

DIGITALIZATION OF TERRITORIAL AND ECONOMIC SYSTEMS AT THE REGIONAL LEVEL

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Abstract

The article considers the features, trends and patterns of the development of digitalization of territorial and economic systems. IT technologies have been implemented in an integrated model for assessing the sectors of digitalization of territorial and economic systems, which are determined on the basis of the concept of “Industry 4.0” and aimed at increasing production and servicing public needs, increasing the competitiveness of the state. It is substantiated that the process of digitalization of the territorial economic system is formed on the basis of Internet economy (environment for introducing e-business) and “digital economy” – a modern type of management, characterized by methods of resource management in production, distribution, exchange and consumption. The hierarchical structure and model of digitalization of territorial and economic systems are presented. Methodical approaches to the assessment of digitalization of territorial and economic systems are determined. Scenarios for ensuring the development of digitalization of sectors of territorial economic systems on an innovative basis are grouped. The analysis of the development of the Internet trade market in Ukraine is carried out. The volume of production (services) by types of economic activity in the field of digital territorial and economic systems is determined. The dynamics of the trend of financial results of enterprises in the field of telecommunications, computer programming, consulting and information services in Ukraine is presented. Forecast indicators of the development of digitalization of territorial and economic systems, including in the production of information and communication technologies, services and use of computer equipment have been calculated.

Keywords: digitalization, Internet trade, business entities, business processes, IT technologies

JEL classification: L24, L81, L86, M15

1. Introduction

The development of relationships in the social environment depends on the level of digitalization of the economy (global, national, regional, territorial) and is a certain technology with its own characteristics, trends and patterns. The use of digital technologies to increase the efficiency of the economic system is considered in the broad context of socio-economic, cultural and historical relations that are in the process of evolutionary change, taking into account historically stable institutional mechanisms that ensure its functioning. The set of qualitative features of the economic system is determined by its parts (their nature, properties), which are dual in nature. In this case, any part has “independent” features of an independent unit that requires support, functioning as “full” and “dependent” properties that show its belonging to the system (part of the whole). Accordingly, the system does not fully determine the properties of all elements that are part of it, but only partially. In turn, the main qualities of the system are accompanied by recommendations of elements that form specific features of the territorial economic system, as the territorial unit is an independent structural part that takes into account the complex of national interests, ensuring the welfare of the population. At the same time, the information revolution, characterized by the massive spread of information technology among the population and business, its constant improvement and adaptation, has a significant impact on the development of national and regional economy, which together with economic relations forms the basis of the information field. Due to this, there is an interaction of different elements of space in the process of their economic life. It forms the specifics of the process of interaction between different levels that make up the economic space of the region.

Features of the development of modern economic systems, in particular and of digital economy are a basis of research of the following scientists O. Demydiuk (2014, 120-126), Sh. Ibatullin and O. Stepenko (2013, 6-10), D. Kolomyichuk (2018, 14-21), R. Matviienko (2013, 152-155), N. Metelenko (2008, 70-79), T. Moshchytska (2015, 100-102), L. Novakovskiy and I. Novakovska (2018, 11-16), V. Shchepak (2010, 144-148), D. Ziuz (2016, 1-12). The issue of capitalization of information-intellectual potential and the development of network-information economy was discussed in the works of H. Karcheva, D. Ohorodnia and V. Openko (2017, 13-21), M. Voinarenko and L. Skorobohata (2015, 18-24), V. Zaharii, T. Kovalchuk and V. Synilnyk (2019, 64-68); the research of transformation processes of economy in the conditions of decentralization was considered in the works of O. Amosha and L. Solomatina (2017), T. Muzhanova (2017, 116-122), P. Putsenteilo and O. Humeniuk (2018, 131-143).

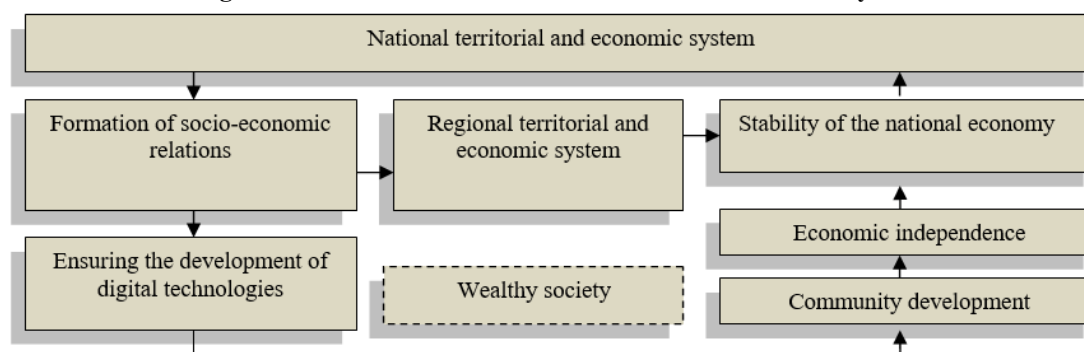
The priority of our study is the implementation of IT technologies in the integrated model of evaluation of the sectors of digitalization of territorial economic systems, which are determined based on the concept of “Industry 4.0” and aimed at increasing production and service needs and the competitiveness of the state.

2. Methods and Materials

The foundation of the development of the economic system is the state, which is the regulator and subject of economic relations, builds the structure of economic growth by creating appropriate conditions for self-realization and welfare of the population. It should be noted that the national characteristics of each country’s development are determined by the economic and social policy of the government, which depends on a certain political orientation and the corresponding theoretical model of economic development, where the quality of state intervention in the economy remains an important factor. It is guaranteed by the high competence of the political elite in these matters, as well as their honesty towards all citizens. Accordingly, socio-economic relations in the structure of the territorial-economic system should be based on the spiritual and moral imperative, strengthening the regulatory function of the state (Moshchytska 2015, 100-102; Ovcharenko et al. 2021, 201-216; Gubanova and Voroshilov 2019, 55-68). The interconnected components of the hierarchical structure of the territorial economic system at the national and regional levels are presented in Image: 1. We should note that the hierarchical structure of the territorial and economic system at the national level forms the socio-economic relations, ensuring the development of digitalization of the territory and communities to ensure economic independence, stability of

the economy as a whole. The development of regional territorial subsystems is subject to the general laws of the development of the national economic system.

Image 1: Hierarchical structure of the territorial economic system



Source: developed by the authors according to data (Matviienko 2013, 152-155; Moshchytska 2015, 100-102)

Development of digital technologies in the e-management system of the regional level, integrates models of information presentation into a single space, formed as a result of analysis and modeling (Biletskyi and Khominich, 2014). Quantitative economic effect from the use of digital technology, allows (Andryeyev et al., 2012):

- reduction of labor costs and time for obtaining and processing information about territorial processes, decision-making, in particular in crisis situations; reduction of labor costs in the electronic document management system;
- reduction of travel (and time) costs by centralizing management and approval through video conferencing;
- increase of receipts to the regional budget of taxes from the use of resources (lands of agricultural, forest, industrial function, under construction, in particular in nature protection and reserved zones); receiving additional funds to the budget for clear and objective accounting of environmental damage in the course of economic activity (fines, payments to the relevant funds);
- assessment of effective nature management, in particular publicly available minerals (sand, gravel, rubble), which are extracted in riverbeds, protected areas, in the territory of recreation; obtaining long-term indirect qualitative effect;
- improving the efficiency, effectiveness and quality of public administration; increasing information asymmetry regarding the transparency of public authorities;
- creating preconditions for the integration of information resources at the regional level; increasing the investment attractiveness and competitiveness of the region via the Internet for advertising promising investment sites; increasing the efficiency of interaction of departmental information systems.

