High Technologies for Smart City Development

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INTRODUCTION

Urbanization has become major trend of the twenty-first century both for Russia and globally. Megacities across the world accumulate enormous human and technical resources. Currently, the world's population is close to 7.7 billion people, 55% of which (4.2 billion) already are urban residents. According to UN forecasts, up to 2050, the world population will continue to grow. The population of India will count a surplus of 416 million people, China will register a surplus of 255 million, and in Nigeria 189 million people more (The UN 2018).

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Today, the most urbanized regions are North America (in 2018, 82% of its population lived in cities), Latin America and the Caribbean (81%), Europe (74%), and Oceania (68%). The level of urbanization in Asia is now approaching 50%. In contrast, Africa remains mostly rural, with only 43% of its population living in urban areas. In the future, by 2050, according to various estimates, urban population will constitute between 66% and 70% of the world's population (6.7 billion people, according to UN forecasts).

Most of the residential and utilities services are consumed by urban people, which leads to multiple problems with the environment. That's why large European cities today try to integrate into the EU project AI4Cities using artificial intelligence (AI) as a solution for cutting down greenhouse gas emissions in the cities. Only in February 2020, six cities—Helsinki, Amsterdam, Copenhagen, Paris Region, Stavanger, and Tallinn—became participants of this three-year EU-funded project, bringing together leading European cities looking for high-technology (HiTech) solutions to reduce their greenhouse gas emissions and meet their climate commitments (Six European cities join project to use AI in move towards carbon neutrality, Feb. 2020).

In 2020, three-quarters of the Russia's population live in cities, generating not only a large share of the country's GDP, but also new models of interaction between the population and the government. However, it is obvious that the growth of urban population entails multiple problems associated with the need to provide citizens with a high standard of living, implying well-paid jobs. Cities play a key role in the Russian economy, which comes along with challenges that impede their effective development: accelerated deterioration of urban infrastructure (more than 60% on average in the country), insufficient budgetary spending, and urban environmental problems. Those challenges call for establishment of sound relationships among municipal authorities, business community, and citizens to ensure sustainable development of society, and eventually eliminate widespread corruption.

These problems may be fixed substantially by introducing a new model for the development of Russian cities—smart cities based on human capital, innovation, and high technologies (Smart Cities – Beyond the Hype 2019). The model implies gradual transformation of cities' governance into an intelligent system embracing all major areas of municipal life: jobs, health, education, energy, transport, resource management, and urban space. Increased workloads and new requirements for the efficiency of

urban infrastructure make it vital to intellectualize it. Therefore, a smart city today is not a luxury, but an indispensable condition for boosting economic growth. In this regard, HiTech or smart technologies will play an increasingly vital role for developing local economies (Smart cities to generate 20 trillion USD in economic benefits by 2026, April 2019).

Methodology

Academic research is supposed to effectively support evolution of smart public governance from smart cities to smart regions and then to smart nation, accelerating the national economy growth on various levels. Sharing the best experience of national development of smart cities will predictably lead to sounder and more elaborated models of smart governance as opposed to initiatives utilizing a trial-and-error approach alone. Thus, our research objective was to find new HiTech solutions to various sectors of municipal economy which will contribute to accelerating economic development of the country, offering a bottom-up model of strategic growth based on international and Russian experience (Smart Cities: Digital Solutions for a More Livable Future, June 2018).

A multidisciplinary approach in the qualitative data analysis embracing strategic management, public governance, international and national law, and economics was used to cover all areas of scientific interest and draw necessary conclusions. We also used the experience of organizing cluster associations in the industrial sector of the economy, including high-tech industries (Stepnov et al. 2019), to identify the connecting elements of digital interactions and apply them to form the concept of urban development. To achieve the objectives of the study, that is, making substantiated recommendations of the subject, we have used such methods as comparison, statistics, and content analysis.

Results

Significant investments are made into smart technologies development across the world. The impact of smart city technologies on economic development and gross domestic product (GDP) growth is supposed to affect three dimensions or phases: open data policies: incremental GDP of close to US$1 trillion over the next decade; public investments multiplier effect: incremental GDP of US$10 trillion over the next decade; structural smart urban economy growth: recurring, sustainable growth of 2.8% by

2026; US$10 trillion incremental GDP generated in the next ten years (Role of Smart Cities for Economic Development ABI Research 2018).

Large investments in smart technologies have been made in Russia. The key objectives of smart technologies in Russia are to improve public services to citizens, reduce costs, save energy and increase energy efficiency, and integrate and develop renewable energy sources in the urban environment. We have identified the most important areas where the smart technologies have proved to lead to considerable improvements.

ENERGY SUPPLY

Smart power supply networks (smart grids) were the first to be used for the intellectualization of energy supply aimed at intelligent generation, transmission, and distribution of electricity. Smart networks are saturated with modern diagnostic tools, electronic control systems, algorithms, and technical devices (e.g., short-circuit current limiters for superconducting lines). The introduction of this technology in the city reduces losses in the transmission of electricity from the generator to the consumer, increases the reliability of power supply, provides additional opportunities for optimal redistribution of energy flows, and reduces peak loads.

