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## AN OVERVIEW-ANALYTICAL DOCUMENT OF THE INTERNATIONAL EXPERIENCE OF BUILDING SMART-CITY

### ОГЛЯДОВО-АНАЛІТИЧНИЙ ДОКУМЕНТ МІЖНАРОДНОГО ДОСВІДУ ПОВУДОВИ SMART-CITY

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*Башинська І.О., Каплун А.С. Оглядково-аналітичний документ міжнародного досвіду побудови smart-city. Оглядова стаття.*

У статті розкрито поняття та розроблена модель ідеального smart-міста, проаналізовано відомі в даний час міжнародні рейтинги, які дозволяють оцінити різні аспекти розвитку smart-міст. Розглянуто переваги та особливості рейтингів як інструменту подання результатів для оцінювання і порівняння smart-міст. Для побудови ідеальної моделі розумного міста, ми будемо використовувати класичні шість smart характеристик: економіка, управління, суспільство, мобільність, середовище та життя. Успіх "smart city" безпосередньо залежить від ефективного планування та контролю за його виконанням, що визначає успіх загальної програми реструктуризації. Гнучким підходом до розробки програми реструктуризації є розумна міська дорожня карта, яка, відповідно до нашої пропозиції, складається з шести етапів.

*Ключові слова:* smart-місто, інновації, стратегія, smart-економіка, smart-управління, smart-суспільство, smart-мобільність, smart-довкілля, smart-життя

*Bashynska I.O., Kaplun A.S. An overview-analytical document of the international experience of building smart-city. Review article.*

The article reveals the concept and developed the model of an ideal smart city, analyzed the currently known international rankings, which assess different aspects of the development of smart cities. The advantages and features of ratings as a tool for presentation of the results for evaluation and comparison of smart cities. To construct the ideal model of a smart city, we will use the classical six smart characteristics: economy, governance, society, mobility, environment and life. The success of "smart city" directly depends on effective planning and control over its implementation, which determines the success of the overall restructuring program. The flexible approach to developing a restructuring program is a smart city roadmap, which, according to our proposal, consists of six stages.

*Keywords:* smart city, innovation, strategy, smart economy, smart governance, smart society, smart mobility, smart environment, smart living

**M**ore than half of the world's population lives in cities. Cities, metropolitan areas give rise to problems of new species. Difficulties in waste management, resource requirements, air pollution, health hazards, road traffic jams and aging urban infrastructures are among the most important technical, physical and material problems. The urgency of the article is the development of "smart cities", by introducing innovations and improving the efficiency of functioning of the main spheres of life of cities.

#### Analysis of recent researches and publications

Different The analysis of literary sources on the development of smart-cities has shown the lively interest of foreign and Ukrainian scientists. Among them there are works of such actors as: Girman A.P., Kiselev V.R., Zhukovich I.A., Diskina A.A., Goncharenko O.S., Cohen B., Kusuma Adi Ahmad, Lukito Edinugroho, Ahmad Junade, Vidavan, Gil Bettis, Christ J. Kassandras, Carlo Alberto Nucci Amerel Atur, Thierry Burger-Helmchen.

The research of the phenomenon of smart-city was engaged and continues to engage a lot of scientists, however, they mainly focus on narrow aspects, or consider countries and cities locally, so it is necessary to generalize the work of scientists.

*The aim of the article is to study the international and domestic experience of building smart-city and develop a smart-city roadmap.*

#### The main part

Each year, the number of studies on the impact of innovation on the development of countries, regions and cities is increasing. In many foreign and domestic studies, a methodology for evaluating and comparing the innovative development of the territory is considered.

Economic, scientific and cultural potential is concentrated in cities, and therefore they play an

important role in the economic, political and public life of each individual country and of humanity as a whole. The economic and technological changes caused by globalization and integration processes lead to the need for sustainable development and increasing the competitiveness of cities. This problem is related to the need to improve the city in areas such as economy, culture, housing and social conditions,

and the environment [1]. One of the ways of the decision was the creation of new cities – "Smart City".