The process of digitalization of the territorial economic system is formed on the basis of the Internet economy (environment for introducing e-business) and “digital economy” – a modern type of management, characterized by methods of resource management in production, distribution, exchange and consumption. Acceleration of digitalization of the economy, which is stimulated by the state, has a positive impact on the economic development of the territory, but this requires not only legislative initiatives, but also scientific grounding (Trusova et al. 2021, 1-15).

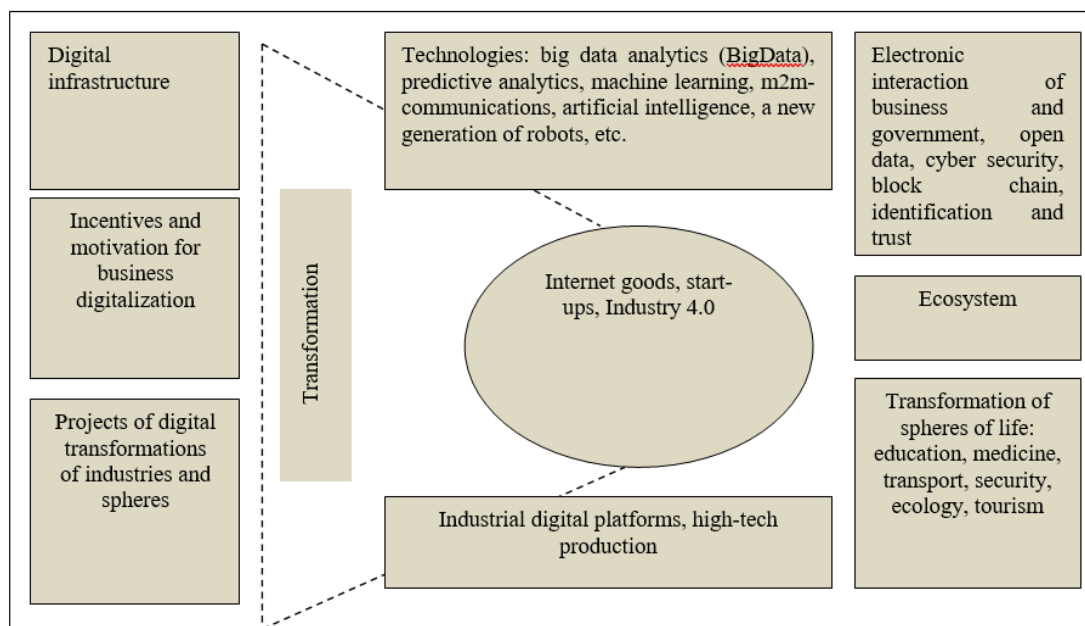
Global trends in the world economy are developed on the basis of the concept of “Industry 4.0”, which allows to implement tools for digital infrastructure development, acquire digital competencies in society, identify pressing issues and digitization projects, stimulate the domestic market, apply and use digital technologies. A corresponding increase in gross regional product is possible only when digitization initiatives and programs are integrated from national into sectoral development strategies and programs (Order of the Cabinet..., 2018).

Levels of Industry 4.0 (functional merging, operational interaction, interoperability, virtualization, decentralization, real-time interaction, service orientation, modularity, learning and continuity of vocational education, synergies and emergencies) embody the production,

exchange and distribution and consumption of “electronic goods”, calculations are made using electronic money (Voinarenko and Skorobohata 2015, 18-24). Therefore, the formation and bridging of the “digital divide” in territorial and economic systems requires the separation of functioning components: the development of a developed digital infrastructure through the provision of new quality and Internet coverage of broadband areas (remote villages, business and social network) which are in digital divide; formation of an effective system of identification, protection of personal data, trust services that are part of the “soft” infrastructure; development of highly qualified human capital which can work with new technologies, meets specific skills and competencies for full integration into the digital space; use of applications and services “Smart-city” and “digitalization of education”, which are components of “Industry 4.0”, implemented in the field of medicine, industry, ecology, public safety, transport; introduction of “digital” legislation, which enshrines the digital rights of citizens, defines the principles and measures to eliminate institutional, tax barriers and stimulate the digitalization of economic sectors; protection of intellectual property as a factor influencing motivation and building of creative ideas, the possibility of obtaining a commercial profit and a guarantee of protection of intellectual work (Puhachevska 2018, 39-45; Trusova et al. 2021, 1-15).

The OECD identifies three key components of digitization of territorial economic systems: infrastructure (hardware and software, telecommunications, networks, etc.); e-commerce (distribution of goods via the Internet), e-business (doing business and any other business processes via computer networks) (Apalkova, 2015). For the development of digitalization of territorial and economic systems, the authors proposed and built a model of its transformation, which is based on the updated concept of the Internet goods, “smart factory” and identified with the fourth industrial revolution and the emergence of cyber system Industry 4.0 (Image: 2).

Image 2: Model of digitization of territorial and economic systems



Source: built by the author

The built model transforms the digital economy of the country and includes incentives and motivation for digitalization of business, development of digital infrastructure, renewal of projects of competitiveness of digital industry and spheres of the national economy.

The main tools that will ensure the transformation of digitalization are technologies (big data analytics (Big Data), predictive analytics, m2m-communications, machine learning, artificial intelligence, a new generation of robots, etc.) and industrial digital platforms (the process of creating a digital economy product), high-tech production. The result of digitalization of territorial and economic systems is the development of electronic interaction between business and government, open data, cybersecurity, blockchain, identification and trust, created ecosystem, transformation of spheres of life (education, medicine, transport,

