International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8, Issue-1, May 2019

Assessment of Environmental Quality of Metropolises under Conditions of Innovative Development of Russia

Olga N. Soboleva, Olga S. Nogovitsina, Konstantin A. Chernyshev, Elena A. Barmina, Elena K. Cheraneva

***Abstract*: This article analyzes procedures of quality assessment of urban environment applied at present at governmental level. The procedure of quality assessment of urban environment under conditions of innovative development is proposed. This procedure has been validated on the basis of data for Russian metropolises with population from 500 thousand to 1 million inhabitants.**

***Index Terms*: environmental quality, metropolises, municipal settlements, innovative development.**

I. INTRODUCTION

Modern Russian cities serve as centers of innovative development since they accumulate resources: funds, innovative technologies, human assets. Exactly the resources are the driving power of innovative development of economy. Nowadays Russian cities compete for creative, professionally trained, economically active population, the winners are the cities with high quality of urban environment [1-3]. Urban environment is the combination of social, economic, ecological, infrastructural living conditions, both created during human living and stipulated by natural surroundings of this or that specific locality. Quality of urban environment is the capability of urban environment to satisfy objective needs of citizens according to currently accepted norms and standards. Under the conditions of innovative development of economy, the governmental priority is transformation of urban environment on the basis of advanced innovative technologies. However, it is impossible to plan development of urban environment without respective assessment of its quality.

Revised Manuscript Received on 22 May 2019.
***** Correspondence Author
Olga N. Soboleva, Vyatka State University, Kirov, Russia.
Olga S. Nogovitsina, Vyatka State University, Kirov, Russia.
Konstantin A. Chernyshev, Vyatka State University, Kirov, Russia.
Elena A. Barmina, Vyatka State University, Kirov, Russia.
Elena K. Cheraneva, Vyatka State University, Kirov, Russia.

II. MATERIALS AND METHODS

A. Relevance

Recently increased concern of researchers and public men to comparison of urban environment was reflected in approval of relevant procedures at official level. The first procedure was proposed in 2013 by the Ministry of regional development of Russian Federation on the basis of 42 statistic indicators characterizing 13 spheres of urban environment. This procedure is based on comparison among Russian metropolises which required simultaneous access to indicators of 163 cities with population higher than 100 thousand persons. In our opinion nomination of some spheres of assessment of urban environment and selection of appropriate indicators were disputable. Thus, the sphere titled "Parameters of social structure' included only characteristics of criminality and employment. Some indicators repeated each other (Level of employment and Level of unemployment; Coefficient of demographic load and Ratio of juvenile to elderly ages). Some indicators were assessed not with regard to population size but in the form of absolute values (Number of issued patents and the like). The assessment results reflected not only quality of urban environment but also the level of their social and economic development. However, the approach of the Ministry of Regional Development was characterized by important advantage: the indicators taken as the assessment basis were well described in municipal statistic bases.

The issues of assessment of urban environment were studied by research teams. For instance, Kataeva and Lapina in 2014 formed procedural approach to cumulative quality assessment of urban environment. The authors proposed to calculate quality factor of urban environment on the basis of 9 groups of indicators (elements of urban environment) having different weights determined experimentally and analytically. This procedure was validated for the case study of cities of the Volga Federal District of the Russian Federation. Some drawbacks of the procedure included complicated calculations of most indicators and unavailability of published data for their calculation [4, 5]. Ilina mentions that quality assessment of urban environment is comprised of searching for possibilities to develop settlement system and should be performed with consideration for powers of municipal level.

As major elements for assessment the author highlights quality of infrastructure (housing, engineering, transport, social, ecological, historical and cultural), quality of urban space, safety and quality of life, availability of services for all population categories. However, no validation results of the procedure were presented in publications by the author [1].

B. Formulation of The Problem

This work is aimed at quality assessment of existing living environment in Russian metropolises, development of complex factor of quality of urban environment of municipal settlement in the form of digital value of status of urban environment of municipal settlement obtained as a result of complex assessment of quantitative and measurable indicators characterizing quality of life within respective territory. Optimized set of criteria and indictors should be proposed and substantiated for complex assessment of quality of urban environment. The number of criteria and indicators should provide the most complete coverage of factors effecting the quality of urban environment.

III. RESULTS AND DISCUSSION

A. Theoretical Part

Generalizing the existing procedures of determination of quality factor of urban environment, it is possible to propose the following approaches to the assessment:

a) initial data used for calculations should be effective, continuously updating, reliable and verifiable;

b) free access to information about indicator, including information on the basis of which it was formed, to the public;

c) application only of calculable indicators excluding subjective nature of assessment and providing their reliability and neutrality;

d) possibility to calculate an indicator for any period with available initial data, thus providing calculation of the indicator both in previous periods and its future application;

e) environment quality should be assessed in cities of one group in terms of population number.

