Smart settlement: indicators of quality of life and demand for the Internet of things

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Abstract. The authors considered the concept of "smart settlement". They highlighted a “smart people” subsystem as the main factor in the creation and development of a “smart settlement” based on the Internet of Things. The discussion concerns new indicators of the life for the population in a rural settlement. The limitations for the development of subsystems of a city and a rural settlement and the possibilities for overcoming differences are determined.

1. Introduction
The intensive introduction of information technologies and the Internet of things in agriculture can give impetus to the development of the industry, since the available groundwork is less than in other industries. A low level of labor productivity, a high proportion of unproductive expenditures and insufficiently developed logistics hamper the development of agriculture, slow down the transition to a “smart settlement” and the growth of indicators of the quality of life of the population.

Rural settlements are mainly such small settlements, whose inhabitants are engaged in geographically dispersed types of activity. In the scientific literature, the discussion of terminology related to the concept of “smart city”, “digital city”, “smart settlement” [1] is widely represented. Let us single out the differences in the concept of “smart settlement”, as a more limited set of technologies developing in rural areas. By “smart settlement”, we will understand the territory where, using modern technologies for collecting, processing and storing information, resources and services one could effectively manage to improve the quality of life of citizens and ensure their safety. A smart settlement is, primarily, a settlement that is convenient for the life of the population.

The need to develop smart territories is a global challenge [2]. In 2010, the European Union adopted the notion "smart" in its new ten-year growth strategy Europe 2020 stating that Europe should become a smart, sustainable, and inclusive economy [3].

Under the Internet of things (IoT) we understand the process of converting data from various devices, meter readings and sensors into a general information system; in this case agriculture becomes a sector with a very intensive data flow [4].

The objective of this study is to compare the results of assessing the quality of life of the population in rural areas of Novosibirsk region and assess the demand for the Internet of things by the population. It is worth noting that our area is urbanized. The population of the Novosibirsk region in 2018 was 2.7
million people, the majority are urban dwellers, about 60% live in Novosibirsk, 17% in the other cities of the region, and only 23% in villages, townships and urban-communities [5].

2. Problem statement
The Internet allows overcoming the differences in indicators of quality of life between rural and urban settlements.

By combining and analyzing the definitions of “smart settlement”, we conclude that the term “smart settlement” implies, like “smart city”, a certain system of communicative and information technologies, the purpose of which is to increase the living standards of citizens and reduce the costs of workflow through automation activities that do not require the use of analytical skills.

To assess the level of development of the smart settlement concept, a complex system of indicators is required. Such a system of indicators of quality of life already exists, but, in our opinion, does not reflect changes occurring in society in connection with the development of information and communication technologies, that is, many indicators either cannot be assessed or do not reflect the real situation.

We have developed a system consisting of eight groups of indicators: smart economy, smart management, smart technologies, smart infrastructure, smart environment, smart education, smart transportation and smart medicine. We briefly define them.

The subsystem "smart economy" at the settlement level is primarily the growth of labor productivity, growth of incomes of the population, reduction of unemployment, etc.

The smart management subsystem automates the processes of providing state and municipal services, as well as the implementation of state functions (for example, automatic tax collection). The basis of smart systems in this area consists of electronic document circulation and electronic signature technologies; the digitization and automation of data collection ensure the efficiency and reusing of information. The main indicators of "smart management" include the activity of citizens in the management of the settlement; high attendance of official administration sites; the smooth functioning of the communication system between residents and government officials, as well as information openness of the administration.

The "Smart technologies" subsystem is one of the fastest growing in the "smart settlement". At the same time, the indicators of the quality of life in this subsystem include the share of the population using the Internet to order goods and services; the number of universities and schools with distance education; availability of self-pay desks; the presence of surveillance cameras on the roads and others. The introduction of smart city technologies increases management efficiency by creating a unified digital environment that allows you to manage any settlement as a whole. Due to the smooth exchange of data, the speed of transactions and operations increases, many of them become available in a virtual environment and do not require personal presence and long waiting times.

The subsystem of "smart infrastructure" reflects the availability of various technological means to meet the daily needs of the residents. This may be the number of access points to free Wi-Fi, the share of Internet banking users, the availability of a booking system, etc.

