

# Integral evaluation of variants of renovation projects for Moscow city blocks

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**Abstract.** The idea of renovation, as a reorganization of the urban area, and the term "renovation" were proposed at the Moscow State University of Civil Engineering at the peak of the period of "spot construction" of the existing town-planning composition of the city of Moscow. The idea was actively supported, and the term "renovation" was actively used in the directive documents and Decrees of the Government of Moscow at that time. Then the idea of "spot construction" was criticized, its popularity and intensity of use decreased significantly. Recently the term "renovation", the content of which is now not associated with the idea of "dotted building" of urban areas, once again acquired relevance in the activities of the Moscow Government in connection with the need to significantly improve the level and quality of life of the population. Renovation is now understood as a complex problem, combining new construction, reconstruction, social and transport aspects of life and work, demolition of buildings and structures that have served their time, handling construction waste and again, as well as organizational and logistical issues of resettlement of Muscovites. The complexity of the coverage of all these aspects of renovation, as a multi-layered and multi-parametrical socio-technical field of activity supposes an examination of the significant diversity of individual characteristics, revealing the degree of their significance and interrelationships, and requires creating new information computer technologies. Their use is able not only to interconnect individual characteristics, to perform diagnostics and monitoring changes in the quantitative values of individual parameters, but also to operate with integral evaluations of the interaction of all the above-mentioned aspects of renovation. Russian construction science pays serious attention to creation and application of models of "folding" of certain parameters and characteristics into integrated comprehensive assessments that allow to operate at such levels of management with such arguments when assessing the quality of processes and performance results. One of the varieties of such models is considered, which is used in the analysis of stationary and mobile environments of construction production.

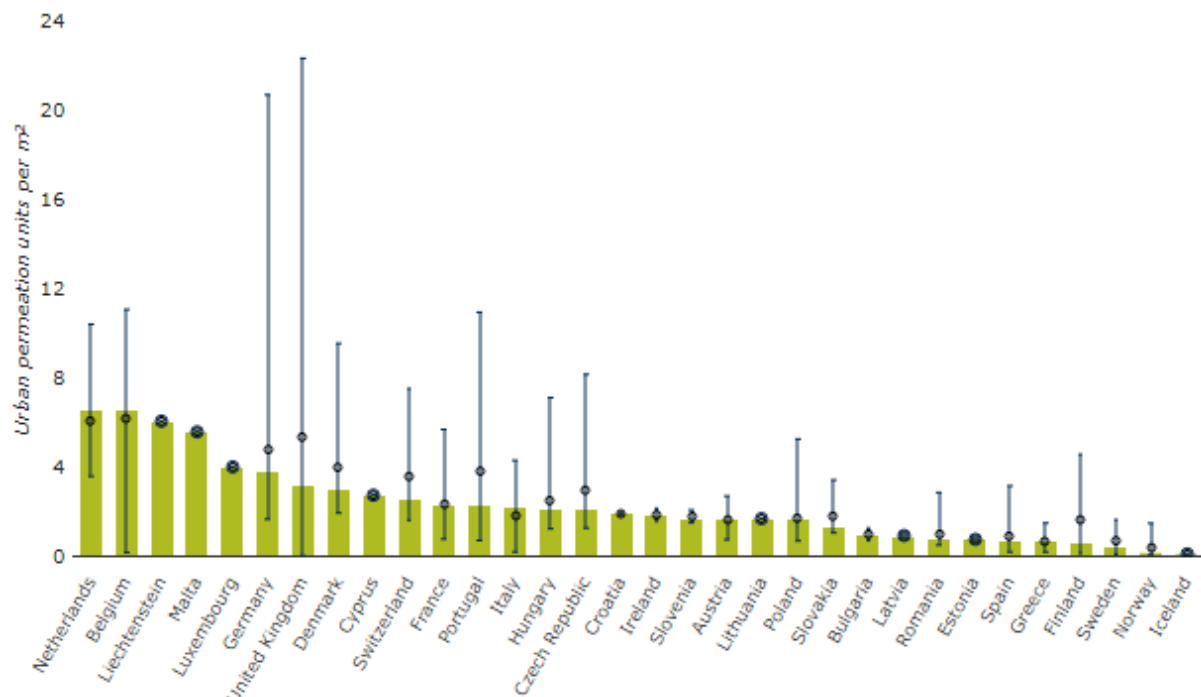
## 1. Introduction

The problem of reconstruction (urbanization) of territories of different countries (including urban areas) seriously worries humanity since the beginning of the twentieth century. At that time the necessity of replacing (renovate) the old housing and relocating the residents of demolished buildings reached its peak and continues to accompany the city territories all over the world very actively. Approximately from the middle of the twentieth century, statistical studies of the processes and results



of such a reorganization are constantly carried out. Fig. 1 shows one of the results of studying the urbanization of urban areas in the European Union.