The abbreviation "Smart" in English translates to "intelligent" and stands for: "Specific" – concreteness; "Measurable" – dimensionality; "Attainable" – reach; "Realistic" – realism, "Timebound" – limited time (tab. 1).

Table 1. Definition of abbreviation "Smart"

S	Specific	Concreteness	the more precise a specific task is described, the higher the probability of obtaining the expected result would be.
M	Measurable	Dimensionality	the result must be measurable. To do this, we determine the criteria by which the process will be conducted.
A	Attainable	Reach	this parameter shows the need to discard the knowingly unattainable results, since obtaining the desired result should be at least potentially.
R	Realistic	Realism	only this aspect involves not only assessing their presence, but correlating their number with the number necessary to achieve the goal.
T	Timebound	Limited time	The purpose setting for this phase involves setting a clear timetable in which it should be implemented.

Source: compiled by the authors on the materials [2]

Thus, the development of "smart-city" is a strategic process that requires the novelty of approach, planning, exploitation, networking and management of urban enterprises. In this way, the concept embodied transforms the city's space into a source of resources for all people who are visiting this city. Thus, the meaning of the term "smart city" indicates the search and implementation of intelligent solutions that help the city to qualitatively and quantitatively increase its own productivity.

"Smart City" is a new strategy aimed at providing assistance to cities in which there are a number of problems, such as: high population density; increase in the number of vehicles; inefficient use of resources, climate change, deterioration of energy infrastructure. To solve the above-mentioned problems, we propose to develop a model of the ideal "smart-city" (fig. 1), which identifies different sectors of the concept through the implementation of projects for the development of modern urban infrastructure.

To build the perfect smart city model, we will use the classic six characteristics: smart economy, smart-management, smart-society, smart-mobility, smart-environment and smart-life.

The need for the transition of "smart-economy" is due to global disturbances in the development and conduct of economic activity of individual cities and the country as a whole. The main goals of the "smart economy" can be attributed to:

- recovery of economic growth after the global crisis;
- adaptation to changes in the ratio of demand and supply of labour at the expense of high levels of general and vocational education, the activity and mobility of the workforce and changes in regulated working hours;
- the formation of an innovation system, the introduction of advanced technologies, smart-networks in all sectors of the economy to provide quick access to information and knowledge, the

generation of new ideas with their subsequent implementation in the production of products and services with increased value added and intelligent component [1];

- creation and maintenance of productive business environment for increasing the degree of innovation, optimal use of nature, energy and material saving technologies, etc.

The technology of the intelligent network allows solving problems for power companies. SmartGrid is a smart meter, dynamic electrical network management, demand regulation, security enhancement and cost savings. This network will allow you to monitor the energy consumption of each home device and maintain certain rules of behaviour at peak hours and at other times of the day, increase safety and reduce costs.

"Smart-management" means participation in public life, development of public and social services, transparent management, lack of corruption, crowd-sourcing. This is a management that is completely inseparable from the use of intellectual and collective technologies, including crowd-sourcing, knowledge management, BigData [3]. Due to the use of such technologies, in particular, a very effective mechanism for the dissemination of the competencies that are currently required, which will always be highly sought after by the "smart-society", is being formed.

The main component of the "smart-society" is the population, so the degree of development of the city directly depends on the level of education of its inhabitants. Therefore, one of the main factors is the level of human qualification. Due to constantly changing technologies, the ability of a person to learn throughout his life was not an important factor in being an active participant in the process of modernization. In principle, factors such as flexibility and agility, creativity, cosmopolitanism, and citizens' openness to change, as well as their readiness for

active participation in public life, follow from the latter characteristic.