New opportunities for the development of smart networks will appear with the development and implementation of cost-effective energy storage devices and the development of electric transport and the corresponding charging infrastructure. Investment programs of Russian network companies include the introduction of intelligent accounting systems in networks. The amount of funding for such projects is now up to 2% of the total amount of the program.

The introduction of smart electricity meters with remote reading will improve the quality of service and reduce commercial losses for network companies. Legislative initiatives are already being prepared to encourage the installation of such metering devices. In the future, technologies for individual automatic weather control will become popular. Thermal energy savings during their implementation are 20–30%.

URBAN LIGHTING

Smart city lighting systems provide light on the streets of the city in the right quality and quantity, at the right time, and for a minimum of investment. That is why smart cities choose energy-saving incandescent lamps.

The potential for energy saving when replacing incandescent lamps with energy-saving ones is up to 90%. Additional savings are achieved through the introduction of automation (motion sensors) and timely switching-off and -on of lighting, reducing the load.

The use of Light-emitting diodes (LEDs) in urban lighting results in energy savings of up to 60%. The main problem of making the new lighting system operational is its high initial cost. The system pays off only after a certain period of time by saving energy. This is not always beneficial for city authorities due to insufficient local budgets and legal regulations. Preferential loans to municipalities for these socially important projects can be one of the ways to attract investment in lighting modernization.

Transportation

To improve the energy efficiency of cities, it is also important to introduce intelligent transport systems. Optimal road traffic may reduce the city's energy consumption by 5–15%. One of the leaders is Moscow, where the corresponding program has already been adopted (Moscow as a Smart City 2019). It includes switching to intelligent traffic light management, giving priority to public transport, dynamic traffic speed control, and routing to prevent traffic jams. Today, every traffic light in Moscow is equipped with an optical channel, allowing to process huge amounts of data. Big data accumulated via traffic sensors serves as a basis for strategic municipal planning of transport system development. Sensors also detect various traffic violations.

The sensors are part of a modernization program of Moscow's current road network systems and have the potential to link up to the city's traffic and control center systems to provide data in real time, which would enable the Moscow city government to better balance demand and improve the process of air and water congestion management. The sensors are also able to detect people walking and other types of traffic, including cars, trucks, motorcyclists, and buses. The same system has been successfully implemented in London (Transport for London Expands Use of Traffic Sensors Using AI, Feb. 2020).

The electronic payment system for public transport is also one of smart city technologies. This system calculates the discount if a person often travels by public transport and constantly uses the same card for payment. The technology has already been implemented in many major Russian cities—Moscow, Yekaterinburg, and Tyumen.

Information Systems

A modern city consists of many subsystems—transport, telecommunications, electricity and water supply systems, and so on—that interact with each other. A comprehensive information system is necessary to control all city systems' functioning, ensure the safety of each resident, receive and archive information about important events, and promptly provide it to the interested entities. It must be able to accumulate, combine, analyze, and group data from multiple sources. This system is the "Safe City" complex, which has been successfully implemented by many local administrations. This is a system of software, hardware and organizational measures to ensure video supervision and technical security in public places (schools, medical institutions, etc.) and management of housing and communal services and other facilities in the modern city.

Internet of Things (IoT)

According to McKinsey Global Institute, the IoT could have a potential economic value of between US$3.9 trillion and US$11.1 trillion annually by 2025, while in the Gulf Cooperation Council (GCC) region, a report by A.T. Kearney found that the value of the IoT solutions market in 2025 would amount to US$11 billion, with a potential economic value of almost US$160 billion.

The Internet of Things (IoT) is becoming part of our day-to-day lives. But still many Russian cities do not have the technology required to run even the most basic of these devices, let alone those that require state-of-the-art, 5G technology (IoT in a 4G/5G World: A Survey of How CSPS Are Preparing to Transition to this New World 2018). Primarily, they lack the funding necessary to implement technological upgrades and lay essential infrastructure. With budgetary cuts in all areas of government, finding a solution to this smart technology deficit is critical for the future of infrastructure in cities. Connecting authorities, public organizations, and businesses to the Internet should be the first objective to be resolved in the smart city, as it will allow to

- make an appointment with a doctor via the Internet;
- vote for city projects on the Active Citizen website;
- submit a request about a problem in the house or yard and monitor its implementation through the "Your City" portal;

– send documents for passport registration, pay for electricity or
  phone, pay taxes via the Internet, pay for parking via phone; and
– report incorrect parking or other public violations via a special app
  on a smartphone.

Free Wi-Fi in the city will make all municipal services available for the
residents at any time and place. The new 5G broadband Internet will fur-
ther improve the municipal governance and services.