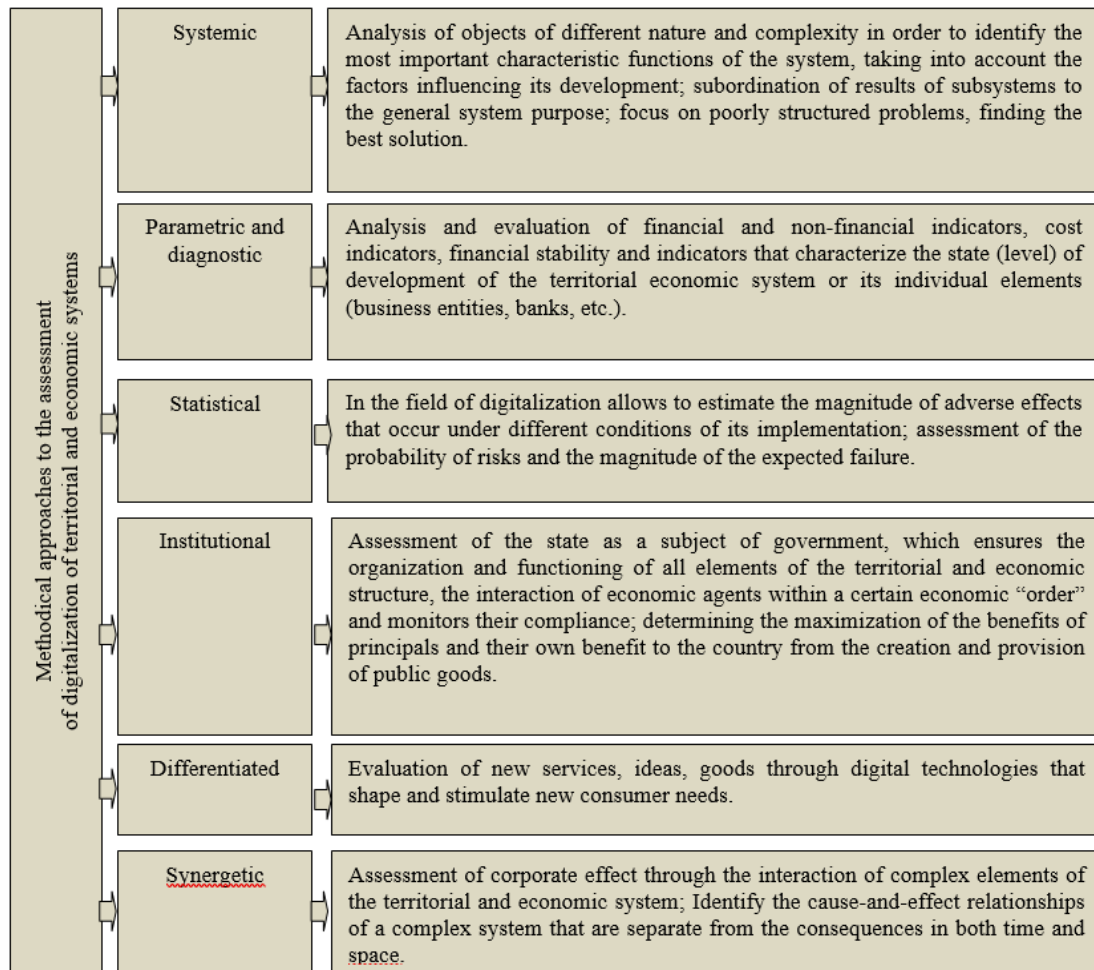
security, ecology, and tourism). The presented model expands the interests of society, considers in a broader socio-economic aspect the demographic, environmental, educational and other changes caused by it. Separately in the model of transformation of the digital economy, an important place is occupied by a system of indicators that determines the level of the development of information and communication technologies in the country. Accordingly, the main areas of measurement of indicators of digitalization of territorial economic systems are: the development of high-tech sector of the economy, its share in manufacturing and services; investment in research and development, education costs and additional retraining; release of information and communication equipment; job creation in science and high technology; indicators of cooperation between corporations, venture firms, universities and research organizations; international flows of knowledge, international cooperation in the field of science and innovation; dynamics of Internet spread; the share of high-tech products in international trade (Puhachevska 2018, 39-45; Dionysopoulou et al. 2021, 153-168; Batabyal and Yoo 2018, 119-125).

At the same time, the degree of impact of digital technologies on territorial and economic systems, taking into account their individual sectors are represented by quantitative digital indices, each of which is based on the organization's chosen priorities: Global Competitiveness Index (GCI), which includes the following indicators (Kovtoniuk 2017, 29-33):

- Company competitiveness, business compliance with modern company requirements and innovation potential and the Networked Readiness Index (NRI);
- Digital Opportunity Index (DOI), estimated on the basis of 3 sub-indices, such as capabilities, infrastructure and usage; digital development index (ICT Development Index (ICT DI)) takes into account 11 indicators that assess the access and use of digital technologies, as well as ICT skills); the Digital Access Index (DAI), developed by the International Telecommunication Union (including within the framework of the World Summit on the Information Society);
- The Global Connectivity Index (GCI) contains four sub-indices: supply, demand, experience and potential.

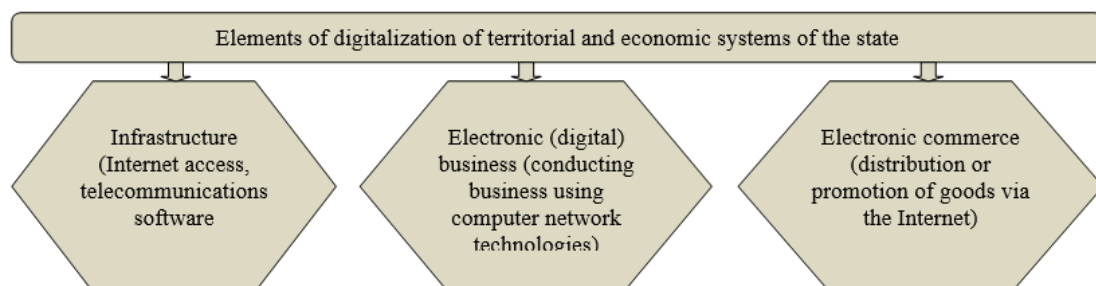
Since territorial and economic systems are an open, complex, nonlinear, unbalanced structure, we have proposed methodological approaches that can be used in the development of digitalization (Image: 3). The presented methodological approaches determine the advantages of digitalization of territorial and economic systems for the development and provision of public welfare of the society and the state as a whole in order to increase competition and quality of products and services; reduction of production costs and product prices; expanding the range of goods and services; increasing the availability of goods and services for ordinary citizens through the use of the Internet; development of technologies in the medical field that will promote the treatment of deadly diseases; emergence of new professions; increasing the mobility and flexibility of the education system; use of scientific development to improve the environmental situation in the country; increasing life expectancy; improving the quality of life of the population.

Digitalization involves the formation of the relationship between government, business and community using the latest information technology, covering innovative activities on the platform of the Internet, mobile and touch networks. The introduction of digital technologies in the territorial and economic systems of the country makes it possible to increase labor productivity, business competitiveness through expanded access to the Internet (Image: 4), as the most important element of economic development.

Image 3: Methodical approaches to the assessment of digitalization of territorial and economic systems

Source: grouped by authors according to data (Metelenko 2008, 70-79; Biletskyi and Khominich, 2014; Demydiuk 2014, 120-126; Voinarenko and Skorobohata 2015, 18-24)

A targeted policy towards the digitalization of territorial and economic systems that already operate in the EU and have their own "digital strategies", allows us to propose the stages of the development of the project "Digital Agenda 2020".

Image 4: Components of digitalization of territorial and economic systems

Source: built by the author

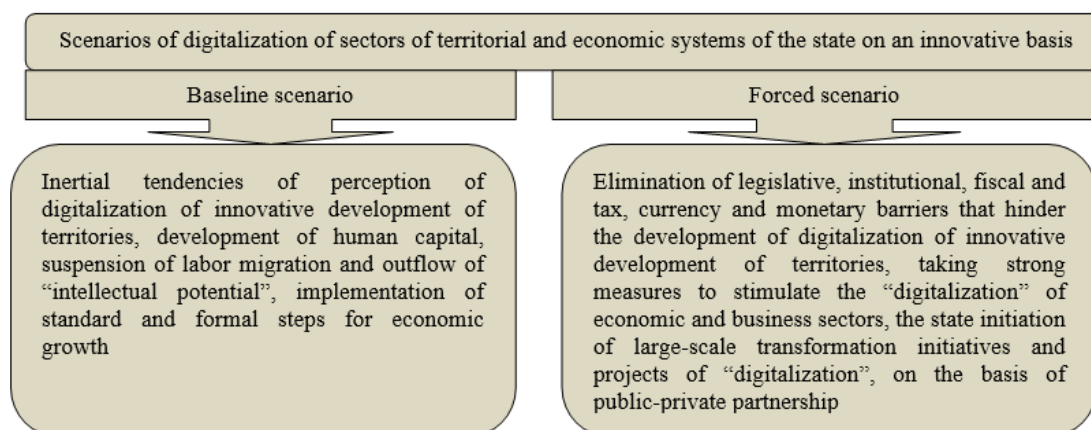
This is a huge industry market, a platform for efficiency and competitiveness of all spheres of the country's economy, as access to the Internet as an open, secure and free space for the dissemination of ideas, information and knowledge allows communication and social interaction on the basis of human rights. Digital development should be aimed at improving the livelihoods of local communities, raising the living standard of citizens, which meets the goals of digital development. The project "Digital Agenda 2020" identifies eight main areas of digitization (Image: 5). Probable scenarios for digitization of innovative development of economic sectors of the state are presented in Image: 6.