We propose the procedure of quality assessment of urban environment comprised of 5 stages. At the first stage indicators are determined and grouped into blocks characterizing individual components of urban environment. The blocks and list of indicators reflecting major spheres in quality assessment of urban environment are illustrated in Fig. 1. The information was obtained from Federal Service of State Statistics, reports by heads of local administrations according to the Decree of President of the Russian Federation dated 28.04.2008 No. 607 titled On assessment of efficiency of activities of municipal authorities, as well as municipal budgets. At the second stage partial indicators are determined for each of the proposed items. The indicators are calculated by the ratio of actual partial value to the value of the best indicator among the cities of a considered group. Upon calculation of indicators of negative pattern, further conversion is based on deduction of the indicator from unity.

At the third stage expert appraisal of indicator block of quality assessment of urban environment is made with subsequent assigning of weight to each block (Vi), the sum thereof should be equal to 1.0.

At the fourth stage the coefficient (Kj) is calculated for each group according to equation (1):

$$K_j = \sum K_i * Vj \quad (1)$$

At the fifth stage cumulative indicator of quality of urban environment (CIUE) is calculated according to equation (2). This indicator does not depend not only on coefficient of each group (Kj) qi but also on their significance determined by weight coefficient Pi, the sum of which should be equal to 1.0. Linear convolution of indicators is used as the equation for Q (q,p):

$$CIUE = \sum K_j * Pi \quad (2)$$

Taking into account the obtained coefficients for each group (Kj), equation (2) of cumulative quality indicator of urban environment will be as follows:

$$CIUE = 0.244Ec + 0.247Sue + 0.168ALue + 0.161SLue + 0.180ETue$$

This procedure was validated with regard to Russian municipal settlements, the centers of which were metropolises (with population from 500 thousand to 1 million). Makhachkala urban district was excluded from the assessment, not all required indicators were available. Analysis of the obtained results makes it possible to obtain conclusions about environmental components of Russian metropolises: the leading position with regard to quality of urban environment is occupied by Krasnodar and Tyumen, the cities attractive for migration (Fig. 1). It should be mentioned that the quality of urban environment can decrease due to rapid growth of population.

Deterioration of engineering and transport infrastructure is responsible for moderate quality of urban environment in such cities as Tomsk, Barnaul, Kirov. Relatively high budget indicators of Vladivostok and low indicators of Izhevsk determine their different positions in economic block of assessment of urban environment. Low indicators of ecological constituent of urban environment are characteristic for the centers of ferrous metallurgy (Lipetsk, Novokuznetsk).

In general, the quality of urban environment is at average level, cumulative indicator of quality of urban environment varies in the range of 0.392-0.696 (Table 1).

