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Econotronics of a smart city

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***Abstract* — The purpose of this study is to systematize the socio-technological drivers of the smart city development based on the author's concept of econotronics. The following theoretical and practical results are obtained. The specificity of the smart city is shown and the main socio-technological drivers of its development are presented. These drivers include big data processing, cloud technologies, blockchain, digital platforms, the Internet of things and the fractional economy. The author's conception of econotronics is presented as a concept of economic analysis of a digital society. Econotronics is an economy section on the institutions of interaction between economic agents and society through digital technologies dynamics development. Socio-technological drivers of smart city development are systematized by levels of econotronics modeling. The design of institutions corresponds to the application of big data technology, the distribution of institutions - to the use of cloud technologies, the measurement of institutions -to the use of blockchain technologies, and the evolution of institutions - to the use of digital platforms, the Internet of things and the sharing economy. The principles and ideas of institutional modeling of a smart city econotronics are presented. It is shown that different levels of modeling of economic institutions correspond to the application of socio-technological drivers of the smart city development. It is concluded that the principles and ideas of econotronics can be used to model the smart city institutional formation.**

Keywords* — *smart city, econotronics, development drivers, big data, cloud technologies, blockchain, digital platforms.

I. INTRODUCTION

The introduction of digital technologies in the management of socio-economic systems has stimulated the emergence of a significant number of new concepts for the development of territories. One of the viable concepts of the digitalization of society is the concept of a smart city. A smart city is an innovative city that uses information and communication technologies and other means to improve the quality of life, the efficiency of urban activities, when the needs of existing and future generations are matched by economic, social, environmental and cultural development.

At the same time, the development of a smart city is possible on the basis of the application of socio-technological drivers of the digital economy, which include big data processing, cloud technologies, blockchain, digital platforms, the Internet of things and the sharing economy.

For designing the development of a smart city, economic modeling tools are needed. The most modern instrumental approach for assessing and forecasting the development of economic systems is the methodology of institutional economics. The development of principles and ideas for modeling economic institutions is possible within the framework of the author's concept of econotronics. Econotronics is an economy section on the institutions of interaction between economic agents and society through digital technologies dynamics development [1].

At the same time, in the domestic and world economic literature, institutional modeling of the development of the smart city concept has not yet found its proper coverage.

Hence, the purpose of this study is to systematize the socio-technological drivers of the smart city development based on the author's concept of econotronics. The logic of the study, in this case, may be as follows. First, let us analyze the specifics of the smart city concept and the possibilities of econotronics for modeling its development. Then, on the base of the research procedure, we formulate the drivers for the smart city development. And then, within the framework of the discussion of the results obtained, we will consider the application of the principles and ideas of econotronics for the smart city institutional modeling.

II. THE SMART CITY ECONOTRONICS AND SPECIFICS

The smart city specifics lies in the formation of regulatory, normative and cognitive mechanisms for the introduction of information and communication technologies to improve the lives of citizens [2]. In this case, the smart city can be described by four indicators: smart economy, smart citizens mobility, smart use of the environment and smart management [3].

Note that bibliometric analysis and analysis of the patent base showed that the concepts of smart cities and sustainable cities converge in many ways. Smart cities should be sustainable and offer a high quality of life, and sustainable cities should use information and communication technologies to monitor resource use [4].

For sustainable urban development, it is advisable to apply the following principles: the development of high population density, mixed use of resources, local food production, ecosystem sustainability, availability of transport alternatives, housing diversification and availability of alternative energy sources [5]. All these principles can be realized on the basis of the introduction of advanced information technologies

implemented in the framework of the emerging digital economy.

We emphasize that the essence of the digital economy is the use of advanced digital technologies and modern socio-economic models for doing business, i.e. there is a convergence of factors of technological and social development, which leads to the emergence of hybrid innovations, including both technological and social components. Such hybrid innovations include big data processing, cloud technologies, blockchain, digital platforms, the Internet of things and the sharing economy.

Big data is the collection, processing, storage of large volumes of various data in a digitized format. The defining characteristics of big data are: data volume; growth rates, processing and obtaining results; variety of data; reliability, viability, value and variability of data [6].

