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STRATEGIC BUSINESS MANAGEMENT IN TODAY'S ENVIRONMENT: DIGITAL DEVELOPMENT TECHNOLOGIES

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DIGITAL MANAGEMENT TEHNOLOGIES IN THE CONDITION OF SUSTANABLE DEVELOPMENT

Summary

«Cybernetic concept of management in the space of marginal resources and states of the object of development» has been adapted to the social component of sustainable development of cities and communities. The concept of CURSOR +, the object of modeling of which is sustainable development has the following components: system-situational model of development; problem-diagnostic model of sustainable development. Indicators and indicators of the goal of «Sustainable development of cities and communities» are considered, in particular: to ensure the availability of housing; to ensure the development of settlements and territories exclusively on the basis of integrated planning and management with public participation; to ensure the preservation of cultural and natural heritage with the involvement of the private sector; to ensure timely notification of the population about emergencies with the use of innovative technologies; reduce the negative impact of pollutants, including on the urban environment, in particular through the use of innovative technologies; to ensure the development and implementation of local development strategies aimed at economic growth, job creation, tourism development, recreation, local culture and local production. The forecast of indicators is applied using the method of exponential smoothing. It has been found that the main digital management technologies used in the economics and society are based on a combination of technological trends such as hybrid reality, artificial intelligence and quantum computing. The advantages, disadvantages and drivers of growth of modern digital technologies are considered.

Introduction

Ukraine has joined the global process of sustainable development, which is taking place in the context of rapid digitalization of economic and social life. Digital technologies fill the living space with smart electronic-digital devices, technical means, components and financial settlement systems based on digital technologies [1].

Achieving the sustainable development goals (SDGs) is an integral part of building a civilized and democratic society, the integrated interaction of physical and virtual space, the transformation of business, financial and social relations [1].

During 2016–2017, a large-scale process of adapting the SDGs to the Ukrainian context continued [2].

The creation of a national strategic framework for Ukraine for the period up to 2030 was based on the principle of «no one left out». Each global goal has been considered to take into account the specifics of national development. The result of this work was a national system of SDGs, which consists of national development tasks with relevant indicators [2].

Therefore, the most important issue for Ukraine is to ensure conditions for sustainable development and achieve the targets of all established indicators and the formation of cyberspace [1].

Sustainable development is a general concept of the need to strike a balance between meeting the modern needs of humanity and protecting the interests of future generations, including their need for a safe and healthy environment. The Brundtland Commission, in its report, formulated the definition of sustainable development as «development that meets the needs of the present without compromising the ability of future generations to meet their own needs» [3].

Harmonizing economic, social and environmental components and moving to specific measures that are a means of achieving sustainable development is a challenge. Because all three elements of sustainable development must be considered in a balanced way.

The mechanisms of interaction of these three components are special. The economic and social elements that interact with each other give rise to new challenges, such as achieving equity within one generation (for example, on income distribution), and providing targeted assistance to the poor. The mechanism of interaction of economic and environmental components has given rise to new methods of valuation and internalization (accounting in the economic reporting of enterprises) of external influences on the environment. The relationship between the social and environmental components has aroused interest in issues such as intergenerational and intragenerational equality, including respect for the rights of future generations, and public participation in decision-making [3].

The concept of sustainable development is constantly evolving, the mechanisms of interaction of components are becoming more complicated, and digital technologies accelerate the transfer of knowledge and their conversion

into an innovative product, and changing basic technologies and business process models on the socio-economic-ecological system, society and man [1].

Features of digitalization of economic and social life are [1]:

– development of the concept of a single information space and the formation of a single information field;

– formation and expansion of the digital market;

– formation of technological consciousness;

– change of time and cost aspects of management;

– dynamism of all processes and fast access to any information;

– transformation of cultural values and formation of culture of the virtual environment.

Thus, in a single cyberphysical space, the boundaries of time and space disappear, and all elements of the physical and virtual worlds interact simultaneously due to the availability of digital copies, codified and formalized knowledge. All this provides opportunities for qualitative modeling of real processes and allows solving the problem of strategic forecasting [1].

Part 1. Cybernetic concept of management in the space of marginal resources and states of the object of development

Sustainable development is a system-driven development. At the heart of its manageability there are a systematic approach and modern information technologies, which allow to quickly model different options for development, with high accuracy to forecast their results and choose the most optimal one [3].

The systemic-situational approach is the basis of the cybernetic concept of management in the space of marginal resources and states of the object of development. The concept of management in the space of marginal resources and states of the object of development was proposed by V. Ruban [4].

The simplest and clearest representation of the system – situational model of development is a four-pole shell (Fig. 1). Its vertical is limited at the top by the extremely positive (desirable) and at the bottom by the extremely negative (dangerous) pole, is adequate to such a fundamental concept as the process of development of the object of modeling (OM). The horizontal, which on the one hand is limited by extremely non-renewable, and on the other – extremely inexhaustible resource, is adequate to the resources used for development. The space bounded by the above poles can be imagined as a space for the development of OM. The introduced concepts of the space of marginal resources and states of development objects became the basis for the title: «Concept of management in the space of marginal resources and states of the object of development» (CURSOR). Due to its further development in recent years, the concept has received a new title: «Cybernetic concept of management in the space of marginal resources and states of the object of development» (CURSOR +).

A meaningful interpretation of each of the poles of the vertical and horizontal of the four-pole shell is considered. The extremely positive pole of the

development vertical should be understood as the highly desirable limit of perfection of the modeling object, i.e. some of its ideals. The concept states that the ideal pole is unattainable, but it can be approached indefinitely. The process of development of any object is considered progressive if its essential properties are monotonously approaching the limit of perfection – «ideal». The unattainability of the «ideal» and, at the same time, the possibility of getting as close as possible to it, makes the process of progressive development potentially infinite, i.e. eternal. Sustainable development is a progressive potentially endless development. The real attainability of an ideal is limited by a positively small distance from the ideal.

The extremely negative pole of development of any object of reality in the concept is meant the extremely dangerous state, which causes significantly premature cessation of functioning or even existence of the object under study. It is natural to call this state a «catastrophe.» Therefore, the concept of «CURSOR +» is also called the concept of «ideals» and «catastrophes».

From a systemic point of view, the boundaries of ideal and catastrophe should be considered as system-forming invariants – classes of its states that are constant in the life cycle of the modeling object. It is worth emphasizing that any object in the real world has a systemic-situational nature. The systematic nature of an object makes it possible to distinguish it from the environment and identify it as reality, and situationality makes it possible to observe or manage the space of its situational states within the system-forming poles of development of this object. These poles, i.e. the limit states, set the boundaries of the progressive or regressive life cycle of the object of modeling, and situational ones reproduce the process of functioning and purposeful development, i.e. the change of states of this object. Situational states include target (planned), adequate to the direct connection of the subject and the object of management, actual (current), adequate to their feedback, expected (forecast) state. Thus, the process of functioning and development of any object of reality can be characterized by a space of states of five types of states – two marginal and three situational. In CURSOR + this state space is called the «universe» of states.

