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FACTORS OF THE DEVELOPMENT OF UKRAINE'S DIGITAL ECONOMY: IDENTIFICATION AND EVALUATION

Introduction. Digital transformation (hereinafter referred to as digitalization) and the widespread introduction of digital technologies in all spheres of public life and economic relations are key milestones in the development of the world economy.

Problem Statement. The economy digitalization requires effective government regulation and support, the mechanisms and tools of which shall be developed in accordance with the current conditions of the digitalization environment through identifying appropriate incentives.

Purpose. The purpose of this research is the identification of factors and the assessment of the development of Ukraine's digital economy based on the methodological approach proposed by the authors.

Materials and Methods. The methodology for assessing the factors of the development of the digital economy (based on the calculation of the integrated index and the results of the expert survey) involves the use of the main components method and the multiplicative approach. The evaluation methodology comprises the six components: (1) strategy, (2) design, (3) expertise, (4) qualitative evaluation, (5) quantitative evaluation, and (6) conclusion. The factors of digital economy development are grouped based on the following elements: (1) self-sufficiency, (2) efficiency, (3) involvement, (4) infrastructure, (5) readiness, and (6) cooperation.

Results. The spheres to which the government policy in the sphere of digital economy development of Ukraine is directed have been defined. The integrated index is equal to 0.603 that which is an evidence of the medium level of development (favorable status) of the digital technology environment. The highest values of the index have reported for self-sufficiency (0.884), efficiency (0.717), and readiness (0.753). The lowest index has been obtained for the involvement component (0.224).

Conclusions. *Favorable environment for the economy digitalization can be achieved through the implementation of measures to develop appropriate infrastructure and organizational and institutional support for pursuing policies of digitalization of the economic system and society, as well as projects and programs for digital cooperation.*

K e y w o r d s : *digital economy, digitization environment, components, integral, information society, and national policy.*

One of the key current global megatrends is the wide-scale transition to the digital economy [1]. The world already lives in a global information environment that has penetrated all areas of social life without exception: economy, entrepreneurship, social activity, public administration, politics, housing and communal services, public sector, information, and technological spheres. It is predominantly an objective development process that contributes to increasing efficiency at all levels: ICT products and services [2—3], the productivity of manufacturing and economic systems [4—5], innovative and technologically active enterprises [6], and industries where digital technologies are being actively deployed [7].

The information society and digital business is a modern reality [8]. Innovations in the field of digital information technology accelerate the growth and improve the quality of life for people [9—12]. The development of information technology also creates new businesses, opens new markets, and creates new products [13—14]. The links between digital technology development and business activity, economic growth, international competitiveness, inclusiveness, and economic security of national economies, are becoming increasingly closer [15—17].

The creation and implementation of digital technologies in the economy is invaluable for transformational economies, including the Ukrainian economy, which have not yet formed a high-quality market and an institutional environment capable of ensuring the functioning and development of the national economy on par with the leading world economies [18]. Moreover, the active expansion of the digital economy allows such countries to make a significant "leap" in their innovative development, and therefore occupy higher positions among the world leading economies.

It is possible as, first, the global digital marketplace, is shaping [19], and secondly, dynamic, and newer, better quality and competitive products can simultaneously supersede products, services and even whole market niches [20—23]. The digital economy is largely an instrument of state regulation of the processes in the circular economy [24—25] and in a society with high levels of shadow relationships [26]. To achieve this, digital technology should become the basis for development strategies [27—29], as well as the foundation of the business behavior models for leading enterprises in the real sector of the national economy [30].

High rates of development of the digital economy, its efficiency and prevalence in all areas and sectors of the economy depend on the quality of state regulation of these processes. The development and implementation of optimal management decisions require sufficient information and analytical basis. Nowadays, there are numerous techniques and methodological approaches for evaluating the digital economy in scholarly research discourse [31—36]. However, they are more concerned with introducing certain aspects of digitization, assessing its impact on business volumes and profits (microeconomic level). At the macroeconomic level, methodological approaches to analyzing trends in the digital economy reduce to ranking world economies. These reports include the Global Competitiveness Index WEF, the IMD World Competitiveness Yearbook, the IMD World Digital Competitiveness Ranking and the Global Innovation Index INSEAD.