Cloud technologies are technologies for placing a company's own data in the information space external to the company. The use of big data forces firms not so much to develop their own ICT-structure as to rent cloud services from providers.

Blockchain is a multifunctional and multi-layered information technology designed for reliable accounting of various decentralized assets.

A digital platform is a set of digital data, standards, models, methods and means, informationally and technologically integrated into a single automated functional system designed to manage the target sphere, its subjects and the organization of interaction between them and with them.

The Internet of things is the concept of a computer network connecting the virtual world and various physical objects of the real world, equipped with embedded digital technologies for interacting with each other in a machine-to-machine communication format and with the external environment, as well as capable of correcting and rebuilding economic and public processes.

sharing economy is a model of prudent management in which consumers of products or services actively participate (form a share of their participation) in the development of a given product or service. This method of management has been known since ancient times, however, it has received the most widespread with use of digital technologies, primarily with the development of the Internet [7].

But the use of socio-technological drivers for the development of the digital economy implies a sequence of introduction of such technologies. For example, the use of big data for smart cities includes at least four steps: search for knowledge about big data, application of knowledge gained, cooperation between organizations in the application of this knowledge, evaluation of results after the implementation of big data technology [8].

Managing smart cities requires “atomic” differentiation, since informatization affects all links of communication between people [9]. In this case, the institutional economic theory describing the norms of interaction between economic agents is applicable.

The introduction of the new concept of economic analysis, apparently, should be based on the following fundamental questions. What instrumental paradigm of research most adequately describes the development of the smart cities economic activities? What is the content of the new concept of economic analysis on the basis of their previous concepts?

The answer to the question about the most adequate instrumental paradigm of research lies in the possibilities of forming forecast estimates. Unfortunately, the “mainstream” of the twentieth century - the neoclassical research paradigm failed to provide a prediction of the global economic crisis of 2008–2009, since it is based on principles that are contrary to changes in the rules of economic activity conduct.

The most adequate paradigm for researching the phenomena of digital society is institutional economic theory, which provides a description of the rules of interaction between economic agents. Institutional economic theory is based on the basic idea that the development of economic activity is determined by institutions, in other words, rules or established norms of interaction between people. Five Nobel Prizes in Economics, awarded for the development of institutional theory, indicate the importance of an institutional approach to economic research.

The answer to the second question about the content of the new concept of economic analysis is in the plane of consideration of the preceding concepts: socioeconomics, constitutional economics, etc.

Socioeconomics - a direction that considers a person as having two basic needs and two sources of assessment: pleasure and morality. But the need for pleasure and the presence of morality are only one of the limitations of human behavior. Institutional economics considers the activity of an individual more broadly, assessing his behavior from various sides.

Constitutional economics is a direction that describes the mutual influence of legal and economic factors when making government decisions, as well as the relationship between the problems of applying the Constitution. But the driving forces of economic development are often initiated by innovators who do not rely on solving the problems of exercising constitutional rights.

Therefore, to describe the development of modern driving forces, it is advisable to use a concept that takes into account new social trends. The same conception was offered by A. Gouldner. Based on his research, sociotronics is a concept according to which the way out of the existing social pathologies can be made exclusively with the help of informatization of modern society [10]. Hence, closest to the subject of study, the driving forces of the development of a modern economy is economic sociotronics. In a more abbreviated version - econotronics.

Thus, econotronics is an economy section on the institutions of interaction between economic agents and society through digital technologies dynamics development [1].

Based on the above, the question arises: what principles and ideas can be used to model the implementation of smart city development drivers? But first it is necessary to systematize innovative technologies that ensure the formation of smart cities.

III. RESEARCH PROCEDURE

We studied the modern process of digitization of the smart city economic activities as an object of research. The subject of the research is the economic relations between agents of economic activity regarding the use of socio-technological

drivers of the digital economy development. The research method is a logical analysis of data published in the world scientific literature.

To systematize the drivers of smart city development, it is possible to apply a sequence of levels of institutional modeling: design, distribution, measurement, evolution of institutions [11].

