

Smart Cities: Challenges and Opportunities

Ciudades inteligentes: desafíos y oportunidades

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ABSTRACT:

The article deals with the transformation of the socio-economic systems at the global and national levels, and the associated changes of life in urban communities. Urban development trends in the modern world were studied in terms of industrial revolution, involving the introduction of intelligent information technology in everyday practice. It is a review article where the main features of the smart cities, their socio-economic problems, and opportunities for sustainable development were examined on examples (Utrecht, Barcelona, Singapore). The most attractive Russian regions and cities for investment were considered (Moscow, Lipetsk, etc.).

Keywords: scientific and technical progress, smart cities, environmental issues, inequality, quality of life

RESUMEN:

El artículo aborda la transformación de los sistemas socioeconómicos a nivel mundial y nacional, y los cambios de vida asociados en las comunidades urbanas. Las tendencias de desarrollo urbano en el mundo moderno se estudiaron en términos de revolución industrial, lo que implica la introducción de tecnología de información inteligente en la práctica cotidiana. Es un artículo de revisión donde se examinaron ejemplos de las principales características de las ciudades inteligentes, sus problemas socioeconómicos y las oportunidades para el desarrollo sostenible (Utrecht, Barcelona, Singapur). Se consideraron las regiones y ciudades rusas más atractivas para la inversión (Moscú, Lipetsk, etc.).

Palabras clave: progreso científico y técnico, ciudades inteligentes, problemas ambientales, desigualdad, calidad de vida

1. Introduction

Scientific and technological progress is rather rapid. It makes the humankind think about how fast and how radically the social reality and environment will change. The issue of Fourth Industrial *Revolution*, its possible social consequences and the need to manage the processes that it intensifies, has been actively discussed since 2016.

It is obvious that industrial production concentrated in large cities arises a lot of urban issues, mainly environmental ones, which require immediate solution (Korkia et al., 2017). Initially, a city was a production area in the industrial society, but the latest industrial revolution made its functions change. Industrial areas are now being moved beyond city boundaries and revitalized (Vershina et al., 2018), and this raises the issue of new urban development strategies.

The modern era requires people to think about the urge to solve the problems inherited from the industrial development period and provides ground for reassigning the functional purpose of cities. Addressing the challenges of rapid urbanization is one of the items on the UN 2030 Agenda for Sustainable Development (Sustainable Development Goals, 2015), which calls for new approaches to sustainable human settlements development. One of the Sustainable Development Goal (SDG) is Sustainable cities and communities (Goal 11): "More than half of us live in cities. By 2050, two-thirds of all humanity—6.5 billion people—will be urban. Sustainable development cannot be achieved without significantly transforming the way we build and manage our urban spaces. The rapid growth of cities—a result of rising populations and increasing migration—has led to a boom in mega-cities, especially in the developing world, and slums are becoming a more significant feature of urban life. Making cities sustainable means creating career and business opportunities, safe and affordable housing, and building resilient societies and economies. It involves investment in public transport, creating green public spaces, and improving urban planning and management in participatory and inclusive ways" (Sustainable Development Goals, 2015).

Nowadays, cities encounter not only well-known challenges, but those that reveal new issues to be addressed (Osipova et al., 2019). Inequality is considered one of the most acute social problems (Polyakova, 2015). It impedes the sustainable development of cities and territories. Its new form, digital divide (Dobrinskaya et al., 2019a; Dobrinskaya et al., 2019b), is a consequence of the growing importance of information and communication technologies in modern society and is spreading rather fast. In particular, the digital economy based on information and communication technologies is developing rapidly (Martyntenko et al., 2019).

Digitalization is a process affecting a great number of aspects of our life. More than half of the world population lives in cities. That is why the urban space is also changing and digitalizing rapidly. The change in urban space caused by the development of information and communication technologies is considered further in the context of the smart city concept (Woetzel et al., 2018). A smart city is viewed as a goal of sustainable development of cities and territories. When reached, it will contribute to improving the quality of life through digitalization. Cities are now playing a huge role in the economy (Sluka et al., 2019). It is not surprising, therefore, that they are rapidly changing to match new opportunities and to maintain their competitiveness.

