Sustainability of the urban environment in the construction of city complexes

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Abstract. The article contains the results of a study aimed to assess the impact of the multifunctional city centers (MCC) construction in various spatial models of cities in terms of providing parameters for the sustainable development of the urban environment. The authors used the methodology of international standards for the assessment of "habitat stability", which includes a three-component analysis of the MUC impact on the city space. The received results allow to draw a conclusion about the best parameters of sustainability development of the city environment at MUC creation within the framework of multicore city planning.

1. Introduction
The sustainable development of the urban environment is due to the formation of a rational spatial structure of the city. The complexity of the interposition of various urban elements poses the task of preserving a favorable urban environment in the process of transforming planning-related structures. For example, the reconstruction of the business center requires a corresponding increase in the capacity of the transport infrastructure elements and creation of recreational zones. The rationale for investment projects for the construction of the multifunctional city centers (MCC) forms the actual task of multi-criteria analysis of the impact of these centers on the urban environment. With a compact planning layout of the MCC, a comprehensive solution to the problems of reducing the excessive load on the infrastructure, environmental and transport environment of the city is possible. The solution of this problem is possible with the introduction into the practice of spatial planning of the city of a single methodology for assessing the parameters of sustainable development of the urban environment in the construction of major facilities.

The purpose of this study is to assess the impact of the MCC construction in various spatial models of cities from the perspective of sustainable urban development parameters.

2. Methods of research
The study is based on classical models of the city spatial structure, including zones for various purposes. In the basic models, the interconnected areas of residential development, industrial, communal, transport and recreational zones are allocated.

The primary is the model of Burgess's concentric zones (1925) [1, 2], which describes the location of urban zones in the form of concentric circles (Fig. 1). The construction of a MCC in this model is made in the historical center of the city and, as a rule, replaces and complements the historical building.
The planning solution presented in Fig. 1 corresponds to the applicable concept of the MCC construction in most Russian megacities such as Ekaterinburg, Novosibirsk, Nizhny Novgorod. The main characteristic of this model is the remoteness of residential quarters from the central district and the corresponding increase in the load during the pendulum movement of MCC employees to and from the place of residence.

Figure 1. Placement of the MCC within the Concentric Zones Model

A similar arrangement of multifunctional city centers is presented in the sectoral model of H. Hoyt (1939, 1946) [3,4], which complements the previous model of spatial development of the city by the main transport corridors (Fig. 2).

Figure 2. Placement of the MCC within the Sector Model

The planning solution presented in Fig. 2 corresponds to the concept that was used when placing Moscow-CITY and Lakhta Center in St. Petersburg. The proximity of the MCC to the transport axes makes it possible to neutralize the negative effects of the pendulum migration; however, such a placement model increases the ecological load on the city center and makes it necessary to include large recreational zones in the layout of the district.

The fundamentally different arrangement of multifunctional urban centers corresponds to the multicore model of Harris and Ullman (1941) [5]. This model characterizes the spatial development of the largest cities with evolving suburban zones, forming independent business districts (Fig. 3).

The planning solution presented in Fig. 3 corresponds to the concept used in the construction of the Défense area in Paris and the Dockland area in London.

Solving the scientific problem of developing a methodology for studying the MCC impact on the sustainable development of the city, it should be noted that a wide range of urban indicators is used in world practice.
In particular, we can cite the UNHabitat housing indicators system that establishes a rating system for assessing the sustainability of people's habitats that meets the goals of the current generation in meeting their needs in a comfortable living environment and performing public functions through the use of residential and public buildings without reducing the level of such opportunities for future generations (Trutnev, 2008).

![Figure 3. Placement of the MCC within the Multi-core Model](image)

Figure 3. Placement of the MCC within the Multi-core Model

In Russia also has been developed a set of standards for real estate valuation, which introduced the notion of "habitat stability", identical in its meaning to the concept of «sustainability in buildings», adopted in international standards (ISO) [8,9]. This methodology is taken as a basis by the authors of the article, the evaluation parameters according to which are presented in Fig. 4.