"Smart-mobility" is a solution to many problems associated with the traffic jams, fares, access to Internet resources in all parts of the city. The main goals of "smart-mobility" are: the ability to easily move around the city, openness and accessibility of the city at the national and international levels, accessibility to information and communication

technologies (ICTs), sustainable, innovative and safe transport system. Mobility is a key component of the Smart City, and first of all, it is worth paying attention to the inclusion of ICT infrastructure in this characteristic.

"Smart-environment" – preserves natural resources, as well as orientation towards sustainable development, combating pollution, sustainable resource management.

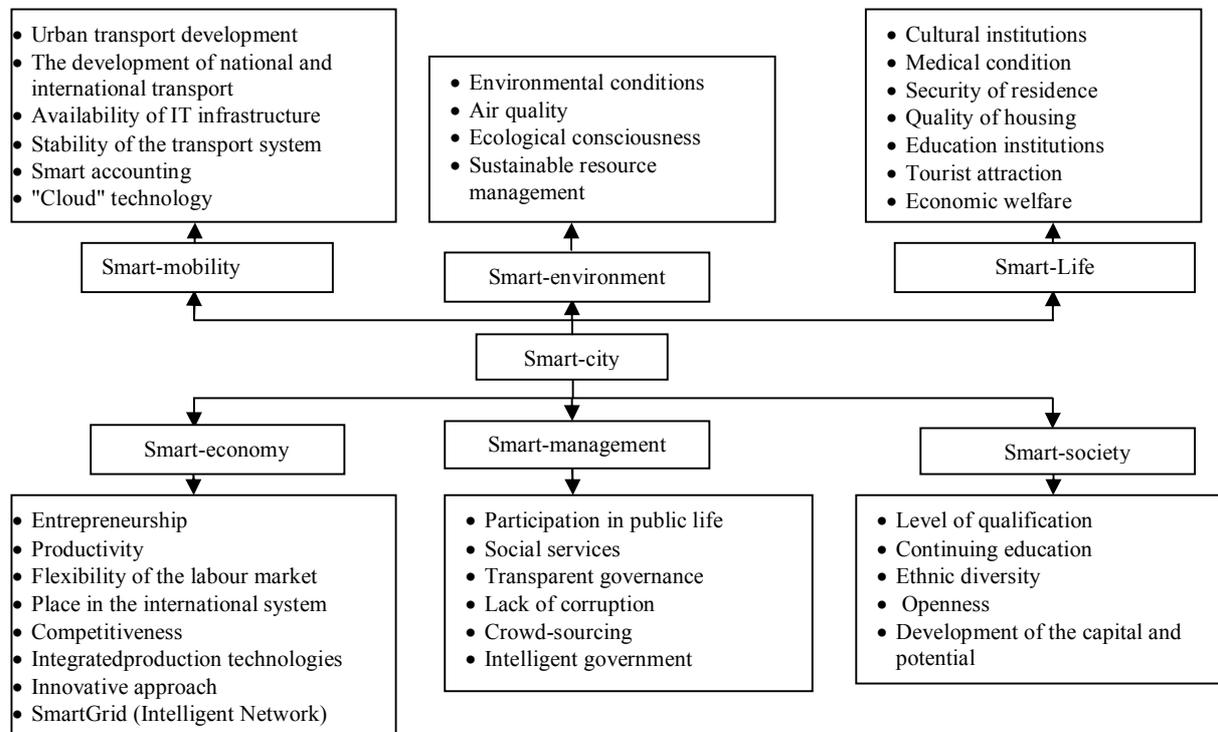


Fig. 1. Characteristics of "Smart-city"

Source: compiled by the authors on the materials [3-14]

"Smart Life" is a project devoted to the development of society. The objectives of this project are: the development of cultural space and the presence of cultural objects; developed medicine, high level of individual safety of people, quality of places of living and level of development of system of housing and operating organizations; availability and level of educational institutions; attractiveness of the city for tourists; social cohesion of citizens.

