

«Experience of Implementing the Smart City Concept in Kazan»

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Abstract: A "smart city" is a modern metropolis in which life support systems are managed using innovative digital technologies. In Russia, the concept of "smart cities" has only recently begun to develop compared to other countries, so a detailed study of this phenomenon is necessary to characterize the consequences of the implementation of "smart city" technologies in Russian reality. According to the provisions of the Strategy for the Socioeconomic Development of the Municipality of Kazan until 2030 (approved by the Decision of the Kazan City Duma dated December 14, 2016 N 2-12), the concept of a "smart city" is one of the key criteria reflecting modern ideas about the characteristics of a successful competitive city, and Kazan, already occupying a worthy place among "smart cities", intends and is ready to improve its position. In this regard, a study of the specifics of the implementation of this concept in the capital of the Republic of Tatarstan is relevant and necessary for urban development. The study is designed to analyze in detail the current state of Kazan in terms of the implementation of the "smart city" concept and to develop recommendations for improving this process. The paper presents the results of calculating the integral index of the degree of integration of elements of the "smart city" concept into the infrastructure and management of Kazan .

INTRODUCTION

Modern cities face challenges such as increasing pressure on their infrastructure and the associated transformation of public expectations for the quality of the urban environment. As a result, a new diversity of city residents' needs is emerging, and a significant revision of previous approaches to urban development management is underway. Digitalization (the introduction of digital technologies into the business models of managed entities) and platformization (the process of changing the organization of an entity through the spread of digital platforms) are beginning to play a leading role as adequate technological solutions. Studying the "smart city" concept is relevant because it represents humanity's direct and creative response to pressing

contemporary issues such as increased environmental pressure, a shortage of social amenities, overcrowding, migration issues, and the increasing volume of information processing and consumption.

Among the city's strengths are the availability of a unified educational platform with electronic access to schools and kindergartens, online access to municipal authorities, and a wide range of free Wi-Fi . Kazan also ranked highly in the Russian Ministry of Construction's "IQ City Index." Therefore, studying the experience of implementing the "smart city" concept in Kazan is essential for further improving the quality of life and taking the city to a new level of development.

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MATERIALS AND METHODS

A smart city is a system that integrates information and communication technologies and the Internet of Things, aimed at improving the standard of living of the population, improving urban management, and meeting the needs of present and future generations .

Most researchers distinguish three generations of "smart cities": Smart city 1.0, Smart City 2.0 and Smart City 3.0. This approach largely reflects the actual state of a given city where the corresponding changes have occurred. Figure 1 shows the phases of "smart city" development.



Figure 1: Evolution of smart city generations.

The idea of a technocratic "smart city" has gained widespread popularity in the United States and Japan due to its active promotion by American consulting companies (Navigant Research , PricewaterhouseCoopers , McKinsey , and others). Early concepts of "smart cities" focused primarily on the widespread use of technical processing of urban planning data. Technological solutions were disconnected from the actual needs and technical capabilities of citizens, which led to only partial occupancy of "smart cities."

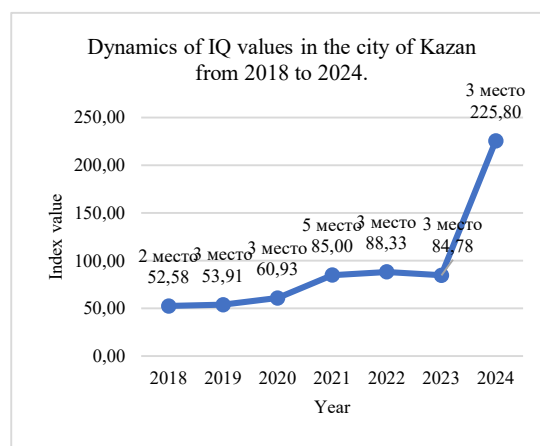
The emergence of serious social problems caused by a lack of means of living, cultural and historical limitations, gave impetus to the development of the second generation of "smart cities." The emphasis in improving "smart cities" shifted to improving management systems to ensure flexible and efficient solutions to urban problems. Instead of developing and implementing technologies, the search for new ways to address social challenges became the primary tool for ensuring the successful functioning of "smart cities." Thanks to the development of creativity, innovation, and intercultural communication in urban spaces, the Smart Generation City 2.0 has become very popular in Europe, but the "smart solutions" could not be made accessible to the general population due to their high cost.