The horizontal of resources, as already noted, is limited, on the one hand, by a non-renewable resource, the role of which in CURSOR + is a fundamental category of time (past, current (present, modern), future); on the other hand, the horizontal of resources is limited by an extremely inexhaustible resource, which progressively grows under the influence of its consumption. The role of this resource in CURSOR + is such a fundamental category as knowledge, i.e. genuine (true) reflection of reality (past, present, future) in human thinking. These marginal resources have only recently begun to be perceived as the most significant intangible assets of development.

The concept of CURSOR +, whose object of modeling is sustainable development, has the following components: systemic-situational model of

development (Figure 1); problem-diagnostic model of sustainable development (Figure 2).

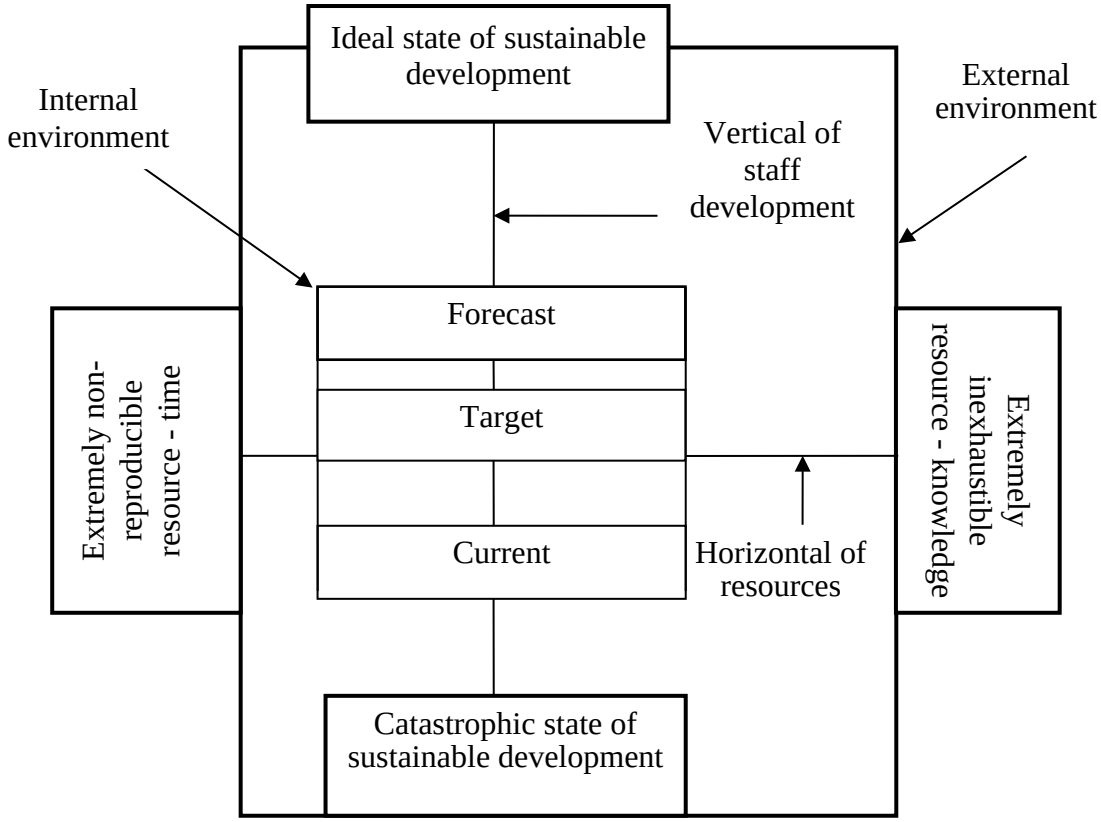

Figure 1. The systemic-situational model of sustainable development

The first component – the system-situational model of sustainable development consists of the vertical of development and the horizontal of resources required for its development (Figure 1). The staff development vertical shows two marginal conditions. Ideal state – the extremely unattainable state can be set by the limit values of economic, environmental and social goals of sustainable development: overcoming poverty; agricultural development; good health; quality education; gender equality; clean water; available and clean energy; decent work and economic growth; industry, innovation and infrastructure; reducing inequality; sustainable urban development; responsible consumption and production; climate change mitigation; conservation of marine resources; protection of the land ecosystem; peace, justice and strong institutions; partnership for sustainable development.

The limit of perfection, like any ideal, is unattainable, but it can be approached indefinitely. This property of the ideal creates the potential for virtually unlimited development. Catastrophic – an extremely dangerous state, as a catastrophe corresponds to a state of premature termination of the system, such as environmental disaster.

The second component – the problem-diagnostic model of the object – is presented in Figure 2.