The idea of renovation, as a reorganization of the urban area, and the term "renovation" were proposed at the Moscow State University of Civil Engineering at the peak of the period of "spot construction" of the existing town-planning composition of the city of Moscow at the turn of the 20th and 21st centuries. This idea was borrowed from the world practice, which considers the consolidation of urban areas as one of the ways to reduce their spatial growth and the associated environmental impacts. The idea was actively supported by the authorities and by Mayor of Moscow Yuriy Luzhkov and the term "renovation" was included in the directive documents and the Moscow Government Decrees of that period.



**Figure 1.** Statistics of urbanization of urban areas of the countries of the European Union

Note. Researchers note significant differences between the diagnostic values of indicators in different regions of each country. In the diagram, a thin line indicates the maximum and minimum of "sprawl" of cities within countries, and the dots indicate the average values. [Data sources: Jaeger, Soukup, Orlitova, Schwick, Hennig, Kienast (2014). The calculation is carried out by ETC / SIA for EEA and FOEN].

After Luzhkov's dismissal (2010), the idea of total "spot development" was criticized, its popularity and intensity of use decreased significantly. Recently the term "renovation", the content of which is not directly associated with the idea of "dotted building" of urban areas, once again acquired relevance in the activities of the Moscow Government, which is explained by the need to significantly improve the level and quality of life of the population. Therefore, the development of scientifically substantiated and coordinated with the population plan and the prospect of renovating the Moscow housing stock for the coming decades is urgent.

One aspect of the scientific justification for such a renovation program is the development of methods for assessing the diversity of parameters of demolished, reconstructed and newly erected buildings and structures of housing stock and social infrastructure. The results of the assessment and forecasting of certain characteristics at the level of global governance should be reduced to integral assessments of the quality of the construction sites themselves, as well as the construction, operation, reconstruction and demolition of the organizational and technological processes of the construction industry.

In other words, we are talking about the advisability of using infographic models of the convolution of a variety of parameters for the integrated evaluation of variants of renovation projects for Moscow's blocks.

Publications of foreign authors, as well as the results of international forums (Altes, WKK, 2009, [1], Bots, P., van Bueren, E., Heuvelhof, E., Hardoy, I., Mitlin, JE, Satterthwaite, D., 1992, [2], Cooke, P., Heidenreich, M., Braczyk, H., 2004, [3], Duffy, A., 2009, [4], Jaeger, JAG, Schwick, C., 2014, [5], Jutaku Shimpō, 2006, [6], Kaiser, E., Godschalk D., Chapin FS, 1995, [7], Kamal-Chaoui, L., Leman E., Fufei Z., 2009, [8], Kohler, N., Lützkendorf T., 2002, [9], Kohler, N., Moffatt, S., 2003, [10], Kunstler, JH, 2001, [11], Millward, H., 2006, [12], Povey, M., Lloyd-Jones T., 2000, [13], Seoul City Government, 2009, [14], Short, J., Fleming S., Witt S., 1986, [15] and others) are devoted to the most common a method of reducing the spatial growth of urban areas - the problem of their "compaction".

Russia's building science is actively studying the problem of "reorganization" of urban areas, as evidenced by numerous publications in domestic and foreign professional publications, as well as dissertational research (Chulkov V., 1989, [16], 2014, [27], 2015, [28], 2017, [29], Musaeva O., 1989, [17], Dzhumabaev Kh., 1990, [18], Sinenko S., 1992, [19], Vlasov M., 1994, [20], Telichenko V., 1994, [21], Yarovenko S., 1995, [22], Shegol A., 1996, [23], Semechkin A., 1999, [24], Ginzburg A., 1999, [25], Masturov I., 1999, [26], Ghazaryan R., 2014, [27], Kuzina O., 2014, [27], 2015, [28], Volkov A., 2015, [28], Kazaryan R., 2015, [28], Fakhratov M., 2015, [28], Tolstova K., 2017, [29] and a number of others). These researchers systematically analyze the arising and continuing to arise, competing with each other, different types of reconstruction in the construction industry. This article is devoted to continuing research on this topic.