Approximately eight out of ten Europeans live in cities, spend 70% of their energy, and the traffic congestion they create in Europe costs roughly 100 billion euro pro year. Therefore, metropolitan areas are constantly looking for ways to become more efficient, resourceful and friendly to the population. Tab. 2 shows the ranking of ten cities that are close to the model of the perfect smart city.

The first place in the 10th "Smart Cities" rating is the prominent business capital of Denmark, Copenhagen. The city has a state-owned enterprise that controls all initiatives within the Smart City program. Also, the company is developing a strategy to reduce CO<sub>2</sub> emissions, so that by 2025 become the first carbon-neutral capital. The city has a well-developed centralized heating system, which serves

about 98% of homes. The system uses excess heat from power generation and redirects it to the heating of buildings. This system allows you to save up to 1400 USD, up to 203 thousand tons of oil annually. Similarly, a large wind power plant built in the city, located at sea 3.5 meters from the coast, produces 4% of the energy for the city.

In the second place ranking is the capital of the Netherlands – Amsterdam. B. Cohen noted that Amsterdam "is the only city in the world that has more problems than pedestrian and cycling traffic congestion than the congestion of vehicles." Almost 67% of Amsterdam's residents travel by bike or on foot.

In the third place in the rating is Vienna. The relatively small Austrian capital is one of the greenest cities in Europe and provides a high standard of living. More than 15% of the city's energy resources come from renewable sources, including the use of Europe's largest biomass power plant.

In addition to pan-European ratings, some EU countries carry out national ratings of Smart cities, namely:

— New York. One of the first smart cities in which city computer systems began to develop. To date,

- it has two "smart" systems at once – Cisco and City24/7, thanks to which each resident has free internet access. It was in New York that a computer program to combat street crime was developed, and now this metropolis has become the safest city in the United States.
- Boston. The first city in the world where the computer system StreetBump was launched: on the wheels of cars installed special sensors that collect information about each pit on the road and send data to the server utilities. Only one year of work of the program has led to the fact that the number of pits on the roads of Boston was reduced almost twice: from 7.8 to 4 thousand.
  - San Francisco. In the city there are over 60 computer programs that fully control the operation of public transport and housing and communal services. Also in San Francisco the implementation program of electric vehicles with built-in autopilot is being implemented, for which the densest worldwide network of public charging stations for such cars is already built in the city. It is assumed that in three years in San Francisco, no gasoline car will remain.
  - Tokyo. The Japanese capital initially had a single system of total computer control of the road network, and now became a training ground for the implementation of the "smart city" project, which involves the leading corporations of the country. In addition to general computerization, this concept involves gardening the city to create conditions for the harmonious coexistence of man with the environment. For example, in one of the districts of Tokyo adopted a program to replace all pillars by 2015 with live trees.
  - Karamay. The first "smart city" in Xinjiang Uighur Autonomous Region of China. Feature of the Chinese concept of SmartHub: emphasis on combining all devices into a single information network and continuous informing of citizens about all aspects of city life. For example, every stop in the city is equipped with an electronic screen, which shows the movement of all buses in the district. Traffic is tracked through thousands of webcams, and any one of them can be connected via a mobile phone.
  - Songdo. The first "smart city" in South Korea, which is decided to completely and completely build from scratch. Now Songdo is practically ready for settlement: the city is calculated for 65 thousand people who will be selected by special tests for the level of IQ. Today in the world about 50 projects of building "smart cities" from the zero cycle are being implemented, but Songdo will become a model for everyone.
- In Ukraine, there are several cities claiming the status of "smart city", including Kiev, Dnipropetrovsk, Kharkiv, Vinnytsia and Lviv.