IV. SMART CITY DEVELOPMENT DRIVERS

We summarize the results in table. 1.

TABLE I. LEVELS OF ECONOTRONICS MODELING AND SMART CITY DEVELOPMENT DRIVERS

Modeling levels	Development drivers	Application of development drivers
Institution design	Big data	1. Big data forms the "digital skin" of the city, which becomes a platform for obtaining data on the activities of society, its interaction with the environment and the variety of economic, political and social processes [12] 2. For the use of big data, an appropriate institutional infrastructure is needed, since the existing solutions are still focused on local pilot sites and data analysis outsourcing [13]
Distribution of institutions	Cloud technologies	1. Cloud technologies are necessary for the formation of the organizational field of smart cities, where the streams of scientific knowledge, the public sector, civil society and business firms can flow in[14] 2.City operating systems have arisen on the basis of systems of military and industrial enterprises due to reengineering, modularity and flexibility, taking into account open use [15]
Institutional measurement	Blockchain	Blockchain-based exchange services can contribute to the development of smart cities in a triangle of "man-technology-management" sides [16]
The evolution of institutions	Digital platforms	Using an open digital platform removes restrictions on participants and geo-referencing. An open digital platform is a new way of developing an innovation system [17] 2. Based on the platforms, you can build joint innovative networks, where the city is: a supplier, participant, catalyst, or experimenter [18]
	The Internet of things	1. The Internet of things is effective for solving problems of public health, social assistance and well-being of the population [19] 2. Smart objects have unique opportunities and personal experience of interaction with the consumer and with each other. The Internet of things has the potential to revolutionize consumer opportunities [20]
	sharing economy	For the all-round development of a smart city, citizen participation in government is necessary, as opposed to the corporate governance of a given territory [21]

The obtained results demonstrate the systematization of socio-technological development drivers by the levels of modeling of economic institutions in the framework of the concept of econotronics. We can see, that the design of institutions corresponds to the application of big data technology, the distribution of institutions to the use of cloud technologies, the measurement of institutions to the use blockchain technologies and the evolution of institutions to the use of digital platforms, the Internet of things and the sharing economy. Such a sequence also corresponds to the hierarchy of application of socio-technological drivers from a more general level (big data) to a more private level of applications (fractional economy).

But what could be the principles and ideas of institutional modeling of the smart city development within the framework of the econotronics concept?

V. THE SMART CITY INSTITUTIONAL MODELING

The evaluation of the design of econotronic institutions should begin with an analysis of research by E. Ostrom, winner of the 2009 Nobel Prize in economics. A system design for the exploitation of collective use resources must conform to a certain set of principles — in this case, the sustainable existence of collective ownership regimes is realized [22]. Thus, the first scientific principle of institutional modeling of econotronics can be formulated as follows: the design of economic institutions is based on the implementation of certain construction rules that describe the specification of the use of resources.

This principle was applied by the author and his colleagues when designing the institutional infrastructure for social entrepreneurship. Based on the results of original research, formal institutions for the development of social entrepreneurship were integrated into three groups: regulatory, supporting and cognitive institutions. From here, the first scientific idea of modeling econotronics can be formulated in the following formula. The design of the institutional infrastructure of econotronics is due to the division of groups of institutions according to the tasks of using various resources.

The distribution model of economic institutions can be represented as a hierarchy of rules by J. Buchanan [23]. Hence, the second scientific principle can be formulated as follows: modeling the distribution of economic institutions is possible on the basis of a hierarchy of functional content of the data of established norms of interaction between economic agents.

Modeling the distribution of economic institutions can be interpreted on the analysis of blockchain technology. The use of blockchain technology is based on decentralization of transactions and economic functions. The basic blockchain technology is a registry or log of data shared, commonly used and shared by all network nodes. Consequently, the following formula of the second scientific idea of the theory of modeling econotronics is possible. Modeling the distribution of economic institutions of econotronics is predetermined by the decentralization of transactions, which can be structured within the framework of blockchain technology.