## 2. Methods

The basic infographic model is the basis of the systemic scientific study of traditional (repair, reconstruction, restoration) and innovative (renovation, reversion, recombination, retrieval, etc.) types of construction in construction, methods and processes of their use in construction (Fig. 2):

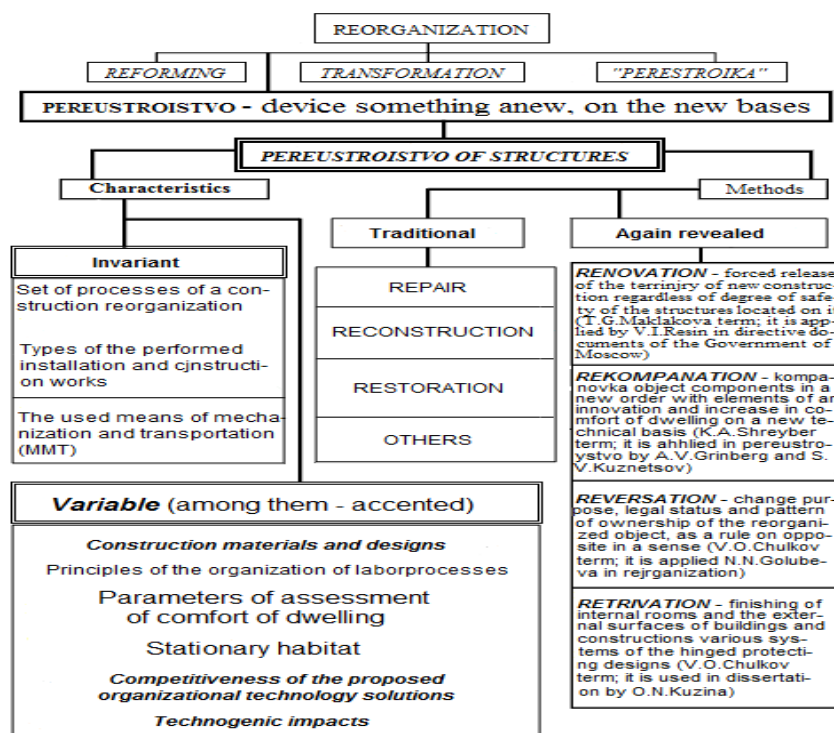


Figure 2. Types of reconstruction in the construction industry [Chulkov V.O., 2009]

Over the past decade, the world's surface has been reorganized to 1000 km<sup>2</sup> every year, including construction reorganization. Up to four percent of the total number of demolished, erected and reorganized construction sites falls on previously used or already mastered territories of secondary use. This is one of the ways to further reduce the newly developed territories, which characterize the cramped spaces of construction sites, the need to take into account the number of risks and their insurance that is much greater than when developing new territories. The consequent and constantly increasing intensity of air and soil pollution, also associated with a steady increase in the number of vehicles and the complexity of restricting their use, adversely affect people's health and quality of life, increase the level of excessively generated heat. The parameters and characteristics of each of these processes in the society are constantly changing dynamically in the process of their interaction, which requires the development and use of adequate methods, technologies and tools for their diagnosis and monitoring.

### 3. Results

The variety of values of such parameters of different characteristics of independent and interconnected processes occurring in the construction industry are monitored and analyzed by operational management (management) of construction. For global (strategic) management of design and implementation of renovation of residential urban areas (in particular, in the city of Moscow), it is necessary to perform a reliable integrated assessment of the quality of renovation projects and the processes of its implementation.

When implementing the program of renovation of Moscow's neighborhoods, it is important to choose such a variant of the renovation project for a particular block that will provide its best performance. In the preparation of renovation projects, developers consider a number of indicators, some of which have directive fixed values, and the values of other parameters can be varied by the designer in order to achieve the best results of renovation in the context of specific external conditions, the circumstances of the renovation and the limitations that have been adopted.

Therefore, already at the stage of developing a renovation project, one can make a prediction about its results based on the application of a flat infographic (visual) model of "folding" the variety of parameter values characterizing the quality of renovation results and the processes of achieving them (Fig.3).

The model is executed in the right polar coordinate system, that is, the axes (the number of which corresponds to the number of the investigated parameters of the research object) are arranged clockwise, and the sequence of axes corresponds to the "weight" (significance) of the parameter, which is determined by the expert method. The number of axes of the model is unlimited, each axis must be graduated from zero to one (for example, axis 1.4 in Fig.3). If necessary, special zones (for example, zones 1,2,3,4 and 5 in Fig.3, which are shown on the callouts).

By connecting successively points on neighboring axes, we obtain a polygon whose area is taken as the integral estimate of the quality of the renovation projects.

