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**COMPARATIVE ASSESSMENT OF SUSTAINABLE URBAN**  
**DEVELOPMENT**

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**Abstract**

Ensuring the continuous development of cities requires the use of available methods of absolute, relative and comparative assessment of the achievement of sustainable development goals. The scientific literature contains numerous studies on the sustainability of individual cities. A large number of indicators in economic, social, environmental and institutional dimensions are used to develop an overall city sustainability index. Cities contribute to socio-economic development and at the same time present many environmental, social and infrastructural challenges and risks. These problems and the inability of municipalities to provide basic services to citizens make cities unsustainable. Data for calculating the resilience of cities are taken from the public and non-governmental organizations, as well as from municipalities and experts. The use of official foreign methods for determining the urban sustainability index, the "smart and green city" indices, as well as the methods presented in scientific papers on measuring the socio-economic and environmental development of municipalities is problematic. The national economy and social processes of the Russian Federation and its regions, urban districts can be classified as developing and inferior to the main economic and social indicators of developed countries. Consequently, the methodology for assessing the sustainability of cities should be specific, due to both strategic and operational development goals. The index of comparative assessment takes into account the peculiarities of the existing stage of social and economic development of urban districts of Russia and contains the most significant indicators.

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*Keywords:* Assessment, cities, index, indicators, methods



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## 1. Introduction

Cities are centers of ideas, trade, culture, science, production, social, human and economic development. Urban planning, transport systems, water supply, sanitation, waste management, disaster risk reduction, access to information, education and capacity building are all important aspects of sustainable urban development (Noskov, 2021a, 2021b). Given the importance of this topic to global development efforts, there have been positive developments around the world to ensure the sustainable development of urban agglomerations. The results of these changes can be seen in the inclusion of a separate goal on cities and urban development in the 2030 Agenda for Sustainable Development. It also recognizes the cross-cutting nature of urban issues that impact on a number of other Sustainable Development Goals. The new Urban Agenda is intended to offer national and local guidelines for urban growth and development until 2036.

The scientific literature addresses the issue of urban sustainability in terms of population, how different cities meet the needs of their citizens. The concept of urban resilience differs depending on the country and its economy (Verma & Raghubanshi, 2018), and a holistic methodological framework is required to develop a system of resilience indicators and its use in strategic planning (Feleki et al., 2020). In urban sustainability management and urban planning, its scores based on indicators (Dizdaroglu, 2017), audits (Balaras et al., 2019) and ratings (Elgert, 2018) are important. The literature discusses the differences between sustainable and smart cities (Ahvenniemi et al., 2017), and ratings of smart sustainable cities in Europe are being developed (Akande et al., 2019).

## 2. Problem Statement

In foreign official publications and unofficial scientific works, methods for calculating socio-economic development indices proposed for use are based on extensive statistics, for example, Eurostat data. Many of the indices of domestic statistics necessary for the formation of indices are not calculated. In addition, a simplified assessment of the weighting coefficients of individual indicators of city sustainability and their constituent indicators is noteworthy. The methodology for calculating the used city sustainability index includes a three-stage averaging process. The sub-indices (social, environmental and economic) are determined by the weighted average values of their indicators, and the index itself in points is determined by the simple average of the sub-indices. The weighting coefficients for each indicator of the corresponding indicator in the sub-index are established by expert judgment.

It is required to define a necessary and sufficient list of indicators of urban sustainability. The list of indicators should reflect the specifics of the current stage of development of cities in the Russian Federation. The choice of the method for constructing the index for the comparative assessment of the sustainability of cities is important. Building an index requires determining the significance of its individual indicators.

## 3. Research Questions

The index of sustainable development of urban districts or the index of socio-economic development of cities can be constructed by various methods based on different methodological approaches and mathematical apparatus. The paper proposes a method for constructing the stability index of the urban

district of Samara as a comparative value with the urban district of Kazan. This method can be supplemented, firstly, with a large number of indicators of socio-economic development, the number of urban districts included in the list under consideration, and secondly, by changing the methods for determining the relative values of absolute indicators.