Image 5: Directions of digitalization of the project “Digital Agenda 2020”



Source: grouped by authors according to data (Apalkova, 2015; Order of the Cabinet..., 2018; Digital Agenda of Ukraine, 2020)

Image 6: Scenarios for ensuring the development of digitalization of sectors of territorial and economic systems of country on the innovative basis



Source: generated by the authors according to data (Apalkova, 2015; Order of the Cabinet..., 2018; Digital Agenda of Ukraine, 2020)

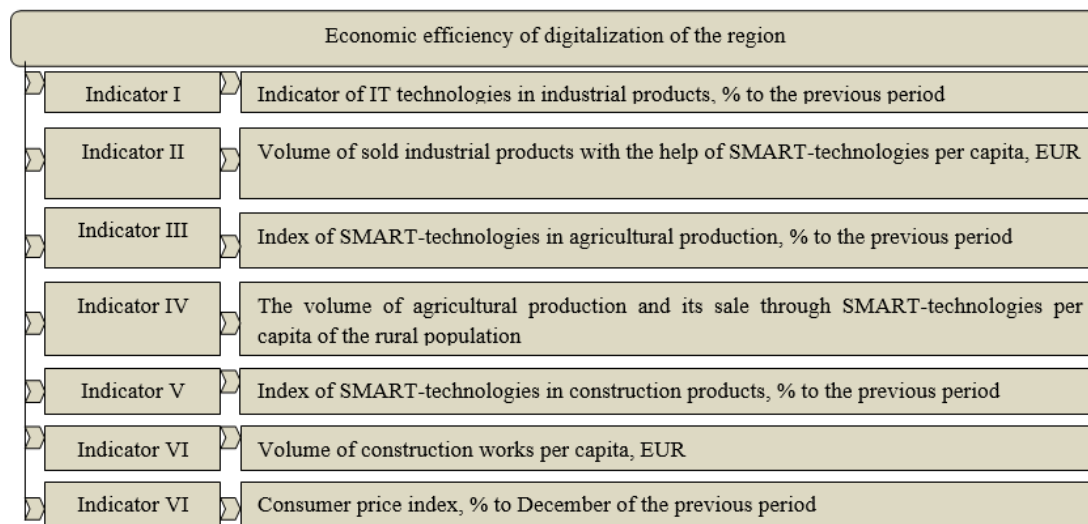
At the stage of transformation of territorial and economic systems, the process of digitalization monitoring through the concept of “Industry 4.0” embodies a set of indicators for assessing the implementation of IT technologies in the field of state regional policy (“economic efficiency of digitalization”, “financial self-sufficiency”, “labor market efficiency”, “investment development and foreign economic cooperation”, “infrastructure development”, “renewable energy and energy efficiency”) to accelerate the innovative development of the territory of the state (Bukht and Heeks, 2017; Puhachevska 2018, 39-45; Batabyal and Beladi 2016, 11-18). The ordinal number of the region in the rating of digitalization of innovative development by IT technologies is determined on the basis of deviations from the largest and smallest values according to formula (1), (Bukht and Heeks, 2017; Irtyshcheva et al. 2018, 586-593):

$$R_j = \sum \frac{x_{max_i} - x_{ij}}{x_{max_i} - x_{min_i}} + \sum \frac{x_{ij} - x_{min_i}}{x_{max_i} - x_{min_i}} \quad (1)$$

where, – the total value of estimates of individual sectors of digitalization of territorial and economic systems on the indicators of IT technologies; – the i -th indicator of the j -th sector of digitalization of territorial and economic systems.

Estimation of economic efficiency of digitalization covers seven indicators (Image: 7).

Image 7: The structure of the assessment of economic efficiency of the region



Source: developed by the authors according to data (Bukht and Heeks, 2017; Irtyshcheva et al. 2018, 586-593)

3. Results and Discussion

Thus, the implementation SMART-technologies in the basic concept of “Industry 4.0” on the basis of smart management is an important element of territorial and economic systems for the development of efficiency criteria, development goals and norms that serve as a basic guideline for innovative development of regions. In addition, the model takes into account the possibilities for using the main tools to stimulate the development of local communities, in particular (Bukht and Heeks, 2017; Irtyshcheva et al. 2018, 586-593; Kalybekova et al. 2021, 31-48):

- development of existing and a new local business: education, consultations, trainings, support, information on soft and targeted loans, simplified conditions for obtaining permits, access to start-up leases, incentives, transparent access to business-oriented information, clusters;

- creation and improvement of local development institutions: activities of economic development agencies or local and regional development agencies, business incubators, urban development centers, business centers, public organizations, business associations, investment agencies, permitting centers, administrative service centers, information and consulting centers, chambers of commerce and industry, business support funds, etc.;

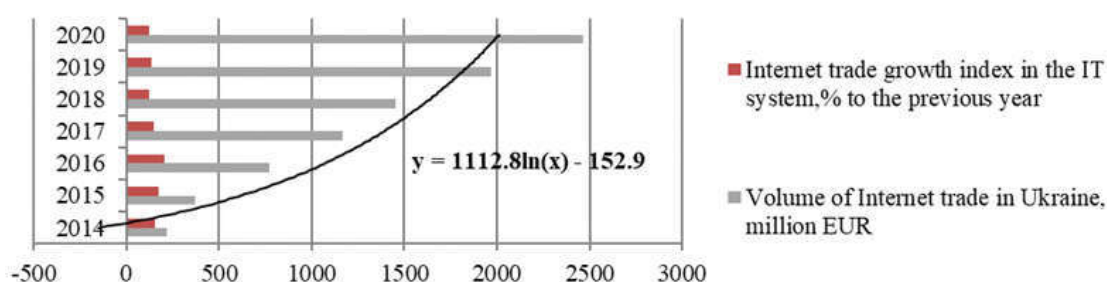
- attraction of business and investments in the territory: creation of investment products and investor’s road map, algorithm of procedure of opening a new enterprise, design of territory, preparation of industrial sites, creation of industrial parks, marketing of attraction of investments in the territory, development of investment passports, promotion of territory, definition of competitive advantages, criteria for the investor, priorities of the development of the territory, etc.

The current stage of the development of territorial economic systems in Ukraine is characterized by rapid structural changes under the influence of the rapid spread of innovative and digital technologies, which have a multiplier effect, require the formation of qualitatively new, adaptive approaches and models of economic management at all levels. Digitization of territorial and economic systems of Ukraine models: changes in the economic structure, changes in traditional markets, social relations, public administration, which is associated with the penetration of IT-technologies; changes in the main source of added value and the structure of the economy through the formation of more efficient economic processes provided by digital infrastructure; the mechanism of economic development of institutions

based on digital models and processes at all levels (markets, industries, areas of activity); technological level, which presents advanced technologies and platforms; the level of a single environment, represented by regulations, information infrastructure, staffing and information security. The single environment is designed to optimize the conditions for the development of economic and technological levels, as well as increase the efficiency of their interaction (Trusova et al. 2021a, 1-19; Ziaril and Mohammadi 2016, 47-63; Xanthos et al. 2013, 173-179; Mustra 2017, 135-144).

