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# METHODOLOGICAL PRINCIPLES OF ASSESSING THE LEVEL OF REGIONAL ECONOMIC SYSTEMS' DIGITALIZATION

*The article is devoted to the theoretical and methodological aspects of assessing the level of digitalization of regional economic systems. The main directions, principles and patterns of digitalization of regional economic systems are outlined. The main areas of digital development of the regions are defined as: implementation of innovative technologies in the management system of urban development based on the concept of a smart city; increasing the institutional capacity in the regions regarding the implementation of digital development projects; development of IT infrastructure; creation of digital platforms and industry solutions; open data and others. The existing methods of assessing the level of digitization are analyzed. A methodology for assessing the level of digitalization of regional economic systems is proposed.*

***Keywords:*** *digitalization; regional economy; regional economic system; digital economy.*
*Fig.: 3. References: 11.*

***Setting objectives.*** In the early 1980s, the concept of the information society of the American sociologist and futurist Alvin Toffler gained popularity, the main features of which are the dominant role of information and knowledge. The transformational processes taking place in the world economy during the last decades are rapidly changing the nature of relations between management entities. Decentralization and the right of regions to have separate socio-economic ties gradually reduces the role of the state as a closed economic space. This contributes to the fact that economic transformations shift from the national to the regional level, and the role of the state in managing the economy decreases. To assess the effectiveness of the implementation and development of the level of digitalization of the regional economy, it is necessary to develop practical methods of its assessment.

***Analysis of recent research and publications.*** The works of such foreign and Ukrainian scientists as H.Albach, V.V.Apalkova, S.S. Apalkov, O.A. Jusov, N. Lein, S.V. Melnyk, H. Meffert, T. Mesenburg, N. Negroponte, A. Pinkquart, R. Reichwald, M. V. Rudenko, L. F. Sokolenko, G. B. Sokolova, D. Tapscot, I. V. Tokmakova, D. A. Shatokhina and others.

The following foreign and Ukrainian scientists devoted their scientific works to the study of the processes of regional development and the impact of digitalization on them: B. M. Danylyshyn, S. I. Oliferuk, T. V. Pepa, M. Porter, L. G. Chernyuk, and others.

***Highlighting unexplored parts of the general problem*.** Despite the large number of studies on the mentioned topic, the issue of assessing the level of digitalization of the regional economic space requires further research, systematization and analysis.

***Purpose*.** The purpose of this article is to systematize, analyze, and deepen the theoretical and methodological foundations of assessing the level of digitalization of regional economic systems.

***Presenting main material*.** Digital transformation of regions is one of the priority goals of the State Strategy for Regional Development for 2021-2027.

The main areas of digital development of the regions are defined as:

- implementation of innovative technologies in the management system of urban development based on the concept of a smart city;
- increasing the institutional capacity in the regions regarding the implementation of digital development projects;
- development of IT infrastructure;
- creation of digital platforms and industry solutions;
- open data and others.

The speed of transformations of socio-economic life of regional economic systems under the influence of information technologies requires qualitatively new approaches and principles to the assessment of the level and management of these processes [7-11].

The principles of digitalization of the regional economy are scientifically based provisions and ideas that form the basis of the process of digitalization of regional development, ensure its structural and systemic nature, contribute to the creation of jobs, increased productivity, economic growth rates, and other positive socio-economic transformations.

In our opinion, the following principles of regional economic systems' digitalization can be distinguished, the observance of which is decisive for the creation and realization of the advantages provided by digital technologies (Fig. 1):

- *the principle of equality* means ensuring equal access to digital services, information and knowledge to every citizen, regardless of their location, social status;
- *the principle of usefulness* provides for the creation of advantages for citizens in various spheres of everyday life: improving the quality of services provided in the field of health care and education, creating new jobs, developing entrepreneurship, agriculture, transport, protecting the natural environment, helping to overcome poverty, preventing disasters, guaranteeing public safety, etc.;
- *the principle of integration* envisages the orientation of the digitization process towards international, European and regional cooperation with the aim of integrating Ukraine into the EU, entering the European and world markets;

- *the principle of standardization* - the construction of digital systems, platforms and infrastructures that should be used by citizens, businesses and the state for participation, competition and success in the global economy and on open markets according to international standards;