Indicators related to the "smart environment" subsystem allow us to estimate the level of interdependence between a person and the world around him within the territory of a settlement. These include ecological recycling of garbage, reduction of pollution of wastewater, civil initiatives to conserve forests and water basins.

The subsystem of "smart education" is applicable to all categories of students. There were identified indicators assessing the quality of education, such as the number of educational subjects chosen by the students, the number of summer schools programs in the field of ICT, the possibility of distance education, online courses, the compliance of graduates’ competences with the labor market and others.

Indicators reflecting the level of technological development of the transport and road sector characterize the subsystem of "smart transport". For example, we consider that it is important to include in this section such an indicator as “the number of systems that provide reliable and complete information about the carrier and its drivers”. Also in this group were included indicators assessing the
availability of transport for people with disabilities, the availability of a wireless Internet connection in transport, the possibility to track their trips using a personal mobile device, the location of transport on a map, the presence of "smart bus stops" and many other aspects.

The “smart medicine” subsystem refers to the key ones, since such important aspects as life expectancy, mortality (including children’s), and curability from various diseases depend on the level of development of medicine. Modern technologies allow one to solve many health problems, especially related to raising public awareness based on Internet technologies, receiving online consultations, availability of telemedicine and something else.

3. Results and Discussion

The purpose of this study is to assess the indicators of the quality of life of the population and the demand for the Internet of Things based on surveys and questionnaires of the population of 30 administrative districts of Novosibirsk Region related to the rural population (Table 1).

### Table 1. Results of a survey of the population of Novosibirsk region to assess the possibility of improving the quality of life based on the Internet of Things

| Quality of life questions | Sample (179 persons) | Specific weight, % | Questions about the demand for IoT | Sample (179 persons) | Specific weight, % |
|---------------------------|-----------------------|--------------------|-----------------------------------|-----------------------|--------------------|
| 1. The smart economy (growth of incomes of the population, growth of labor productivity, decrease in level of unemployment) | 83 46 | Transfer of technological systems in plant growing, animal husbandry, etc. to the IoT principles. | 172 96 |
| 2. Smart management (electronic document flow, no references, decision making based on an assessment of the collective opinion of citizens) | 112 63 | Informational portal | 146 82 |
| 3. Smart technologies (in education, medicine and sports) | 79 44 | Computer training and testing systems, computer simulators | 76 42 |
| 4. Smart infrastructure (smart home) | 43 24 | Machine-to-machine interaction (M2M) | 68 38 |
| 5. Intelligent environment (video surveillance and security, environmental monitoring) | 38 21 | Smart sensor networks, satellite navigation systems | 112 63 |
| 6. Smart education (distance, online, electronic libraries) | 98 55 | Internet space, computer, mobile applications | 56 31 |
| 7. Smart transport (ecological and smart transport systems) | 34 19 | GPS - Global Positioning System, drones, satellites | 98 55 |
| 8. Smart medicine (quality and efficiency of medical services) | 46 26 | Telemedicine, consultations, online mobile equipment | 98 55 |

3.1. Identification of problems in the field of perception of the system (projects) of “smart settlement”

We have formulated questions for obtaining estimates from the population, perceiving the possibilities of improving the quality of life in accordance with the considered subsystems of “smart settlements”. One should keep in mind that all questions that fall in the sample depend on the level of information technologies development and rely on the Internet of Things solutions.

The study conducted surveys and surveys of different age groups in the districts of the Novosibirsk region. One hundred seventy nine persons aged from 20 to 78 years were participants of the sample evenly presented by gender and age composition. Table 1 presents the most frequently answered
questions. The most popular were questions about the quality and efficiency of medical services, the provision of public services, transport accessibility (mobility of the population) and environmental problems.

Most of the issues related to the definition of the above-specified groups of indicators can be resolved by implementing the concept of a smart city in Russian cities and rural settlements and the presence of the following conditions (Table 2).

