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DIGITAL TECHNOLOGIES AND THEIR IMPACT ON ECONOMIC AND SOCIAL SPHERES IN UKRAINE

Purpose. To determine the specifics of the impact of IT use on the economic and social spheres in Ukraine. To develop a mathematical model for evaluating and forecasting the impact of IT on these areas.

Methodology. General and special methods of cognition were used in the research: mathematical formalization for evaluating and forecasting the impact of IT on the economic and social spheres, correlation analysis – to establish multiplicative relationships of parameters and basic functions; comparison – to establish the nature of the IT impact on the social and economic spheres; analogies – to analyze the level of IT development in Ukraine and other countries; quantitative and qualitative comparison to analyze the level of social Information and Communications Technologies (ICT) use at enterprises by types of economic activity.

Findings. It is proved that there are limiting factors to the growth of the positive IT impact, in particular the average level of income per capita. This is also evidenced by the comparison of agricultural and industrial regions of Ukraine, which indicated a significant gap in the introduction of IT in the countryside and the city. The weaknesses and successes of Ukraine in the implementation of IT are identified. The causes of hampering the positive impact of IT use on the development of social and economic spheres are indicated. A significant level of differentiation in the use of IT by business by types of technologies was proven.

Originality. The peculiarities of the IT impact on the economic and social spheres in Ukraine are determined. The main feature is balancing between the development of IT technologies and social sphere and the state of stagnation of this process. A mathematical model for evaluating and forecasting the IT impact on the economic and social spheres has been developed; the intermediate results of its use have been given.

Practical value. Recommendations for removing obstacles to the implementation of IT in Ukrainian social and economic spheres have been proposed.

Keywords: *digital technologies, information and communication technologies, mathematical model, multiplicative communication*

Introduction. The significant level of the impact of IT use in industry and business on the social and economic sphere, the entire set of Sustainable Development Goals (SDGs), proves the importance of its research. Digitization of the entire business activity of enterprises, a change in the paradigm of the efficiency of this activity from the production of material goods to the provision of information services, the growth of requirements for the quality of goods and services, the need for direct contact with the consumer through the use of information technologies forms a new type of society and a new type of economy, which is called the Economy 5.0. This requires a study on national peculiarities of IT implementation and the impact of digital technology on economic and social spheres in every country of the world, a relevant assessment of IT implementation in all spheres of human activity, a comparison of the level of IT implementation in Ukraine and other countries of the world. It is also necessary to study the interaction of the social, economic sphere and industrial and business activities, to evaluate this impact and, if necessary, to make adjustments in real time in a regulatory manner to strengthen positive trends. It is also relevant to determine the factors that complicate the implementation of IT in all spheres of activity and the factors whose influence is negative.

To increase the relevance of assessing and forecasting the impact of digital technologies on the economic and social level of development in Ukraine, the business sphere, the development of mathematical models that can provide the most relevant results, is needed.

Literature review. Scientific works on this problem can be conditionally divided into studies of a general theoretical nature and applied ones. Applied scientific works, in turn, can be stratified into two main categories – those that rely on expert evaluations and surveys and those that rely on modeling methods. In addition, the review of the literature highlights the articles in which the peculiarities of the Ukrainian realities of the specified issues are studied.

The general theoretical articles include, in particular, the work by Hilbert [1], devoted to the study on the meta-paradigm of information transformation as a tool for the socio-economic evolution of mankind. Elements of this approach were used in the presented study. In the work by Isachenko [2], the role of information and communication technologies (ICT) in the development of modern society is researched. The problems of business informatization are considered from three perspectives: technocratic, informational and social, and their synergistic interaction is indicated, which is also taken into account in our work [2]. Lynn, et al. [3] study the difference in the pace of IT for urban and rural areas, which, in their opinion, is the main reason for the social gap between them. This is also considered in the presented study. Agarwal [4] analyzes the introduction of IT into the business processes of socially significant spheres and indicates the formation of a negative influence of these spheres on the further IT transformation of the economy and society. At the same time, Iqbal, et al. [5] consider the economy as a system, the subsystems of which are the economy, technology, society and politics, and dwells on the negative impact of IT. Undoubtedly, there are negative aspects of the influence of IT, but, in our opinion, all manifestations of this influence should be considered in a complex manner. Li, et al. [6] considered this influence as a tool for overcoming obstacles to social development. It is indicated that the use of IT in business can replace economic and