However, scholarly research discourse lacks a methodology for evaluating the digitalization of the economy at the junction of micro- and macro-levels. There is a lack of a methodology for evaluating the environment for the expansion of the digitalization of the economy as a digitalization
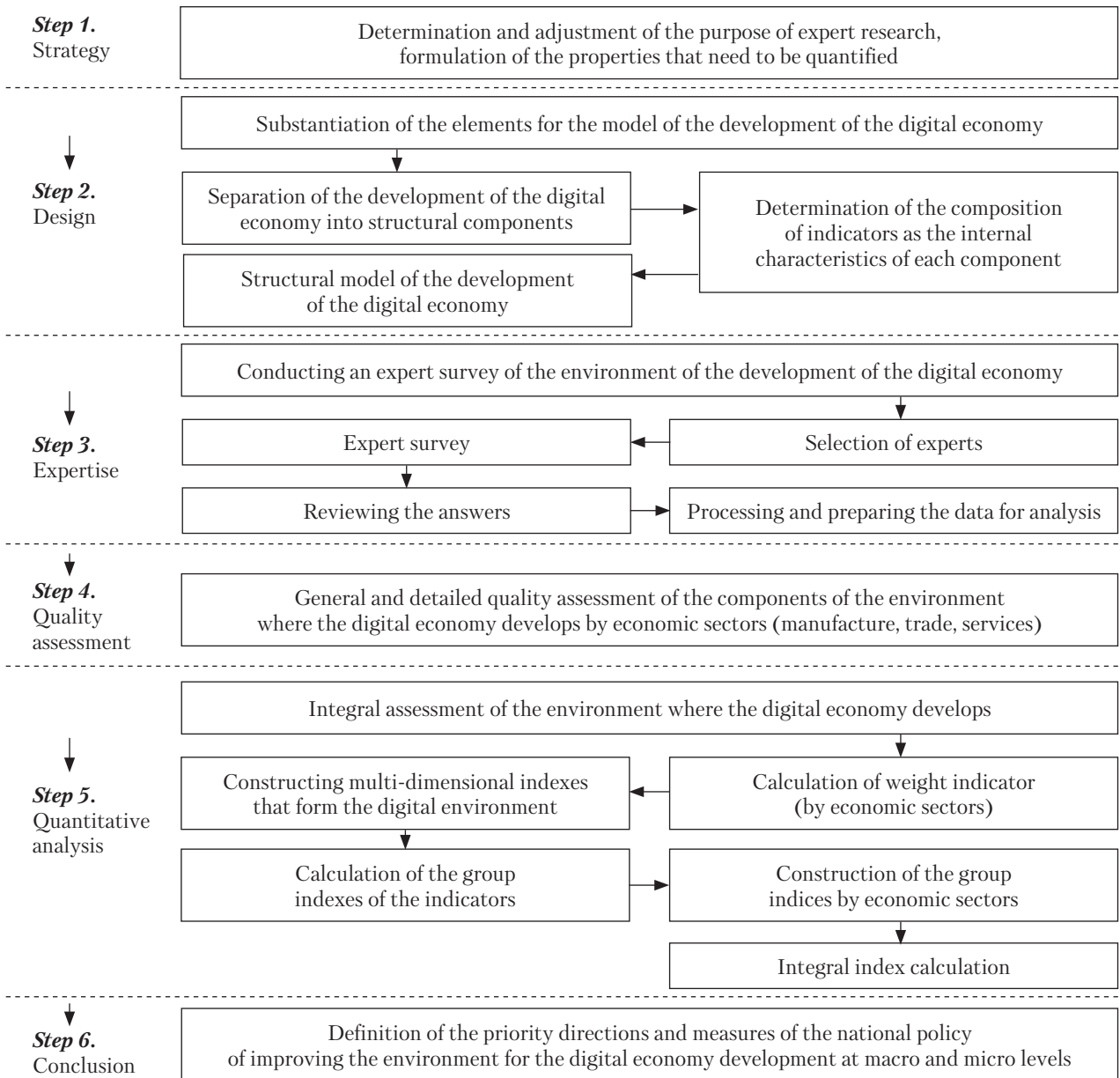
Step 1.
Strategy

Determination and adjustment of the purpose of expert research,
formulation of the properties that need to be quantified

Substantiation of the elements for the model of the development of the digital economy

Step 2.
Design

Separation of the development of the digital economy into structural components

Determination of the composition of indicators as the internal characteristics of each component

Structural model of the development of the digital economy

Conducting an expert survey of the environment of the development of the digital economy

Step 3.
Expertise

Expert survey

Selection of experts

Reviewing the answers

Processing and preparing the data for analysis

Step 4.
Quality assessment

General and detailed quality assessment of the components of the environment where the digital economy develops by economic sectors (manufacture, trade, services)

Integral assessment of the environment where the digital economy develops

Step 5.
Quantitative analysis

Constructing multi-dimensional indexes that form the digital environment

Calculation of weight indicator (by economic sectors)

Calculation of the group indexes of the indicators

Construction of the group indices by economic sectors

Integral index calculation

Step 6.
Conclusion

Definition of the priority directions and measures of the national policy of improving the environment for the digital economy development at macro and micro levels

Fig. 1. Methodological algorithm for identification and analysing factors of the development of the digital economy
Source: author's own processing.

important informational and analytical basis for identifying problematic aspects. The methodological gap is the lack of identification of the factors contributing to the development of this sector of the economy. After all, the available methods do not answer the following questions: whether a high-quality digital economy functions in the country;

what aspects of the environment have not been developed and what are the key factors for stimulating digitization.

This paper presents the authors' methodological approach to identification and assessing factors of the development of the digital economy, which involves the calculation of the integral in-

dex and the corresponding sub-indexes, the levels of importance of indicators and sub-indexes and the identification of factors influencing further digitization. The results are differentiated according to the business sectors (manufacture, trade, services), enabling the further detailed scholarly research [37] in the field, as well as study of the factors of digital economy [38—40].

The purpose of this research is identifying the factors and evaluate the development of the digital economy of Ukraine based on the authors' methodological approach.