The measurement of economic institutions is possible on the basis of the theory of transaction costs of the 1991 Nobel Prize winner in economics R. Coase [24]. He defined the relationship of institutional structure and transaction costs. Based on this, the third scientific principle can be formulated as follows: the institutional structure of the economic system can be measured by the costs of transactions for the formation and maintenance of these economic institutions.

At the same time, the measurement of the institutional structure of social innovation projects can be carried out according to the effectiveness of the implementation of economic institutions [25]. Thus, a third idea of institutional modeling of econotronics can be formulated. The measurement of economic institutions of econotronics can be based on the effectiveness of their application by evaluating commercial and public benefits.

A significant amount of Russian and foreign studies is devoted to a model description of the evolution of economic institutions. In this series, among domestic developments, the theory of V. Polterovich reforms is the most representative, as well as the macrogenerations theory of V. Mayevsky [26]. Hence, the fourth scientific principle can be formulated as follows: modeling of the evolution of institutions is possible on the basis of the formalization of the resource potential and the existing institutional infrastructure of the economic system.

One of the new social phenomena that have received the greatest development due to the digital economy is the formation and implementation of the mechanisms of a sharing economy. Therefore, we can formulate the fourth idea of the theory of institutional modeling of econotronics: the evolution of the institutional infrastructure of social projects is due to the use of methods for implementing a sharing economy.

Let us summarize the presented principles and ideas of the institutional modeling of the smart city econotronics in a table. 2

TABLE II. THE PRINCIPLES AND IDEAS OF INSTITUTIONAL MODELING OF THE SMART CITY ECONOTRONICS

Modeling level	Scientific principle	Scientific idea
Institutions designing Example: introduction of a specific project in the cities of Spain, the UK and Turkey ensures the formation of a smart city [27].	Execution of construction rules describing resource usage specification.	Separation of groups of institutions according to the tasks of using various resources.
Distribution of institutions Example: urban sustainability can be classified by planning objects and location [28].	Modeling based on the hierarchy of functional content of the established norms	Simulation is predetermined by the decentralization of transactions, which can be structured within the blockchain technology.
Measurement of institutions Example: new technologies for a smart city can be assessed through their usefulness and applicability [29]	The institutional structure of the system can be measured by transaction costs.	The measurement of econotronics institutions can be based on the effectiveness of their application by evaluating commercial and public benefits.
The evolution of institutions Example: Smart city modeling implies an assessment of the evolution of the city life cycle [30]	Modeling based on the formalization of the resource potential and the existing institutional structure	Modeling the evolution of social projects through the application of methods for implementing a sharing economy

Table 2 also presents examples of the design, distribution, measurement and evolution of economic institutions. Consequently, these levels of modeling of economic institutions correspond to the use of socio-technological drivers for the development of a smart city, and the principles and ideas of econotronics can be applied to model the institutional formation of a smart city.

VI. CONCLUSIONS

In the present study, in order to systematize the socio-technological drivers of the smart city development, the following theoretical and practical results were obtained based on the author's concept of econotronics.

Firstly, the smart city specifics is shown, and the main socio-technological drivers of its development are presented. These drivers include big data processing, cloud technologies, blockchain, digital platforms, the Internet of things and the fractional economy.

Secondly, the author presents the concept of econotronics as the concept of the economic analysis of digital society. Econotronics is an economy section on the institutions of interaction between economic agents and society through digital technologies dynamics development.

Thirdly, the socio-technological drivers of the smart city development are systematized according to the levels of econotronics modeling. The design of institutions corresponds to the application of big data technology, the distribution of institutions - to the use of cloud technologies, the measurement of institutions -to the use of blockchain technologies, and the evolution of institutions - to the use of digital platforms, the Internet of things and the sharing economy.

Fourthly, the principles and ideas of the institutional modeling of the smart city econotronics are presented. It is shown that different levels of modeling of economic institutions correspond to the application of socio-technological drivers of the smart city development. It is concluded that the principles and ideas of econotronics can be used to model the smart city institutional formation.

The application of principles and ideas of econotronics for the institutional modeling of the activities of a smart city makes it possible to form full-fledged prognostic models of using socio-technological drivers for the development of the digital economy.

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