social stagnation with dynamism, but it can also have adverse consequences. Mgunda [7] researched the drivers of economic innovation caused by IT and their impact on social systems, in particular those aspects that the use of IT in business led to: a change in consumer values; the emergence of new types of business and the creation of jobs, which increased the level of well-being. Unfortunately, only a qualitative (and not a quantitative) method of analysis was used in [7]. Roztocki, et al. [8] studied the role of IT in the development of social capital, which somewhat narrows the analysis of the impact of IT on the social sphere. Royakkers, et al. [9] indicated that the insufficient development of civil society, its lack of control and publicity in the implementation of IT can lead to the narrowing of the implementation of social values. This necessitated the analysis of social ICT in the presented work. An example of a scientific work based on expert evaluations and surveys is the article by Palvia, et al. [10] in which, using the narrative method, a model for measuring the impact of IT on socio-economic development was developed by the factors: GDP growth, employment, labor productivity, quality of life, education and health care, and poverty alleviation. The use of citizens' assessment of the socio-economic development of the country, which is developing due to the introduction of IT, limits the level of relevance of the results. Scientific works that use modeling methods include the article by Jabłonski, et al. [11], where the Analytic Hierarchy Process (AHP) method is used to evaluate social criteria as a result of digitalization of business processes. Tosheva [12] also uses the general approach of the AHP model to study IT as a driver of enterprise competitiveness and its impact on the formation of social guarantees. The general approach proposed in works [11, 12] regarding the hierarchical approach to the formation of goals is used in our work. Sazonets, et al. [13] use a statistical indicative model and factor correlation analysis. The results of the study confirm the close connection between the migration of highly qualified personnel and the complex impact of the introduction of IT on the social and economic spheres.

Peculiarities of the Ukrainian realities of the specified problems were studied by Shkvaryliuk, et al. [14]. They pointed out that only 5 % of Ukrainian enterprises used all prospective directions of IT technologies. This provided the basis for the assertion that there are factors restraining the impact of IT technologies on social processes in Ukraine. Okhrimenko, et al. [15] indicated the importance of adjusting the impact of IT for Ukraine to reduce the digital divide between different population groups. Spivakovsky, et al. [16] consider the impact of IT on the economy, in particular in the formation of "digital inequality", which requires smoothing the impact of digital transformations on economic security. Kholiavko, et al. [17] indicated that the implementation of IT should be controlled by the state because it has a significant impact on the security of the state in terms of social and economic consequences. Shevchuk, et al. [18] indicated that the further digital transformation of Ukraine will take place either with the inertial perception of IT development as a non-priority for the state, or according to an accelerated scenario. It is necessary to eliminate legislative, institutional, fiscal and tax, currency and monetary barriers to IT development to achieve this.

The analysis of literary sources revealed that in the majority of scientific works, which use modeling methods when considering this problem, an evaluative method of information analysis or a qualitative analysis of the effect of influencing factors was used. The use of the indicative approach in some works, in the opinion of the authors, has certain advantages, but the relevance level of the influence assessment of factors and the trends of their change due to its use is not sufficient. When studying the peculiarities of the Ukrainian realities of IT implementation, the mathematical models used by scientists are also based mainly on evaluation methods.

Unresolved aspects of the problem. The study on the Ukrainian peculiarities of IT implementation and the impact of digital technology on the economic and social spheres in Ukraine requires further in-depth research. It is also necessary to develop a mathematical model for evaluating and forecasting the impact of digital technologies on the economic and social level of development in Ukraine.

The purpose of the article. To determine the peculiarities of the impact of IT application on the economic and social spheres in Ukraine. To develop a mathematical model for evaluating and forecasting the impact of IT on these areas.