However, there are certain concerns regarding the rapid spread of information and communication technologies in all social spheres (Kal'ner, 2018). Researchers claim that unequal access to modern technologies together with unequal opportunities for their use, can further increase socio-economic inequality (Dobrinskaya et al., 2019a; Dobrinskaya et al., 2019b, Volkova, 2018). Although, the inevitability of further digitalization is hardly ever questioned.

People-oriented development of cities and territories ensures equal access to services, jobs and opportunities. Therefore, the construction of environmentally sustainable, socially integrated and prosperous settlements is becoming one of the main tasks. One of the sustainable development concepts deals with the creation of smart cities.

Smart cities are widely discussed in modern scientific literature. Researchers name their most diverse characteristics. The key components of smart cities are as follows:

- 1) smart management, which is efficient cooperation of various authorities. It suggests a rapid response system to needs of the population and increased quality of state services by implementation of electronic government;
- 2) smart people, mastering new educational technologies that provide equal access to knowledge and electronic services for all social sectors (for more information: Volkova, Filatova, 2019).
- 3) smart environment with new energy-saving and other technologies aimed at reducing human impacts on the environment;
- 4) smart mobility, which requires building intelligent transport systems;
- 5) smart economy, which provides better business opportunities, primarily due to the implementation of various forms of electronic commerce;
- 6) high living standards, including high-quality healthcare, social services, and the building information modeling (Steinert et al., 2011).

According to the European Commission, a smart city is a place where traditional networks and services are made more efficient with the use of digital and telecommunication technologies for the benefit of its inhabitants and business. «A smart city goes beyond the use of information and communication technologies (ICT) for better resource use and less emissions. It means striving for sustainability through smarter urban transport networks, upgraded water supply and waste disposal facilities, and more efficient ways to light and heat buildings. It also means a more interactive and responsive city's administration, safer public spaces and meeting the needs of an ageing population» (Smart Cities, 2019). Thus, smart cities are cities that demonstrate integrated sustainable development.

Analytics of PricewaterhouseCoopers (PwC) see the complex approach as the main distinction between smart cities and other cities: various components of urban infrastructure, such as housing, transportation, healthcare, and education, are considered comprehensively, that is, as integral parts of a complex system (Smart Cities, 2012). Often, urban authorities try to solve problems in individual areas. But in smart cities, all problems are approached as complex urban problems, since all components of the city are closely interconnected and are parts of the same networks.

Therefore, it is incorrect to think that the smart city concept is possible due to the introduction of technological innovations. The smart city concept assumes that investments are to be directed to human and social capital and to such traditional areas as transport, information and communication technologies. That is, a smart city not only requires the modern technology and digitalization in different aspects of everyday life, but it is aimed at the fulfillment of its residents' potential in various fields, which should improve living standards significantly.

The goal of the article is a review of publications about smart cities to demonstrate that the development of smart cities as places with technological innovations includes advancing human well-being and sustainability. In our highly urbanized planet, there is an urgent need to develop intelligent solutions to overcome the social challenges of urbanization. The main features of the smart cities, their socio-economic problems, and opportunities for sustainable development are discussed in different countries. Therefore, each city tries to find its own way to become smart and Russian cities are not the exception.

2. Methodology

It is a review article and so the study uses existing data on a certain research subject from government statistics, published market research reports from different international organizations and agencies (United Nations, PricewaterhouseCoopers and so on). A traditional literature review was conducted using a search of PubMed and Google Scholar and other data bases for certain specific key terms or key words (smart city, intelligent city, sustainable city etc.).

3. Smart Cities in the Modern World

3.1. Ecological Aspects

Scientific and technological progress inspired the greatest achievements of humankind, but became a source of new social issues, such as the most obvious environmental ones, which have unpredictable consequences (Vershina et al., 2019). Environmental issues threaten the existence of all humankind, which makes them top priority for contemporary researchers.