We should note that in the EU group, the cost dimension of digitalization of territories is 3.2 trillion euro, which corresponds to about 8% of GDP (Nykolaev, 2018; Batabyal 2016, 31-35; Cutrini and Valentini 2017, 107-117). Every year, the digital economy expands 9 large companies (Apple, Google, Facebook, Amazon, Microsoft and four Chinese: Baidu, Alibaba, JD.com, Tencent) produce 90% of their income and profits at the expense of the digital economy (Gada, 2016). In Ukraine, the mass dissemination of information technology among the population and business, its constant improvement and adaptation has a significant impact on the development of the national economy and individual regions. One of the areas of information economy is e-business (Internet commerce), which is developing in the direction of diversification, increase, integration and reduction of online services, while repeating the global trends of the virtual market. This is evidenced by the main trends in the growth of the e-commerce market, the volume of which for the period 2014-2020 has increased almost 12 times. At the same time, the peak of growth of consumers of e-commerce services (in 207% times) compared to the previous year was observed in 2016. During 2017-2020, there is also an increase, but at a slightly slower pace.

Image 8: Development of the Internet trade market in Ukraine for 2014-2020



Source: calculated by the authors according to data (Scientific and innovative activity..., 2018; Monitoring of socio-economic..., 2020; State Statistics Service..., 2020)

The growth of e-commerce in Ukraine is due to the preferences of consumers to use the Internet service and turn it into a natural environment, within which most needs are met, due to such factors as: saving consumer time and choosing products according to the selected filter; the ability to consider a wider range of product items; the ability to choose goods outside the country.

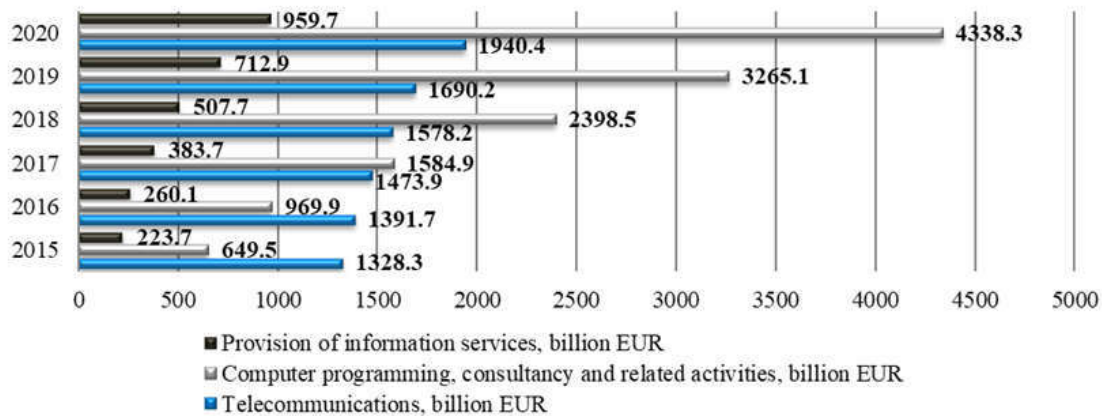
E-commerce also has a number of advantages (including contactless delivery and no need to go out in crowded places) in emergencies, which can be quarantined due to the rapid spread of the corona-virus epidemic. In particular, according to a study of the Chinese market, in just one-month quarantine, e-commerce platforms received more than 200% increase in demand for food and more than 75% increase in demand for non-food products. A structured business network that works in contact with consumers has increased sales through Internet platforms created and improved for this purpose (European innovation scoreboard, 2020; Napolskikh and Yalyalieva 2019, 73-81). The most successful e-business in China, the volume of online trade which has increased during the quarantine period includes: car sales on electronic platforms, delivery of ready meals and beverages, remote work services (Microsoft Teams, WeChat Work, and DingTalk and others), services for online learning, platforms for online travel (Chishti and Barberis, 2016; Vgenopoulou et al. 2016, 85-98; Engin Duran and Pelin Özkan 2015, 35-46).

The COVID-19 outbreak has led to the advancement of artificial intelligence technology, which has improved data capabilities by combining online and offline customer data. In addition, it has accelerated the use of 5G technology, which optimizes the process of online shopping and affects the accelerated construction of “smart cities”. The entertainment

industry has grown to retain customers. For example, bars launched live broadcasts of DJ sets in the Chinese version of TikTok – the Douyin application. Revenues from some broadcasts were equivalent to (more than 229 thousand EUR) (Trend 3. Platform Economy..., 2016; Alexiadis and Felsenstein 2012, 39-44).

The quality system of information security and development of the IT sphere in Ukraine under the influence of globalization processes, as a reaction to the new requirements of the market environment, is developing quite rapidly. The rapid growth of sales of services and value added by business entities in the field of IT technologies allows to stimulate the relationship with the industries and services, ensuring the efficiency of digitalization of territorial and economic systems in Ukraine, namely: telecommunication, which is the main component of the digital infrastructure of the state; computer programming, consulting and related activities of business entities that create a basic product for the transition of the regional economy to a new level of business processes and management, economic and social relations; provision of information services and servicing of regional market segments, taking into account individual and specific requests and needs.

Image 9: Volume of production (services) by types of economic activity in the field of digital territorial and economic systems of Ukraine for 2015-2020, billion EUR

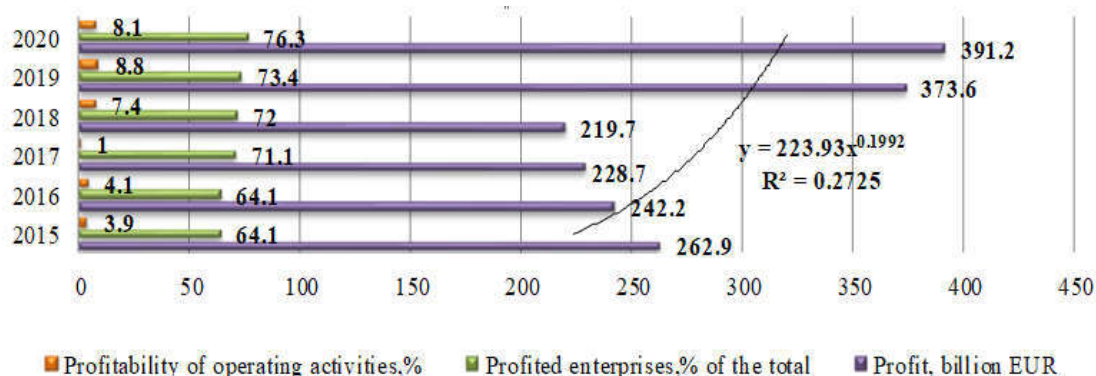


Source: calculated by the authors according to data (Chishti, and Barberis, 2016; Scientific and innovative activity..., 2018; Monitoring of socio-economic..., 2019; State Statistics Service..., 2020)

Thus, in 2015-2018 there was a rapid increase in sales of products and services of enterprises operating in the field of information and communication (Image: 9). IT products grew the fastest (more than 5 times), including software development and implementation, IT consulting and related activities. The share of this type of activity in GDP has increased by 3.5%, which indicates a significant innovation shift in the development of the economy of the territories. Almost 180 thousand of specialists work in the field of IT and their number is constantly growing, which allows to develop this business in the field of small business, which is not subject to income tax. During this period, the volume of information services (in the field of web portal development, cloud computing, creation and management of online platforms) increased, the rate of which increased by 3.0 times, times, their share in GDP increased by 0.4%. However, the volume of production of products and services in the field of telecommunications grew at a slower pace (+46%), which is explained by the faster pace of the development of the industry in 2009-2015, which has led to some stabilization of domestic demand. In particular, the volumes of gross value added of telecommunications enterprises increased by 15.5 times, information services and IT – by 5.2%.