Methods. The research used general and special methods of cognition. The method of mathematical formalization was used to assess and forecast the impact of digital technologies on the economic and social level of development in Ukraine. This method is as follows: three basic functions are determined: economic (F_1), social (F_2), business (F_3). The parameters on which the specified functions depend are determined by the SDGs. For this purpose, parameters that determine one or another basic function are selected out of the 183 national indicators of the SDGs. These indicators are determined according to the "List of national indicators of the SDGs", approved by the order of the Cabinet of Ministers of Ukraine dated August 21, 2019 No. 686. According to variable studies, other significant parameters that specified certain index indicators were added, in particular, the average monthly pension (Table 1) [20]. These parameters formed three groups of arrays according to the functions F_1, F_2, F_3, dimensionalities, respectively, n, m, k. This gave reason to consider the basic functions as vectors: $\vec{F}_1(n)$, $\vec{F}_2(m)$, $\vec{F}_3(k)$. And the task, accordingly, is considered as the optimization of three functions by time (τ) in a multidimensional space with the dimensionality $n+m+k+4$ (where four stands for three basic functions and time).

The first step of the algorithm was the stratification of the basic functions, by selecting the main function and classifying the others as second-order functions. For example, we choose the option when the main function is social (F_2). This simplifies calculations, since the domain of the basic functions is divided into three subdomains with the change in interval F_2: undesirable values of the social component, its possible values, and desired values, that, accordingly, reduces the solution search range. We look for the optimum in the "desired values" domain under the condition that

$$opt\left\langle \vec{F}_1(n), \vec{F}_2(m), \vec{F}_3(k) \right\rangle \sum F_1^{\max}; F_2^{\max}; F_3^{\max}.$$

For this, first of all, it is necessary to establish multiplicative relationships of indicators that determine the basic functions. This, in turn, requires the formation of correlation dependences of parameters. The presence of correlation of parameters means not only their multiplicative relationship, the density of this relationship, but also the density of the relationship of basic functions that depend on these parameters and the level of mutual influence of these basic functions.

The forecast is based on the determination of the first derivatives of the basic functions with respect to time. As it is known graphically, the first derivatives represent the tangents to the response surface of the basic functions at the basic point, which is calculated according to the parameters determined for

Table 1

Dynamics of the average monthly pension, hryvnias

Years	2014	2015	2016	2017	2018	2019	2020
Average amount of monthly pension per person, hryvnias	1526.10	1581.50	1699.50	1828.30	2479.20	2888.60	3082.98

the current time (τ_1). And by the method of integration, we find the value of the basic functions at a given time (τ_2). By the values of the functions, we find a set of parameters in time τ_2, respectively, n_2, m_2, k_2. Obviously, it is necessary to find three basic functions at the same time, since they influence each other

$$n_2, m_2, k_2 \rightarrow \begin{cases} \int_{\tau_1}^{\tau_2} \vec{F}_1(n)d\tau \\ \int_{\tau_1}^{\tau_2} \vec{F}_2(m)d\tau. \\ \int_{\tau_1}^{\tau_2} \vec{F}_3(k)d\tau \end{cases}$$

Unfortunately, large-scale military actions nullified the results of forecasts, and the State Statistics Service of Ukraine stopped updating statistical data. Nevertheless, the interim results of the study are, in our opinion, worth publishing. Thus, a comparison of the number of enterprises that used IT by types of IT technologies (Table 2) indicated a significant level of correlation with some social and economic parameters, for example, with the average monthly pension. The correlation coefficient of this indicator with the number of enterprises that used, in particular, "Cloud computing services" is 0.998819; "External connection to the Internet" ÷ 0.999519; "Own website" ÷ 0.999519. The application of the analytical method made it possible to confirm that the increase in the number of these enterprises leads to an increase in the number of employees and, accordingly, an increase in deductions to the pension fund. But the return on investment for some types of IT is not always justified. Therefore, for some types of IT, there is a decrease in the number of enterprises that use them (Table 2) [20].

At the same time, the method of comparison made it possible to establish the presence of both the positive impact of the latest technologies on the social sphere and their negative impact for Ukraine. For example, the negative correlation coefficients for the use by enterprises of "Sources of "bigdata" for the analysis of "bigdata" ÷ -0.9923 and "E-commerce via the Internet" ÷-0.90708 confirmed the thesis as to the presence of a negative impact of the use of some IT types on social indicators by the fact that these technologies, in particular, lead to the reduction of employees, since the need for employees may decrease due to the effectiveness of some types of IT.