2. DETAILS OF IDENTIFICATION FACTORS OF THE DEVELOPMENT OF THE DIGITAL ECONOMY

The authors' methodology for identification and assessing factors of the development of the digital economy is based on an algorithm that includes six stages: strategy, design, expertise, qualitative and quantitative assessment, and conclusion (Fig. 1). The methodology also separates the conditions necessary for the development of the digital economy: (1) self-sufficiency; (2) efficiency; (3) involvement; (4) infrastructure; (5) readiness, and (6) cooperation.

The key role in ensuring the reliability of the obtained data (comprehensive study), as well as reflecting the real situation, is given to the justification of components of the development of the digital economy. It is necessary to consider the background, the "past", that is, the readiness of local units for their current activity in line with the implementation of digital technologies and ensuring the digitalization of the national economy. Such readiness implies the accumulation of financial and investment resources by economic entities, which can be invested in business digitalization projects, training of necessary management and R&D personnel, acquisition of software and hardware and enabling access to data networks ("Self-sufficiency" component).

Secondly, it is important to reflect the "real situation", in particular the impact of the use of digital technologies on the growth of efficiency of business entities that implement them ("Efficiency" component).

Thirdly, readiness of enterprises to adopt processes of digitalization should be assessed, which is the "future" characteristic of their readiness for digital development (component "Readiness"). Qualitative and systematic development of a digital economy requires an equal involvement in this process of all its institutional sectors: e-business, e-governance and the information society ("Involvement" component). It is acknowledged that one of the basic preconditions of formation and development of each market, industry, economic activity, and economic sector, is to build up the infrastructure, elements of which can provide sufficient support for the development of appropriate processes for all their components and parameters. Given this, the availability and effectiveness of the functioning of its infrastructure ("Infrastructure" component) is an important component of the environment sector development of the digital economy to consider.

To develop and implement the digital technologies, companies must cooperate with business consultants, IT freelancers, IT companies, research institutions, experts of the market of intellectual property, law firms and engineering companies. They must establish cooperation to build shared information and communication networks with customers and contractors.

Considering these circumstances, there is a growing assertion that the level of developmental cooperation in the sphere of business digitalization and economics is an important component of the quality of the environment in this area ("Cooperation" component).

Accordingly, the architecture of the digital economy development model (IEID) is represented by the following system (1):

$$IE_{ID} = F \begin{array}{l} Self_S \uparrow (FI_S \uparrow; P_M \uparrow; P_T \uparrow; S_a H \uparrow; D_N \uparrow) \\ Efec \uparrow (P_I \uparrow; E_L \uparrow; R_S \uparrow; BP_A \uparrow; P_C \uparrow) \\ Atr \uparrow (PB_C \uparrow; P_{IA} \uparrow; BA_C \uparrow; G_S \uparrow; PP_C \uparrow) \\ Infr \uparrow (DP_D \uparrow; CP_D \uparrow; D_I \uparrow; BIT_S \uparrow; S_a H_s \uparrow), \\ Dev \uparrow (S_a H_M \uparrow; D_D \uparrow; AT_I \uparrow; S_C \uparrow; D_M \uparrow) \\ Coop \uparrow (ITC_P \uparrow; C_C \uparrow; BP_C \uparrow; eB_D \uparrow; D_{Clu} \uparrow) \end{array} (1)$$

in which $Self_S$ is a component of *"Self-sufficiency"* level; FI_S is the adequacy of financial and investment support; P_M is the availability of managerial staff for the project management of digitalization; P_T is opportunities to attract R&D personnel; S_aH is the availability of software and hardware; D_N is the availability of networks and data storage;

Efec is a component of *"Efficiency"* level; P_I is the level of influence on the intensification of production; E_L is the measure to eliminate unproductive losses; R_S is the impact of resources savings; BP_A is impact assessment on the acceleration management of business processes; P_C is the level of influence on the product competitiveness;

Atr is the component of *"Involvement"* level; PB_C is readiness for digital cooperation between the population and businesses; P_{IA} is the population activity for the acquisition and using of digital products; BA_C is the development of digital communication of businesses and the government; G_S is the level of government support to introduce digital technologies; PP_C is the development of public and private cooperation in the sphere of digitalization;

Infr is the component of *"Infrastructure"* level; DP_D is the availability of digital platforms for businesses, government and population; CP_D is the development status of digital cloud platforms; D_I is the accessibility of services by the subjects of technological, R&D activities; BIT_S is the accessibility of IT products for businesses; S_aH_s is the availability of modern software and hardware for businesses;

Dev is the component of *"Readiness"* level; S_aH_M is the state-of-the-art level of software and hardware at companies; D_D is the current status of digitalization in the business processes; AT_I is the involvement of enterprises for the creation and implementation of advanced digital technologies; S_C is the effectiveness of cooperation of businesses and providers of digital products; D_M denotes the management systems for t implementing digitalization at enterprises;

Coop is the component of *"Cooperation"* level; ITC_P is the level of enterprise participation in the IT cluster; C_C is the online "transfer" of the relations with buyers; BP_C is the level of online "transfer" of partner relations; eB_D is the quality of enterprise operations to create digital platforms for virtual environment for user interaction; D_{Clu} is the digitization level of the members of existing clusters as well as of other integrated systems, on a unified digital platform.

