Urbanized Environment Quality Assessment Methodology

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Abstract. Urbanized environment is a complex multi-element system. Urbanization has negative effects on the urban environment and necessitates finding balance to optimize the development of urbanized spaces. This paper proposes an urbanized environment quality assessment method based on evaluating the architecture, nature, development, technogenic effects, and infrastructure. All the aspects of urbanized development are split into positive and negative. The assessment of these aspects helps conclude how favorable urbanized environment is. The assessments must be analyzed to conclude on the quality of development. Then the aspects that score the worst should be addressed in order to improve the quality of the urbanized environment. Ranking can be done by comparing against the scores of other urbanized systems.

1. Introduction

Urbanized environment is a complex system of urban structural elements plus a set of factors of urban development. Urban structure is the city’s social environment and its infrastructure. Urbanized environment is created by urbanization, i.e., by the very development of urban structure. The more economically advanced the urban structure is, the more urbanized the environment will be [1, 2, 3, 4, 5]. Notably, urbanization has both positive and negative impact on the urban environment [6, 7]. On the positive side, it stands for adoption of state-of-the-art technology that improves the quality of urban life. On the negative side, it alters the environmental (ecological) quality of the city [8]. Balance must be found between developing the urban structure and the negative effects that urbanization has on living within this structure, if the development and functional efficiency of the urban planning system are to be rated [9, 10].

This paper proposes an urbanized environment quality assessment methodology in order to find the optimal balance between the necessary urbanization-related development and the required development of urban structure. The proposed methodology helps quantify the urbanized development of structure as adjusted for the negative impact on the urban environment.

2. Overview of the approved urbanized environment quality assessment guidelines

Russia’s Ministry of Regional Development has approved the Urban Residential Environment Quality Assessment Guidelines. These guidelines define 41 metrics grouped into 13 aspects or indices. All metrics can also be classified into social, economic, infrastructural, and environmental (ecological) metrics. The economic ones have greater weight. Social metrics include population dynamics, housing development, social metrics of the society, social infrastructure, demographics, and human resources. This group has a total weight of 0.5. The economic metrics include residents’ well-being,
housing affordability, city economy, and innovation. This group has a total weight of 0.35. The next group covers the urban infrastructure. These metrics determine the extent to which the urban environment is developed. They include transport and engineering infrastructure. This group has a total weight of 0.1. Analysis of the environmental (ecological) situation implies an overview of natural disasters, mean annual temperatures, and air pollution. This group has a total weight of 0.05. Cities are rated and ranked based on the assessment under these guidelines. However, researchers note the main goal should be to identify the problems that need to be solved for the urban environment to improve [11].

These guidelines are focused on the social conditions of the urban environment. This is, indeed, a valid approach, if the city is viewed as a social environment first and foremost. However, as noted above, a city is not only its social environment; it is also the infrastructures that create the living conditions in the process of urbanization. These is why urban environment quality assessment must be multifaceted and cover different aspects of city structure.

The Russian government has approved the Urban Environment Quality Index guidelines. These guidelines are part of the Federal Comfortable Urban Environment Project and National Housing and Urban Environment Project. The idea is to split the entire urban environment into spaces and to assess them on a set of criteria. The guidelines define the following spaces: housing and adjacent space; green spaces; social and business infrastructure; social and leisure infrastructure; road network; public spaces. These spaces are then assessed in terms of management efficiency, modernity and state-of-the-art, identity and diversity, eco-friendliness and health, comfort and safety. Urban environment is then categorized into positive and negative, or favorable and unfavorable. The guidelines are designed to involve people and organizations in the efforts to improve the quality of the urban environment [12].

### 3. Essence of the proposed urbanized environment quality assessment methodology

The authors have studied the existing guidelines [13, 14, 15, 16, 17, 18, 19, 20] and propose an approach to urban environment quality assessment based on rating the following aspects: natural environment, architecture, urban planning, technogenic impact, and infrastructure [21, 22, 23, 24]. Each of the aspects has a set of metrics, a total of 18, see Table 1. Each of the metrics is then assigned a score of up to 1 point. All the metrics are conditionally split into positive and negative ones. For the negative metrics, a score of 1 means the associated factor is present and has negative impact on the urban environment. For the positive metrics, a score of 1 means the associated factor is present and has a positive effect on the urban structure, creates good living conditions, and enables positive urban development.

| **Table 1.** Urbanized environment quality assessment metrics. |
|---------------------------------------------------------------|
| **Group** | **Metric** | **Note for assessors** |
| Natural environment | Geophysical | Assess whether the city is favorable for construction and land management |
| | Geological | |
| | Climatic | |
| | Hydrological | |
| Architectural | Value of buildings | The more pronounced the metric-associated factor, the higher its score (1) |
| | Compositional design | |
| | Visual integrity | |
| Urban planning | Functional zoning | Matching the functional usage |
| | Greenspace | Compliance with standards |
| | Improvements | Various forms of spatial improvements present |
Underground space | Use
Transport | Assess the availability and condition
Engineering | Information infrastructure
Special

Social
Disease incidence | Assess the dynamics of the associated metrics.
Demographics
Socioeconomic
Living standards
Life expectancy

The general urban structure quality formula involves summing the scores of different metrics. This returns a total rating or score of the urban structure quality. The closer it is to 90, the more optimal impact urbanization has on the urban structure, the more sustainable the city’s development is. In order to simplify the methodology, we propose comparing the results against the region’s statistics.

\[
K_{YS} = \frac{\sum_{i=1}^{n} O_{YS} \times 100}{n}
\]

where \( K_{YS} \) is the integrated urbanized environment quality score; \( O_{YS} \) is a factor-specific score; \( n \) is the number of metrics included in the assessment.