**Table 2.** Conditions required for the implementation of “smart settlement” and “digital city” projects (forecast for 2020)*

| Provision of the population | Novosibirsk (urban population) | Rural areas of Novosibirsk region (rural population) |
|-----------------------------|---------------------------------|-----------------------------------------------------|
| Availability of computers per 100 households | 98                              | 80                                                  |
| Household Internet connection | 87,2                            | 62,9                                                |
| Mobile Application Development | 117                            | 117                                                 |
| Number of Wi-Fi access points | 76,8                            | 41,3                                                |
| Digital and cable networks | 98                              | 72,6                                                |

*Compiled by the authors according to the data of the Novosibirsk region's program “Development of the Information Society Infrastructure of the Novosibirsk Region for 2015-2020”

It is obvious that all subsystems are in demand both in the city and in the countryside. Both urban and rural population can access Internet resources intended for informing citizens about various spheres of life in Russia and in a separate subject of the country. For example, such websites as the website of the Federal State Statistics Service, the website of the Russian Ministry of Civil Defense, Emergencies and Disaster Relief, the Electronic Government website, the Civil Initiative, the districts and settlements administration sites.

The differences concern separate indicators related to population density and the effectiveness of centralized provision of public services. Thus, we can conclude that, as the development of subsystems of a “smart settlement” is a global trend, this a realistic attainable prospect for Novosibirsk region, too.

### 3.2. Development of the "smart economy" subsystem

A comparative analysis of the subsystems of “smart settlement” and “digital city” shows that the main constraint in the uneven development and growth of quality of life indicators remains the income level of the population. The aggregate indicator of the quality of life of the population is the volume per capita of the national income. These data characterize the degree of achievement of the socio-economic development of society as a whole [5].

The most significant are the following issues as unemployment rate, the proportion of the urban population living below the poverty line; the proportion of the school-age population listed in educational institutions; the proportion of people who have completed higher education per 100,000 inhabitants. Serious influence on the quality of life have total household electricity consumption per capita, the ratio of actual tax collection, the response time to the primary call of emergency services, fire services and police; the proportion of the population with constant access to an improved water supply and sanitation system.

Since rural areas have lower incomes, the quality of life indicators related to a comfortable living environment remain low, despite the fact that these problems have technological solutions for a long time. For example, installation of dry closets, autonomous sources of high-quality water supply for the dwelling, sources of autonomous power supply and so on.

Transformation into “smart” rural settlements implies high costs. The fundamental changes in the agricultural production sector and, as a consequence, income growth of the population are necessary.
We can also note that there is a number of issues hindering the development of the agriculture, namely technological backwardness, low educational level of the population, etc. Nevertheless, analyzing all the above-said, we can conclude that, despite all the difficulties, the projects will gradually develop.

3.3. Development of the "smart people" subsystem

“Smart settlement” focused primarily on people relies on ICT infrastructure and continuous development with constant consideration of environmental and economic sustainability requirements. The approach to defining “smart settlement” based on a deep understanding of the role of social connections and human capital. In this sense, this is a settlement in which local communities are constantly learning, adapting, creating and using innovations. The challenge is for a wide variety of people to be included in social life and participate whether in managing a settlement and changing it for the better [6, 7].

Now, consider the directions, each of which will present new indicators.

Population capable of maximizing the use of computer technology. The use of new technologies should bring the daily life of the population to a new level of development, change the type of relationship to cooperation and coordination that arise in the production process. The introduction of new technologies of machine-to-machine interaction does also create conditions for a continuous cycle in education and self-education.

Population that participates in the “Russians of the Future” program. It involves expanding the list of disciplines for students in all types of educational institutions, studying both the basics and in-depth knowledge of information technologies. Such training should be accessible not only to students, but also to all citizens on the principle of distance education.

Population capable of implementing a smart settlement system. Introduce such systems should be "smart people", capable of innovation, having the need to master, invent something new to improve the quality of life. For example, in many Russian cities, the Internet is used to manage the city, these include the Active Citizen Project, which is an electronic referendum system developed at the initiative of the authorities. Such forums for residents of communities must be available for all settlements.

The share of "electronic officials" in the country. The representatives of all types of government bodies start switching to electronic media first. In the near future, the authorities plan to digitize the entire document circulation. The rights and obligations of members of the "e-government" are enshrined in legislative norms.