Toffler wrote that, due to industrial opposition to nature, increasing population, harmful technology, and insatiable need for expansion, industrial civilization has done more harm to environment than any of the previous ages, which made the problems of environmental pollution and consumption of resources in industrial society more acute than ever (Toffler, 1980). An ecologically destabilized environment can trigger flows of migration, which can exacerbate social conflicts in countries which already have large numbers of migrants (Prokhoda et al., 2019). It should be noted that material resources provide a competitive advantage allowing minimizing environmental risks, thereby complicating the system of inequality, in which the environmental component is becoming increasingly important.

Rifkin listed a number of priorities, such as: transition to renewable energy sources; the implementation of the Smart House Project, which assumes that buildings will provide themselves with electricity for their own needs; storing energy in buildings using modern technologies; the creation of an intelligent energy network on each continent, which will enable buildings exchange the accumulated energy and share it when needed; the transition to the widespread use of electric vehicles, which will also be able to charge by connecting to a continental smart network (Rifkin, 2014).

Environmental sustainability was never considered a key component of urban development during the industrialization period. However, the challenges of this century force humankind to reconsider priorities, introducing the best available technologies to preserve a productive natural environment for existing and future generations. If consumer behavior patterns continue to dominate, an environmental disaster is inevitable. This alone requires a change in people's everyday behavior (Kurbanov et al., 2019). Smart cities offer new behavior patterns to reduce human impact on the environment.

In the middle of the last century researchers already spoke of the exhaustion of natural resources, which is the cornerstone of the industrial civilization, and the damage done to the environment. Therefore, it is not surprising that energy conservation technologies become the key component of smart cities. Rifkin claims Utrecht, the capital of the province of the same name in the Netherlands, to be an outstanding example of a new-generation city (Rifkin, 2011). Utrecht made a decision to become the vanguard of European Union in the third industrial revolution by becoming the first province of the biospheric era. In thirty years, the government of Utrecht wants to decrease carbon dioxide emissions to zero without slowing the economic growth. This task is relevant for all modern cities. With approximately 55 percent of the world's population living in cities, they consume about 70 percent of the world's energy and are sources of the most part of air emissions (State of City Climate Finance, 2015). Experts say that cities of the world must inevitably become the key grounds for building models of sustainable development, which assumes the care for the environment. Therefore, one of the most popular concepts of urban development is the smart city concept, which is based on the modern information and communication technology, energy saving, and, therefore, care for the environment.

Barcelona has consistently tried to become a smart city for about ten years. Huge data arrays are collected and processed in the city and these databases become the basis for decision-making by local authorities. In addition, all actions of city services are coordinated by the operating system, which ensures the interaction of multiple services with each other and with a center. It helps not only to solve problems but also to predict various situations and avoid difficulties. However, Barcelona needs new technologies that will increase safety, since this problem still remains relevant.

One of the leaders in digitalization is Singapore, which launched the Smart Nation program in 2014. Its main goals are: reducing the effects of high population density and aging process, improving the quality of medical care, sustainable energy and sustainable transport. There is a priority bus program at traffic lights, older people and people with reduced mobility can extend the green traffic light by attaching their social cards. Smart medicine in Singapore allows citizens to receive remote medical care, and smart watches immediately respond to a sharp change in the position of the person's body, causing an ambulance. Thus, more and more cities are starting to implement various programs that, based on new technologies, can improve the quality of life of their residents.

The transformation of urban space requires large financial costs, that is why modern cities are interested in attracting investments. Global cities are particularly successful in attracting investments (Sassen, 1991). They offer developed infrastructure to transnational corporations, open representative offices of new companies, create jobs and, as a result, internal and external migrants replenish the number of their citizens.

