housing stock.
2. Inspection of objects of urban areas.
3. Establishment of the state of these objects, characterized by generally accepted qualitative and quantitative indicators.
4. Making informed decisions to update them.
5. Optimization of the consumption of resources consumed in this case.

It should be noted that the performers of these stages

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(administrative bodies, engineers, designers, etc.) are not always able to fully take into account the complexity and compatibility of solving social, urban planning and economic problems, they have not fully mastered the variant organizational and technological design and digital methods of work. with information [7]. In addition, a significant gap between them, caused by the inertia of information transfer from one stage to another and their processing by various groups of specialists, may turn out to be a difficulty on the way of implementing the stages under consideration [7]. To improve the efficiency of the implementation of these stages, it is proposed to apply a systematic approach, which is a powerful philosophical and methodological basis [8] to [11]. Its established and repeatedly confirmed advantage, realized in system design, consists in a set of fundamental ideas, methods, algorithms, formalisms inherent in it, the creative application of which ensures the solution of both individual problems and their combined set with the achievement of the required optimized indicators [8] to [11]. The methodology of the systematic approach has made it possible to solve an interconnected set of scientific problems, which makes it possible to effectively plan and implement projects for the complex renovation of urban areas.Initially, a systemic model of urban areas was developed in the form of a multi-level system. At the same time, in accordance with the methods of system analysis, with a stratified display of systems [12] in the most general form: in a semantic, problematic, fundamental understanding - an urban area or its sections can be represented as a system (fig. 1) [13].

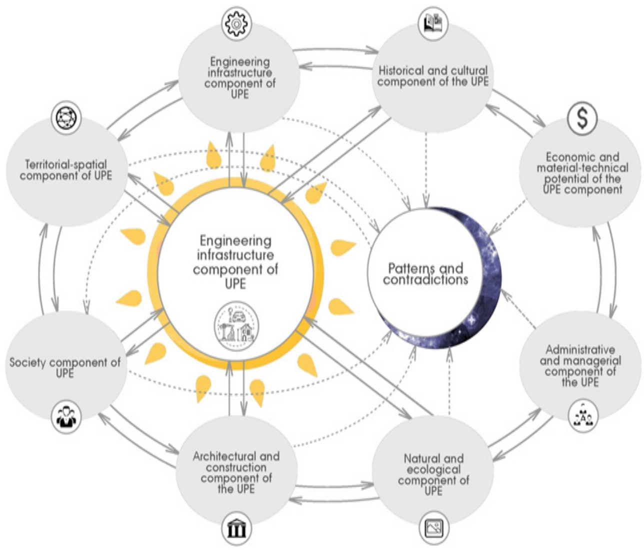


Figure 1: System modeling of urban areas

At the stage of the formation of the system as a system-integrated urban planning education (UPE) in conceptual form, it included various components of the urban environment. Thus, system-integrated urban planning education can be defined as a set of interconnected, manageable, due to the economic and material and technical potential of a given territory, spatial, architectural and construction, engineering solutions for the habitat of population groups (society) that provide the existing living conditions and human life [13]. The stratified method made it possible to clarify and detail the composition and content of the UPE through the description using the synthesis of complex systems with the formation of a multilevel hierarchical system (fig. 2) [13, 14].