The method of analogies was used in the comparative analysis of the level of IT development and its impact on the economic and social level in Ukraine and other countries using the network readiness index (NRI) and its components. Quantitative and qualitative comparison methods are used to analyze the level of use of social ICT at enterprises by type of economic activity.

Results. A comparative analysis of social, political and other spheres of Ukraine and other countries using NRI and its components [19] made it possible to identify the weak points and successes of Ukraine in the implementation of IT.

The developers of the new model of the NRI index included in it the ability to assess not only the level of development of the IT infrastructure according to 62 main parameters combined into four groups, but also to assess the level of implementation of social standards [19]. Thus, according to the group of sub-indices D of the NRI index, an assessment of the impact of IT on the socio-economic state of the country and the well-being of citizens, the quality of life (the impact of the digital economy on the social sphere) and the level of achievement of the SDGs, for example, health and well-being; quality education; gender equality, etc. That is, NRI nowadays is a comprehensive indicator of the impact of IT on the level of socio-economic development of the country.

Seven countries with the greatest success in economic development (Finland, Switzerland, Sweden, Israel, Singapore, the Netherlands and the United States) take the highest positions according to the NRI. Since, according to [16], there is a strong correlation between network readiness and income per capita for the leading countries of the NRI, and the groups of parameters by which this index is determined indicate the level of network activity of civil society, it can be asserted that the level of the NRI affects social economy. This is confirmed by the fact that the NRI of these countries is 33 % higher than in other countries with developed economies and, on average, twice as much as in countries with developing economies. A common feature for the specified seven countries is that they were the first to widely introduce IT, purposefully promoted and stimulated this introduction. In addition, high-quality infrastructure and trained personnel were formed in these countries. To analyze the values of the sub-indices for the NRI of business and society in Ukraine, let us consider, first, the so-called "environmental sub-index", which consists of components of the evaluation of the political, regulatory and business innovation environment, the level of support of state institutions for the implementation of IT, in particular, in the social sphere and business. According to this indicator, Ukraine ranks *94th* among the countries of the world. Even third world countries are ahead of Ukraine in terms of this indicator. Regarding the component of implementation of regulation of the IT sphere ("political environment"), Ukraine occupies the unprestigious *113th* place in the rating. This means that ICTs in Ukraine need stronger institutional support. According to the sub-index of the development of the business innovation environment, Ukraine is in *67th* place. That is, the rate of introduction of IT innovations into business processes is relatively insignificant, which indicates the need to improve this component. The sub-index of readiness for the implementation of IT technologies for Ukraine is 5.7, with the highest value of the rating indicator being 6.6 (for Finland). This subindex consists of the components: state of infrastructure (Ukraine ranks *51st* in the ranking); admissibility of technologies (high 6th position); skills and abilities (rating: 33). According to the value of the subindex of IT use, Ukraine ranks *88th*. This indicates that IT is not being used properly by society. The sub-index of individual use of IT technologies has a

Table 2

The number of enterprises that used IT by types of IT technologies, units

The type of information technologies used in baseness	Years							Rate of change
	2015	2016	2017	2018	2019	2020	2021	
Cloud computing services	3900	4051	4135	4831	5207	5251	5327	536
Sources of "big data" for the analysis of "big data"	10,440	10,321	10,252	9188	9280	9206	9118	–486
3-D printing	–	–	–	1219	1471	1170	1215	252
E-commerce via the Internet	12,502	12,530	12,609	12,059	12,609	13,494	13,711	~0
External connection to the Internet	38,207	38,920	39,582	43,303	43,785	44,854	45,198	2101
Own website	15,695	15,986	16,240	17,522	17,856	18,778	19,521	808

rating of 76. The sub-index of business use of IT has a rating of 63. The sub-index of state support for the use of IT has a rating of 114. That is, the level of state support for the implementation of IT for citizens (IT-feedback) is lower than all other sub-indices. This reduces the multiplicative interaction between the development of IT and society. According to the IT impact sub-index, Ukraine is *69th* in the ranking. According to the sub-index of economic influence, the country ranks *59th* in the rating. According to the sub-index of the social impact of IT, Ukraine occupies a not-so-prestigious *75th* place in the rating. In general, the results of the analysis indicate the insufficient level of IT implementation in all spheres – social, business, insufficient attention of institutional structures to IT implementation. The gap in the pace of IT implementation in the business, social, and political spheres was also confirmed.