Population receiving “electronic documents”. This indicator will count the number of people who have already switched to electronic documents, reducing paper workflow.

Population choosing online education. This indicator will count the number of people who prefer online education to regular. Now more and more people are undergoing various online refresher courses, numerous trainings, webinars for self-study and improvement in their professional activities.

Population using the public services portal. Over time, the portal providing public services, more and more improves the services provided. Now, there is a huge variety of services for the population - from tax debts to enrollment in kindergarten. There is also a feedback to assess the quality of the services provided.

Population able to social activities and self-organization. Every person is able to change his environment for the better. Such people organize meetings, groups and clubs, in which they will create and apply into life in the course of joint activities the innovations, which can change their life in a given society for the better and modernize it. For example, to organize a campaign on greening the city, collecting waste paper, collecting garbage in a local park, various fairs and public holidays. So, they can themselves achieve what they would like for a more comfortable standard of living, but not without the help of the state, which should encourage the activities of their citizens in organizing socially useful activities.

Population ready for inclusion in public political life. These are the people who are ready, together with the authorities, to design new projects and organizations that will promote closer ties between the
population and the state. They will also develop and implement certain services, forums that improve people's lives [7].

Having reviewed the content of the “smart people” subsystem, we propose new indicators for assessing the quality of life of the population (Table 3).

Table 3. Indicators of the quality of life of the population for the "smart people" subsystem (developed by the authors)

| Quality of life indicators | Indicator calculation | Source of information |
|----------------------------|-----------------------|-----------------------|
| The proportion of the population that can maximize the use of computer technology | Shows the proportion of the population of the total number, % | Specialists’ expert evaluation |
| Percentage of the population trained by the program "Russians of the Future" | Shows the proportion of this population, % | Expert evaluation and collection of information from sites |
| Proportion of population able to implement the smart settlement system | Shows the proportion of the population that can transform a settlement in various fields, % | Statistics on professional participants, public organizations |
| The share of "electronic services" in government bodies | Shows the proportion of "electronic services", % | Collection of data on the sites of government bodies (local, district) |
| Percentage of population ready for online education | Shows the proportion of the population receiving online education, % | Collection of data on the websites of educational organizations. Survey, population questioning |
| Proportion of population using government services portal | Shows the proportion of the population using government services portal, % | Government services https://ulpressa.ru/2018/02/09/nol-sekund-nol-chinovnikov-ulyanovskih-chinovnikov-zamenit-iskusstvennyiy-intellekt/ |
| Proportion of population participating in social activities and self-organization | Shows the proportion of the population participating in social activities, % | Population polls. Statistics of public organizations |
| Percentage of the population participating in the work of projects on the Civil Initiative website | Shows the proportion of the population participating in public political life, % | Expert assessment of specialists, indicators of site visits |

The adopted strategy for the development of the digital economy leads to a change of priorities, a system of goals, objectives, methods for their solution, indicators of the completeness of the goals and their effectiveness. In the place of classical economic indicators of efficiency come socially oriented indicators characterizing the transition to the information society, where the focus is on self-realization of the individual.

4. Conclusion
Modern opportunities allow participants of the Internet space to build their “smart settlement” independently in almost any locality - through mobile applications in smartphones, launching their own start-ups aimed at improving the quality of life of the population and introducing digital services within their community.
“Smart people” are persons who are able to think outside the box and quickly, with high intelligence, to solve the most complex scientific and technical tasks, to serve and create new technologies. The population of a “smart settlement” distinguish themselves by its ability to integrate into the interregional and international intellectual network, and make the most efficient use of the territorial and resource potential available to it. Technologies of “smart settlement” allow one successfully, quickly receive, and analyze information on all subsystems of “smart settlement”, control and effectively distribute investments, observe principle of uniform development of all subsystems.

There is a need to intensify the transition of agriculture to digital intellectual and robotic systems aimed at solving both economic and social problems. For the development and implementation of the Internet of Things in agricultural production, it is necessary to develop a mechanism for coordinating authority and responsibility for the implementation of the Digital Agriculture Program.

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