- *the principle of trust and security* provides that information security, cyber security, protection of personal data, inviolability of personal life and rights of users of digital technologies, strengthening and protection of trust in cyberspace are a necessary condition for simultaneous digital development and corresponding prevention of accompanying risks, their elimination and management;

- *the principle of comprehensive state management of the digitization process* ensures the correction of defects in market mechanisms, overcoming institutional and legislative barriers, initiation of digital transformation projects at the national level and attracting relevant investments, stimulating the development of digital infrastructures are the main tasks of the state on the way to digitization of the country and its regions;

- *the principle of harmony* determines the need to cover all spheres of society's life with digitalization, uniformly replacing analog methods of achieving goals with digital ones;

- *the principle of purposefulness* provides that the implementation of each project of digitization of the regional economic space should have a goal, the achievement of which will positively affect social and economic life;

- *the principle of continuity* means that the management of the process of digitization of regional economic systems is not a permanent phenomenon, but must constantly develop and adapt to changes in the environment in which the organization exists;

- *the principle of synergy* implies that the digitalization of the regional economic space should take place on the basis of ensuring compliance with the law of synergy, i.e. creating conditions so that the result obtained by joint efforts is greater than the sum of the results that could be obtained by different parts of the system;

- *the principle of the scientific approach* determines the need to use scientific techniques in the implementation of digitization processes;

- *the principle of creating a legal system* emphasizes the need for the development of the state legal framework for regulating the process of building the digital economy. Issues of the development of digital technologies should be presented in state programs, especially those related to public services, small and medium-sized enterprises, the consumer market, health care, education, the creation of information and analytical systems for their support, etc.;

- *the principle of modernization of the public administration system* means the need to modernize the public administration system as a response to the technological challenge and competition that is intensifying within the framework of the digital economy, and the development of human capital must necessarily include the training of people who possess the competencies necessary in the digital economy and development of digital society;

- *the principle of individualization* - implies the need to take into account the peculiarities of the state of individual components that go through the process of digital transformation, and to adjust the digitalization process in accordance with the needs of the components [1].