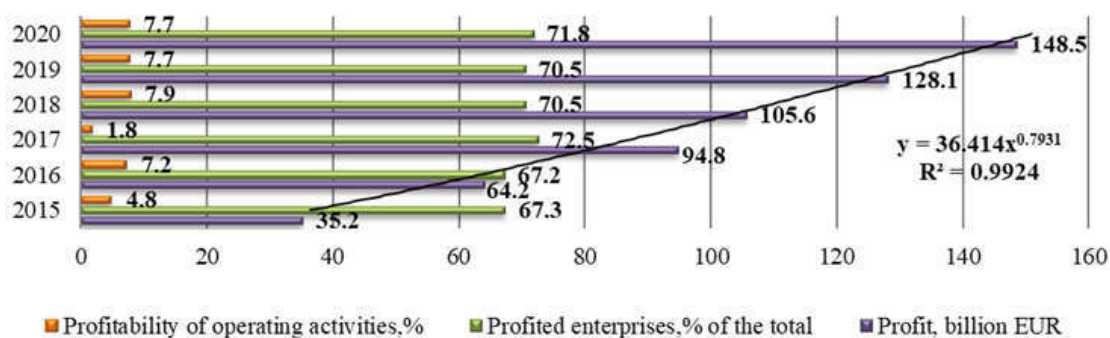
A significant advantage of information and communications in addition to the fast-growing market and relatively high wages is a high level of profitability compared to certain economic activities in Ukraine. Image: 10-12 shows the dynamics of financial results of digital enterprises in Ukraine.

Image 10: Financial results of enterprises in the field of telecommunications in Ukraine for 2015-2020



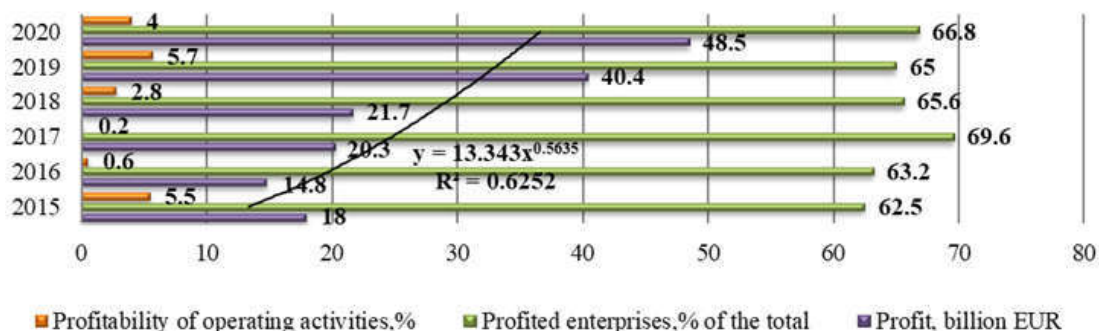
Source: calculated by the authors according to data (Chishti, and Barberis, 2016; Scientific and innovative activity..., 2018; Monitoring of socio-economic..., 2019; State Statistics Service..., 2020)

Image 11: Financial results of enterprises in the field of computer programming, consulting and related activities in Ukraine for 2015-2020



Source: calculated by the authors according to data (Chishti, and Barberis, 2016; Scientific and innovative activity..., 2018; Monitoring of socio-economic..., 2019; State Statistics Service..., 2020)

Image 12: Financial results of enterprises in the field of information services in Ukraine for 2015-2020



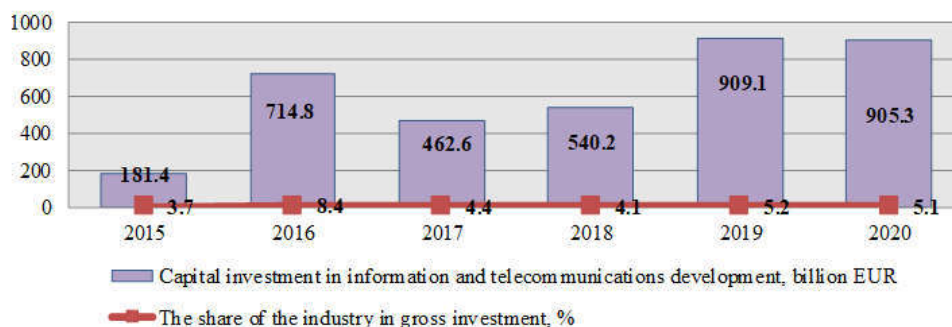
Source: calculated by the authors according to data (Chishti, and Barberis, 2016; Scientific and innovative activity..., 2018; Monitoring of socio-economic..., 2019; State Statistics Service..., 2020)

In 2015-2018, the growth rate of gross profit of IT enterprises (computer programming, consulting and related activities) increased by 4.2 times, in the field of information services – by 2.7 times, and in the field of telecommunications – by 1.5 times. The share of profitable enterprises on average in the industry is about 72%, which is higher than the industry average. At the same time, there is a tendency to increase the level of profitability of operating activities on average by 4%. This indicates the presence of significant domestic economic potential for enterprise development in Ukraine, which, while creating a favorable environment, can create the conditions for a strong economic leap of the national economy both by increasing exports of digital technologies and services and by multiplier influence on innovation development of other areas of economic activity of the country. Information

technology is the most promising area of investment. An increase in broadband investment at 10% leads to an increase in average annual GDP at 0.6-0.7%.

During the period 2015-2018, the volume of capital investment in the development of the information and telecommunications industry increased by 5.0 times (or by 723.9 thousand EUR) However, the share of gross capital investment in the country's economy during this period increased only by 0.4%, except in 2016, when the share was over 8.4%. In 2020, the volume of capital investment in the field of information and telecommunications decreased by 0.4% compared to 2019, the share in gross investment also decreased by 0.1% (Image: 13).

Image 13: Capital investments in the field of information and communications of Ukraine for 2015-2020



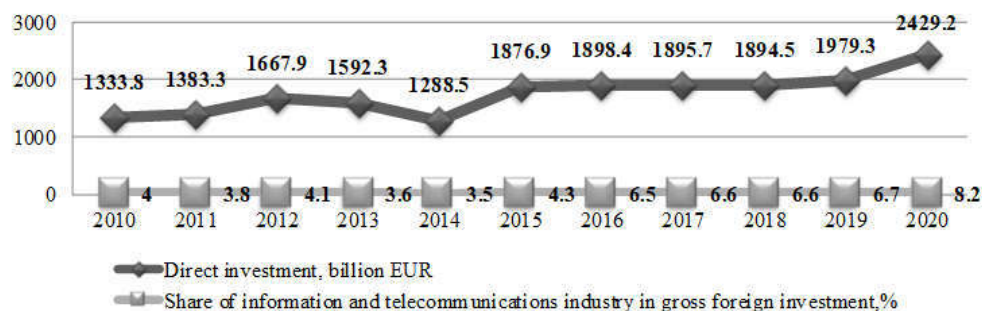
Source: calculated by the authors according to data (Chishti, and Barberis, 2016; Scientific and innovative activity..., 2018; Monitoring of socio-economic..., 2019; State Statistics Service..., 2020)

In terms of the main components of the industry 11.8% investments in 2019 are directed to the field of telecommunications (radio), 0.8% – to the field of computer modeling and 1.2% – to the development of information services. This distribution is primarily related to the level of capital intensity of production of services in these areas.

At the same time, the volume of foreign investments in the field of information and telecommunications in Ukraine is growing. In particular, in 2020 their value amounted to billion EUR, which was 8.2% of all foreign investment in Ukraine (Image: 14). The largest share of foreign investment is directed to the IT sector, which is explained by the orientation of most IT companies in Ukraine and the execution of foreign orders on the terms of outsourcing and export of services.