The given analysis made it possible to reveal the specifics of the impact of business application of IT on the development of the social sphere of Ukraine and to form recommendations on the elimination of obstacles in the use of IT technologies for the development of the social sphere, the effective implementation of IT technologies in Ukrainian business. Since business is the driving force of the development of IT technologies, invests in them, develops IT infrastructure, including that for society, it is necessary to: strengthen institutional, first of all, government support for IT business in forming relations with foreign investors and foreign IT companies to increase the level of cooperation; strengthen institutional, primarily governmental, support for IT business, in particular, by introducing tax benefits for both IT companies and companies that introduce new types of IT services and ICT for the population; contribute to the expansion of the IT infrastructure; promote new IT products and services for business and society.

In order to increase the influence of IT on the formation of the social sphere, it is necessary to: increase budgetary support for the introduction of IT in socially significant areas, first of all, in the spheres of health care and education; implement a policy to reduce the cost of IT products and services to increase the level of IT implementation in the social sphere; to form IT implementation programs to realize socially important SDGs: No. 1, 3, 4, 8; ensure reliable monitoring of this process and proper regular reporting to the public on the level of implementation or reasons for non-implementation of the specified programs. It is the open discussion of these important issues for society that will contribute to the development of civil society and, indirectly, the social economy.

This also allows us to formulate the reasons for inhibiting the positive impact of IT use in business on the development of the social sphere. The business is focused on solving its problems and purposefully does not engage in the development of the social sphere. Expanding the IT infrastructure for its future use by society requires significant investments from business. The payback of these investments for some types of IT technologies, as indicated above, is not always justified. In recent years, there has been an increase in tax pressure on the IT business, which reduces the insufficient investment opportunities of the national IT business, and accordingly, for some years, a certain reduction in its weight, in particular, in the export of services (Figure) [20].

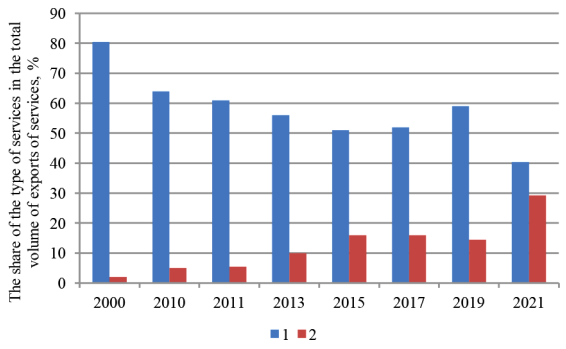

Fig. Dynamics of transport services (row 1) and services in the field of telecommunications, computer and information services (row 2), %

Although over the period from 2000 to 2020, the share of added value in the GDP of the IT sector of Ukraine increased from 2.8 to 5 % [20] still there are limiting factors for the growth of this indicator. In particular, the level of investment guarantee is not sufficient for foreign investors to enter the Ukrainian market. This contributes to the fact that the level of implementation of IT technologies in social and other spheres has not assumed a stable character. This indicates that the gap in the use of IT, in particular, the gap in the use of social ICT at enterprises (Table 4) contributes to the formation of a permanent gap in the ICT infrastructure. This peculiarity of the impact of IT business application on the development of the social sphere of Ukraine requires an increase in the role of institutional structures in this process. Unfortunately, state support for the implementation of IT in the social sphere, economy and business is not systematic in nature, which is evidenced, in particular, by comparing the pace of IT implementation by enterprises by type of economic activity. All of the above leads to inhibition of the positive impact of IT introduction in business on the development of the social sphere. These conclusions are supported by the analysis of statistical data (Tables 2 and 3).

The analysis of the data on how different types of IT technologies are used in business processes (Table 2) proved the existence of significant differences in the rates of change in the use of different types of IT technologies by Ukrainian businesses. The most impressive thing is that in some cases the indicated rates are opposite. In particular, with regard to E-commerce, there is no development over time, and with regard to "Sources of "big data" for the analysis of "big data"" development is generally negative – that is, there is a decline in this indicator.