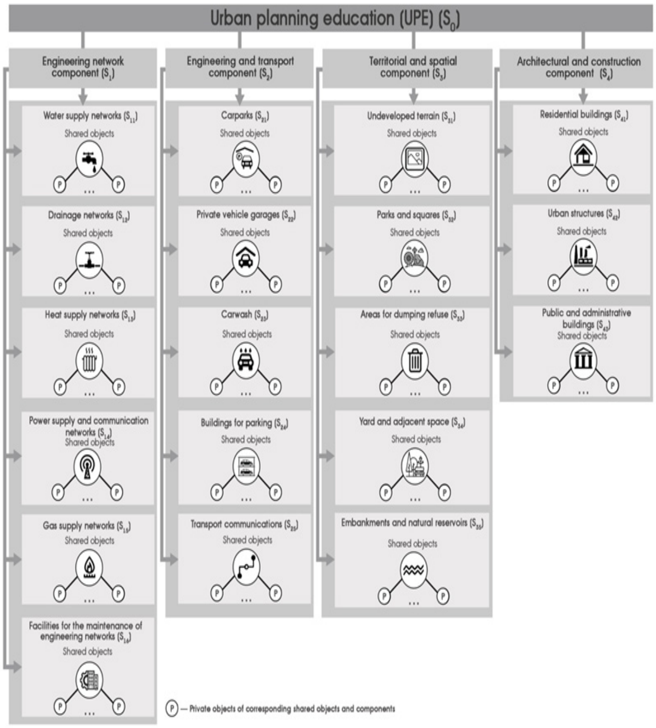
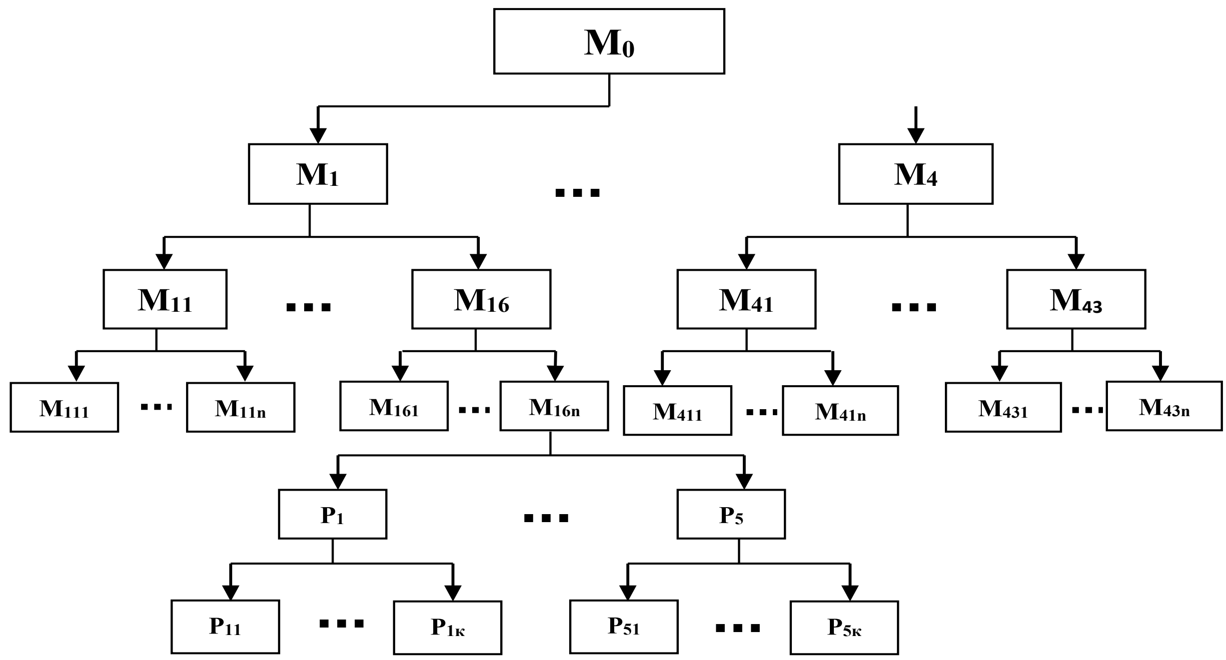