![Figure 4. Methodology for assessing the impact of the MCC construction on the Urban Development Stability](image)

Figure 4. Methodology for assessing the impact of the MCC construction on the Urban Development Stability

The authors believe that the implementation of the construction projects of the largest Multifunctional city centers within the framework of urban zoning models has different effects on the parameters of sustainable urban development. The analysis was carried out in the context of the following groups of indicators:
Firstly, it is necessary to assess the comfort and quality of the external environment when placing the MCC, such an assessment is made in the context of the provision of transport, household infrastructure, and the possibility of external negative impact.

Secondly, the object itself is evaluated from the point of view of utility for the urban environment. Thirdly, the quality of sanitary protection and waste recycling created by the input of the MCC operation is assessed.

Interpretation of the results obtained using the above assessment methodology was carried out in accordance with four possible options: high, rather high, rather low and low value of the indicator. Conclusion on the favorable impact on the urban development sustainability during the construction of the facility is carried out in the case of obtaining a "high" and "rather high" estimates for all three groups of parameters.

Conclusion on the adverse impact on the urban development sustainability in the MCC construction was carried out in the case of obtaining a "Low" and "rather low" estimates for the three groups of parameters.

In general, the conclusion about the negative impact on the urban environment development sustainability will also have an intermediate result when, in the aggregate assessment, there are values on the one hand as "high" and "rather high", and "low" and "rather low". In this case, it is possible to recommend a change in the project for the MCC construction with the aim of changing the negative assessments, for example, including additional parking spaces or expanding the recreational zone in the construction project.

3. Results
To assess the impact of the MCC construction on the urban development stability in the framework of sectoral and multicore urban planning models there were used the materials of the substantiation...
reports for the construction of the Moscow-CITY (2009) and UNHabitat (2007) [7] provided by the consulting company RBC-Real Estate. The results of the study can be seen in Fig. 5.

As can be seen in the figure, the assessment of the impact of the MCC construction has multidirectional consequences for the urban development sustainability. The most negative consequences of the MCC introduction in the sectoral model of the city planning will be caused by the lack of parking spaces and the availability of external objects of the household infrastructure. If the second drawback can be resolved by placing the necessary facilities on the territory of the complex itself, the solution of the first problem requires additional investment in the construction of parking lots.

Next, in Fig. 6, we present the assessment results of the impact of the MCC construction on the urban environment stability in the framework of the multi-core model.

As can be seen in the figure, the respondents in general are positively assessing the MCC construction in terms of the urban environment stability. Rather, the low value of the indicator is observed in terms of the protection of the territory from noise and infrasound, the solution of this problem is possible with the installation of special soundproof shields.

To assess the impact of the MCC construction on the urban development stability in the framework of the concentric zones model, an empirical study was conducted. The method used by the authors was a questionnaire conducted during the implementation of research work on the topic «The Justification of the investment project for the construction of the MCC "Ekaterinburg-CITY"». Questioning on the block of questions «I – Comfort and quality of the environment» was conducted among residents of the streets of Boris Yeltsin, Chelyuskintsev, Marshal Zhukov, a total of 155 questionnaires. Questioning by blocks «II – Quality of architecture and object layout» and «III – Quality of sanitary protection and waste management» was carried out among the specialists and designers, on the whole 7 questionnaires were received. The results of the study can be seen in Fig. 7.
The survey showed that, in general, the respondents made a negative assessment of the consequences of the MCC construction on the urban environment development sustainability in the framework of the concentric zones model.

![Figure 7. Assessment of the impact of the MCC construction on the urban development stability within the concentric zones model, %](image)

4. Conclusion

The study shows that from the position of sustainable development of the urban environment the most promising is the construction of multi-functional city centers within the multi-core urban planning model. This result confirms the thesis about the future direction of cities spatial development, cited in the works of Harris, Ullman and their followers. The creation of multifunctional city centers is expedient to carry out unloading the center of the city and redirecting traffic flows to newly formed centers.

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