The conducted analysis established a significant level of correlation between the use of the Internet in business and in society. The correlation coefficient is 0.8756. At the same time, a significant level of differentiation in IT use by business by type of technology (Table 2) and the values of Ukraine's rating by NRI sub-indices indicates that the trend of digitalization of business and, accordingly, the level of its influence on the achievement of the SDGs have not assumed a stable character. This also indicates that Ukraine is currently balancing between the sustainable nature of the multiplicative relationship between the development of IT technologies along with the development of the social sphere and the state of stagnation of this process. Reverse trends in the use of certain types of IT not only lead to a reduction in investments, but also result in a reduction in their infrastructural support, which leads to gaps in the IT infrastructure by types of technologies and industries. First of all, this concerns the infrastructure of those types of IT, where their widespread use by the population was predicted, because business support of IT infrastructure, which is not used, determines the formation of losses of IT companies.

Many researchers declare the purely positive nature of the impact of IT on other spheres of society [2, 4]. But our research has proven that for Ukrainian realities the impact of IT on the social sphere is of an ambivalent nature. For example, there is a direct connection between the growth of the number of unemployed population [20] (according to the ILO methodology) and some positions of Table 2. In particular, the correlation coefficient between the number of the unemployed population and the number of enterprises using "Sources of "big data" for the analysis of "big data"" is ÷ 0.865029. The correlation coefficient of the number of enterprises that use "Sources of "big data" for the analysis of "big data"" and the total expenditure of the population on average per month per

Table 3

Areas of use of social ICT in enterprises by type of economic activity, share of the number of enterprises using ICT by type* in the total number of enterprises, %

Type of economic activity of enterprises	social networks				blogs/microblogs				multimedia websites				means of knowledge exchange			
	2017	2018	2019	2021	2017	2018	2019	2021	2017	2018	2019	2021	2017	2018	2019	2021
Processing industry	22.4	23.4	24.6	25.1	6.3	6.4	6.6	6.9	12.3	12.4	12.5	12.9	10.2	10.2	10.3	10.4
Supply of electricity, gas, steam and air conditioning	225	23.1	23.3	23.2	7.5	6.4	5.9	6.2	12.8	12.9	12.2	12.4	10.5	10.6	11.6	11.7
Water supply; sewerage, waste management	25.4	26.0	27.5	27.1	5.2	5.4	5.5	5.4	8.9	8.8	9.5	9.2	10.9	11.0	11.9	12.1
Construction	20.9	20.8	20.6	20.7	5.5	5.3	5.4	5.3	9.3	9.2	9.3	9.3	11.1	11.1	11.0	11.1
Transport, warehousing, postal and courier activities	17.6	18.8	19.4	21.2	4.4	4.5	5.1	5.9	6.1	7.6	8.4	10.2	9.8	9.9	9.9	10.6
Information and telecommunications	44.3	45.9	47.3	49.2	14.3	15.9	17.3	19.4	25.2	27.4	28.6	30.1	16.9	18.1	19.1	20.2
Professional, scientific and technical activity	26.2	28.6	29.4	30.1	9.2	9.3	9.7	9.8	14.0	15.8	16.3	16.4	13.2	13.7	14.3	14.4
Activities in the field of administration	21.2	22.1	21.0	20.9	5.8	5.7	5.4	5.4	9.9	9.2	9.1	9.2	10.2	10.3	10.2	10.2

* The State Statistics Service of Ukraine does not have data for 2020

household is ÷ 0.554046. Our analysis proved that there are limiting factors for the growth of the positive impact of IT. For example, the average level of income per capita is one of such factors. This, in particular, is evidenced by a comparison of agricultural and industrial regions of Ukraine. For example, if the number of private entrepreneurs for providing IT services in the predominantly agricultural Kherson region is 1.47 per thousand people, then in the predominantly industrial Dnipropetrovsk region it is 3.24.