It is important for municipal authorities to understand that smart tech-
nologies are not a fashionable novelty, but necessary a tool for solving
problems. Many of the technologies will eventually soon become not only
more sophisticated but also more affordable. For example, over the past
three years, the price of LEDs in Russia has decreased three times, and of
solar panels, seven times. Therefore, today the authorities of many Russian
cities are ready to start mass implementation of smart technologies that
have until recently been considered a pipe dream.

Advanced results can be achieved by using HiTech, which have already
proved their efficiency internationally. For example, the 2020 Smart 50
Awards honor projects in five categories: community engagement, digital
transformation, smart mobility, urban infrastructure, and urban opera-
tions. Applicants must have achieved results at a municipal scale or equiva-
lent to qualify. These projects exemplify innovation and concrete influence
in their communities as a result of HiTech implementation (Smart 50
Awards 2020).

We would also welcome Russia's more active participation (along with
other Brazil, Russia, India, China and South Africa (BRICS) states) in the
G20 Global Smart Cities Alliance on Technology Governance. Founded
in 2019—in conjunction with the G20 Summit in Osaka, Japan—the
organization has the goal of creating global norms and policy standards
for the use of connected devices in public spaces. Partners include Japan,
the Kingdom of Saudi Arabia, the Smart City Mission of India, Cities for
All, Cities Today Institute, the Commonwealth Local Government Forum,
the Commonwealth Sustainable Cities Network, Connected Places
Catapult, Digital Future Society, ICLEI—Local Governments for
Sustainability, the International Telecommunication Union, Open and
Agile Smart Cities, the Smart City Expo World Congress, United Cities
and Local Governments, What Works Cities, the World Economic Forum,
and World Enabled (India Joins G20 Global Smart Cities Alliance on
Technology Governance, Oct. 2019).

Conclusions

We understand that Russian megacities (there are 16 of them with a population at least 1 million or more) have more access to the entire range of smart technologies, while small residential communities have limited individual solutions. Today, there are about 100,000 settlements across the country with a population of less than 200 people. These citizens have no access to high-quality infrastructure—education services, energy, telecommunications, healthcare, and banking.

A small city model implies that standard modular smart tech solutions may be implemented: autonomous power supply, distant education, telemedicine, and postal and banking services using modern information technologies. Standards of service level have to be established for small communities. Then, if federal, regional, and municipal authorities actively work together with infrastructure ITC companies, these communities will be able to enjoy similar service level as megacities in terms of smart technology.

Surveys of Russian cities' officials, telecom executives, and systems have demonstrated that the key challenges in creating a comprehensive smart city strategy are: funding, partner search, and data management. These challenges will critically affect the success of smart technology implementation. Funding is the most difficult issue due to the significant amount of investment required and the need to develop a unique funding structure for each individual smart city project. Upgrading urban infrastructure through integrated implementation of smart technologies not only is a high-cost project from a financial point of view, but also requires a creative approach in developing short-and long-term goals. To solve this problem, cities need to implement reliable business models that allow them to attract private funds.

The specifics of financing smart city HiTech development projects are determined by the presence of technology risks deterring potential investors generally focused on long-term projects. As a result, financing of smart city development projects is tightly concerned with the development of a comprehensive strategic plan that allows all involved parties to maximize the benefits of the project and ensure that investors are willing to participate in its development. Smart city development projects should be implemented by municipal authorities in a step-by-step approach, starting with the assessment of existing assets, selecting optimal business

model, choosing timeline and methods of gaining financial benefits from the project, and planning financial public and private financing.

Nevertheless, "half of the initial investment made by the public sector could generate a positive return, whether in direct savings or opportunities to produce revenue" (McKinsey Global Institute Report 2018). That is why we believe that special focus should be made on helping city authorities build partnerships in order to understand, prioritize, and address their risks and potentials in four ways:

- Design roadmaps enabling private businesses to participate in city development planning processes.
- Establish HiTech project incubators to develop projects maximizing the resilience impact and ensuring cities and business communities have access to technical, financial, and project preparation expertise.
- Create regulatory sand boxes allowing city authorities to test new smart technologies before taking decisions about their implementation in the city's economy.
- Develop end-to-end technologies offering cross-functional and cross-industry solutions. Competent use of end-to-end technologies will ultimately stimulate improvement in the quality of life, comfort of the urban environment, and management of various sectors of the urban economy while reducing resource consumption. For example, geo-information technologies and ultra-precise navigation, together with 5G, are the basis for the emergence of unmanned public transport. Digital technologies for supporting decision-making and processing unstructured data, as well as machine learning, are needed to create smart road infrastructure management systems that include traffic forecasting, smart traffic lights, and even fatigue control for bus drivers.

To sum it up, a smart city is an innovative city that implements complex high-technology solutions aimed at achieving the highest possible quality of resource management and providing services in order to create a sustainable environment for life and business activity of now and future generations. In the nearest future, smart cities will become the basis for smart governments (Dupont Jonathan. The Smart State 2018), bringing along new challenges of global income disparity.

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