To create a database as part of the characteristics of the state of the main aspects of the development of the digital economy, the Delphi method of collective expert evaluation is used. This approach has been applied to determine the relative importance of block components to eliminate less influential blocks and to identify priority components. Based on the expert assessments, it is possible to construct an integrated index of the environment for the digital economy development.

The principles of using peer expert reviews are:
- using a heterogeneous composition of the expert group (experts represent three sectors of economic activity: manufacture, trade, and services). Experts are managers, experts of leading enterprises; executives, specialists of IT-companies that cooperate with domestic businesses; executives, experts of leading organizations dealing with digital transformation; representatives of the relevant authorities;
- involvement of 36 experts in the panel group (12 persons from each area).
- involving high-level experts (profile and experience, level of problems solved), to ensure objectivity and impartiality;
- ensuring high self-evaluation by the experts of their awareness of the current state of development of digitalization processes at the macro- and micro-levels, conditions, factors, and trends that determine them.

The questionnaire for expert survey is given in Appendix A.

3. RESEARCH METHODOLOGY

The methodology of identification and assessing factors of the development of the digital economy (based on calculating an integral index and results of the expert survey), involves the use of the

Appendix A
Questionnaire for expert research

Assess the level of self-sufficiency (financial, resource, personnel, communication and technological support and readiness) of domestic business entities in relation to the creation, attraction, and implementation of digital technologies.

	Indicators	Mark
1.	Adequacy of the necessary financial and investment support	
2.	Availability of trained management personnel for the implementation of business digitalization projects	
3.	Possibility of attracting scientific and technical personnel for the introduction of digital technologies	
4.	Availability of necessary software and hardware	

Identify the potential impact of the introduction of digital technologies on the effectiveness of their functioning and development about domestic business.

	Indicators	Mark
1.	Intensification of production volumes	
2.	Complete elimination of unproductive losses	
3.	Resource savings	
4.	Acceleration of business management processes	
5.	Increasing the competitiveness of products (services)	

Describe the current state of involvement of sectors of the digital economy (e-governance, e-society, e-business) in the processes of its development in Ukraine.

	Indicators	Mark
1.	Readiness for digital cooperation (purchase of goods (services) online, electronic data accounting, communication, etc.) of the population with business	
2.	Activity of the population on acquisition and use of digital products and services	
3.	Development of digital communication of business and administrative authorities	
4.	The level of state support for the introduction of digital technologies in enterprises	
5.	Development of public-private cooperation in the field of digitalization	

Assess the state of development of the digitalization infrastructure of the economy in Ukraine.

	Indicators	Mark
1.	Availability and efficiency of digital platforms of business, state, population	
2.	State of development and availability of unified digital cloud platforms	
3.	Quality and availability of services of subjects of innovation-technological and scientific-technical activity	
4.	Quality of supply and availability of IT products for business	
5.	Quality and availability of modern business software and hardware	

Provide your description of the readiness of domestic business entities for the development of the digitalization sector

	Indicators	Mark
1.	The level of modernity and sufficiency of software and hardware of enterprises	
2.	The level of the current state of digitalization of business processes	
3.	Activity of enterprises on creation, attraction, and introduction of advanced digital technologies	
4.	The scale and effectiveness of cooperation with suppliers (developers) of digital products, services, technologies	
5.	Presence at the enterprises of the adjusted systems of management of development of processes of digitalization of business	

Describe the current state of development in Ukraine of cooperation and cooperation of business focused on the development of the digitalization sector.

	Indicators	Mark
1.	The level of participation of domestic business in IT clusters, other integrated systems based on the participation of representatives of the IT sector	
2.	The level of 'transfer' of relations with buyers (consumers) in the electronic plane	
3.	Level of 'transfer' of relations with basic contractors (suppliers, sales and logistics networks, permanent service providers) to the electronic plane	
4.	Quality of work of domestic enterprises on creation of digital platforms of the virtual environment of interaction of users (e-business)	
5.	The level of digitalization of participants of existing clusters, other integrated systems on a single digital platform	

principal component method and the multiplicative approach. The proposed authors' methodology allows normalizing the data, identifying the structure of indicators correlation and groups of indicators correlation, studying the indicator significance (assigning weights) for each group and groups of experts according to the area of activity of experts, interpreting the obtained economic results, as well as determining integrated group indexes and the total integral index based on the determined values of the principal components.

An algorithm for analyzing the factors of the development of the digital economy, estimated by industry, trade, and services experts, involves performing two stages, resulting in the highest scores of reliabilities. The first stage involves components (indicators), which are the principal components, and the in second stage averaged group indicators are considered.

The first stage:

1.1. Forming a matrix of baseline expert assessments for each indicators' group.

1.2. Normalizing the series of group indicators based on the logarithm.

1.3. Determining the weights of group indicators (W_i^g) based on the principal component method (the calculations are made with the use of *Statistica 7* software) and identifying the indicators' relationships.