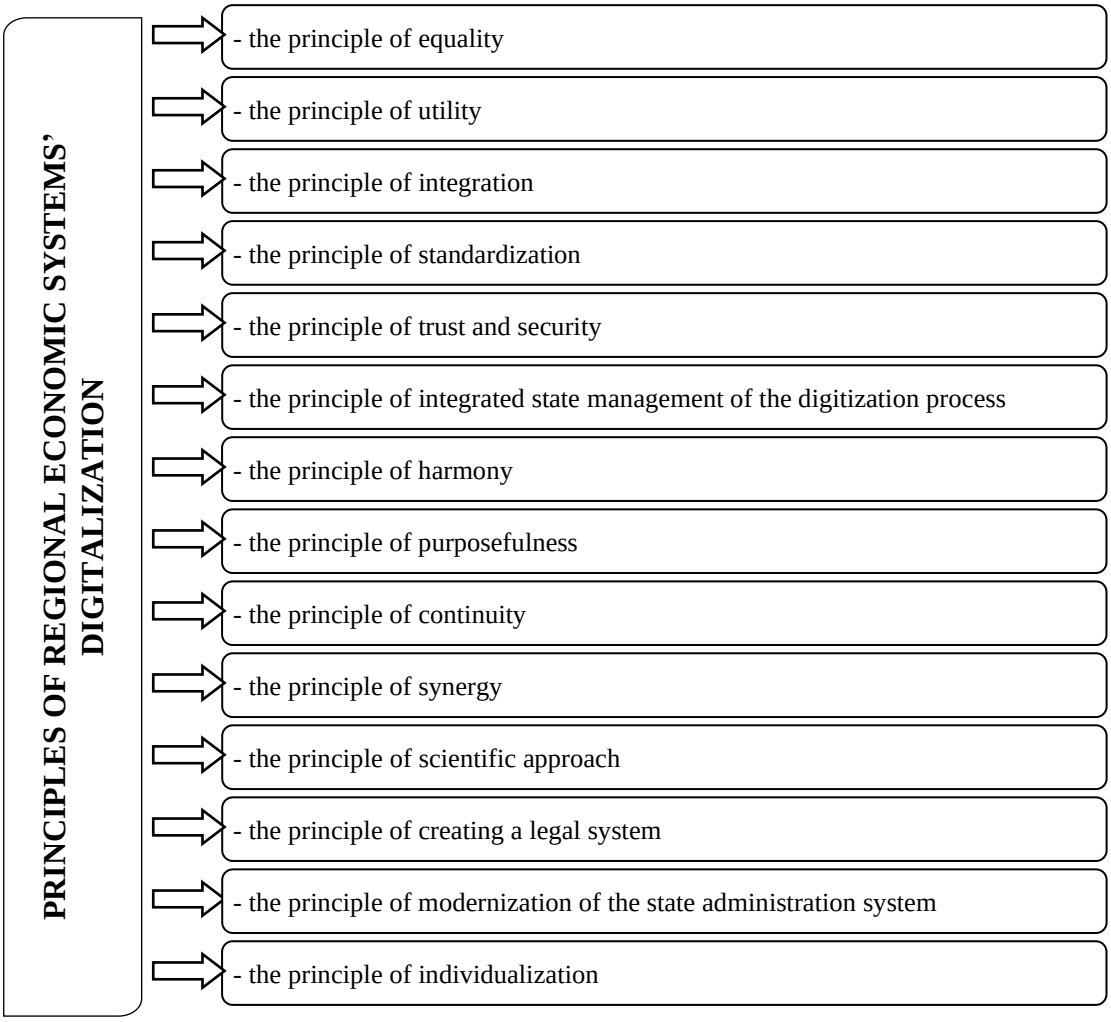


*Fig. 1. Principles of regional economic systems' digitalization*

*Source: systematized by the authors*

To achieve the goals of the regional economic systems' digitization, this process must be subject to certain laws. In our opinion, the regularities of the development of digitalization of regional economic systems are the objectively existing, constant cause-and-effect relationship between economic spheres and phenomena in the regional economic space. Among the main patterns of regional economic systems' digitalization, in our opinion, it is necessary to highlight the following (Fig. 2):

- *the regularity of planning and controllability of the digitization process* is based on the theoretical principles of development planning as a synthesis of state administration, indicative planning and economic forecasting;

- *the consistency of the development of the digitalization process with the requirements of national economic security*. The level of economic security of the state depends on the level of provision of its own needs in mineral raw materials and energy resources; sectoral and production structure of economic complexes; completeness of production technological cycles; integration into the global economic space;

- *the regularity of the harmonious development of digitalization of regions* implies uniform development and effective management of the digitalization process to achieve a competitive level of regional development. The regularity of the harmonious development of digitalization can be defined as the coordinated distribution of all elements throughout the country with the aim of ensuring the effective development of digitalization and improving the socio-economic life of society. Harmony should be aimed at economic efficiency and economic expediency;

- *the regularity of taking into account the peculiarities of the level of regional development* is based on the fact that the socio-economic development of regions, the level of infrastructure development, the level of income of the population, etc. is heterogeneous, which affects the digitalization process, its goals and objectives in different regions;

- *the pattern of proportional development of regional economic systems* follows from the economic law of concentration of production. The implementation of this regularity contributes to the uniform development of the digitalization process of regional economic systems. Taking into account the regularity of the proportional development of digitalization of regions contributes to the actual leveling of socio-economic development of regions, and also has a significant impact on the formation of territorial proportions characterizing the spatial structure of the economic complex, socio-economic relations between different regions of the country;

- *the regularity of the humanistic orientation of digitalization of regional economic systems* stems from the need for general socialization of the economic system, since it is the all-round development of man and the satisfaction of his needs that is the goal of digitalization of economic development. It is implemented by taking into account the interests of the population in relation to individual digitalization programs of the territory, prioritizing the solution of social problems and realizing the right of all citizens to freely use the advantages that digitalization provides;

- *the regularity of the integrity of the regional socio-economic system* consists in the organic unity of the natural, economic and social spheres, which are combined under the influence of certain patterns, factors and prerequisites. As a result, each region is unique. Therefore, even the most successful model of digitization in one region cannot be mechanically transferred to another, neglecting its specificities. Each region should be defined as an independent object of socio-economic management while preserving the system of centralized and regional elements;