Anthropocentric concept of the "smart city" (Smart City 3.0 is based on the hypothesis that changes in society, not technology, are the guiding

principle for urban development. The goal of a "smart city" in this case is to maximize the intellectual potential and creativity of urban community members. This goal is achieved through democratic principles of local self-government, information openness and transparency, and the creation of conditions for demand for innovation in the urban environment. To determine the level of implementation of the "smart city" concept in Kazan, we analyzed Kazan's statistical indicators in this area.

One of the quantitative analysis indicators is the assessment of the progress and effectiveness of the digital transformation of the Russian Federation's urban economy (City IQ). The methodology for calculating the City IQ Index was approved by Order No. 696/pr of the Ministry of Construction, Housing, and Utilities of the Russian Federation dated September 28, 2023. The purpose of this methodology is to ensure a unified methodology for assessing the progress and effectiveness of departmental projects.

Figure 2 shows a graph reflecting the dynamics of the results of the assessment of the progress and effectiveness of the digital transformation of the urban economy of the Russian Federation (IQ of cities) in Kazan from 2018 to 2024, with index values and places in the overall ranking.



Sources: Results of the IQ Index calculation for cities for 2018-2024 / Smart City. Departmental project of the Ministry of Construction of Russia. URL : <https://russiasmartcity.ru/documents> (date of access: 24.10.2025).

Figure 2: Dynamics of IQ values in the city of Kazan from 2018 to 2024.

Based on the graph, we can conclude that Kazan's IQ scores increased significantly from 2018 to 2024, and the selected cities occupy leading positions in the overall ranking. We consider it important to note the

significant increase in IQ scores from 2023 to 2024. This characterizes Kazan as a leader in the implementation of digital technologies and effective urban management, demonstrating significant progress in infrastructure development and improving the quality of life of its residents.

To assess the integration of smart city concept elements into Kazan's infrastructure and governance, we analyzed statistical data presented in the 2020-2024 performance reports of the Kazan Executive Committee, the Kazan Transport Committee, the Kazan Housing and Utilities Committee, and the Kazan Education Department (Kazan Education) and municipal data sheets. The analysis was conducted over a five-year period (2020-2024) across five areas: "Transport," "Housing and Utilities," "Education," "Security," and "Financing." The list of indicators is presented in Table 1.

Table 1 : List of indicators selected to assess the degree of integration of elements of the “smart city” concept into the infrastructure and management of Kazan

Block name	Indicators
"Transport"	electronic information boards operating at large passenger-generating stopping points
	Number of issued electronic travel tickets
	Number of transport card top-up points
	Number of traffic lights connected to the adaptive traffic control system
	Number of functioning parking meters
	carsharing vehicles entered into the register (Yandex.Drive , Delimobil)
	Number of electric vehicles registered
	Number of electric charging stations
Housing and communal services	The number of completed requests from the public through the Open Kazan system
	The number of management companies registered in the Open Kazan system
	The number of electronic requests received from the population (e-mail, online reception, citizen requests from the Unified Identification and Authentication System)
"Education"	The number of personal computers and laptops in general education organizations
	The proportion of subject classrooms equipped with an interactive whiteboard or screen and a multimedia projector

	Wi-Fi access points
	Number of registered users on the Kazan educational portal
	The share of schools participating in projects to develop a digital educational environment (Uchi.ru , Yandex, Sberclass , etc.)
"Safety"	The number of CCTV cameras installed in apartment buildings
	The number of Smart Intercom systems installed in apartment buildings
	The number of CCTV cameras installed at social infrastructure facilities
	The number of social infrastructure facilities where maintenance work was carried out on automatic fire alarm and evacuation control systems
	Length of street lighting networks
"Financing"	The amount of funding for the Municipal Programs "Digital Municipality of Kazan for 2020-2022" and "Digital Transformation of Municipal Administration of Kazan for 2023-2025" (from the budgets of Kazan and the Republic of Tatarstan)
	The funding volume of the Raisa of the Republic of Tatarstan "Our Yard" program in Kazan
	The amount of funding for the improvement of public spaces in Kazan under the federal project "Formation of a Comfortable Urban Environment"

Source: compiled by the author.

We calculated an integrated index for all years selected for the study. An integrated index is a generalized indicator that combines several individual indicators to assess or measure a complex object that cannot be described using a single indicator. Standardization formula 1 was used for its calculation:

$$\bar{X}_i = (X_i - X_{\min}) / (X_{\max} - X_{\min}) - \text{direct connection, (1)}$$

where \bar{X}_i is the normalized value of the variable;
 X_i – the real value of the variable;
 X_{\min} – the minimum value of the variable;
 X_{\max} – the maximum value of the variable.