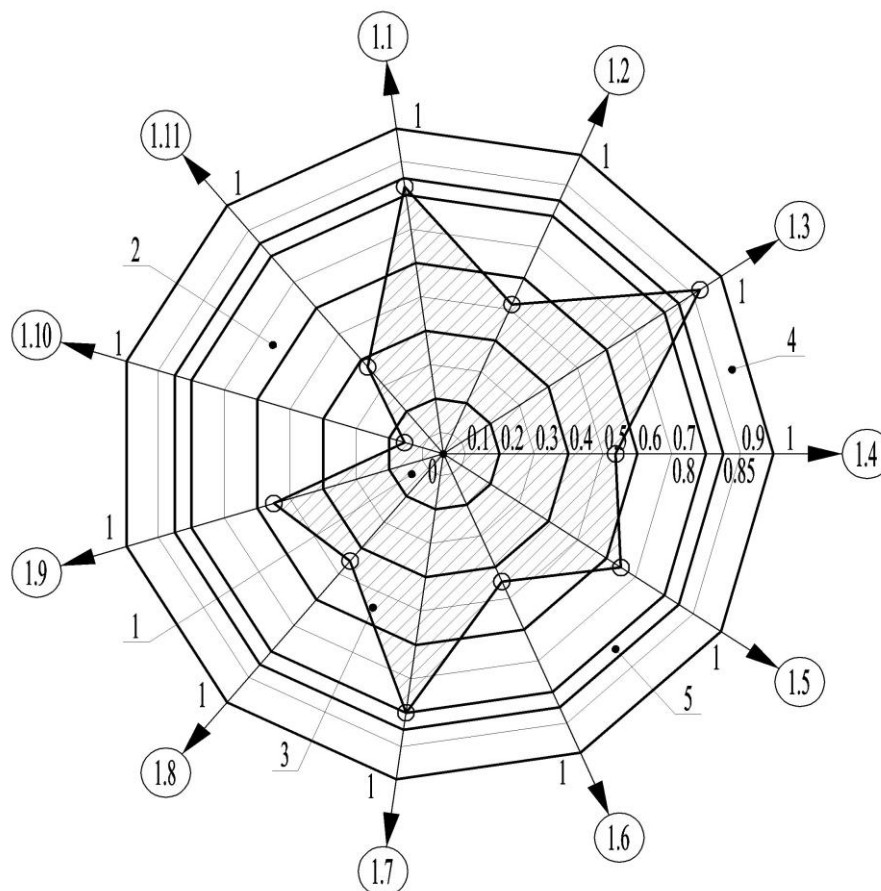
Each renovation project has a number of variants for combining the values of the original parameters. The purpose is to find the combination that will provide the best values of the final indicators of renovation and will allow making an informed choice of a specific version of the renovation project.

To do this, the numerical values of all model parameters must be divided into three groups:

- **Directional** fixed values;
- **Variable** values for each variant of the project, which are set by the designer according to existing or accepted by this designer limits;
- **Derived** values for each version of the renovation project, which are calculated according to the previously developed mathematical formulas.

Parameters within each of the last two groups should be divided into two subgroups: - striving to **minimize** or **maximize** their values;

In each subgroup of parameters and their numerical values, we select the minimum or maximum numerical values for the parameters of each denomination, which we take as unity. For the remaining values of the parameters of each denomination, we find their dimensionless quantities (less than or equal to 1) relative to the minimum or maximum value, respectively. All parameters (variables or derivatives) receive dimensionless values of  $P_i$  ( $i = 1, \dots, n$ ) on the interval  $[0,1]$ , where  $n$  is the number of parameters considered for the renovation project variant. The received priority sequence of parameters, as was indicated above, determines the ordinal numbers of the axes of the infographic model of "convolution", on which the relative values of the corresponding parameters will be plotted. Thus, the number of axes of an infographic model of convolution will be equal to the number of  $n$  names of variables and derived parameters, and the sequence of their location in the model relative to each other will not be arbitrary, but will be chosen by the customer (or developer) consciously.



**Figure 3.** Flat infographic model of "convolution" of the parameters of the object of investigation [Chulkov VO, Ghazaryan R.K., 2011]

The infographic model of such a "convolution" (Fig. 3) is a system of  $n > 2$  coordinate axes with a common origin and angular pitch of  $360/n$  (degrees). On each of the axes separate segments are plotted, graphically displaying the reference values of the corresponding parameters. The ends of the adjacent single segments are joined by straight lines, resulting in a flat reference polygon.