Figure 1. Urbanized environment quality analysis methodology.

This method can be used not only to rank the city structure but also to analyze its various aspects that emerge as the city becomes urbanized. Analysis in terms of the covered metrics helps timely
adjust and devise measures to improve the quality of the urban structure. Figure 1 shows the proposed assessment mechanism as a flowchart.

4. Conclusions
The proposed approach is easy to use and does not require collecting extensive statistics. Each of the aspects has factor-associated metrics. In fact, scoring for each of the metric boils down to determining whether the associated factor is present. The more pronounced the factor is, the higher will be its score. Totaling the scores determines the average score for this urbanized area. For more detailed analysis, we recommend in-depth evaluation of all the scores for this or that aspect. The purpose of such analysis should be to devise measures to improve this aspect. This simplified urbanized environment quality assessment methods will help the system under analysis develop favorably. Comparing different cities in different aspects can produce rankings. Analysis of the least developed aspects will help devise and adopt measures to improve the quality of the habitat.

5. References
[1] Prokopenko V V, Ganzha O A, Rastyapina O A 2019 Urban ecology features of large city disturbed territory development (case of Volgograd) *IOP Conference series Materials science and engineering*

[2] Dolzhennkova A V 2017 Problems and impact on the human's life of the urbanized environment *Colloquium-journal 11-1(11)* pp 19-21

[3] Dubenok N N, Kuzmichev V V, Lebedev A V 2019 Ecological functions of forest stands in urbanized environment of moscow *Rudn journal of agronomy and animal industries* 2 pp 154-161

[4] Ussembeva A N, Khodjikov A V, Samoilov K I 2019 Color in an urbanized environment and performance of the development of urban colority programs *Science, Education and Culture* 8(42) pp 58-60

[5] Krivoruchko N I, Krivitskaya A S 2018 Regeneration of urbanized environment: city ecology as a basis of sustainable development *International scientific and practical conference world science* 4(32) pp 29-34

[6] Растяпина О А 2016 The impact of urbanization on the well-being of urban settlement *Vestnik Volgogradskogo gosudarstvennogo arhitekturno-stroitelnogo universiteta* 45 (64) pp 168-187

[7] Cui N, Feng C C, Han R Guo L 2019 Impact of Urbanization on Ecosystem Health: A Case Study in Zhuhai, China *International journal of environmental research and public health* 4717

[8] Adubrimpong J, Coffey V, Ayers C 2017 Optimizing Scoring and Sampling Methods for Assessing Built Neighborhood Environment Quality in Residential Areas *International journal of environmental research and public health* 273

[9] Rastyapina O A Polyakov V G, Kalashnikova E V 2020 Metods of evaluating area development in the context of urbanization *IOP Conference series Materials science and engineering*

[10] Rastyapina O A, Ganzha O A, Prokopenko V V 2020 Setting-up ecological settlements to promote sustainable development of urban areas *IOP Conference series Materials science and engineering*

[11] Russova O N, Smak T S, Tarasov I A 2020 Assessment of the Comfort of the Urban Environment as a Factor in the Social Well-Being of Citizens of the Arkhangelsk Oblast *Arctic and North* 41 pp 236-247

[12] Koroleva E N, Mishchenko V V 2020 Some approaches to the calculating of the urban environment quality index *Economics. Profession. Business* 4 pp 61-66

[13] Ganzha O A, Prokopenko V V 2016 Towards technique defining the indicator of comfort of objects of planting (by the example of the city of Volgograd) *Vestnik Volgogradskogo gosudarstvennogo arhitekturno-stroitelnogo universiteta* 45 (64) pp 136-148

[14] Charenbroch B C, Carter D, Bialecki M 2017 A rapid urban site index for assessing the quality of street tree planting sites *Urban forestry & urban greening* 27 pp 279-286
[15] True E M Kilicaslan C 2019 Quality of urban environment: analysis of sigacik settlement Journal of environmental protection and ecology 4 pp 2068-2076
[16] Stossel Z, Kissinger M, Meir A 2015 Assessing the state of environmental quality in cities - A multi-component urban performance (EMCUP) index Environmental pollution 206 pp 679-687
[17] Tozhiboev I M, Krivogina D N 2020 Subject-oriented methodology for assessing the quality of the city environment Advanced Construction Technologies. Theory and Practice 1 pp 435-441
[18] Yaskova N Yu, Sarchenko V I, Khirevich S A 2020 Comprehensive approach to creating a quality urban environment Real Estate: Economics, Management 2 pp 12-21
[19] Agafonova Ju O 2019 Quality analysis of the urban environment in Russian millionion-person cities Kazan Economic Vestnik 4(42) pp 42-48,
[20] Tebekin A V, Anisimov Ye G, Tebekin P A, Yegorova A A 2020 Ensuring the quality of life in an urban environment using smart city technology Transport business of Russia 2 pp 11-17
[21] Rastyapina O A 2020 Definition of the indicators of assessment of the improvement of the yard space Vestnik Volgogradskogo gosudarstvennogo arhitekturno-stroitel'nogo universiteta 1(78) pp 287-296
[22] Rastyapina O A, Ganzha O A, Babenko K V 2018 Development of quality evaluation method for visual representation of the urban environment Vestnik Volgogradskogo gosudarstvennogo arhitekturno-stroitel'nogo universiteta 52(71) pp 188-198
[23] Ivanova N, Ganzha O, Prokopenko V 2018 Methodology of planning of landscape and ecological sustainability of natural components in the virtual model (on the example of Volgograd Matec web of conferences
[24] Ivanova N, Ganzha O, Prokopenko V, Artyukhina A 2018 Architectural and ecological integration of postindustrial landscapes revitalization in to socially oriented space of the embankment Matec web of conferences