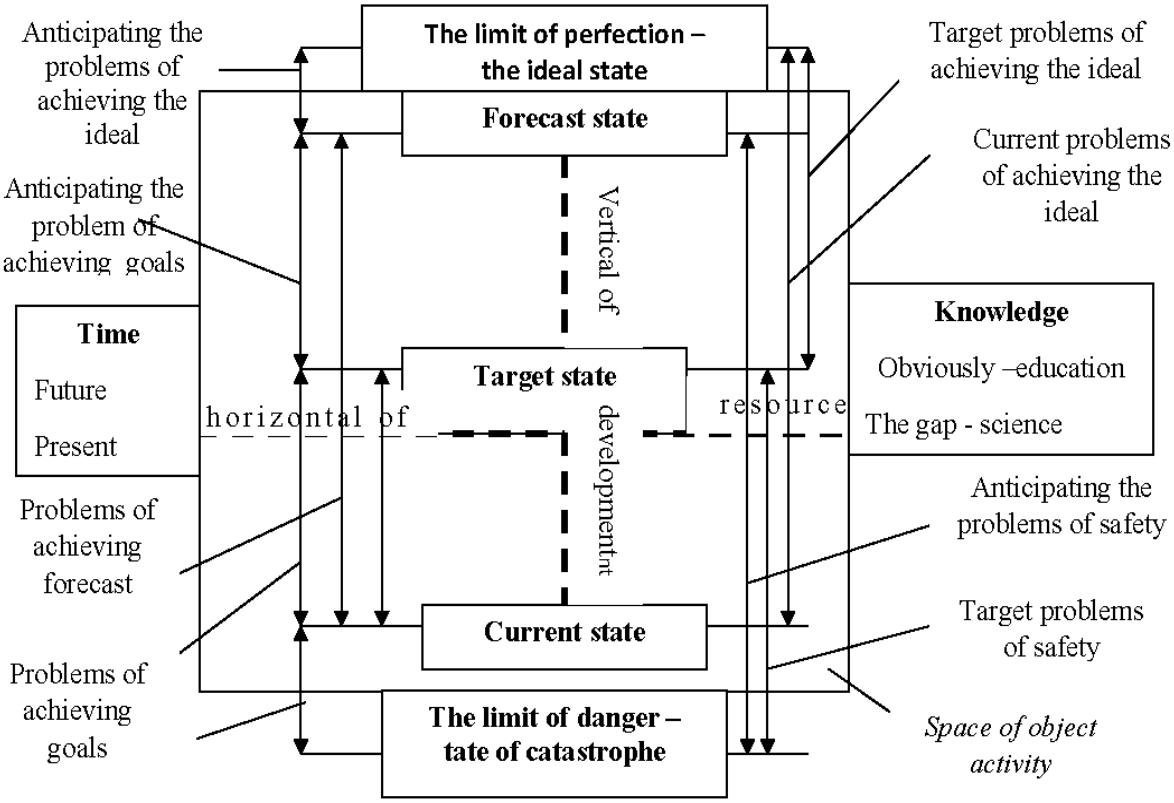

Figure 2. Problem-diagnostic model of the object

To build a problem-diagnostic activity model of any economic system, such system-forming invariants are accepted: marginal types of resources – time (maximum non-renewable resource), knowledge (maximum non-exhaustive resource); the ultimate poles of development, respectively, positive – «ideal» and negative – «catastrophe».

To implement the concept of sustainable development, an important issue is the definition and forecasting of its practical and measurable indicators. Based on the above triad, such indicators can link all three components and reflect the environmental, economic and social aspects [3].

Modeling on a set of systemic-forming and situational financial and economic states of sustainable development allows implementing the problem-diagnostic functions, separating strategic, tactical, operational and other systemic, systemic-situational or situational problems.

Part 2. Sustainable development of cities and communities

One of the goals of the social component of sustainable development is: «Sustainable development of cities and communities.» Achieving it requires the following tasks [2]:

Goal 1. To ensure housing affordability:

– the borrower's solvency ratio, PTI (the ratio of monthly expenses of the borrower and his family members to service the debt on a soft mortgage loan obtained from the state or local budget and the total monthly income). *Target guide is not set;*

– coverage of territorial units of Ukraine (regions), programs to provide affordable housing for different categories of citizens, %.

Goal 2. To ensure the development of settlements and territories exclusively on the basis of integrated planning and management with public participation:

– the share of regions that have approved and implemented regional development strategies and action plans for their implementation, developed with public participation, %.

The target guide set for 2020 is 100% (25 regions) (Table 1).

Table 1

Dynamics of indicators for ensuring Goals 1, 2

Years	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
the borrower's solvency ratio, PTI (the ratio of monthly expenses of the borrower and his family members to service the debt on a soft mortgage loan obtained from the state or local budget and the total monthly income).	0,36	0,5	0,28	0,23	0,19	0,34
Coverage of territorial units of Ukraine (regions), programs to provide affordable housing for different categories of citizens, %	100	100	100	100	100	100
Share of regions that approve and implement:						
Regional strategy	88 (22)	100 (25)	100 (25)	100 (25)	100 (25)	100 (25)
Regional strategy and action plan for its implementation (stage 1)	64 (16)	96 (24)	100 (25)			
Regional strategy and action plan for its implementation (stage 2)			52 (13)	84 (21)	92 (23)	100 (25)

Source: sorted by data [2]

Goal 3. To ensure the preservation of cultural and natural heritage with the involvement of the private sector:

– number of cultural and natural heritage sites included in the UNESCO World Heritage List, units. *The target guide set for 2020 is 9;*

– the number of monuments of national importance included in the State Register of Immovable Monuments of Ukraine, units. *The target guide set for 2020 is 1005;*

– the area of nature reserve fund of national importance, % of the country's territory. *The target guide set for 2020 is 5,14.*

Goal 4. To ensure timely notification of the population about emergencies using innovative technologies:

– level of implementation (creation, modernization, improvement) of local automated systems of centralized notification of the population, %. *Target guide for 2020 is not set.*

Goal 6. To ensure the development and implementation of local development strategies aimed at economic growth, job creation, tourism development, recreation, local culture and local production:

– the number of employees in the business entities of tourism (ISIC code – 2010 – 55.1,55.2, 55.3, 79.11, 79.12), persons. *Target guide for 2020 is not set.*

Table 2

Dynamics of indicators of providing Goals 3, 4, 6

Years	2015	2016	2017	2018	2019	2020
Number of cultural and natural heritage sites included in the UNESCO World Heritage List, units.	7	7	7	7	7	7
Number of monuments of national importance included in the State Register of Immovable Monuments of Ukraine, units.	891	891	906	956	995	998
the area of nature reserve fund of national importance, % of the country's territory.	3,72	4,10	4,10	4,10	4,24	4,32
Level of implementation (creation, modernization, improvement) of local automated systems of centralized notification of the population, %.	0,05	0,05	0,05	0,1	0,1	0,1
the number of employees in the business entities of tourism (ISIC code – 2010 – 55.1,55.2, 55.3, 79.11, 79.12), persons.	54421	55413	58588	62585	61342	60256

Source: sorted by data [2]

Goal 5. To reduce the negative impact of pollutants, including on the urban environment, in particular through the use of innovative technologies:

– the volume of emissions of pollutants into the atmosphere by stationary sources of emissions,% to the level of 2015. *Target guide is not set;*

– the number of cities in which the average annual concentrations of major pollutants in the air exceed the average daily maximum allowable concentrations, units. *Target guide for 2020 is not set.*

The results of the first stage of statistical research, namely statistical observation, are disparate information about each unit of the totality under study, which varies in space and time (Table 3). Such information does not characterize the population as a whole: does not give an idea of the magnitude of the phenomenon, its composition, size, characteristics, connection with other phenomena; in isolated phenomena so far there is no general and natural [5].

Table 3

Dynamics of indicators of providing Goal 5

Years	2015	2016	2017	2018	2019	2020
1. Volume of emissions of pollutants into the atmosphere by stationary sources of emissions, % to the level of 2015.	100	107,7	90,5	87,8	86,1	68,5
2. Number of cities in which the average annual concentrations of major pollutants in the air exceed the average daily maximum allowable concentrations, units.	34	34	34	35	36	36
Suspended matter (dust)	11	10	9	11	11	11
Sulfur dioxin	-	-	-	-	1	1
Carbon monoxide	2	5	4	3	4	4
Nitrogen dioxin	23	23	21	22	26	27
Nitric oxide	1	2	1	2	2	2
Phenol	6	5	8	7	9	8
Soot	1	1	1	1	1	1
Hydrogen fluoride	2	2	2	2	3	3
Ammonia	2	2	1	1	2	2
Formaldehyde	23	23	24	25	25	25

Source: sorted by data [2]

To obtain a summary of the entire object under study using a system of summary indicators, it is necessary to bring the whole mass of individual data to a certain order, systematize, process and summarize the results obtained as a result of statistical observation. This will make it possible to identify the features and characteristics of the statistical population as a whole and its individual components, to show the patterns of the studied socio-economic phenomena of processes. This problem is solved in the second stage of statistical research, which is called the summary of statistics [5].