Since 2010, the volume of export of telecommunications, computer and information services has been growing on average by 7-11% every year (Image: 14). At the same time, the export of IT services is growing the fastest, which has increased 1.8 times during the studied period. The main customers of Ukrainian IT services are US companies (over 60%), as well as European companies, whose share in the import of information services produced in Ukraine has reached 11%.

Image 14: Capital investments in the field of information and communications of Ukraine for 2015-2020



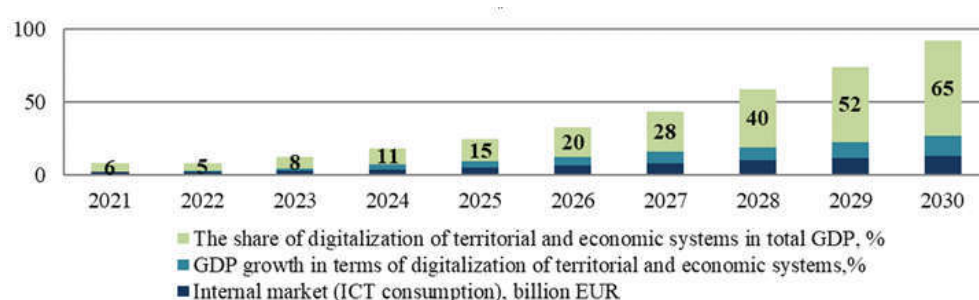
Source: calculated by the authors according to data (Chishti, and Barberis, 2016; Monitoring of socio-economic..., 2019; Scientific and innovative activity..., 2018; State Statistics Service..., 2020)

The volume of export of digital services from Ukraine in 2021-2022, under favorable conditions, can increase by 3.0 times and improve the country's export potential. Thus, the export of IT services from Ukraine has significant potential for development and growth. At the same time, the predominant export orientation of telecommunication products leads to

insufficient consumption of IT products in Ukraine. In particular, in 2020 the total volume of ICT services amounted to approximately 1.31 billion EUR, which is 6.0 times less than consumed by the Polish economy during the same period.

The current stage of digitalization of territorial and economic systems in Ukraine is the removal of legislative, institutional, fiscal and tax barriers that hinder the development of the digital economy. Another important task is to create motivation for digitalization of society, which is to ensure the affordability of digital technologies for consumers, creating conditions in various spheres of life to form the needs of citizens and businesses to use new digital tools instead of the usual, traditional (Trend 3. Platform Economy..., 2016). Taking into account the impact of digitalization processes on the innovative development of Ukraine's economy and its share in the country's GDP, and the growth trends of IT in the country, in the context of the project "Digital Agenda of Ukraine" the forecast indicators of the development of territorial and economic systems are developed that is resulted in Image: 15.

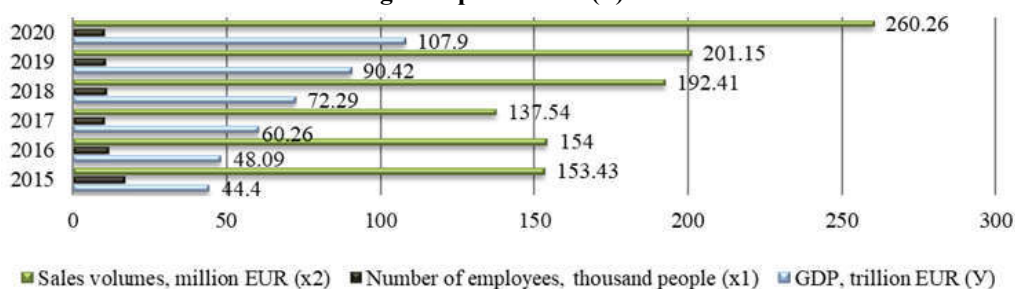
Image 15: Forecast indicators of digitalization of territorial and economic systems in Ukraine for 2021-2030



Source: calculated by the authors according to data (Trend 3. Platform Economy..., 2016; Digital Agenda of Ukraine, 2020; European innovation scoreboard, 2020)

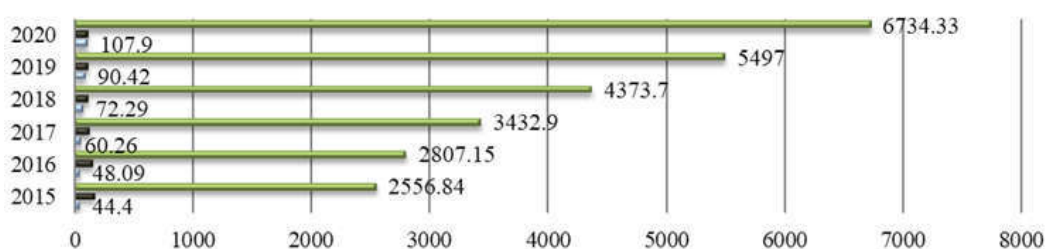
These forecasts are relative and the conditions for the formation of a purposeful state policy in the field of digitalization, as well as the development of effective mechanisms for its implementation in all areas of management and economic activity can be implemented. In Image: 16-18 the dynamics of the indicators of production (services) and the number of employees involved in the field of digital technologies in terms of key sectors are given.

Image 16: Indicators of the development of enterprises of the sector of information and communication technologies in production (P) of Ukraine for 2015-2020

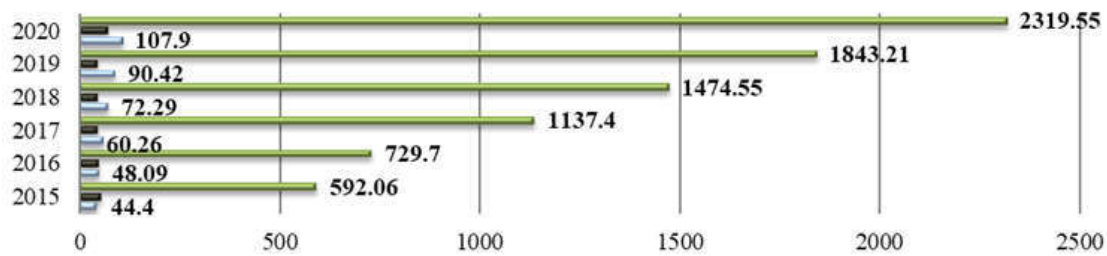


Source: calculated by the authors according to data (Trend 3. Platform Economy..., 2016; Digital Agenda of Ukraine, 2020; European innovation scoreboard, 2020)

Image 17: Indicators of the development of enterprises in the sector of information and communication technologies in services (S) of Ukraine for 2015-2020



Source: calculated by the authors according to data (Trend 3. Platform Economy..., 2016; Digital Agenda of Ukraine, 2020; European innovation scoreboard, 2020)

Image 18: Indicators of the development of enterprises in the sector of services for the use of computer equipment (I) of Ukraine for 2015-2020

Source: calculated by the authors according to data (Trend 3. Platform Economy..., 2016; Digital Agenda of Ukraine, 2020; European innovation scoreboard, 2020)

Thus, the dynamics of the main areas of digitalization of territorial and economic systems of Ukraine in 2015-2020 and the dynamics of GDP has negative trends (-56 due to the reduction in the number of employees employed in knowledge-intensive industries for technology and equipment used in economic and social processes. However, there is a relatively small increase in the output of the information and communication technology sector (+63%) compared to other areas of IT. This means that in the context of growing trends in the digital economy of the regions, Ukraine is becoming increasingly dependent on import of relevant equipment and technologies. The largest increase during 2015-2020 is observed in the information sector, i.e., the sector of services for the use of computer equipment – the number of employees in this sector increased by 31%, the volume of services provided – by 4.0 times.