On the axis corresponding to a certain parameter, its value  $P_i$  is postponed. By connecting in similar fashion the ends of  $P_i$  of neighboring segments, we obtain the actual polygon. Each variant of the renovation project will have its own actual polygon on the convolution model.

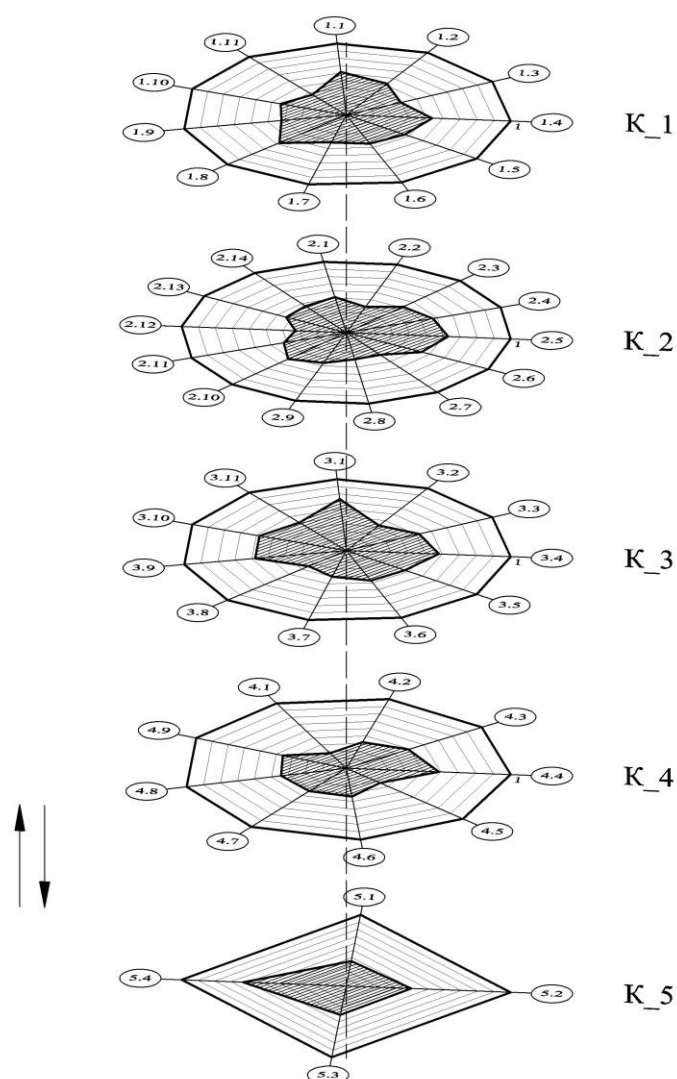
The ratio of the areas of the actual and reference polygons characterizes the quality level of a renovation project, which is related to each other.



#### 4. Discussion

In the domestic construction science, the flat infographic models considered are called "star" [Chulkov V.O., Chulkov G.O., 1985] and have been used in studies of multicomponent and multiparameter systems of the construction industry of the USSR and Russia. Subsequent studies [Chulkov V.O., 1986-2014, Ivashchenko A.V., 2001, Veykum I.I., 2001, Burianov P.D., 2003, Golubeva N.N., 2004, Fakhratov M.A., 2004, Kazaryan R.R., 2004, Makarentsev A.V., 2005, Kozyakov A.V., 2005, Losev K.Yu., 2005, Kiselev M.S., 2006, Kuzina O.N., 2009, Ghazaryan R.K., 2011, etc.] confirmed the wide possibilities and unlimited range and application of "star" infographic models.

This class of models is widely used in the economy (where they are called the "Kiwiat diagram"), on transport (where they are called "portrait of the object under study", the scope of application of these models is constantly expanding due to the simplicity and speed of their use in computer information technology.



**Figure 4.** A multilayered model of the "convolution" of the parameters of the object of investigation [proposed by Chulkov V.O. and Ghazaryan R.K. when reorganizing and reorganizing the territory of the ZIL plant, Moscow, 2011]

These models can be multi-layered (Fig.4), they are used for research objects that have a multifaceted characterization and application areas, for example, when reorganizing the territories of former industrial enterprises.

## 5. Conclusion

The scientific and practical problem of renovation of urban areas and neighborhoods is relevant in all developed countries of the world. Its solution in Russia, and in particular in Moscow, is planned to be provided by 2025-2030.

To evaluate the results of renovation and the processes of its implementation, it is advisable to use flat and multilayer "star" infographic models, considered in the article

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