Tasks and indicators of the goal «Sustainable development of cities and communities» are presented in Figure 3.

Monitoring of the SDGs in Ukraine showed that the goal «Sustainable development of cities and communities» has a medium / low probability of achievement [2]. Also, the analysis showed that there is a weak positive dynamics that needs to be significantly accelerated.

Therefore, it is necessary to use the tools of the «Cybernetic concept of management of marginal resources and states of the development object (CURSOR +)» to determine the target (P^T), current (P^C) and forecast (P^F) states of each indicator of the goal «Sustainable development of cities and communities». goals and provide an opportunity to identify vectors for their further development.

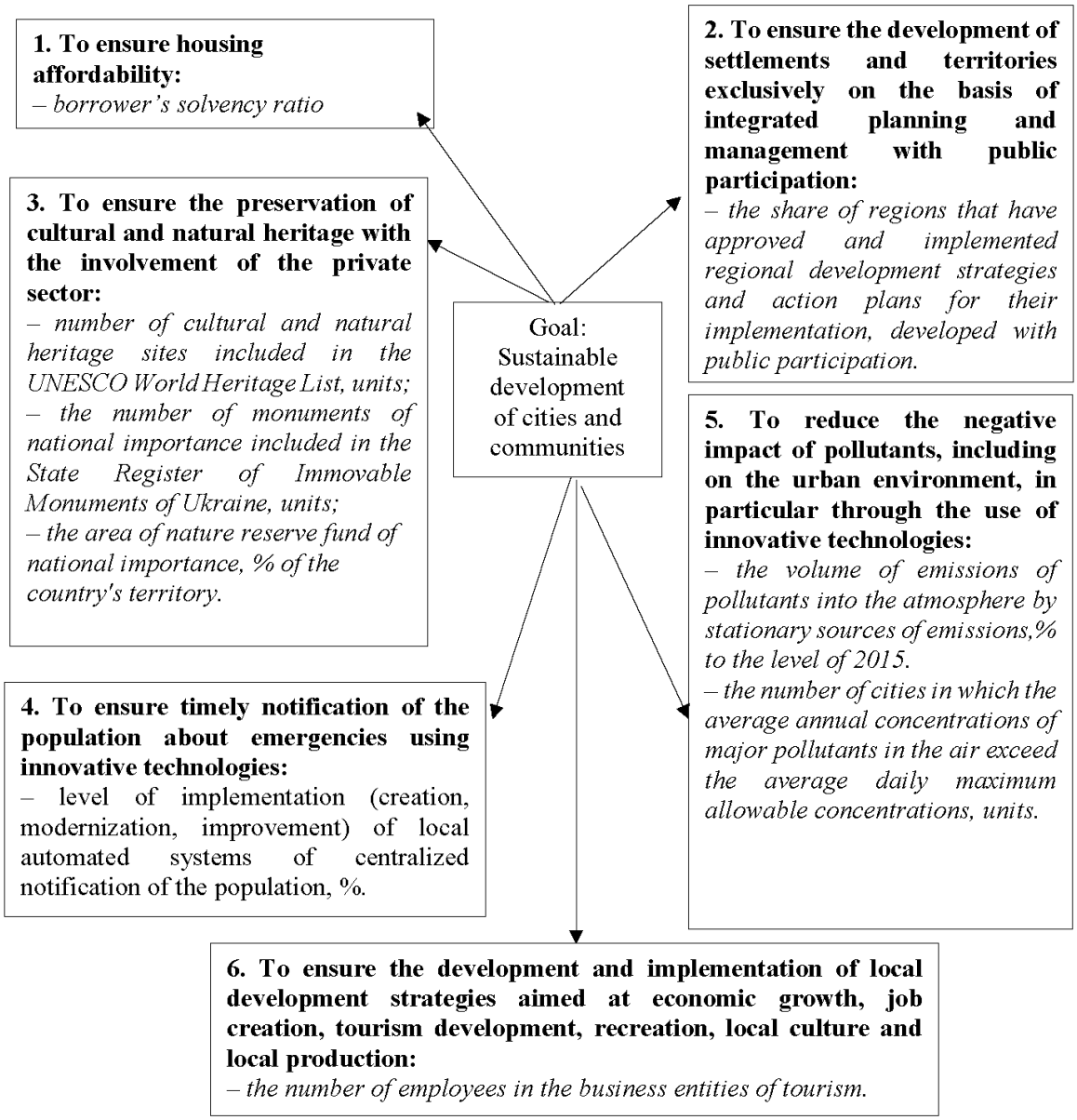

Figure 3. Objectives and indicators of the goal «Sustainable development of cities and communities»

Part 3. Digital technologies for goal development management: «Sustainable development of cities and communities»

Key digital management technologies used in the economics and society are based on a combination of technological trends such as hybrid reality, artificial intelligence and quantum computing (Figure 4) [6].

We will focus on a more detailed consideration of digital technologies in economics and business. In particular, to consider their advantages, disadvantages and drivers of development.

The first modern digital technology is *Big Data.*

Advantages: improving and accelerating decision-making, increasing the number of real-time decisions, open data for innovation, jobs for lawyers,

eliminating difficulties and increasing efficiency for citizens, cost savings, new categories of jobs.