A correlation-regression analysis of the impact of the development of certain sectors of the information and communication sphere on GDP is given, the results of which will adjust the tactical plans for the strategy of digitization of territorial economic systems in the regions by stimulating the development of certain economic activities. Regression models of the impact of individual sectors of the digital technology sector on Ukraine's GDP have been verified (Table 1).

Table 1. Correlation-regression analysis of the impact of indicators of the development of sectors of digitalization of territorial and economic systems on the GDP of Ukraine

Indicators	Volumes of production (works, services), million EUR		
	Information and communication technologies in production (x1)	Information and communication technologies in services (x2)	Computer equipment services (x3)
Regression equation	$y = 21.44 + 0.20x_1$	$y = 6.93 + 0.016x_2$	$y = 0.14 x_3 - 20.84$
Coefficient of determination (R ²)	0.18	0.99	0.69
Checking the significance of the equation $F_{calc.} > F_{table.}$ ($\alpha=0.05$)	$F_{calc.}$ 1.54	89.07	6.99
	$F_{table.}$ 0.82	0.82	0.82
Coefficient of elasticity, %	-	0.093	0.0013

Note. F_{calc.} – Fisher's criterion (calculated); F_{table.} – Fisher's criterion (tabular).

Source: calculated by the authors

Forecast GDP growth under the influence of forecast growth of individual sectors of digitalization of territorial and economic systems is carried out according to formula (2) (Byrkovych et al. 2019, 9; Kunanets et al. 2016, 257-274):

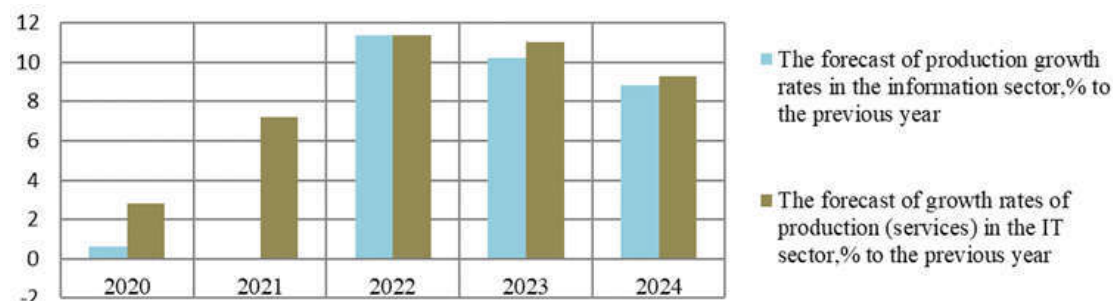
$$GDP_t^f = GDP_t^e + (K_c \times T_{ef}^f \times GDP_t^e) \quad (2)$$

where, – is the forecast value of GDP in year t under the influence of the development of the sector; – extrapolation forecast value of GDP in period t; – the coefficient of elasticity of

GDP from the development of a particular IT sector; – the forecast growth rate of the sector in the year t, %.

Extrapolation growth of production (services) of the information sector for the period up to 2023 is shown in Image: 19.

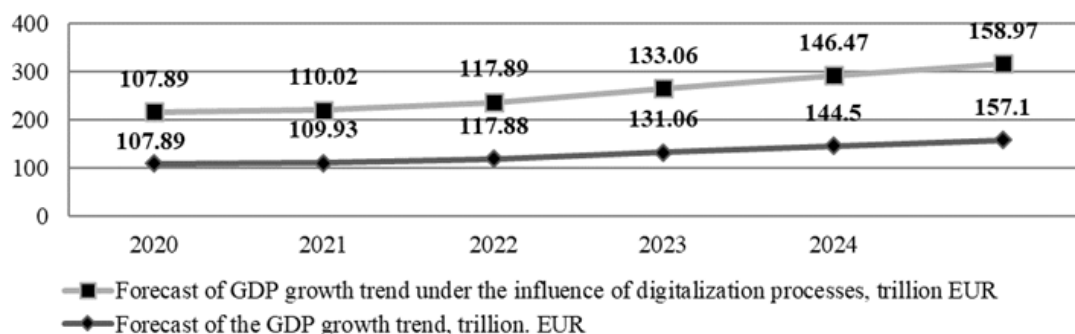
Image 19: Forecast extrapolation trend of growth of production (services) in the information and IT sectors of Ukraine for 2020-2024, %



Source: calculated by the authors

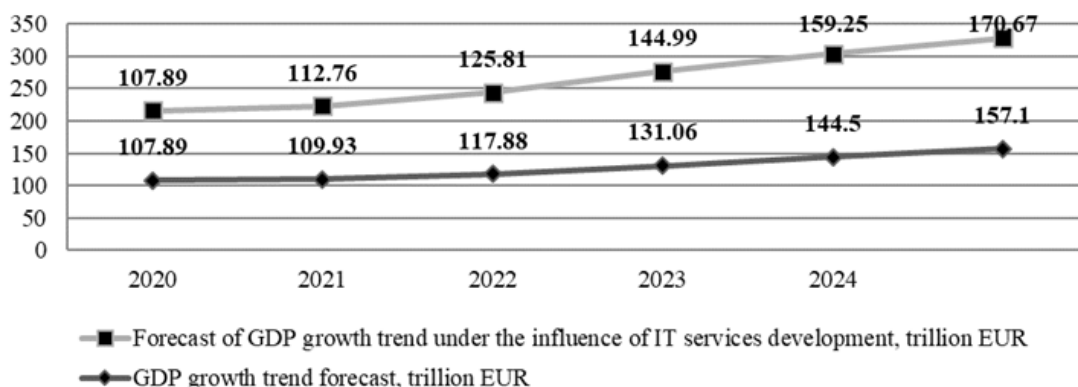
According to the algorithm of formula (2), the forecast value of GDP is calculated under the influence of trends in the development of the sectors of information services and IT technologies of territorial and economic systems. It is established that the increase in the volume of information services on the use of computer technology in the forecast period (2020-2024) will be 25%, which will increase the significant impact on GDP growth to 47.3% with 45.6% of forecast growth, without taking into account the impact of this sector (Image: 20). This is primarily due to the intensification of informatization processes in all areas of production, management, marketing and social activities, a significant part of which is the development of e-marketing and commerce.

Image 20: Forecast of GDP growth of Ukraine taking into account the processes of digitalization of territorial and economic systems in accordance with certain trends



Source: calculated by the authors

Image 21: Forecast of GDP growth in Ukraine under the influence of the development of the IT sector in accordance with certain trends



Source: calculated by the authors

The analysis showed that the level of the development of industrial production of information and communication technologies and equipment in Ukraine has significant

prospects for intensification of digitalization processes in all areas of territorial and economic systems, job creation and GDP growth.

4. Conclusions

Thus, the current stage of the development of territorial economic systems in Ukraine is caused by the implementation of structural, administrative and economic processes using the mechanism of digitalization, which is one of the important integration tools to optimize the management of economic sectors and increase the manageability of changes.

The main vectors of digitalization of territorial and economic systems, adapted to the global network of IT technologies and models of innovation-oriented development are:

- development of digital infrastructure in the regions and elimination of inter-territorial gaps in the provision of Internet services;
- improvement of electronic systems of public management of territories, increase of transparency of management of economic activity of communities and expansion of opportunities of citizens in the processes of discussion and formation of key decisions concerning development of territorial communities;
- introduction of geolocation systems of all types of business in the region and electronic inventories of natural resources;
- development and implementation of digital services (standard mandatory minimum of public services) for citizens covering key areas of life, i.e., social security, education, medicine, security, environment;
- formation of programs to attract investment in the processes of digitalization of the public sphere and business, in particular in terms of priority industries;
- development of regional programs of digital competencies, skills and culture of using digital services for citizens.

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