Table 2. The ranking of ten "smart cities" of Europe in 2016

City's name	Ratings of city assessment criteria						Σ
	Smart-economy	Smart-management	Smart-society	Smart-mobility	Smart-environment	Smart-life	
Copenhagen	7	7	1	4	1	2	22
Amsterdam	6	9	2	1	4	4	26
Vienna	4	3	7	6	6	1	27
Barcelona	5	5	5	3	5	6	29
Paris	3	8	4	2	7	9	33
Stockholm	8	4	6	7	2	7	34
London	1	2	3	10	10	10	36
Hamburg	8	10	8	5	3	3	37
Berlin	2	6	10	8	8	5	39
Helsinki	10	1	9	9	9	8	46

Source: compiled by the authors on the materials [4-13]

Kyiv is the first city in Ukraine, integrating smart technologies and building digital infrastructure. To date, there are 4100 special cameras HikVision and Huawei. It is planned to cover all entrances and exits from the city (61), entrances/exits to the subway, 120 traffic lights. Plan for the end of the year – another 4.000 cameras. Also, cameras will have the main places of accumulation of people on the level of city districts, the main transport interchanges. Similarly, it is planned to install Wi-Fi in tourist places and medical institutions. The private company will cover the main locations: Bessarabskaya Square, Khreshchatyk, Independence Square, European and Mikhailovskaya Square, Andriyivsky Uzviz, Postal and Kontraktova Square, Leo Tolstoy Square and Shevchenko Park [14]. Until the beginning of 2018, it

is planned to introduce a single electronic ticket in the subway, trams, trolleybuses and buses. Estimated purchase amount – 300 million UAH. These funds are expected to cost 1.500 on-board computers for buses, trams and trolleybuses, as well as 5500 electronic validators. The KyivPass hotel project is already presented – the only ticket for a tourist that will allow you to visit interesting places and move around the city on the road.

In Dnipropetrovsk's plans are to install smart city-wide stops, equipped with heaters, charging for mobile phones, Wi-Fi, information boards, fixtures; introduce a single electronic ticket to the metro and tram; to establish a system of reasonable traffic lights, which will allow remotely control the traffic of streets [14].

Vinnitsa operates an automated system for managing utilities on a Microsoft cloud platform; an internal portal is created for the city council in which the working documentation is kept, the database of executive bodies is kept, and a number of electronic services are available to the residents of the city: online registration in kindergarten, the possibility to pay utility services via the Internet, search of the necessary public transport route; about 70 cameras were installed on the streets to ensure the safety of the citizens on the streets, information from them goes to the servers of the city council and the police center [14].

In Lviv, on the basis of the cloud platform, Microsoft Azure operates a portal of open data, which makes information on the tourism industry automated and displayed in a visual fashion; a tender for the purchase of a single electronic ticket system was announced; operates a traffic control center and dispatching a vehicle to which 150 traffic lights are connected. Some of them are intelligent traffic lights; a smart tourist route with QR-tags will soon be created in the city center [14].

Cities and their transformation in smart cities are not in the empty space, but in the context of the global transformation of the world economy into the digital economy. And practically everything that is happening in this or that country is related to the "capital" of the digital economy – a smart city. The success of the "smart-city" project depends directly on effective planning and control of its implementation. Therefore, the planning and control of the implementation of the change in the structure of the project are important components that determine the success of the restructuring program as a whole. A smart approach to developing a restructuring program is the smart-city roadmap. A roadmap is a set of methodologies and tools for preparing real organizational documents for each particular city with its diverse peculiarities. Work begins with the problem statement and moves to finding the optimal solution.

The first stage is the preparation and planning, it is necessary to develop, taking into account the road map of the city, in order to ensure that the business case is fully formulated and that all key stakeholders in it are foreseen.

At the second stage of development, the emphasis is on creating a maximum impulse for implementing a roadmap at a minimal risk of implementation. This means, in particular, targeting: quick victories to demonstrate progress and early benefits, with low expense, in order to strengthen faith and trust through the interested city parties; the introduction of a roadmap in the governance structures and processes that will be needed to create an environment for informing all future investments.