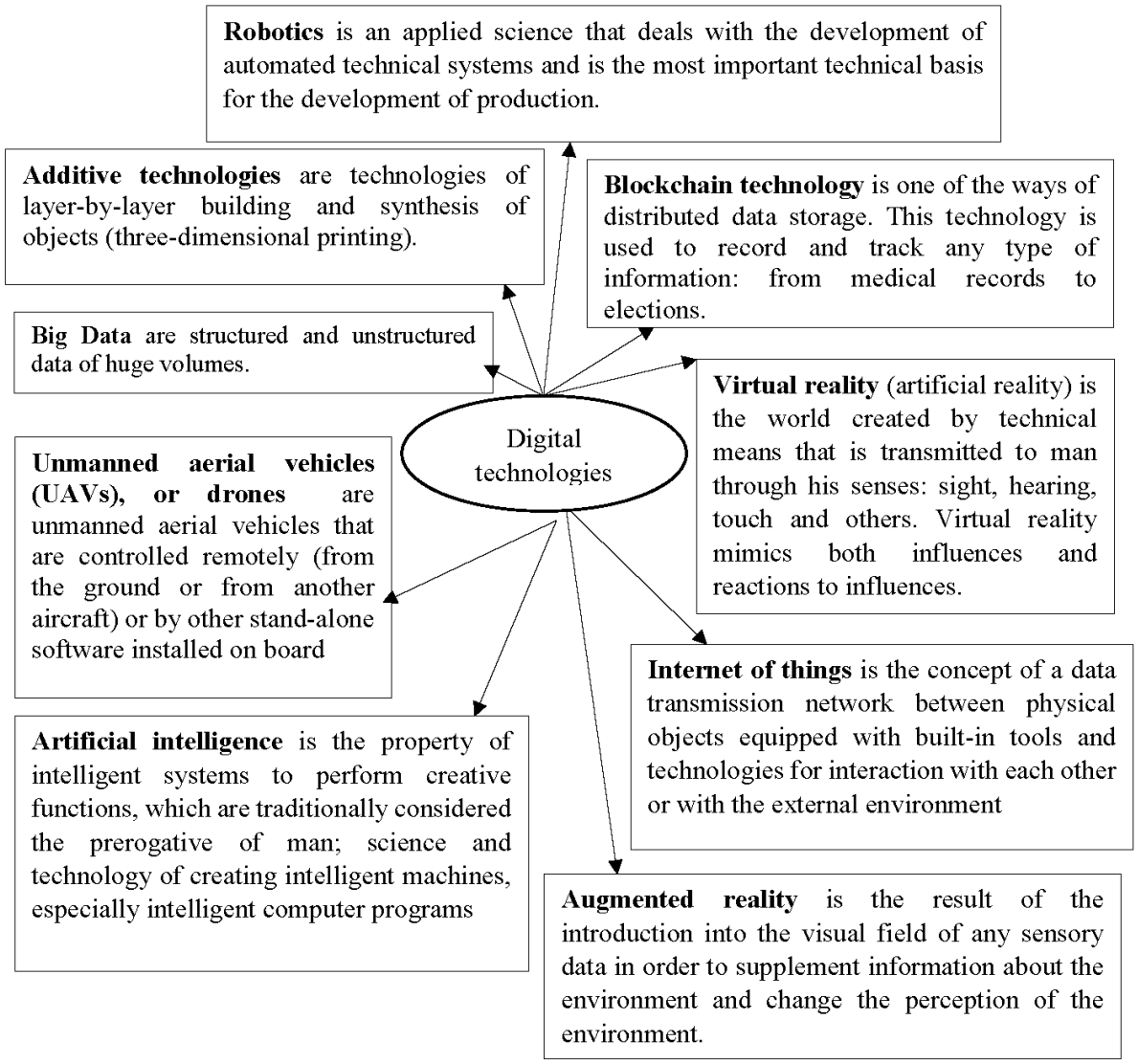

Figure 4. Key technologies in economics and business

Disadvantages: job loss, concern for the preservation of personal information, accountability, data trust, the struggle for algorithms.

Development drivers: increasing the speed of data transfer and media capacity, reducing the cost of data storage, increasing the availability of cloud services for data processing, launching educational programs for training specialists in data processing and analysis, increasing the amount of open data.

The second digital technology includes *Blockchain.*

Advantages: exemption from intermediary services of financial institutions, increase in the number of current assets, reduction of transaction fees, multiple increase in the speed of operations (transactions), better documentation of

property in developing markets, reasonable contracts with unbreakable escrow account, transparency of all transactions.

Disadvantages: legal uncertainty, the need to build infrastructure for the blockchain, the possibility of use by criminal organizations, the need to use huge computing power leads to expensive maintenance of equipment, the difficulty of using the technology is manifested in the lack of technical support.

Development drivers: the presence of an environment of trust between the parties to digital transactions, the need for new tools for data storage and processing, the growth of non-cash payments, the development of marketplaces based on blockchain technology, the need to increase transaction transparency.

Unmanned aerial vehicles, robots, sensors and artificial intelligence are the third digital technologies.

Advantages: elimination of intermediaries in supply and logistics, more free time, is used in ATMs, greater access to materials, industrial «reshoring», independence from energy, reorganization of outdated bureaucratic structures.

Disadvantages: job loss, cybercrime, going beyond what is clear, increasing inequality, responsibility and accountability.

Development drivers: increasing requirements for production flexibility, increasing demand for industrial equipment from companies to modernize production, increasing demand for service robots, increasing the capacity of fuel elements, the need to use robotics in conditions dangerous to human life and health.

The fourth digital technology is *three-dimensional printing.*

Advantages: accelerated product development, reduced «development-production» cycle, ease of production of complex parts, democratization of creation processes, the emergence of a new industry for the supply of materials for printing, creating niche products, more personalized products and custom manufacturing.

Disadvantages: increase in the amount of garbage and negative impact on the environment, the creation of parts that will not have the same fortress in all directions, changing the work cycle with further reduction of jobs, the quality of the brand and product.

Development drivers: growing demand for product developers, the use of 3D printing by educational institutions to accelerate the process of learning and understanding.

The fifth digital technology is *virtual and augmented reality.*

Advantages: immediate transfer of information to a person for decision-making, improved ability to perform tasks or produce goods and services, providing people with disabilities, resources.

Disadvantages: mental disorders, injuries from the negative effects of immersion, increased dependence level, increased amount of one-time information.

Development drivers: increasing demand for display systems, augmented and virtual reality devices and programs, increasing demand from companies

for UX design solutions, increasing display power and resolution, availability of navigation sensors in smartphones, development of global media content, demand for immersive learning.

The last of the major digital technologies in economics and business is *the Internet of Things.*

Advantages: increasing efficiency of resource usage, productivity growth, improving quality of life, reducing the cost of providing services, efficiency increase, setting up new businesses, adding digital services to the core functionality of the product, a digital counterpart in the life of the client.

Disadvantages: personal confidentiality, loss of jobs for unskilled workers, security threats, increasing the level of complexity.

Development drivers: reducing the cost of sensors, standardization of industrial Internet technologies, the spread of fifth-generation communications, the development of unmanned vehicles, increasing the number of connected devices [6].

The use of modern forecasting tools is suitable for diagnosing the achievement of sustainable development goals. The most popular and less expensive methods and models for predicting time series include: naive models, forecasting methods based on averaging and methods of exponential smoothing.

It is proposed to use the method of exponential smoothing to forecast quantitative indicators of the goal of sustainable development «Sustainable development of cities and communities». This method uses weighted current averages of all data from past observations of indicators [7].

The purpose of this approach is to assess the current situation, the results of which determine all subsequent forecasts. Forecast values by this method are determined by the formula. $\hat{Y}_{t+1} = \alpha Y_t + (1-\alpha)\hat{Y}_t$, де $\hat{Y}_{t+1}$ – forecast value for the next period; Y_t – observed value for the current period t; $\hat{Y}_t$ – forecast for the period t; α – constant of smoothing ($0 < \alpha < 1$) [7]. It has been experimentally established that α=0,8.

We will use this method to forecast the targets that are set to achieve the goal of sustainable development «Sustainable development of cities and communities».

Before using the forecasting method, we perform a statistical summary of data.

Summary means a set of methods of scientific generalization and processing of statistical observation data in order to obtain statistical indicators and their subsequent analysis. On the basis of these indicators a description of the population should be given, as well as the size of its inherent features, the structure of the population and its qualitative composition, established specific features and patterns of the phenomenon under study, the relationship between features, etc. [5].