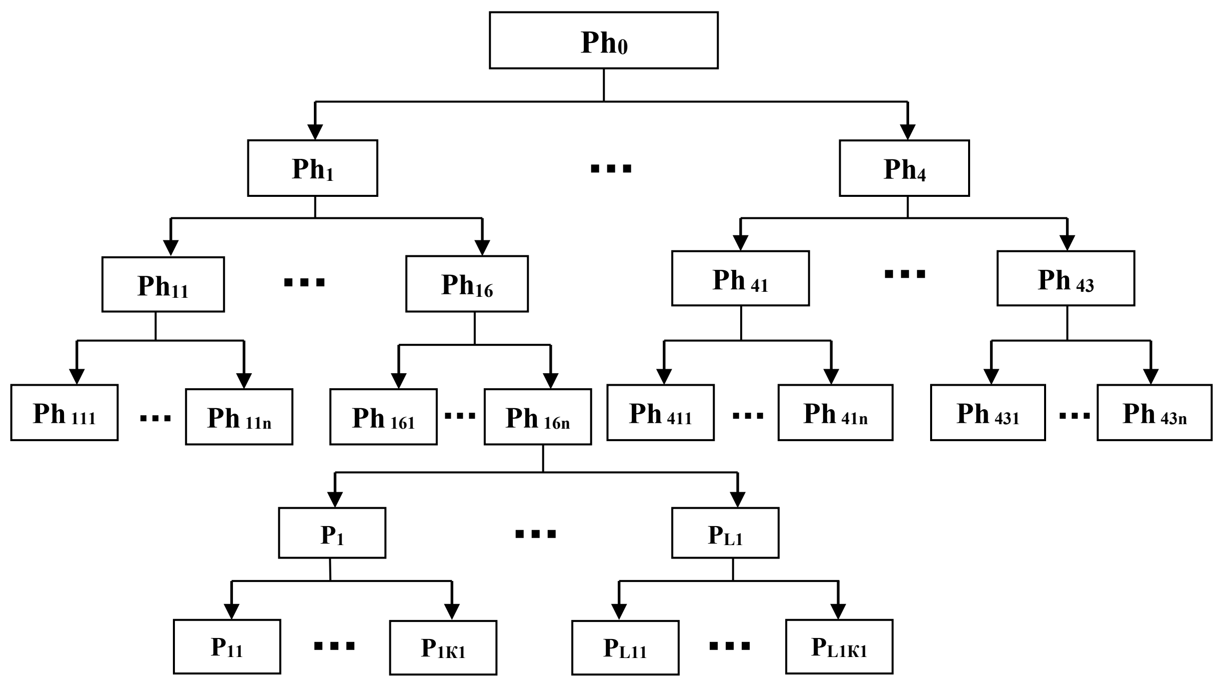
Figure 2: System-integrated urban planning education as a multilevel hierarchical system

Further, indicators that determine the state of the urban environment, its components and objects were established: obsolescence (M), physical deterioration (F), technical comfort. Technical comfort (TC) is considered as the convenience of the technical construction of the environment of society, assessed by the degree of its compliance with sanitary and hygienic norms, rules and standards for the safety of this environment and other indicators established, if necessary, by qualified experts [15]. Based on the structure of the UPE (fig. 2), a structural diagram of the representation and determination of the values of M, F, system-integrated urban planning education, its components and objects was formed (fig. 3, fig. 4) [15].



$P_i, i = \overline{1,5}$ - general indicators of obsolescence of private objects;
$P_{i\kappa}$, $i = \overline{1,5}$, $\kappa = \overline{1,\kappa 1}$ - private indicators of obsolescence of private objects;
M – integral indicators of obsolescence of UPE, its components, general and private facilities

Figure 3: Obsolescence indicators tree for UPE



P_l, $l = \overline{1,L1}$ - indicators of physical wear and tear of structures or elements of private objects;
$P_{l\kappa}$, $l = \overline{1,L1}$, $\kappa = \overline{1,K1}$ - indicators of physical wear of individual sections of structures or elements of private objects;
Ph – integral indicators of physical wear and tear of UPE, its components, general and private facilities.