At the first step of calculating the comparative urban sustainability index, it is necessary to develop a list of 10 most important and available in municipal statistics indicators related to the characteristics of the human capital of the urban district, economy, ecology and safety, institutional and social spheres of activity. The second step is to calculate the relative estimates of the absolute values of the selected indicators for the urban districts of Samara and Kazan. At the third step, the coefficients of the relative importance of individual indicators of the socio-economic development of urban districts are calculated. The obtained estimates of the relative importance of individual spheres of activity correspond to the results of their calculations by other methods set forth in the literature. The indices of the socio-economic development of the urban districts of Samara and Kazan are determined by the sum of the products of the normalized values of the indicators and the corresponding weight coefficients of significance.

#### **4. Purpose of the Study**

The aim of the study is to develop a method for comparative assessment of sustainable development of cities in the Russian Federation. The tasks of the study include the selection and ranking of social and economic indicators of cities that are most important for the dynamics of their development. All indicators of the urban sustainability index should reflect the state and development of human capital, economy, ecology and safety, social and institutional spheres. The importance or significance of individual indicators is established by an expert method with subsequent processing of the estimates obtained by mathematical methods. There is a variety of expert assessments of the significance of indicators of social and economic development. The disadvantage of expert assessments is some subjectivity of the expert's personal opinion. This disadvantage can be mitigated by using the hierarchy analysis method. Building the urban sustainability index also requires bringing the selected indicators to a single unit of measurement. The final objective of the study is to determine, based on its results, the most important indicators constraining urban development.

#### **5. Research Methods**

The research methodology included an analysis of statistical indicators of social and economic development of cities in the Russian Federation. Methods for selection and ranking of indicators were used. The index is constructed on the basis of a point system, and the weights are established by an expert method. The specificity of the state of developed countries requires the use of a necessary and sufficient number of indicators of sustainability, which are available in municipal statistics. In addition, it is of interest to develop methods for constructing the urban sustainability index as a comparative value. A comparative assessment of the sustainability of the cities of Samara and Kazan is given for the ten most important indicators, the values of which were normalized in the range from 0 to 1. The hierarchy analysis method was used to assess the importance of indicators. The urban sustainability index was calculated in matrix form as the sum of the products of the relative values of the sustainability indicators and the corresponding weights.

## 6. Findings

The selection of the most important indicators of social and economic development of the cities of Samara and Kazan was carried out, followed by their normalization from 0 to 1. The results of calculating the normalized values of indicators of social and economic development are presented in Table 1.

**Table 1.** Calculation of normalized values of indicators of socio-economic development of cities

№	Indicators	Areas of activity	Absolute values		Normalized values	
			Samara	Kazan	Samara	Kazan
1.	Life expectancy at birth, years	Human capital	72.3	75.5	0.96	1.00
2.	Level of education (higher education) per 1000 people		266	255	1.00	0.96
3.	Average monthly wages of employees of organizations, thousand rubles/person	Economy	46.0	47.3	0.97	1.00
4.	Labor productivity, million rubles/person		1.43	1.65	0.87	1.00
5.	Number of registered crimes per 1 million, thousand people	Ecology and safety	13.4	12.8	0.96	1.00
6.	Total amount of pollutants, thousand tons		26.94	16.08	0.60	1.00
7.	Share of the population that received housing and improved housing conditions in the reporting year, in the total population, %	Institutional sphere	1.3	2.9	0.45	1.00
8.	Share of length of local public roads that do not meet regulatory requirements, %		33.6	22.0	0.65	1.00
9.	Total area of residential premises per one city dweller, m <sup>2</sup>	Social sphere	29.4	26.4	1.00	0.90
10.	Average size of assigned pensions, thousand rubles/person		15.6	15.0	1.00	0.96

Source: author.

The method of analysis of hierarchies was used to assess the importance or significance of individual indicators of the sustainability of cities in Mathcad. A matrix of paired comparisons of urban sustainability indicators has been developed and the characteristics of the matrix have been calculated. The matrix  $A$  of the coefficients of the significance of indicators is obtained. The row number in matrix  $A$  corresponds to the ordinal number of the indicator in Table 1:

$$A := \begin{bmatrix} 0.274 \\ 0.102 \\ 0.092 \\ 0.118 \\ 0.034 \\ 0.032 \\ 0.031 \\ 0.044 \\ 0.044 \\ 0.229 \end{bmatrix}$$

The coefficient of consistency of expert assessments of urban sustainability indicators was calculated, which was 0.035.