A comparison of rural and urban IT coverage indicates a significant gap in the adoption of digital technologies. For example, a comparison of the level of IT proficiency indicates that 19.8 % of the rural population do not have such skills at all, compared to 13.0 % of the urban population. 20.2 % against 27.9 %, respectively, consider IT proficiency to be sufficient.

It is the lower level of income per capita of the rural population in Ukraine compared to the level of income for the urban population that is a factor that inhibits the spread of the influence of IT technologies on the development of the economy in rural areas. And this, in turn, forms the prerequisites for a decrease in business activity, which causes a decrease in the level of income per capita and a much lower rate of its growth, that is, a certain closed cycle is formed.

The level of prices for IT technologies is unaffordable for a significant number of Ukrainian enterprises, and even more so for some social strata. This is also a factor of restraining the development of social and economic spheres, in particular, by the factor of providing production and political class with personnel who have experience in using IT. Leading companies in Ukraine, having both the resources and the experience of implementing ICT, at present, even with the desire to contribute to the development of the national social economy, are unable to fully realize this desire due to political, regulatory and legislative restrictions, the level of corporate and organizational culture, the need to incur significant costs and, in a certain way, due to the lack of social control.

The analysis of directions for the use of social ICT at enterprises by types of economic activity (Table 3) confirms a significant difference in their implementation. So, in general, the implementation of the ultra-modern direction of using social ICT – means of knowledge exchange is ~10–20 % of the total number of enterprises. This direction is preceded by the field of "Information and telecommunications" ~0.2 % according to data for 2021 and "Professional, scientific and technical activities" ~ 14.4 %. The use of websites with multimedia tools is ~9–30 % of the total number of enterprises with a significant level of differentiation by types of economic activity. The spheres of "Information and telecommunications" and "Professional, scientific and technical activities" are also among leaders by this indicator, respectively, ~28 and 16 %. The use of blogs and microblogs is ~5–6 % of the total number of enterprises. The spheres of "Information and telecommunications" and "Professional, scientific and technical activities", make up, respectively, ~30 and ~16 %. In recent years, the number of enterprises using social networks has increased significantly (~20–27 %). According to the type of activity "information and telecommunications", the indicator is significantly more than ~49 %. "Professional, scientific and technical activities" ~30 %. It is characteristic that the worst indicators of the use of social ICT are labor-intensive activities: "Transport, warehousing, postal and courier activities" and "Activities in the field of administration", although the transport industry, as well as banking, are leaders in Ukraine in terms of the level of IT implementation. This shows that these industries do not consider it necessary to form feedback with social strata.

The pace of ICT implementation in the most socially significant types of economic activity of enterprises, for example, "Electricity supply, gas, steam and conditioned air", "Water supply; sewerage, waste management" is insufficient. According to some types of ICT, the specified types of economic activity of enterprises show a decrease in indicators.

A significant level of differentiation of the values of the indicated indicators and the rates of their change by industry confirm the thesis that the impact of IT implementation by business is not sustainable in order to increase social impact.

Conclusions. A mathematical model has been developed for evaluating and forecasting the impact of IT on the economic and social spheres in Ukraine, and the intermediate results of its implementation are given. In particular, a comparison of the number of enterprises that used IT by types of IT technologies indicated a significant level of correlation with social and economic parameters, for example, the average monthly pension. Both positive and negative signs of the impact of IT on the economic and social spheres of Ukraine

have been established. Although the use of modern technologies is a sign and condition for the economic success of enterprises, and the increase in the number of these enterprises leads to an increase in the number of employees in general and, accordingly, to the resulting increase in deductions to the pension fund, but the return on investment for some types of IT is not always justified. Therefore, according to the specified types, there is a decrease in the number of enterprises that use them.

The negative values of the correlation coefficient of such indicators as, in particular, the number of the unemployed population, the aggregate expenditure of the population on average per month per household and the number of enterprises that used "Sources of "big data" for the analysis of "big data"" and "E-commerce via the Internet" confirmed the presence of negative effects of IT use on social indicators by the fact that these technologies lead to the reduction of employees in the relevant departments of these enterprises, since the need for employees for the specified departments decreases due to the effectiveness of IT.