As a result of the summary, the transition is made from the data collected for each individual unit of the object of observation, to the final data on the totality as a whole or groups selected within it. This data fills in the compiled layouts of tables or forms of statistical forms [5].

There are summarys in the narrow and broad sense. Statistical summary in the narrow sense is the calculation of results in groups and subgroups and the design of the obtained material in tables [5].

Statistical summary in a broad sense includes: 1) grouping of statistical observation data, which includes the selection of grouping characteristics, determining the number of groups and the size of the interval, the formation of groups and subgroups; 2) summarization (summary in the narrow sense of the word) of indicators for individual groups and the whole, i.e. obtaining absolute statistical indicators; 3) calculation based on absolute indicators of average and relative values; 4) tabular and graphical design of the results of construction and their analysis [5].

Completeness, reliability and substantiation of the results are provided by the program and its implementation plan.

The program of statistical summary contains a list of groups into which the set of observation units can be divided, as well as a system of indicators that characterize the studied set of phenomena and processes as a whole and its individual parts. It also includes grouping features to form homogeneous, typical groups; determining the order of formation of groups; development of a system of statistical indicators for the characterization of groups and the object as a whole; development of layouts of statistical tables to present the results of summary and selection of methods for compiling statistical observation data [5].

Statistical summary is carried out according to the developed plan. The summary plan includes issues related to the sequential implementation of its individual stages, the order of processing of observation materials, it indicates who and in what time frame carries out the summary, what method, the destination of the summary data, who conducts their further processing, analysis and registration of its results in tables, publications, statistical collections, etc. It differs in the following features: the complexity of construction, the method of development of statistical observation materials and location [5].

The complexity of the summary construction can be simple and group. A simple summary consists in obtaining a summary of the entire array of source information. Any preliminary grouping and systematization of the source information is not performed. A simple summary has mainly ancillary purposes. The group summary is developed on the basis of the source information which is preliminary systematized and grouped. Thus, the group summary differs from the simple in its informativeness, the content of a larger number of group results [5].

According to the method of developing materials for statistical observation, the report is divided into manual and machine. In manual summary, all basic operations (encryption, sorting, counting, etc.) are performed manually using cards or lists. Machine summary is performed using computers [5].

It can be centralized or decentralized at the place of construction. Centralized is a summary in which all primary statistical materials are concentrated in one place, where they are developed according to a single program in the right sections and groups. Decentralized is a summary in which the final data are obtained on the basis of their processing in successive stages [5].

The forecasting results are presented in table 4.

Table 4

Real and forecast values of the main indicators of achieving the goal of sustainable development «Sustainable development of cities and communities»

Years	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021***	**2022***
The main indicators of Goals 1-6 (OPC 1-6), % by 2015								
OPC 1	36	50	28	23	19	34	29	3
OPC 2	88	100	100	100	100	100	99	98
OPC 3	100	100	102	107	112	112	111	108
OPC 4	5	5	5	10	10	10	9	8
OPC 5	110	108	91	88	86	69	76	85
OPC 6	100	102	118	115	113	111	111	109

*Source: formed by the authors, where * – forecast values of indicators, OPC (1-6)- the main indicators of goals 1-6.*

Figure 5 presents real data and forecasts for 2021–2022 of the main indicators of achieving the goals of sustainable development «Sustainable development of cities and communities».

Based on the calculations presented in Table 4 and Figure 5, we can draw the following conclusions about the implementation of the targets:

– share of regions that have approved and implemented regional development strategies and action plans for their implementation, developed with public participation,%. The target set for 2020 – 100% (25 regions) is performed, although there is a tendency to reduce the value of the indicator in 2021–2022;

– the number of monuments of national importance included in the State Register of Immovable Monuments of Ukraine, units. The target set for 2020 – 1005 is not performed and amounts to 998 units, there is a decrease in their number in 2021–2022.

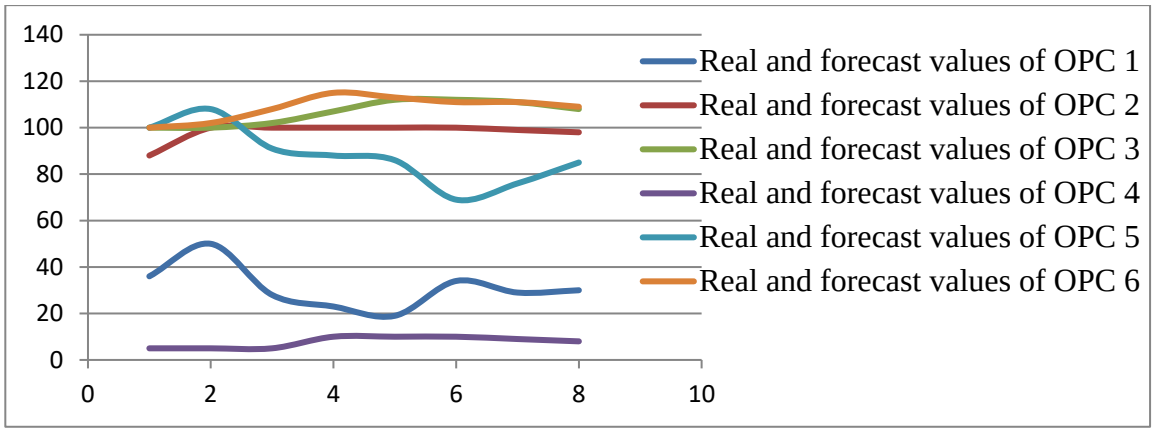

Figure 5. Real and forecast values of OPC 1-6 for 2015–2022

Taking into account the results of the forecast for 2021–2022 presented in Table.4 we can draw the following conclusions:

– the value of the borrower's solvency ratio (RTI) begins to grow, which indicates a positive trend in the implementation of Goal 1 of sustainable development;

– the value of the indicator of implementation of Goal 2, namely: the share of regions that have approved and implemented regional development strategies and action plans for their implementation, developed with public participation is declining, indicating problems in the implementation of Goal 2;

– the level of implementation (creation, modernization, improvement) of local automated systems of centralized notification of the population, % decreases, which indicates problems in the implementation of Goal 4;

– the value of the indicator of emissions of pollutants into the atmosphere by stationary sources of emissions, % to the level of 2015 increases, which indicates a problem in the implementation of Goal 5;

– the number of employees in tourism businesses is declining, indicating problems with Goal 6.

Carried out diagnosis of the indicators of the goal of sustainable development «Sustainable development of cities and communities» provided an opportunity to conclude that in order to achieve the established targets in Ukraine it is necessary to implement modern innovative concepts of urban and community development. One of such concepts is the concept of «smart» city.

A «smart» city is a concept based on the idea that a city should use a variety of information technologies and innovative solutions to improve the efficiency of its operation and use all resources according to the needs of its inhabitants.