At the third stage, some of the most significant investments are starting to emerge, for example, an open Data Platform for supporting small and medium businesses and an innovative community with city data for the creation of community services. Also, here comes the first wave of intelligent services and

applications from leaders of these areas within the city.

At the fourth stage, the focus shifts away from the decisions taken on the basis of the creation of primary smart city services and applications, the training of smart data (intelligent data) and feedback from users, and, through feedback, the definition of business changes and technologies, development of architecture for a longer term and strategic decisions.

Finally, when smart city services are catching up with the critical mass, the program is being upgraded to a wider range of smart city projects, completing the transition to a complete strategic IT platform becomes necessary to ensure future maneuverability as changes and business priorities to customers.

A traditional operating model for the city was founded around functionally-oriented service providers that work as non-interconnected vertical silos, which are often not built around the needs of users. Smart cities should develop new operating models, stimulate innovation and cooperation between these vertical silos. Decision making and service delivery have been built into a vertically integrated supply chain within cities – implementation silos that are built around a function that does not belong to the needs of users:

- a single citizen or business must deal with each silos individually: establishing a connection for themselves, and not receiving seamless and connected services that are appropriate to their needs;
- data and information has typically been locked in these silos, limiting the potential for collaboration and innovation throughout the city, and limiting the speed of city-wide change.

## Conclusions

The conducted research makes it possible to draw some conclusions. There is currently no single methodology for evaluating and comparing smart cities. Researchers working in this area use rating agencies as the tool for presenting survey results.

The construction of "Smart City" is a complex of measures aimed at modernizing all areas of city management. Each city, as a rule, has its own tasks. Some solve security-related problems, others will improve the functioning of municipal transport, while others reduce energy losses in homes. None of these tasks will be addressed effectively if the city does not have a basic infrastructure.

With efficient organization, smart cities have a lot of advantages:

- Development with a long-term perspective. Implementation of IT-technologies allows the municipal authorities to optimize the cost of resources: water, fuel, electricity and even household waste.
- The city. Implementation of IT technologies contributes to the formation of a well-informed and healthy society.
- Expansion. Intelligent cities not only save municipal funds and improve the quality of life of the inhabitants.

### Abstract

**Introduction.** More than half of the world's population lives in cities. Cities, metropolitan areas give rise to problems of new species. Difficulties in waste management, resource requirements, air pollution, health hazards, road traffic jams and aging urban infrastructures are among the most important technical, physical and material problems. The urgency of the article is the development of "smart cities", by introducing innovations and improving the efficiency of functioning of the main spheres of life of cities.

**Purpose.** The article is to study the international and domestic experience of building smart-city and develop a smart-city roadmap.

**Research results.** "Smart City" is a new strategy aimed at providing assistance to cities in which there are a number of problems, such as: high population density; increase in the number of vehicles; inefficient use of resources, climate change, deterioration of energy infrastructure. To solve the above problems, we propose to develop a model of the ideal "smart-city". To build the perfect smart city model, we will use the classic six characteristics: smart economy, smart-management, smart-society, smart-mobility, smart-environment and smart-life. Cities and their transformation in smart cities are not in the empty space, but in the context of the global transformation of the world economy into the digital economy. And practically everything that is happening in this or that country is related to the "capital" of the digital economy - a smart city. The success of the "smart-city" project depends directly on effective planning and control of its implementation. Therefore, planning and controlling the implementation of the change in the structure of the project are important components that determine the success of the overall restructuring program. A flexible approach to developing a restructuring program is the smart-city roadmap, which, according to our proposal, consists of six stages.

**Conclusion.** There is currently no single methodology for evaluating and comparing smart cities. Researchers working in this area use rating agencies as the tool for presenting survey results. The construction of "Smart City" is a complex of measures aimed at modernizing all areas of city management. Each city, as a rule, has its own tasks. Some solve security-related problems, others will improve the functioning of municipal transport, while others reduce energy losses in homes. None of these tasks will be addressed effectively if the city does not have a basic infrastructure.

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