- *the regularity of interregional integration* involves the process of convergence and interpenetration of regional socio-economic systems in order to develop digitization processes, by establishing permanent purposeful relations between them for effective and dynamic functioning and development;

- *the regularity of digitalization of regional economic systems, taking into account the processes of globalization and European integration*. The phenomena of globalization and European integration of socio-economic processes cover almost all spheres of society. Globalization processes led to objective efforts to make the most complete use of regional digitalization prerequisites to maximize the economic effect and increase the competitiveness of regional production. In this case, the globalization of socio-economic processes is understood as a trend of ever-increasing mutual integration of territorial production and economic systems into a single global reproductive-economic and market-informational space. Globalization of development is accompanied by appropriate coordination of financial-economic, socio-economic, socio-political, military-political and other measures at the national and international levels [2, p. 233–235].

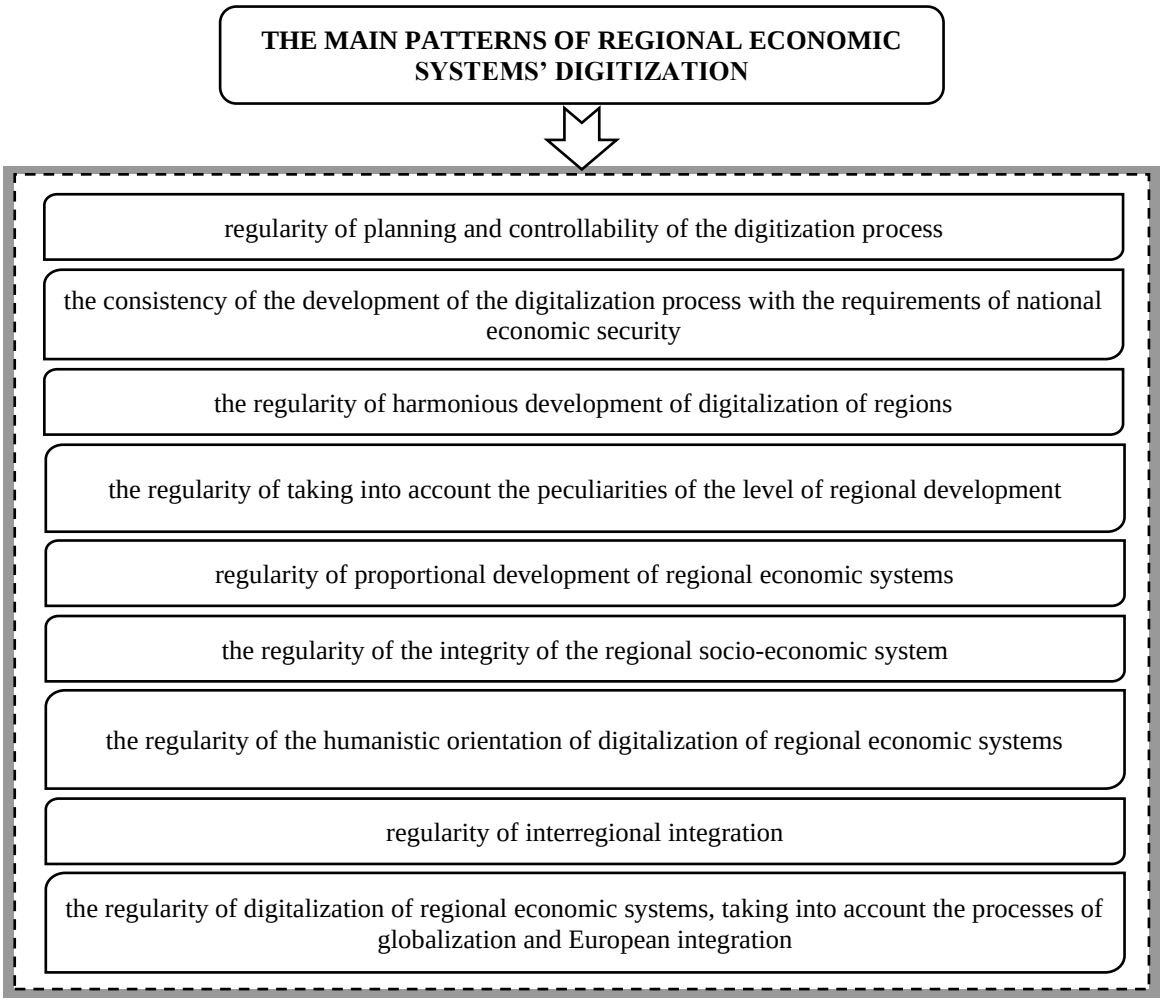


*Fig. 2. The main patterns of regional economic systems' digitization*
Source: systematized by the authors