Figure 4: The tree of indicators of physical deterioration of UPE

In this case, TC is determined using the F and M indicators according to the formula (1) (fig.5)

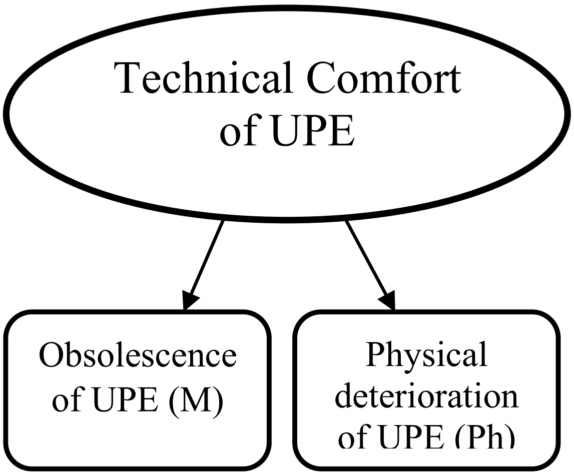


Figure 5: The structure of the indicator of the technical comfort of UPE

$$TC = [1 - f(Ph, M)] * 100 \quad (1)$$

where, TC – indicator of the technical comfort of the UPE, its components and facilities;

Ph – integral indicator of physical deterioration of UPE, its components and objects;

M – integral indicator of obsolescence of UPE, its components and objects;

f (Ph, M) – aggregate indicator of physical and moral deterioration. The method for determining the Ph, M and TC of the UPE, its components and objects, including mathematical, expert and normative methods, is described in detail in [16, 17].

The next task is to develop a systematic mathematical model of a methodological approach to the choice of options for action, technical and technological solutions to increase the TC of the UPE and (or) its individual components and objects during their renovation with minimization of resource consumption (P) (fig. 6) [18]. To solve such problems of synthesis of complex systems, step-by-step solution schemes based on a stratified approach are used [12].The stratified approach provides for the consideration of this problem at 3 levels of detail - 3 strata: functional, technical, technological. The decision-making content for each stratum includes the following procedure when considering different options: "generation-analysis-selection" [19,20].