These technologies and innovations are used to interact with government agencies and receive digitalized administrative services, to improve streets, improve the transport network, medical care, energy and water supply, to improve living conditions, and more. However, the main purpose of a «smart» city is to provide comfort and benefit citizens, increase energy efficiency and save them time and money.

Analysis of cities in different countries according to nine criteria: human capital (development, attraction and education of talents), social cohesion (consensus between social groups), economy, environment, governance, urban planning, international relations, technology, mobility ease of movement) allowed to summarize the main features of a «smart» city [8]:

Intelligent transport system. It is aimed at improving the safety and efficiency of the transport process, comfort for its participants. It often involves video surveillance on highways; obtaining data on the condition of roads, congestion of parking lot in the city; informing passengers about the time of arrival of public transport, changes in traffic directions, etc.

Intelligent traffic control systems.

They provide for increased safety and efficiency of the transport process, comfort for drivers and transport users. As an example, in many countries around the world, and in Ukraine in particular, video surveillance is installed on highways, which allows controlling violations of traffic rules. In addition, information on the condition of roads, congestion in the city, informing passengers about the arrival time of public transport, changes in traffic directions, etc. play an important role in this concept. This information allows saving time and managing it properly. «Smart» public transport, which allows monitoring everything that happens in the cabin and outside during the movement, using geolocation and transmitting information about violations to the appropriate authorities.

Cashless payments. Today, paper money is almost never used in developed countries – it has been replaced by bank payment cards. But this is not the final decision. The concept of a smart city provides for the constant use of mobile payments so that residents do not have to carry large sums or many cards, special devices are installed that can make payments using a mobile phone and special in relation to it.

A smart approach to street lighting. Here, motion sensors are especially popular, which turn on the light only when they detect certain movements or the presence of a person, and turn it off when you, for example, leave the room. Street lighting works the same way. In addition, LED lamps (Light Emitting Diode – light products for domestic, industrial and street lighting, in which light sources are LEDs) are in great demand, as they reduce energy consumption by up to 80% compared to conventional incandescent lamps, to which we are accustomed.

Involvement of city residents in management. The most important component here is e-government and governance due to the influence of local authorities. All over the world, these areas have become widespread and many citizens communicate with the municipal authorities through electronic applications. In Ukraine, in recent years, this area has also begun to develop actively. Today, the most in demand are electronic petitions on the President's website, the ProZorro electronic public procurement system, and the iGov volunteer project, which gathers all possible means of obtaining information

from the state online. Online platforms of the government and agencies, which minimize the need to visit government agencies, allow involving city residents in management.

Smart house. This technology involves the use of a system of high-tech devices in the house for the most comfortable living. In particular, there are several main areas of smart house technology: security (sensors of motion, presence, vibration, glass breakage, window or door opening, video surveillance, electronic locks and gate control modules, sirens), lighting control (smart switches, curtain and shutter control modules), controllers for control of LED lamps, motion and presence sensors), climate control (humidity and temperature sensors, thermostats to maintain a constant temperature or its automatic regulation, thermostats to control the power of the heating battery, humidistats to maintain a constant humidity or its regulation). The «smart» house is a very important cleanliness of Smart City, which is aimed at improving the comfort of people's lives in homes through the use of high-tech devices.

Emergency notifications (EM). A personal alert network that sends regular SMS messages to the phones of subscribers in the emergency zone is extremely effective in many countries. In this way, it is possible to prevent an increase in the number of victims, as well as panic attacks, which in such situations are often no less harmful.

Emergency response buttons. Such tools help law enforcement to respond more quickly to certain events and arrive on the scene more quickly. This practice takes place in the United States and shows positive results.

Use of solar panels. In many cities around the world, where the climate allows, this practice is an integral part of a smart city. Solar panels are installed on the roofs of buildings, which can provide autonomous power supply for individual apartments or houses in general, depending on their area.

«Smart» healthcare solutions. Remote medical care, which allows therapists to consult and treat patients at home; special buttons that help a person in case of need to get first aid.

Combating pollution in cities. Provides constant control of air quality by means of sensors.

Digital security. It provides for, for example, the creation of special police services that protect information security and provide advice to small and medium-sized businesses.

Improving digital capabilities. For citizens, which will increase their social mobility and create opportunities for work in the new digital economy.

To become a smart city, governments, businesses and NGOs need to analyze open data and make decisions to improve the lives of residents.

In the leading cities of Ukraine, Smart City concepts are being actively developed and relevant modern technologies are being introduced [9].

The volume of capital investments in the city of Kyiv is UAH 61.2 billion. Within the framework of Kyiv Smart City, a dozen projects have already been implemented: issuance of certificates of housing registration, privatization of

housing, property management system, e-petitions service, medical portal, Kyiv resident information system, etc. [9].

The volume of capital investments in the city of Lviv is UAH 6.47 billion. The greatest successes in Lviv have been achieved in the field of information technology implementation: the creation of an electronic budget, public procurement system and electronic petitions, the Lviv authorities are ahead of colleagues from other cities [9].

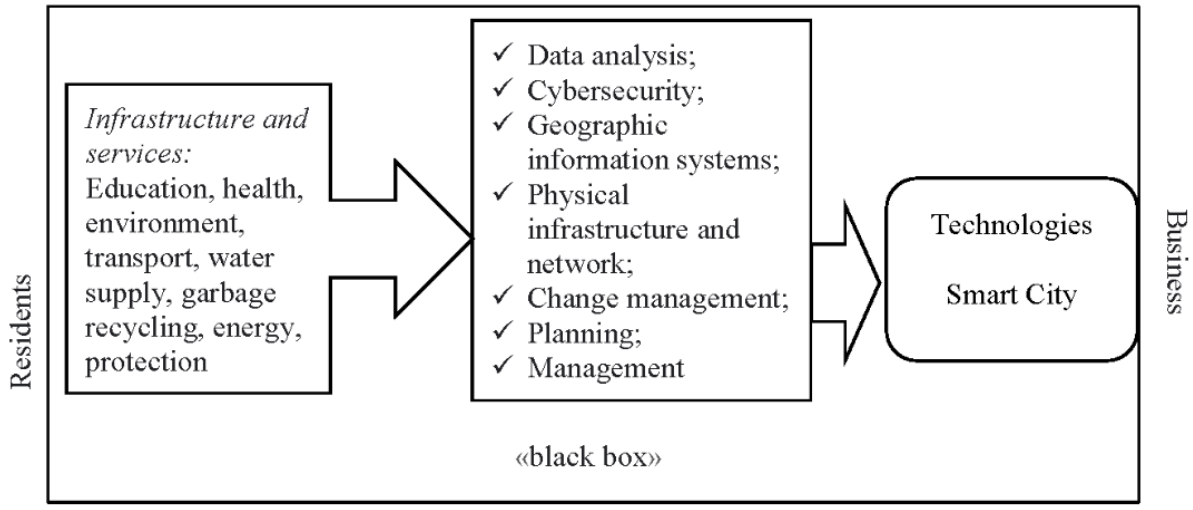

Figure 6. Smart city «black box» model

In addition, work is carried out to organize personal online offices of citizens and transfer to online administrative services.