The calculations show both the importance of individual indicators of the sustainability of cities, and the overall importance of the identified areas of activity by the sum of their constituent indicators in Table 2.

**Table 2.** Significance of the spheres of activity of the urban district

Field of activity	Relative significance
Social sphere	0.376
Economy	0.210
Ecology and safety	0.066
Institutional sphere	0.075
Social sphere	0.273
<b>Total</b>	<b>1.000</b>

Source: author.

The initial data for determining the sustainability indices of the cities of Samara and Kazan are presented in Table 3.

**Table 3.** Initial data for determining urban sustainability indices

№	Indicators	Areas of activity	Normalized values		Significance coefficients
			Samara	Kazan	
1.	Life expectancy at birth, years	Human capital	0.96	1.00	0.274
2.	Level of education (higher education) per 1000 people		1.00	0.96	0.102
3.	Average monthly wages of employees of organizations, thousand rubles/person	Economy	0.97	1.00	0.092
4.	Labor productivity, million rubles/person		0.87	1.00	0.118
5.	Number of registered crimes per 1 million, thousand people	Ecology and safety	0.96	1.00	0.034

6.	Total amount of pollutants, thousand tons		0.60	100	0.032
7.	Share of the population that received housing and improved housing conditions in the reporting year, in the total population, %	Institutional sphere	0.45	1.00	0.031
8.	Share of length of local public roads that do not meet regulatory requirements, %		0.66	100	0.044
9.	Total area of residential premises per one city dweller, m <sup>2</sup>	Social sphere	1.00	0.90	0.044
10.	Average size of assigned pensions, thousand rubles/person		1.00	0.96	0.229

Source: author.

The calculation of the stability indices of the cities of Samara and Kazan as comparative values was carried out in matrix form:

where  $A$  – matrix of normalized values of the stability indicators of Samara (top row) and Kazan (bottom row);

$B$  - matrix of coefficients of significance of individual indicators;

$A \cdot B$  – matrix of stability indices of Samara (upper row) and Kazan (lower row).

$$A := \begin{pmatrix} 0.96 & 1.00 & 0.97 & 0.87 & 0.96 & 0.60 & 0.45 & 0.65 & 1.00 & 1.00 \\ 1.00 & 0.96 & 1.00 & 1.00 & 1.00 & 1.00 & 1.00 & 1.00 & 0.90 & 0.96 \end{pmatrix}$$

$$B := \begin{pmatrix} 0.274 \\ 0.102 \\ 0.092 \\ 0.118 \\ 0.034 \\ 0.032 \\ 0.031 \\ 0.044 \\ 0.044 \\ 0.229 \end{pmatrix} \quad A \cdot B = \begin{pmatrix} 0.926 \\ 0.982 \end{pmatrix}$$

The Samara sustainability index (0.926) is inferior to the Kazan sustainability index (0.982), especially in the following indicators, taking into account their importance in descending order: the share of the population that received housing and improved living conditions in the reporting year in the total population; labor productivity; the share of the length of public roads of local importance that do not meet regulatory requirements; the total amount of pollutants.

## 7. Conclusion

The development of cities in the Russian Federation is uneven and unsustainable. A comparative assessment of the sustainability of urban districts of the constituent entities of the Russian Federation is important for determining the main decisions of municipalities in social and economic development. The aim of the study was to develop methods for comparative assessment of the sustainability of cities. The tasks of the study included the formation of a list of the most important indicators of the sustainability of cities, their ranking by degree of importance and distribution by spheres of activity of municipalities, the choice of a method for comparative assessment of the sustainability of cities. Methods of grouping, standardization of indicators, analysis of hierarchies and matrix calculations were used in the work. The research results include the methodology for calculating the index of comparative sustainability of cities. Based on the results of the calculations, the main directions of the activity of the urban district of Samara in terms of the growth of stability in comparison with the stability of the urban district of Kazan were identified.

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