The second stage:

2.1. Forming indicators' matrix for each group based on the method of calculating the average values of expert assessments in three areas.

Table 1. **Matrix of Normalized Indicators of the Factors of the Digital Economy Development**

Sphere	Groups (Zn_i)					
	I	II	III	IV	V	VI
Manufacture	0.850238	0.942008	0.691671	−0.160100	0.778151	0.367977
	0.698970	0.898542	0.511883	−0.234080	0.574031	−0.037790
	0.916454	0.790050	0.199572	0.676694	0.602060	0.452298
	0.845098	0.691671	0.425969	0.544068	0.452298	0.301030
	0.706149	0.884607	0.066947	0.829304	0.628389	0.533603
Trade	0.916454	0.870209	−0.060380	0.383217	0.937852	0.554287
	0.795880	0.706149	−0.151100	0.096910	0.850238	0.583577
	0.795880	0.522879	−0.281600	0.464887	0.706149	0.753328
	0.916454	0.823909	−0.084120	0.720159	0.753328	0.746894
	0.875061	0.636822	−0.195980	0.962211	0.823909	0.676694
Services	0.713210	0.845098	0.912045	0.464887	0.845098	0.221849
	0.746894	0.611015	0.790050	0.282547	0.807309	0.706149
	0.645095	0.263241	0.397940	0.367977	0.733732	0.611015
	0.893947	0.746894	0.383217	0.823909	0.818446	0.855317
	0.818446	0.477121	0.439333	0.916454	0.823909	0.452298

Note: Group I is the level of self-sufficiency (financial resources, human resources, communication and technological security and readiness) of the domestic business entities regarding the creation, involvement, and implementation of digital technologies. Group II is the potential impact of the introduction of digital technologies on the efficiency of their functioning and development on domestic businesses. Group III is the current state of involvement of the digital economy sectors (e-governance, e-society, e-business) in the processes of economic development of Ukraine. Group IV is the state of development of infrastructure of digitalization of the economy in Ukraine. Group V is the readiness of domestic business entities to develop the digital sector. Group VI is the current state of development of business cooperation aiming at improving the digitalization in Ukraine.

Source: authors' calculations based on stage 2.2 of an algorithm for analyzing the factors of the development of the digital economy.

2.2. Normalizing indicators using the logarithmic method; formation group series of normalization indicators (Z_{n_i}) for each group.

2.3. Determining of weights of indicators group by sectors economic (W_n^s) based on the principal component method. According to the method of the main components, the process of weighing indicators is carried out simultaneously on the parameters of time and space, which allows identifying the relational structure between the indicators.

$$w_i^g = |comp_i^g| / \sum_{i=1}^{j} |comp_i^g|, \qquad (2)$$

where w_i^g is the weight of *i-th* indicator of *g-th* group; $comp_i^g$ is the main component of *i-th* indicator of *g-th* group; *j* is the number of indicators.

2.4. Constructing multi-dimensional indexes of factors of the development of the digital economy by economic sectors (based on the multiplicative method):

$$Y_n^s = Z^{W_n^s}, \qquad (3)$$

in which Y_n^s is the value of partial weighted index of *n*-group for *s*-sphere of experts;

2.5. Calculating group indexes of factors of the development of the digital economy as assessed by experts representing three areas, based on the formula (4):

$$I_n^s = W_n^s \times Z_{n_i}^s, \qquad (4)$$

in which I_n^s is the value of *n*-group indices of *s*-sphere of an expert;

W_n^s is the value of weights of indicators' *n*-group of *s*-sphere of experts.

3. Integral index construction. The integral index of the development of the digital economy development is calculated by the formula (4):

$$I_{nd} = I_n^{W^s}, \qquad (4)$$

in which I_{nd} is the value of the integral index of the development of the digital economy.

4. EMPIRICAL RESULTS. THE AUTHORS' METHODOLOGICAL APPROACH APPROBATION

4.1. Assessing the development of the digital economy: identifying the relationship among the indicators

The calculation of normalized values of group indicators by economic sectors to reduce the output to a homogeneous form is a prerequisite for a database matrix. To bring the initial data to a homogeneous state, we have formed a matrix of averaged prolonged values (Table 1).

Table 2 shows the calculated weighting coefficients of the components for integral index of the conditions of the digital economy development.

Table 2. **Weights of Indicator Groups That Form the System of Factors of the Digital Economy Development**

Groups of indicators	Weight, per cent (W_n^s)		
	Manufacture	Trade	Services
Level of self-sufficiency (financial resources, human resources, communication and technological security and readiness) of the domestic business entities regarding the creation, involvement, and implementation of digital technologies	8.07	15.48	17.57
Potential impact of the introduction of digital technologies on the efficiency of their functioning and development on the domestic businesses	18.44	21.43	24.48
Current state of involvement of the digital economy sectors (e-governance, e-society, e-business) in the processes of its development in Ukraine	19.89	21.51	11.39
State of development of infrastructure of digitalization of the economy in Ukraine	24.02	4.53	12.68
Readiness of domestic business entities to develop the digital sector	13.60	19.89	26.76
Current state of development of business cooperation aiming at improving the digitalization in Ukraine	15.98	17.17	7.12

Note: weights are provided according to economic sectors.
Source: authors' calculations based on formula (2) and data of Table 1.