Subindices were calculated for all indicators in each block. The simple arithmetic mean method

was used to calculate the integrated index of block indicators and the consolidated integrated index for the year.

The dynamics of the integral index values by blocks is presented in Table 2.

Table 2: Dynamics of the integral index values for blocks of indicators for assessing the degree of integration of elements of the “smart city” concept into the infrastructure and management of Kazan.

Year	"Transport"	Housing and communal services	" Education "	" Safety "	" Finance "
2020	0.161	0.188	0.184	0.000	0.280
2021	0.257	0.704	0.400	0.337	0.333
2022	0.497	0.624	0.783	0.556	0.229
2023	0.678	0.366	0.789	0.596	0.441
2024	0.861	0.842	0.858	0.946	0.739

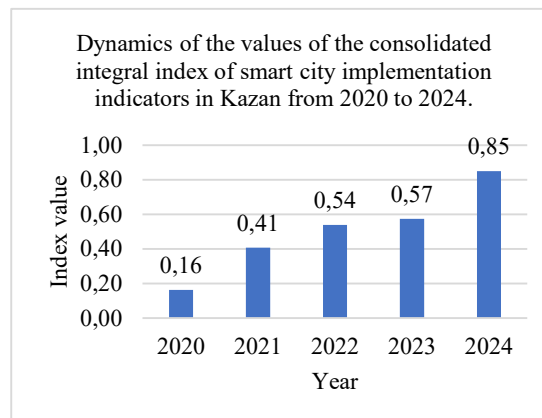
Source: compiled by the author.

For all blocks, except for the “Housing and Public Utilities” and “Financing” blocks, there is a steady increase in the values of the indicators and the integral index.

Let's look at the indicators of the Housing and Utilities block. From 2021 to 2023, there was a significant decrease in the integral index of the Housing and Utilities block, almost halving compared to the 2021 value (from 0.7 to 0.37). This is due to a decrease in the number of requests from the public processed through the Open Kazan system by almost 1.5 times (from 300,700 to 231,821 requests; the indicator value for 2023 was calculated based on weekly reports posted on the website of the Housing and Utilities Committee of the Kazan Executive Committee). Another factor in this trend is a halving of the number of electronic requests received from the public (from 1,414 to 696 requests). The integral index value of this block for 2024 is the highest compared to previous years, indicating the effectiveness of the measures taken by the Housing and Utilities Committee, which have significantly improved the situation.

Let's look at the indicators in the "Funding" block. In 2022, spending on municipal programs, specifically the "Digital Municipality of Kazan for 2020-2022" program, was more than halved (from 1,206,015,000 rubles to 519,366,190 rubles). We believe this is due to the program entering its completion and support phase in 2022, with the main, most resource-intensive stages of its implementation occurring in the previous two years.

Figure 3 shows the values of the summary integral index for all blocks for each year.



Source: compiled by the author.

Figure 3: Dynamics of the values of the consolidated integral index for assessing the degree of integration of elements of the “smart city” concept into the infrastructure and management of Kazan from 2020 to 2024.

The integrated smart city assessment index (SII) for Kazan demonstrates steady growth from 2020 to 2024. A significant jump in 2024 is particularly noticeable, demonstrating the rapid development and successful implementation of smart city initiatives.

RESULTS AND DISCUSSION

By applying integrated index calculation methods, we were able to thoroughly characterize the current status of the capital of the Republic of Tatarstan as a "smart city." High statistical and rating indicators confirm that modern technologies are harmoniously integrated into the daily lives of residents in Kazan, ensuring a high level of comfort, safety, and efficient management of the city's infrastructure.

CONCLUSION

This paper examined the specifics of the "smart city" concept implementation process in Kazan. "Smart city" is an urban development concept aimed at improving the quality of life of the population through the integration of modern technologies and a sustainable approach to urban management. In our study, we applied the integral index calculation method. the degree of integration of elements of the “smart city” concept into the infrastructure and management of Kazan.

Based on an analysis of the Kazan IQ Index and statistical data published in the reports of the Kazan Executive Committee, its committees, and municipal program data sheets, a steady increase in the indicators and values of the integrated index was observed from 2020 to 2024. Particularly pronounced growth was observed in 2024, confirming the rapid development and effective implementation of initiatives in the field of smart urban technologies.

In conclusion, we can conclude that Kazan is at a high level of digital development. This is reflected in the positive dynamics of statistical indicators, the wide range of smart technologies, and the high-quality operation of digital services and platforms.

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