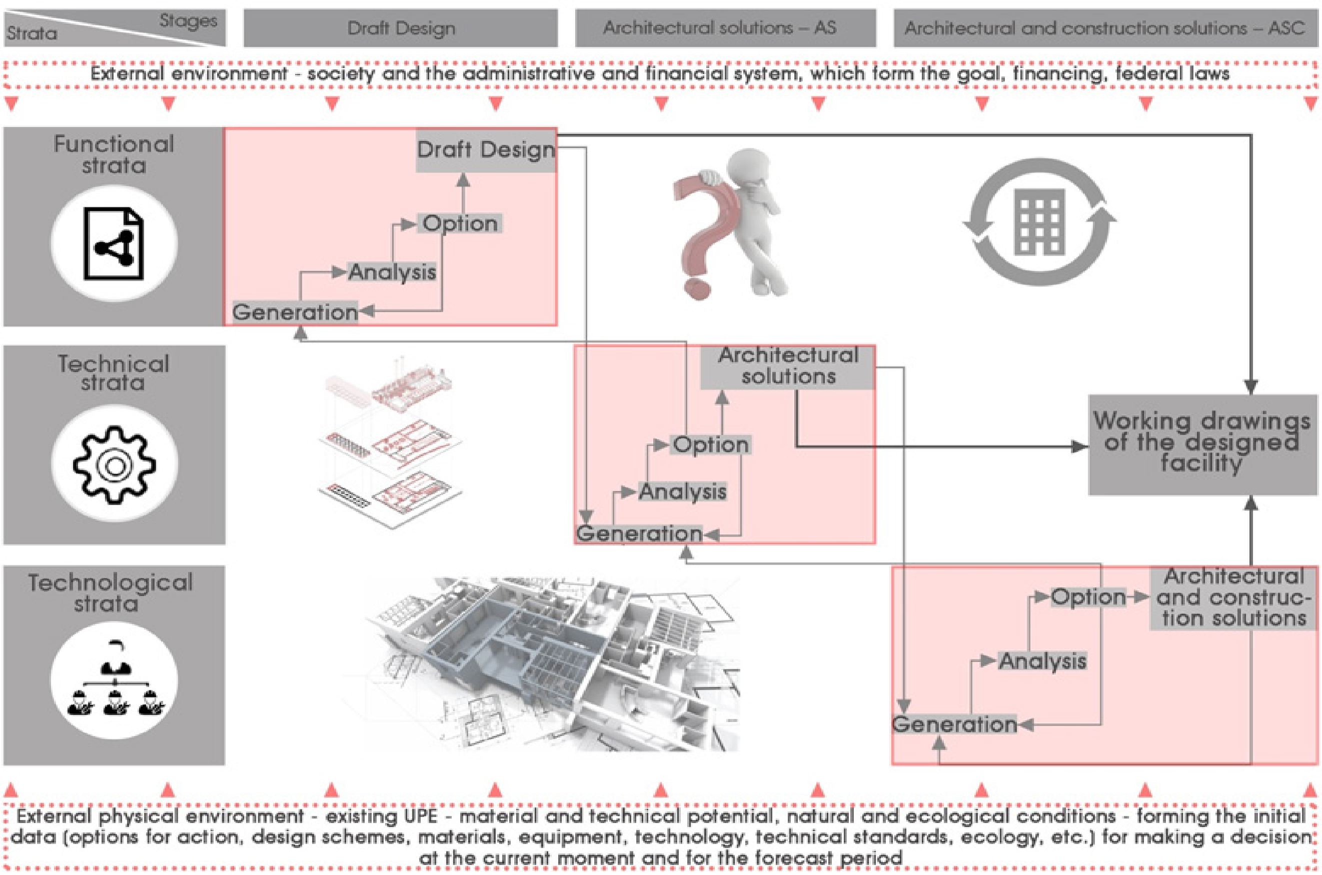


Figure 6: Technological scheme for making decisions on the renovation of UPE, its components and objects

On the 1st functional stratum, solutions (R1) are selected for the options for the renovation of the UPE and its components (current repairs, major repairs, reconstruction, etc.) to achieve an acceptable ratio between the achieved TC and the resources required for this. The second level of detail in the description of solutions is the technical stratum, where the corresponding solutions (R2) are established, which technically implement the actions selected on the functional stratum. The third level of the description of solutions is the technological stratum, which provides detailed design and technological solutions (R3) that implement the decisions made at the technical stratum. Thus, the technology for synthesizing UPE as determining options for actions and decisions on the functional, technical and technological strata consists in studying in time the totality of formal and heuristic operations for compromise decision-making, providing a rational ratio between the TC of the UPE and the resources required for this(P). Mathematically, the problem can be expressed in the following form: find (R_1,R_2,R_3) opt=arqminP(R_1,R_2,R_3)withrestrictionsTC$(R_1,R_2,R_3)\geq$ TCreq,$<R_1,R_2,R_3>$ whereR_1, R_2, R_3 accordingly - a lot of permissible actions, technical and technological solutions. The given set of mathematical and system models, techniques, methodological schemes is intended for the development of databases, algorithms and computer programs integrated into a single automated functional system representing a technological digital platform for planning and implementing projects for the reconstruction of the territories of cities and settlements.

CONCLUSIONS

1. The expediency and necessity of applying a systematic approach in the development and implementation of plans and programs for multidimensional reconstruction of the territories of cities and settlements is substantiated.
2. A model of urban areas is presented in the form of a multilevel hierarchical system - a system-integrated urban planning education.
3. Indicators of the efficiency of the functioning of the system-integrated urban planning education were established: physical and moral (functional) wear, technical comfort, resource intensity. A general methodology for their determination has been developed, including mathematical, expert and normative methods.
4. A systematic mathematical model has been developed for choosing options for actions, technical and technological solutions to improve the technical comfort of objects of urban planning education during their reconstruction and renovation with minimization of resource consumption.
5. The expediency of using the developed models, methods, methodological schemes for the formation of a digital technological platform that regulates the multidimensional renovation of the territories of cities and settlements is shown.