It has been proven that the average level of income per capita is also a limiting factor in the growth of the positive impact of IT. This, in particular, is evidenced by a comparison of agricultural and industrial regions of Ukraine. This comparison also indicated a significant gap in the implementation of IT in rural and urban areas. And this, in turn, forms the prerequisites for relatively low growth rates of business activity in some regions, which causes a decrease in the level of income per capita and a much lower rate of its growth. That is, a certain closed cycle is formed.

Also, the unaffordable level of IT prices for a significant number of Ukrainian enterprises and for certain social strata is a factor restraining the development of social and economic spheres. Leading companies in Ukraine, having both the resources and the experience of implementing ICT nowadays, even with the desire to contribute to the development of the social sphere, are unable to realize this desire due to political, regulatory and legislative restrictions, the level of corporate and organizational culture, the need to incur significant costs and, in a certain way, due to the lack of social control.

It has been proven that there is a significant level of differentiation in the use of IT by business by type of technology. This factor and the value of Ukraine's rating according to the NRI sub-indices indicate that the trend of digitalization of business and, accordingly, the level of its influence on achieving the SDGs have not assumed a sustainable character. This also shows that Ukraine is still balancing between the sustainable nature of the multiplicative relationship between the development of IT and the development of the social sphere and the state of stagnation of this process. Reverse trends in the use of certain types of IT not only lead to a reduction in investments, but also result in a reduction in their infrastructural support, which leads to gaps in the IT infrastructure by types of technologies and industries. First of all, this concerns the infrastructure of those types of IT, where their widespread use by the population was predicted, because business support of IT infrastructure, which is not used by the appropriate number of consumers, causes the formation of losses for IT companies.

The analysis of the directions of use of social ICT at enterprises confirmed a significant difference in their introduction by types of economic activity. Research on the pace of ICT implementation in the most socially significant types of economic activity of enterprises, for example, "Electricity supply, gas, steam and conditioned air", "Water supply; sewerage, waste management" proved their inadequacy. According to some types of ICT, the specified types of economic activity of enterprises demonstrate even a decrease in indicators.

A significant level of differentiation of the values of the specified indicators and their rates of change by industry confirms the thesis that the impact of IT business implementation is not sustainable in order to increase social influence.

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Цифрові технології та їх вплив на економічну й соціальну сфери в Україні

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Мета. Визначити особливості впливу застосування ІТ на економічну й соціальну сфери в Україні. Розробити математичну модель для оцінювання іта прогнозування впливу ІТ на ці сфери.

Методика. У дослідженні використані загальні та спеціальні методи пізнання: математичної формалізації для оцінювання та прогнозування впливу ІТ на економічний і соціальний рівень розвитку в Україні; кореляційного аналізу для встановлення мультиплікативних зв'язків параметрів і базових функцій; порівняння – для встановлення характеру впливу ІТ на соціальну та економічну сфери; аналогій для аналізу рівня розвитку ІТ в Україні та інших країнах; кількісного та якісного порівняння для аналізу рівня використання соціальних інформаційно-комунікаційних технологій (ІКТ) на підприємствах за видами економічної діяльності.

Результати. Доведено, що є обмежуючі фактори зростанню позитивного впливу ІТ, зокрема, середній рівень доходу на душу населення. Про це також свідчить порівняння сільськогосподарських і промислових регіонів України, що вказало на значний розрив використання ІТ у селі та місті. Виявлені слабкі місця та успіхи України при впровадженні ІТ. Указані причини гальмування позитивного впливу використання ІТ на розвиток соціальної та економічної сфер. Доведено значний рівень диференціації у використанні ІТ бізнесом за видами технологій і ІКТ за видами економічної діяльності.

Наукова новизна. Визначені особливості впливу ІТ на економічну й соціальну сфери в Україні. Основна особливість – балансування між розвитком ІТ-технологій і соціальної сфери та станом стагнації цього процесу. Розроблена математична модель для оцінювання та прогнозування впливу ІТ на економічну й соціальну сфери, наведені проміжні результати її використання.

Практична значимість. Запропоновані рекомендації щодо усунення перепон упровадженню ІТ в українському бізнесі, соціальній і економічні сферах.

Ключові слова: *цифрові технології, інформаційно-комунікаційні технології, математична модель, мультиплікативний зв'язок*

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