The search and application of innovative approaches to regional development is a requirement of time, a condition for rational use of available resources at the local level, optimal use of the potential of the domestic market, intensive accumulation and use of intellectual capital, activation of entrepreneurial and public initiatives for effective management. Taking into account the discussed patterns of digitization of regional economic systems in the context of modern state regional policy will contribute to unlocking the processes of socio-economic growth at the regional level - the basis for achieving dynamic, balanced development of regions and increasing the level of population welfare.

To assess the level of digitalization of regional economic systems, it is necessary to develop an assessment methodology.

The International Telecommunication Union defines the index of development of information and communication technologies (IDI) as a unique benchmark of the level of ICT development in the countries of the world. This index brings together eleven indicators of ICT access, use and skills, capturing key aspects of ICT development in a single dimension that allows cross-country comparisons. The 2016 IDI, which covers 175 economies worldwide and compares with the 2015 IDI, highlights both progress and persistent disparities in the global information society.

Voskoboyeva O.V. and Romaschenko O.S. emphasize the importance of analyzing the Digitization Index (DI - Digitization index), which is "calculated as the average weighted sum of three sub-indices: infrastructure development, online spending, user activity" [3, pp. 56-61].

Kovtonyuk K.V. notes that "despite the variety of methods for calculating international indices that characterize the degree of ICT development in the countries of the world, leading countries have been identified that do not significantly change their positions within the group. Such a course of events confirms the transformational shifts in the national economies of the leading countries, which are carried out, including on the basis of ICT. Today, the international economy continues to move towards the digital future at different rates, since the activation of the involvement of national economies in the process of formation and development of the digital economy will ensure not only digital leadership, but also further economic growth" [4, pp. 29-33].

Pizhuk O.I. notes that "several internationally recognized indices are used, determined by various methods by companies, namely: the ICT Development Index calculated by the International Telecommunication Union, the Internet Development Index in the world (The Web Index); Index of network readiness - by the World Economic Forum" [5, p. 81]. However, the indexes specified by the author are not limited to the assessment of the level of digital transformation. Every year, the number of indexes increases, and their components also change.

According to Skoryk O.O. and Ryabokon N.P., "the approach based on the application of a comparative analysis of the set of existing indicator models appears to be the most rational, determining the best one (according to the selected

criteria) and refining it in order to take into account the peculiarities of the development of the digital economy in Ukraine as much as possible. In international practice, composite ICT indices (e-indices) are used as an integrated characteristic of the level of development of the digital society or its structural elements, built on the basis of sets of ICT indicators, while the specified set of indicators and the method of constructing the index largely depend on the selected priorities. World practice today includes more than twenty international e-indices" [6].

Therefore, the basis of the Digitization Index (DI - Digitization index) is the calculation of the activity of the population, companies, and state institutions regarding the use of digital technologies.

The methodology proposed by the authors for determining the level of regional economic systems' digitalization provides for the following algorithm (Fig. 3):

- formation of a system of indicators characterizing the level of regional economic systems' digitalization;
- determining the levels of development of the regions according to such indicators as: the level of network availability, the level of employment of the population in the field of ICT and the level of consumer activity;
- selection of criteria for grouping regions according to the level of regional economic systems' digitalization;
- determination of regional characteristics according to the level of regional economic systems' digitalization;
- analysis of complex indicators of regional economic systems' digitalization, identification of causes of deviations and identification of the most important problems of each region.