Table 3. **Weight Coefficients of Individual Indicators That Form the System of Factors of Digital Economy**

Indicators	Weight, W_i^g ,% per cent		
	Manufacture	Trade	Services
Group I. Level of self-sufficiency (financial resources, human resources, communication and technological security and readiness) of the domestic business entities regarding the creation, involvement, and implementation of digital technology			
Adequacy of financial and investment support	24.16	11.76	24.55
Availability of managerial staff for the project management of digitalization	6.51	22.27	24.99
Opportunities to attract R&D personnel	22.14	19.00	9.78
Availability of software and hardware	22.78	21.26	13.73
Availability of networks and data storage	24.40	25.72	26.96
Group II. Potential impact of the introduction of digital technologies on the efficiency of their functioning and development on the subjects of the domestic businesses			
Intensification of production volumes	24.66	18.10	3.32
Completed elimination of unproductive losses	17.58	21.50	28.99
Resource savings	9.62	25.19	13.63
Accelerating management business processes	20.70	14.46	20.79
Increasing the competitiveness of products (services)	27.44	20.74	33.27
Group III. Current state of involvement of the digital economy sectors (e-governance, e-society, e-business) in the processes of its development in Ukraine			
Readiness for digital collaboration (purchase of goods (services) online, electronic data recording, communication, etc.) of the population with business	36.63	13.09	16.65
High levels of purchasing and using digital products and services among population	33.57	28.04	20.76
Development of digital communication of business and administrative authorities	0.20	20.09	25.89
Level of state support for implementing digital technologies at enterprises	7.06	5.92	13.65
Development of public-private cooperation in the field of digitalization	22.54	32.85	23.05
Group IV. State of development of infrastructure of digitalization of economy in Ukraine			
Availability and efficiency of functioning of digital platforms of business, state, population	17.89	19.70	24.01
State of development and availability of single digital cloud platforms	30.75	24.46	19.81
Quality and accessibility of services of subjects of innovation, technological and scientific-technical activity	29.24	20.41	21.84
Quality of offer and availability of IT products for business	9.64	19.13	9.75
The quality and affordability of the business software and hardware offer	12.49	16.30	24.59
Group V. Readiness of domestic business entities to develop the digital sector			
The level of modernity and sufficiency of software and hardware of enterprises	10.65	25.86	3.38
The level of the current state of digitalization of business processes	12.14	25.65	16.40
The activity of enterprises for creation, attraction and introduction of advanced digital technologies	28.59	15.04	38.71
Scale and effectiveness of collaboration with suppliers (developers) of digital products, services, technologies	29.74	12.00	11.14
Stock enterprises management systems development of digitalization processes	18.87	21.45	30.38
Group VI. Current state of development of business cooperation aiming at the development of improving the digitalization sector in Ukraine			
The level of enterprises participation in the IT-cluster	28.69	29.02	10.65
Transfer level of buyers relations in the e-plane	7.57	3.02	30.16

Indicators	Weight, W_i^g ,% per cent		
	Manufacture	Trade	Services
Level "transfer" of partners relations in the e-plane	24.84	28.16	30.34
Quality operation of enterprises to create digital platforms for virtual environment for user interaction	9.47	18.16	19.42
The digital level of the existing cluster members, other integrated systems of a unified digital platform	29.44	21.65	9.43

Note: weights are provided by economic sectors.
Source: authors' calculations based on formulas 2 and Tables 1—2.

The most significant for manufacturers are the state of digital infrastructure development (24.02 per cent), the current state of involvement of the digital economy sectors in its development processes in Ukraine (19.89 per cent) and the potential impact of digital technology implementation on business efficiency (18.44 per cent). Together, these three components determine the development of the environment for digitalization by over 60 per cent. For manufacturing companies, self-sufficiency determines the development of digitalization least (8.07 per cent). Whereas in trade and services, this factor is more important (15.48 per cent and 17.57 per cent respectively).

For trading companies, the main components that determine the development of the digital sector are the potential impact of digital technologies on business development (21.43 per cent) and the current state of involvement of the digital economy sectors (21.51 per cent). Businesses' readiness to develop the digitalization sector (19.89 per cent) remains a significant factor in this type of economic activity.

Thus, for trade enterprises, the weight of factors is not as differentiated as in manufacturing and services. On the latter, the status of their cooperation and cooperation with other counterparts in digital economy development (7.12 per cent) is insignificant for its subjects. Whereas the leading factors in digitalization are the readiness of enterprises to sell digital products (26.76 per cent) and the potential impact of implementation on digital businesses (24.48 per cent).

The values obtained (weighting coefficients) are important for considering and implementing a public policy to stimulate the development of the digital economy. Changing the values of the weights of the indicators has a significant and statistically significant effect on the activation of the processes of digitalization of the national economy.