Global cities are not the only option attractive to investors. The authorities of any city or region can make it attractive for investment if they just make the necessary efforts. One of the key prerequisites for success is the willingness to innovate and the desire to implement innovations. The economy is transforming so that knowledge and skills are becoming the key resources. Accordingly, there is a growing need for the tools to generate and disseminate innovations at various levels, including the city level. City authorities are facing rapid changes which force them to keep up with the times and to implement the smart city concept. The ability to use high technology potential is becoming one of the main competitive advantages of cities and territories nowadays. The cities which successfully implemented the latest knowledge and technologies can become a testing ground for the most daring innovations. Besides, they are far ahead of their rivals. Smart cities have competitive advantages that can help them be the most attractive for investors.

According to the experts from McKinsey Global Institute, «as cities get smarter, they are becoming more livable and more responsive—and today we are seeing only a preview of what technology could eventually do in the urban environment» (Woetzel et al., 2018).

It is obvious that new technologies cannot be viewed as a decision for all social problems; on the contrary, a lot of them require great care. Besides, environment protection and creating smart cities are not among the priority tasks in the countries, which still cannot solve such issues as hunger, poverty and misery.

It is important to remember that digital technologies not only make life easier and services more convenient, but also involve new risks. There is an uncertain possibility of remote interfering of third parties in transactions of various kinds, and therefore users can be endangered. This factor is significant for all projects of smart cities, where data security should be one of the top priorities.

3.2. Smart Cities in Russia

Innovations are implemented in Russia every now and then. Therefore, the prospects for building smart cities look very real. Some Russian cities and regions are quite successfully implementing the smart city concept, striving for sustainable development and thereby increasing their competitiveness in the world market.

Moscow, the capital of Russia, is both the political and economic center of the country. The city is strengthening its positions in various ratings, including a smart city concept, and it managed to achieve a certain success in this matter (Woetzel et al., 2018). The city has a program that can improve the population's quality of life through the widespread use of information and communication technologies in the social sphere, in the fields of security, urban management, as well as in the citizens' everyday life. Residents of Moscow can receive many services remotely, and they can also participate in the voting on decisions taken by the Moscow Government on online platforms (Official site of the Mayor and the Government of Moscow, Active citizen, Moscow Government crowdsourcing projects, Moscow is our city, etc.), which increases the efficiency and transparency of city management. Obviously, various electronic platforms are an important element of any smart city (Alvear et al., 2018), so the Moscow Government pays much attention to their development.

One of the most important projects in Moscow – Unified Medical Information Analytical System ([Emias](#)), because smart cities are healthy cities, where government pay much attention to the healthcare (Mouton et al., 2019; Ramaswami et al., 2016). The Emias system allows to make an appointment with a doctor, evaluate the quality of received services, and also access an electronic medical record. Nevertheless, Moscow has yet to solve a number of problems, in particular, in the city there are still difficulties with the implementation of a sustainable approach to waste management ([Vershinina et al., 2019](#)), although examples of other cities show that there are solutions (Esmailian et al., 2018) and the capital of Russia can use their experience in this area.

There are other quite successful cities and territories, which are less famous in the world than Moscow. It should be noted that for several years (since 2014) Lipetsk has held strong positions in the ranking of economic zones (Mullan, 2014) made by the Foreign Direct Investment Intelligence (fDi). In 2019, it was awarded in 5 nominations, such as "Deployment of Technology", "Expansions", "Facilities Upgrades", "New Investments" and "Red Tape Reduction" (Davies, 2019).

The Lipetsk industrial special economic zone attracted several transnational corporations, such as the Japanese tire manufacturer Yokohama, the German rubber and plastic manufacturer Lanxess, and the American chemical company PPG. Experts explain that the geographical position of this economic zone at the intersection of the two largest highways is one of its main advantages. The authorities of the Lipetsk region are striving to improve the living standards in the region, creating new jobs (due to attracting investments) and introducing modern technologies used in smart cities.