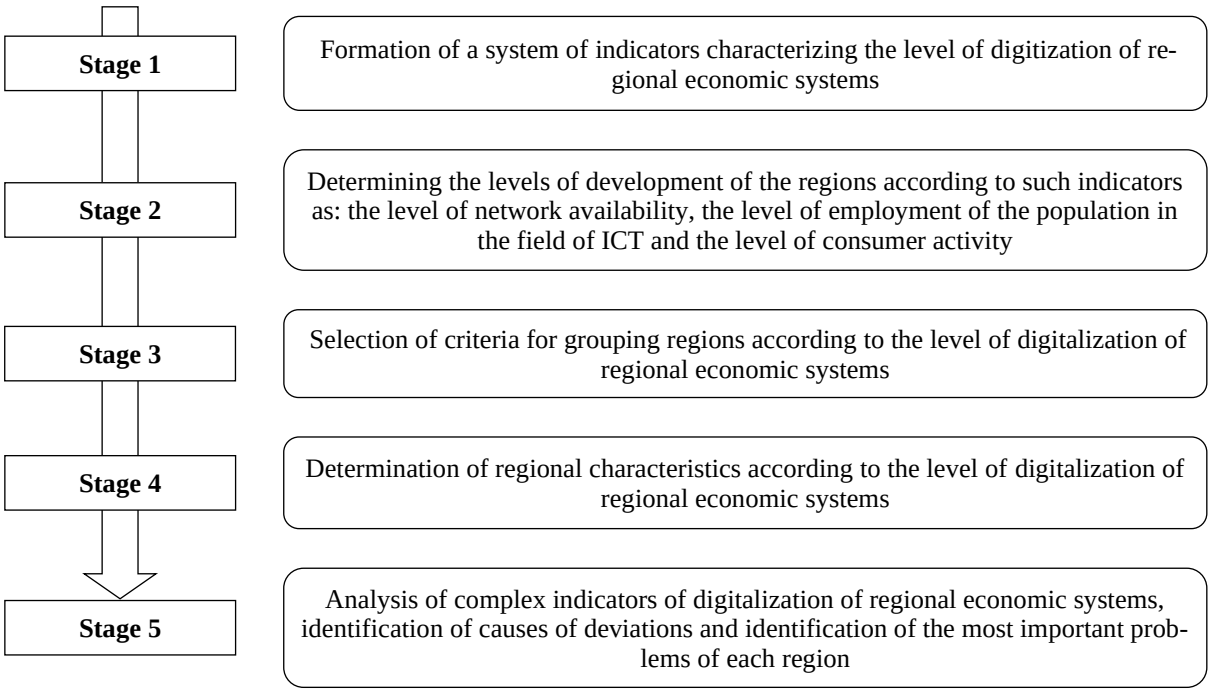


*Fig. 3. Algorithm for determining the level of regional economic systems' digitalization*

Source: suggested by the authors.

We propose to determine the complex index of regional economic systems' digitalization ($I_D$) using partial indices, namely: the infrastructure readiness index ($I_{ir}$), the population employment index in the field of ICT ($I_e$) and the index of consumer activity of Internet services ($I_{ca}$).

The formula for calculating the complex index of regional economic systems' digitization will have the form (1)

$$I_{D_j} = \sqrt[3]{I_{Irj} \cdot I_{ej} \cdot I_{caj}} . \quad (1)$$

*The index of infrastructure readiness ($I_{ir}$)* in the region characterizes the share of households that have access to Internet services at home.

The index for the indicator of infrastructure readiness is calculated according to formula (2):

$$I_{irj} = \frac{IR_j^t}{IR_j^{t-1}}, \quad (2)$$

where $I_{irj}$ –the index of the indicator of infrastructure readiness in the j-th region for the specified period;

$IR_j{}^t$ – is the share of households that have access to Internet services at home in the j-th region for a certain year;

$IR_j{}^{t-1}$ – the share of households that have access to Internet services at home in the j-th region for the previous year.

*The employment index of the population in the field of ICT ($L_e$)* in the region is determined based on the share of the population employed in the field of ICT.

The index for the indicator of the share of the employed population in the field of ICT is calculated according to formula (3):

$$I_{ej} = \frac{E_j^t}{E_j^{t-1}}, \quad (3)$$

where $I_{e\,j}$ – population employment index in the field of ICT in the j-th region for the specified period;

$E_j{}^t$ – the share of the employed population in the field of ICT in the j-th region for a certain year;

$E_j{}^{t-1}$ – is the share of the employed population in the field of ICT in the j-th region for the previous year.

*The index of consumer activity of Internet services ($L_{ca}$)* in the region characterizes the frequency of use of Internet services. For calculations, we use the indicator of the share of households that used Internet services at least once a week (in % of the population that reported using Internet services).