Table 3 presents the results of the calculation of the weights in the structure of all indicators of the digital economy. Most of the factors have a significant impact on the development of the digital economy. Additionally, particularly noticeable indicators should be emphasized. These are the state of development and accessibility of external networks for data transmission and storage; the impact of digital technologies on the growth of competitiveness of products (services); readiness for digital cooperation of the population with businesses, development of public and private cooperation in the sphere of digitalization; state of development and availability of single digital Cloud platforms; activate participation of enterprises in creation, attraction and application of advanced technologies; participation of business in IT-clusters and digitalization of business processes of traditional local integrated systems.

4.2. Integrated index of the factors of the development of the digital economy

Table 4 shows partial weighted group indexes of the digital economy. The level of development of

the digital economy in the three areas of research ranged from 0.50 to 1.00. In particular, the lowest value is the unit "transfer" relations with customers (consumers) in the digital sector (0.592). This tendency is caused by the systemic economic crisis and is linked to the socio-economic instability of the country, which causes a decrease in the purchasing power of citizens.

Unstable labor market conditions, including a low employment rate of the labor pool and a high unemployment rate, have influenced the living standards of the population and, at the same time, their purchasing parity, which is reflected in e-commerce volumes. Thus, the highest value of the weighted index is the indicator of quality and accessibility of the offer for the business of modern software and hardware (0.998), which testifies to the possibilities for the transformation of business processes and implementation of ICT in the sphere of production, trade, and services.

The analysis results are statistically significant. Fig. 2 and Fig. 3 provide summarized results of the group indexes of the development of the digital economy of Ukraine.

Thus, the value of the integral index was 0.603, which is evidence of the medium level of development (favorable state) of the environment. At the same time, the "self-sufficiency" component scored the highest value (0.884). "Efficiency" (0.717) and "readiness for development" (0.753) scored high values as well. The lowest index value was demonstrated by the "involvement" component (0.224). Therefore, it is precisely this direction of public policy in the area under analysis, which needs much attention.

The growth of the integrated index of digital economy development can be achieved by the implementation of measures for the development of digitalization infrastructure, as well as the implementation of projects and programs in the field of digital cooperation. Among the businesses, despite the lowest score for the "involvement", this component is provided at a sufficiently high level in the service sector. Instead, the impact of digital technology on the efficiency of business operations and development remains problematic for the service sector (0.477). For manufacturing enterprises, the low level of cooperation bet-

Table 4. **Partially Weighted Indexes of the Digital Economy Development**

Sphere		Groups (Zn_i)					
		I	II	III	IV	V	VI
Manufacture	Y_n^1	0.9870	0.9890	0.9293	0.6440	0.9665	0.8523
		0.9715	0.9805	0.8753	0.7055	0.9273	0.5924
		0.9930	0.9575	0.7258	0.9105	0.9333	0.8809
		0.9865	0.9343	0.8439	0.8640	0.8977	0.8254
		0.9723	0.9776	0.5841	0.9560	0.9388	0.9045
Trade	Y_n^2	0.9866	0.9706	0.5467	0.9575	0.9873	0.9037
		0.9653	0.9281	0.6660	0.8998	0.9682	0.9117
		0.9653	0.8703	0.7614	0.9659	0.9331	0.9525
		0.9866	0.9593	0.5871	0.9853	0.9452	0.9511
		0.9796	0.9078	0.7043	0.9983	0.9622	0.9352
Services	Y_n^3	0.9423	0.9596	0.9896	0.9074	0.9560	0.8983
		0.9500	0.8864	0.9735	0.8519	0.9443	0.9755
		0.9259	0.7213	0.9003	0.8809	0.9205	0.9655
		0.9805	0.9311	0.8965	0.9757	0.9478	0.9889
		0.9654	0.8343	0.9105	0.9890	0.9495	0.9451

Source: authors' calculations based on formulas (3) and (4) and Table 3.

ween the population and the state (0.291), the underdevelopment of digital infrastructure (0.342) and the low level of project participation for the development of digital cooperation (0.332) remain weak.

To raise the level of digitalization in the trading business, it is necessary to work on the development of cooperation for enterprises, the e-governance and e-commerce. This component has the lowest value (0.115). The obtained results allow us to identify effective directions for digital economy development of Ukraine and those that require state support and regulation.

The results of the analysis of the factors for the digital economy development of Ukraine, is an important informational and analytical basis for developing qualitative and effective management decisions to regulate and stimulate digital economy development and information society. Therefore, the identification of factors that either contribute or impede the development of the digital economy, as well as the assessment of the values of components of digital development and the establishment of the level of importance of indicators that determine the processes of development of the digital economy of the country, are of practical importance for the formation of development strategies for the national economy. To enable such practices, the authors' method has been developed and tested. The Delphi method was applied for the database, which processed the information provided by 12 experts in the areas of (1) manufacturing, (2) trade and (3) services; the total number of experts amounted to 36 persons. The experts were selected according to pre-defined criteria. The expertise research was conducted using the questionnaire for each expert. The experts evaluated the quality of the environment for the development of digitalization for each indicator under the pre-designed systematic model. Five indicators for each of the components of the integral index were considered: (1) self-sufficiency, (2) efficiency, (3) involvement, (4) infrastructure, (5) readiness and (6) cooperation.
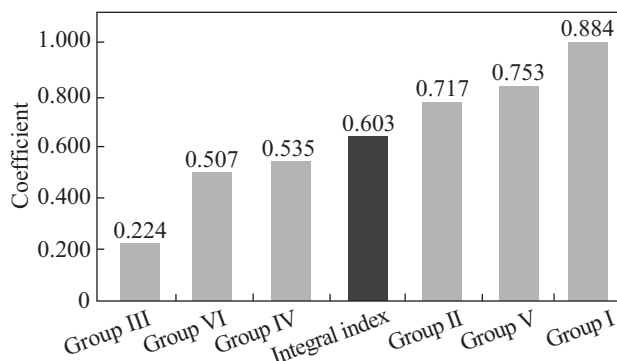