However, the authorities of the Lipetsk region care not only about attracting investments, but about improving the lives of the locals as well. In 2014, a program was implemented in the new Universitetsky district of Lipetsk, aimed at creating an integrated system for ensuring the safety. This system is used to contact an emergency manager using intercom panels installed in entrance halls and apartments. By holding the finger for four seconds on the intercom handset button, residents can report emergency situations, offenses in yards or hallways and various household issues (leaks, etc.). In emergency situations, the intercom handset can be used as a loudspeaker, allowing the authorities to notify the residents of possible emergencies in the house, neighborhood or in Lipetsk. Besides, residents can be informed in the entrance hall, or when the elevator button is pressed. Residents can hear storm warnings, information on icy roads, snowfalls, or, for example, on the upcoming water supply cut, etc. The public warning system used in Lipetsk will be installed in all new buildings and houses in which major repairs are carried out.

Intercoms are equipped with video cameras to prevent false calls. These cameras provide emergency dispatchers with additional information. Cameras are also installed on blocks of apartments for dispatchers and residents to watch porches, courtyards, children's and sports grounds online. To do this, they must register on the district website and connect to the video surveillance system. All these services are provided free of charge.

In Russia, the creation and development of public warning system was applied for the first time in the Lipetsk region (Administrative Office of the Lipetsk Region, 2014). This emergency warning system turned out to be rather cost effective and efficient in informing the maximum possible number of residents.

Alabuga is another example of a successful economic zone in Russia. Alabuga became a leading European economic area for large companies in 2015 (Mullan, 2015). In 2019, it was awarded in three categories: Crossborder Collaboration, Academic Collaboration, and Skills Development (Davies, 2019). Being a smart city sometimes means being a successful city because smart city in Russia has more possibilities to become a successful economic zone.

Experts believe that such economic zones as Dubna, Innopolis and Togliatti can also be of certain interest to investors (Davies, 2019). Cities which effectively attract investments receive resources to solve social problems and improve the living standards. Creating world-class economic zones meeting current requirements is the first step towards smart cities in Russia.

Moreover, it should be noted that when investments are actively attracted by a limited number of cities and regions, the problem of spatial inequality in Russia, which is quite serious, especially due to the climatic features of the country, gets even worse (Kolomak, 2013).

It should be noted that during the COVID-19 pandemic, which swept the world at the beginning of 2020, smart cities have more opportunities to prevent its spread than others. For example, in Moscow, the face recognition system allowed quickly identify those who violated quarantine and prevent them from moving across the city. At the same time, the availability of digital services made it possible to solve some problems even at a time when all residents of the city were allowed to leave their houses only in cases of emergency. Thus, modern technologies in the conditions of a pandemic have allowed many services to continue working, which is especially important for such a large city as Moscow, where about 10 percent of the country's population lives. At the same time, residents of the city realized how comprehensive a control system can be in a smart city, where for each exit from the house (even for a walk with a dog) you need to get permission in the form of a QR code.

4. Conclusions

Nowadays, the discourse about smart cities is becoming increasingly popular, however, there is still no unity on their main features, and it is unlikely to appear in the coming years (Ahvenniemi et al., 2017). Thus, it can be argued that this concept is one of the most controversial in modern science, but despite this, a smart city is considered by most researchers as the desired goal of urban development.

Nevertheless, it is obvious that one of the main components of a smart city is the active use of new technologies in it. A smart city is a digital city in which various data are accumulated, analyzed and become the basis for management decisions. Today it is possible to talk not just about smart cities, but about networks of smart cities, since they exchange information with each other to work out optimal solutions to common problems – improving the transport situation, security, etc.

Obviously, it is impossible to stop technological progress and trying to do this is pointless. But in a rapidly changing reality, both technological and social, it is necessary to take more care to increase not only digital literacy, but also digital security, which should become the basis for sustainable development of smart cities, providing their residents, first of all, new technologies' advantages and minimizing their risks. The creation of smart cities and widespread use of modern technology is not a goal, it is only a means to improve the quality of life and achieve sustainable development.

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