The index for the indicator of consumer activity of Internet services in the region is calculated according to formula (4):

$$I_{caj} = \frac{CA_j^t}{CA_j^{t-1}}, \quad (4)$$

where $I_{ca\,j}$ – the index of consumer activity of Internet services in the j-th region for the specified period;

$CA_j{}^t$ – the share of households that used Internet services at least once a week in the j-th region for a certain year;

$CA_j{}^{t-1}$ – the share of households that used Internet services at least once a week in the j-th region for the previous year.

Therefore, the final formula for calculating the complex index of regional economic systems' digitalization will have the form (5):

$$I_{D_j} = \sqrt[3]{\frac{IR_j^t}{IR_j^{t-1}} \cdot \frac{E_j^t}{E_j^{t-1}} \cdot \frac{CA_j^t}{CA_j^{t-1}}}\,. \qquad (5)$$

The proposed indices for assessing the level of regional economic systems' digitization are based on available statistical data. The development of qualitatively different methods of assessing the level of regional economic systems' digitization must be ensured by the availability of official statistical data.

**Conclusion.** The digital transformation of regional economic systems is the basis of successful social and economic development of society. The speed of transformations of regional economic systems under the influence of information technologies requires qualitatively new approaches, laws and principles to the assessment of the level and management of this process. The lack of a single definition of the method of assessing the level of digitalization of regional economic systems causes the emergence of a number of different approaches both among Ukrainian and foreign scientists.

The scientific novelty of the study consists in the systematization of laws and principles, as well as the development of a methodology for determining the level of regional economic systems' digitalization.

Prospects for further research consist in the study of modern trends in regions' digitalization, the calculation of comprehensive indices regional economic systems' digitalization and grouping of Ukraine's regions by the level of digitization.

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# МЕТОДОЛОГІЧНІ ЗАСАДИ ОЦІНКИ РІВНЯ ЦИФРОВІЗАЦІЇ РЕГІОНАЛЬНИХ ЕКОНОМІЧНИХ СИСТЕМ

*Стаття присвячена теоретичним та методологічним аспектам оцінки рівня цифровізації регіональних економічних систем. Окреслено основні напрями, принципи та закономірності цифровізації регіональних економічних систем. Основними напрямами цифрового розвитку регіонів визначено: впровадження інноваційних технологій у системі управління розвитком міст на засадах концепції смарт-сіті; підвищення інституційної спроможності в регіонах щодо впровадження проектів цифрового розвитку; розбудова IT- інфраструктури; створення цифрових платформ та галузевих рішень; відкриті дані та інше.*

*Проаналізовано існуючі методи оцінки рівня цифровізації. Запропоновано методику оцінки рівня цифровізації регіональних економічних систем. Авторська методика визначення рівня цифровізації регіональних економічних систем передбачає наступний алгоритм: формування системи індикаторів, які характеризують рівень цифровізації регіональних економічних систем; визначення рівнів розвитку регіонів за такими показниками, як: як рівень мережевої доступності, рівень зайнятості населення у сфері ІКТ та рівень споживчої активності; визначення експертним шляхом вагових коефіцієнтів для кожної групи індикаторів та розрахунок інтегральних показників рівня розвитку, ранжування регіонів; виділення критеріїв для класифікації та групування регіонів за рівнем цифровізації регіональних економічних систем; визначення регіональних характеристик за рівнем цифровізації регіональних економічних систем; аналіз інтегральних цифровізації регіональних економічних систем, виявлення причин відхилень та виокремлення найважливіших проблем кожного регіону; виділення проблемних регіонів та розробка механізмів стимулювання їхнього розвитку.*

*У статті доведено, що пошук і застосування інноваційно-інформаційних підходів до регіонального розвитку – вимога часу, умова раціонального використання наявних на місцевому рівні ресурсів, оптимального задіяння потенціалу внутрішнього ринку, інтенсивного накопичення й використання інтелектуального капіталу, активізації ініціатив підприємництва та громадськості щодо ефективного ведення господарювання.*

***Ключові слова:*** *цифровізація; регіональна економіка; регіональна економічна система; цифрова економіка.*

*Рис.: 3. Бібл.: 11.*

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