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REFERENCES

1. Kievsky, I. L., Kievsky, L. V., Argunov, S. V. (2018). Multiple effects of renovation. Renovation. Large scale urban dispersed building project. Russian school, Moscow.
2. Kasyanov, V.F., Chernysheva, O.I. (2016). Reconstruction as a form of city development. Scientific Review, no. 12.
3. Ilyichev, V.A., Kolchunov, V.I., Timofeeva, E.A., Bakaeva, N.V. (2016). Reconstruction of urban areas and engineering structures according to the principle of biosphere compatibility. Water supply and sanitary engineering, no. 3.
4. Rimshin, V.I., Kimyaeva, E.V. (2017). Comprehensive renovation of the southern microdistrict of the Lobnya urban district of the Moscow region. Housing construction, no. 12.
5. Lunyakov, M.A., Grabovy, P.G. (2017). Genesis and evolution of a single-industry city and the main directions of its modernization. Publishing house MISI-MGSU, Moscow.
6. Silka, D.N., Lukmanova, I.G., Afanasev, A.A., Kasyanov, M.A. (2015). Synchronization of processes related to economic activity with stages of development of spatially-organized systems. International. Journal of Economics and Financial Issues, vol. 5, no. 3.
7. Schreiber, K.A. (2008). Technology and organization of repair and construction production. ASV Publishing House, Moscow.
8. Novikov, D.A. (2016). Cybernetics: Navigator. History of cybernetics, current state, development prospects. LENAND, Moscow.

9. Burkov, V.N., Gubko, M.V., Korgin, N.A., Novikov, D.A. (2012). Theory of management of organizational systems and other sciences of management of organizations. Management problems, no. 4.
10. Burkov, V.N., Novikov, D.A. (2009). Theory of active systems (history of development and current state). Control problems. Special. release 3.1.
11. Blauberg, I.V., Sadovsky, V.N., Yudin, E.G. (1970). Systems approach in modern science. Problems of methodology of systemic research. Mysl ', Moscow.
12. Mesarovich, M., Mako, D., Takahara, I. (1973). Theory of hierarchical multi-level systems. Mir, Moscow.
13. Matreninsky, S.I., Mishchenko, V.Ya., Chernyshov, E.M. (2014). Methodological approach to decision-making on reconstruction of compact built-up development areas. Recent Advances in Environmental & Biological Engineering, p. 9-17.
14. Mishchenko, V.Ya., Matreninsky, S.I., Chertov, V.A. (2014). Justification of the form of territories of mass residential development for their reconstruction and renovation. Real estate: economics, management, no. 1-2.
15. Matreninsky, S.I., Mishchenko, V.Ya., Spivak, I.E. (2016). Methodological approach to the classification of areas of compact built-up development areas for selecting variants of actions and sequence of technical and technological solutions for the renovation of these areas. WSEAS Transactions on Environment and Development, vol. 12.
16. Matreninsky, S.I., Mischenko, V.Ya. (2016). Methodological approach to the substantiation of the form of compact built-up development areas with the aim of their renovation. WSEAS Transactions on Systems, vol. 15, no. 1.
17. Matreninskiy, S.I., Mischenko, V.Ya., Chernyshov, E.M. (2015). The systemic approach to modeling of compact built-up development areas and planning of their renovation. International Journal of Energy and Environment, vol. 9.
18. Matreninskiy, S.I., Mischenko, V.Y. (2015). Methodological approach to the formation of action variants and solutions implementing them for renovation of compact built-up development areas.Proceedings of the 4th NAUN International Conference on Energy Systems, Environment, Entrepreneurship and Innovation (ICESEEI15), pp 18-23.
19. Panenkov ,A., Lukmanova, I., Kuzovleva, I., Bredikhin, V. (2020). Methodology of the theory of change management in the implementation of digital transformation of construction: problems and prospects. 22nd International Scientific Conference on Energy Management of Municipal Facilities and Sustainable Energy Technologies, EMMFT, pp 05005
20. Bredikhin, V., Bredikhina, N., Ezerskiy, V. (2020). Modeling of property management process at territorial level. Journal of Applied Engineering Science, vol. 18, no.2, 257-261, DOI: 10.5937/jaes18-26306

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