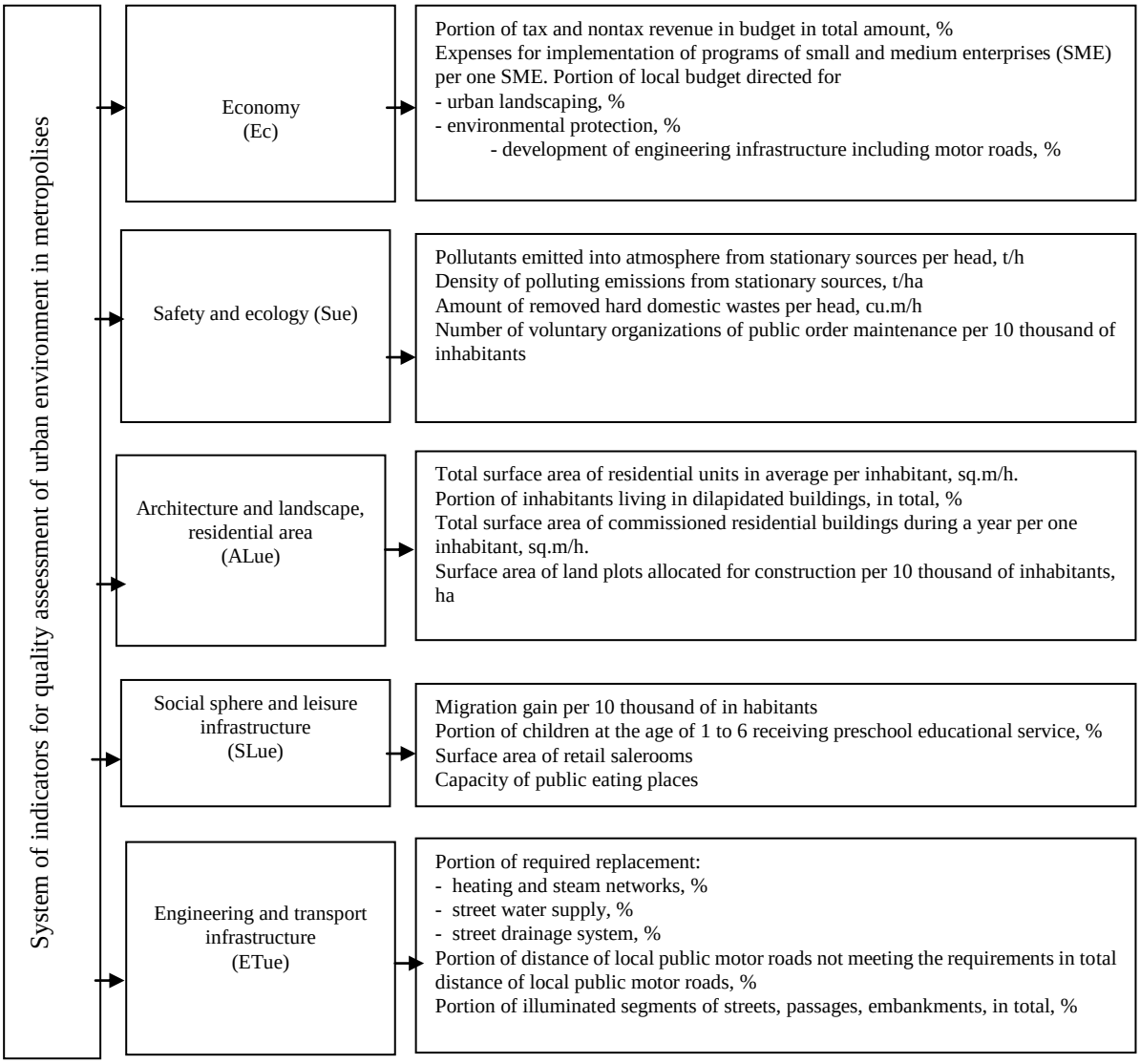

Fig. 1: System of indicators for quality assessment of urban environment

According to the proposed procedure, Krasnodar occupies the leading position in terms of indicator of comfort urban environment. In the scope of priority federal project on formation of comfort urban environment with consideration for cofinancing by the krai and municipal budgets, Krasnodar in 2017 received additionally 811 million rubles. The funds were allocated as follows: 1/3 — for urban beautification (gardens, boulevards, parks), 2/3 — i.e. the major portion — for beautification of near-house sites according to requests by residents.

Table 1: Quality assessment of urban environment in Russian metropolises

	Economy	Social sphere	Architecture and landscape, residential areas	Engineering and transport infrastructure	Ecology	Cumulative index	Rating
Astrakhan	0.350	0.269	0.502	0.589	0.375	0.412	20
Barnaul	0.348	0.491	0.528	0.528	0.720	0.526	9
Vladivostok	0.349	0.383	0.534	0.648	0.669	0.518	13
Izhevsk	0.227	0.585	0.491	0.592	0.736	0.521	11
Irkutsk	0.265	0.422	0.538	0.608	0.400	0.431	19
Kemerovo	0.237	0.476	0.398	0.805	0.557	0.484	15
Kirov	0.337	0.590	0.609	0.493	0.728	0.548	7
Krasnodar	0.439	0.788	1.000	0.683	0.693	0.696	1
Lipetsk	0.375	0.456	0.613	0.677	0.175	0.433	18

Naberezhnye Chelny	0.536	0.498	0.513	0.766	0.823	0.638	3
Novokuznetsk	0.323	0.504	0.508	0.510	0.222	0.392	21
Orenburg	0.269	0.418	0.582	0.667	0.743	0.534	8
Penza	0.334	0.490	0.582	0.682	0.561	0.520	12
Ryazan`	0.306	0.509	0.584	0.655	0.572	0.514	14
Saratov	0.202	0.419	0.594	0.603	0.531	0.456	17
Tolyatti	0.382	0.634	0.291	0.802	0.879	0.606	4
Tomsk	0.440	0.396	0.667	0.421	0.881	0.577	5
Tyumen`	0.506	0.800	0.651	0.851	0.614	0.666	2
Ulyanovsk	0.193	0.525	0.731	0.628	0.633	0.524	10
Khabarovsk	0.317	0.498	0.708	0.704	0.668	0.568	6
Yaroslavl	0.137	0.501	0.522	0.577	0.656	0.467	16

IV. CONCLUSION

The proposed procedure makes it possible to reveal strengths and weaknesses of urban environment of metropolises. On the basis of assessment, substantiated recommendations can be given for quality improvement of urban environment. The obtained results according to the proposed procedure can be used as tools for adoption of managerial decisions by municipal authorities and local communities during formation of comfort life environment. Application of innovative technologies promotes development of favorable living conditions for inhabitants of Russian cities. Recent R&D developments are already applied for equipment of stops, traffic signs, light poles, becoming conventional attributes of urban space which perform not only their initial utilitarian functions.

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