Also, more than 80 km of bicycle paths have been laid in Lviv, six municipal bicycle rental points have been established, the introduction of electronic parking meters and the charging of electric cars has begun. The first electric bus of the Lviv concern «Electron» was also presented in Ukraine [9].

The volume of capital investments in the city of Dnipro is UAH 36.5 billion [9].

Among the current projects, the focus is on services that simplify communications and prevent theft of budget funds: electronic document management, e-petitions and administrative services, open budget and e-procurement system ProZorro. About 6.6 thousand electronic auctions were held in the city [9].

Many electronic innovations have been launched in the city, some of which have been implemented in Ukraine for the first time (for example, the interactive road condition analysis map «Navizor» and others).

The volume of capital investments in the city of Odesa is UAH 12.9 billion. The priority programs of the city of Odesa are public management of the city: the most open government, the introduction of various tools of interaction between government and society, as well as the relationship of different government agencies to create a «convenient city» [9].

The volume of capital investments in the city of Kharkiv is UAH 16.47 billion [9].

The city has succeeded in creating a single city information system of territorial management, which allows automating the work of government departments, information collection, control over the implementation of decisions and business processes.

Also, the city of Kharkiv is a leader in several categories – lighting, garbage collection, heating, second place in the development of transport infrastructure [9].

The entrances and entrance groups are being actively repaired in the city, the zoo has been reconstructed, yards are being improved, playgrounds for dogs are being opened, etc.

As part of the city's «Clean House» program, a tender was held for the purchase of 22 modern garbage trucks and 1,500 new containers through the ProZorro system [9].

Some of the problems that prevent the rapid implementation of smart infrastructure projects in Ukraine are:

– lack of quality and ubiquitous access to the Internet;

– low level of dissemination of the concept of «smart» city;

– «smartness» should be developed and disseminated not only at the level of local authorities and the non-governmental sector, but also at the level of residents – the main consumers of smart solutions;

– lack of clear quantitative and qualitative indicators of the efficiency of smart infrastructure implementation;

– lack of standardization (certification) of smart-equipment and inability to meet the relevant technical support of the project;

– inconsistency of legislation with the current socio-economic development in the field of digital technologies;

– inertia of state and municipal structures;

– insufficient level of funding (lack of a favorable investment climate that would attract the necessary investment, including foreigners);

– lack of highly qualified specialists in the field of development and implementation of digital technologies and others.

IT startups, mobile operators, companies working in the field of «Internet of Things» – are active participants in the process of creating urban innovations. There are a number of companies in Ukraine that are engaged in the creation of «smart» houses. Their experience can be scaled to develop a system of «smart» city.

Thus, OMO company, with the help of a collective access control system, automates routine actions for homeowners: entering the house or the territory of residential complexes from a mobile phone, using Face ID or video surveillance. The system also successfully solves utility problems of service organizations.

Kyivstar successfully tested NB-IoT, the Internet of Things network. With its help you can read the readings of sensors of municipal transport, water and heat consumption, adjust lighting depending on the time of day and weather, regulate traffic to avoid congestion, monitor the environment, increase safety on the streets [10].

Prolonged bureaucratic procedures and the unstable economic situation in Ukraine are slowing down the implementation of digital solutions. Given the number of technologies and their growth rates in the world, the transformation of cities must take place constantly. There are many IT companies in Ukraine that are ready to work to make cities «smarter».

One of the tools for the accelerated introduction of modern technologies in cities is the partnership between the state and private business. It is necessary to simplify the procedure of involving business in the implementation of state projects. However, this process is not regulated either at the legislative level or in practice.

It is also advisable to study the possibility of introducing the best foreign experience in building «smart» cities in Ukraine, and not only in large but medium-sized cities. This will lead to a life without traffic jams, without fear for safety during evening walks, without queues when paying for services. Living with an awareness of where the money from the local budget goes. This is possible only in a «smart» city. The concept of development of such cities is just beginning to be implemented in Ukraine, although in developed countries these things have long been a reality. Now «smart» cities are competing for the championship in international rankings.

Conclusions

1. Ensuring sustainable development is an integral part of building a civilized and democratic society in Ukraine, development planning and management decisions. The most important issue for Ukraine is to ensure the conditions for sustainable development and achieve the targets of all established indicators.

2. Sustainable development is systemically managed development. Therefore, to meet its needs, it is advisable to use the system-situational model of development, which is part of the «Cybernetic concept of management in the space of marginal resources and states of the object of development (CURSOR +)».

3. Providing conditions for sustainable development using the systemic-situational model of development allows assessing the relationship of its three components, taking into account the limits of development: lower – the limit of danger and -upper – the limit of perfection. Approaching the limit of perfection means approaching the limit values of economic, environmental and social goals: overcoming poverty; agricultural development; good health; quality education; gender equality; clean water; available and clean energy; decent work and economic growth; industry, innovation and infrastructure; reducing inequality; sustainable urban development; responsible consumption and

production; climate change mitigation; conservation of marine resources; protection of the terrestrial ecosystem; peace, justice and strong institutions; partnership for sustainable development. Approaching the danger limit corresponds to a state of premature cessation of the system, such as an environmental disaster.

4. The space of business activities of objects in the systemic-situational model of development (SSMD) should be determined using the components of sustainable development: economic, social and environmental, which will assess their relationship.

5. Diagnosis of the goal «Sustainable development of cities and communities» showed that it has a medium / low probability of achievement. There is also a weak positive trend that needs to be significantly accelerated. Therefore, determining the target (P^T), current (P^C) and forecast (P^F) states of each indicator of the goal «Sustainable development of cities and communities» will provide an opportunity to determine the vectors of their further development.

6. The results of forecasting the values of the six sustainable development goals provided an opportunity to draw the following conclusions:

– the forecast value of the borrower's solvency ratio (PTI) begins to grow, which indicates a positive trend in the implementation of Goal 1 of sustainable development (to ensure the availability of housing);

– target guide of Goal 2 is being carried out (to ensure the development of settlements and territories exclusively on the basis of integrated planning and management with public participation), although there is a tendency to reduce the share of regions that have approved and implemented regional development strategies and action plans the public in 2021–2022;

– based on the obtained forecast values of the main indicators of Goals 3-6 of sustainable development, we can conclude that the dynamics is negative, and therefore there are problems with the implementation of these Goals.

1. The vector of further development of the goal «Sustainable development of cities and communities» is the concept of «smart» city. This concept generates positive social changes, promotes the management and delivery of public services, human development and the accumulation of investment capital, serves to form highly integrated economic centers.

2. The main tool for implementing the concept of «smart» city is digital technology. Digital technologies, communication and data transmission infrastructure, cloud computing services and others can accelerate the achievement of the goal of sustainable development «Sustainable Development of Cities and Communities» in Ukraine.

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