Fig. 2. Integral group indices and integral indices of the development of the digital economy of Ukraine
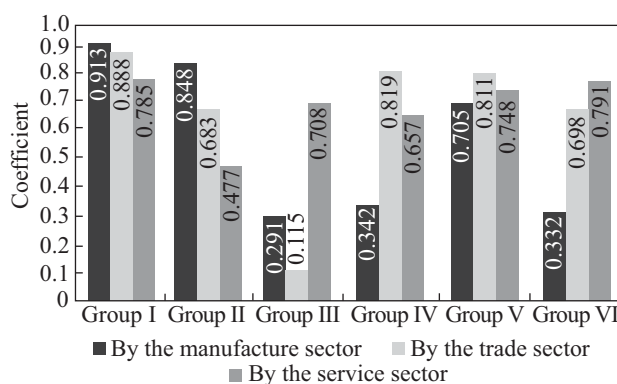

Fig. 3. Group indexes of the development of the digital economy for each area in Ukraine

It has been established that the values of the integral index of digital economy development in Ukraine amounted to 0.603, which is evidence of the average level of favourability of the environment. Thus, at a high level was a component of "self-sufficiency" (0.884). A high value of the integrated index had components "efficiency" (0.717) and "readiness for development" (0.753). The lowest value of the index was set for the component "involvement" (0.224). This demonstrates that the national policy in the analyzed area needs the most attention. The growth of the integral index of the environment for digitalization will be contributed by the implementation of activities towards the development of the domestic infrastructure of digitalization and implementation of projects and programs in the field of digital cooperation.

Among the entrepreneurship fields, despite "involvement" component being at a low-level, this component is provided at a sufficiently high level in the market of services. However, the impact of digital technology on the functioning and business development remains problematic for the services at (0.477). For manufacturing enterprises low level of cooperation with the public and the government (0.291), underdeveloped digital infrastructure (0.342) and low level of participation in the projects for the development of digital cooperation (0.332) remain a problem to be solved. To raise the level of digitalization in Ukrainian domestic trade business, it is necessary to improve the cooperation of enterprises with e-governance and e-commerce, which is currently at (0.115).

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ФАКТОРИ РОЗВИТКУ ЦИФРОВОЇ ЕКОНОМІКИ УКРАЇНИ: ІДЕНТИФІКАЦІЯ Й ОЦІНЮВАННЯ

Вступ. Сучасною віхою у розвитку світової економіки стала цифрова трансформація (надалі — цифровізація) та широке впровадження цифрових технологій у всі сфери суспільного життя та економічних відносин.

Проблематика. Цифровізація економіки вимагає ефективного державного регулювання та підтримки, механізми та інструменти якої повинні бути розроблені відповідно до сучасних умов середовища діджиталізації шляхом визначення відповідних стимулюючих факторів.

Мета. Метою дослідження є ідентифікація факторів та оцінка розвитку цифрової економіки України на основі авторського методичного підходу.

Матеріали і методи. Методичний підхід до ідентифікації й оцінки факторів розвитку цифрової економіки (на основі розрахунку інтегрального індексу за результатами експертного опитування) передбачає використання методу головних компонент та мультиплікативного підходу. Методологія оцінки охоплює шість етапів: (1) стратегія, (2) дизайн, (3) експертиза, (4) якісна оцінка, (5) кількісна оцінка та (6) висновок. Компонування факторів розвитку цифрової економіки здійснено за елементами: (1) самодостатність, (2) ефективність, (3) залучення, (4) інфраструктура, (5) готовність, (6) співпраця.

Результати. Визначено сфери, на які спрямовано державну політику у сфері розвитку цифрової економіки України. Значення інтегрального індексу становило 0,603, що є свідченням середнього рівня розвитку (сприятливого стану) середовища цифрових технологій. Компонента «Самодостатність» має найвище значення (0,884), а також «Ефективність» (0,717) та «Готовність до розвитку» (0,753). Найнижче значення індексу продемонструвала компонента «Залучення» (0,224).

Висновки. Сприятливість середовища поступу цифровізації економіки може бути досягнуто шляхом реалізації заходів щодо розвитку відповідної інфраструктури та організаційно-інституційного забезпечення реалізації політики діджиталізації економічної системи та суспільства, а також реалізації проєктів та програм у галузі цифрової співпраці.

Ключові слова: цифрова економіка, діджиталізація середовища, компоненти, інтегральний підхід, інформаційне суспільство, національна політика.