Original article

PUBLIC MANAGEMENT OF EDUCATION AND SCIENCE: TENDENCIES FOR GLOBALIZATION, DIGITALIZATION, AND UKRAINIZATION

Yurii Liannoi[1], Sergii Khrapatyi[2], Vladyslav Hanzha[3], Daria Kononova[4], Oksana Mykhailova[5]

[1,3]*Sumy State Pedagogical University named after A. S. Makarenko, Sumy, Ukraine*
[2]*Department of Computational Mathematics and Computer Modelling, Interregional Academy of Personnel Management, Kyiv, Ukraine*
[4]*National Academy of the Security Service of Ukraine, Kyiv, Ukraine*
[5]*Department of the English Language and Primary ELT Methodology Educational and Research Institute of Pedagogics Zhytomyr Ivan Franko State University, Zhytomyr, Ukraine*

Received: 29 February 2024
Revised: 14 July 2024
Accepted: 28 October 2024

Abstract: Globalization have a strong impact on education and science, being a catalyst for progressive changes. This research aims to analyze a new paradigm of public management as a unique symbiosis of cosmopolitan and Ukraine-centric thinking. The research methodology combines quantitative and qualitative approaches to analyze the impact of globalization on education and science in Ukraine. Key components include a review of recent literature on governance, digitalization, and national identity, alongside a comparative analysis of digitalization strategies in different countries to identify best practices for Ukraine. This multidisciplinary approach forms a basis for developing effective policies in the management of education and science in the face of globalization and digitalization. Thus, the analysis of globalization and digitalization impact on the development of education and science in 2003-2022 demonstrated the lack of clear patterns against the background of increased turbulence of the market space, which complicates designing the universal public management model. On the basis of differential calculus, the public management optimization model of digitalization in education and science is developed. This optimization model can be applied as an element of the national public management strategy for digitalization in education and science. Finally, it was established that there are significant direct links between digitalization expenditures, global partnership, Ukrainization level, digital competences, and socio-economic gains of digitalization.

Keywords: Decision matrix; Digital technologies; Education globalization; Good Governance concept; Ukraine-centrism.

1. INTRODUCTION

The mindset of “vision of changes” has been expending, while a person has become capable of constructing multidimensional development scenarios and has deepened knowledge about changes through the diversification and optimization of knowledge, digital competences, “change skills” (Qiu, 2023).

The digital transformation of education and science has a range of socio-economic gains. Digitalization of these spheres requires constant innovations, and thus, capital injections in education and science. By implementing digital technologies in public institutions, the government enhance the services quality, save funds, and improve the quality of life for citizens. Thus, they follow a positive experience in digital transformation of business to obtain additional advantages in providing services for citizens and business even in case of budget funds deficiencies. According to the estimation of McKensey

Corresponding author. Email: yurii_liannoi@edu.cn.ua
ISSN 2560-4961 (online)
Copyright © 2024, The Authors. Published by IPMA Serbia.
This is an open access article under the CC BY-NC 4.0 license (https://creativecommons.org/licenses/by-nc/4.0/)
https://doi.org/10.56889/hycc4784

Company, digitalization can generate more than 1 trillion USD annually throughout the world (Corydon et al., 2016).

In today's rapidly changing world, public administration of education and science is gaining particular significance as an important tool for shaping social development and the intellectual potential of the nation (Markevych, 2021). Against the backdrop of globalization processes that require integration into the international educational and scientific space, digital technologies are playing an increasingly important role, changing approaches to management, education, and research. At the same time, the Ukrainianization of the educational and scientific space is gaining special attention, which is aimed at preserving and developing national identity in the face of global challenges.

The impact of globalization and digitalization on education and science is especially acute in the context of the Ukrainian national identity and a new wave of Ukrainization of all spheres of public life during the Russian-Ukrainian war. Against the background of political confrontations and the need to unite the society around the national identification idea, social turbulence is enhanced because the social development is accelerated in the conditions of the utmost tension in society. Currently, the Ukrainian academia is in the midst of geopolitical shifts when unpredictability of social system behavior is increased after the ultimate level of socio-political energy is achieved (Kubalskyi, 2022).

The core of modern public management paradigm in the national education and science is the cultivation of the unique worldview in the youth, educators, and scholars (Tight, 2021). This is a symbiosis of a world citizen's mindset, which involves the awareness of being involved in the achievements of civilization, the ability of a person to social, language, and cultural adaptation in another environment in combination with the Ukrainian national identity, the impetus for exporting Ukrainian national values to the cultural spaces in other countries. Thus, having such a symbiotic worldview, the person is capable of continuous learning, cross-cultural communication, exporting Ukrainian institutions to the cultural spaces in other countries, etc.

The paradigm superstructure consists of internal legal, organizational, economic, information mechanisms for public management of education and science as well as the external tendencies towards globalization and digitalization, adding uncertainty and fluctuations to the system. They effectiveness determine the prospects of implementing national strategies and programs, in particular, "Ukraine-2030: Future changes strategy" (National Institute for Strategic Studies, 2020). This strategy involves structural modernization and Ukrainization, which in turn determines the effective implementation of the Strategy for the establishment of Ukrainian national and civic identity for the period until 2030 (Cabinet of Ministers of Ukraine, 2023).

Therefore, the public management system moves to a new stage of its development because it is the combination of effective decisions and socially significant actions by public authorities, local self-government authorities, business, and civil society institutions in the context of globalization and digitalization (Clarke, 2020). The effectiveness of such a transition depends on education and science that produce knowledge, innovations, necessary for social production. Accordingly, the development of public management mechanisms and the creation of the criteria for regulation of education and science in order to enhance its socio-economic gains is a topical issue thar requires thorough research. In this regard, there is a need to develop an effective instrument for analyzing public management of education and science, to rationalize the use of scarce resources, and to improve management strategies. These problems are especially acute in wartime when the national identity has become an essential factor.

The article examines the main trends and challenges associated with globalization, digitalization and Ukrainization in the context of public administration of education and science. The purpose of the article is to study the impact of globalization, digitalization and Ukrainization on public administration of education and science in Ukraine, as well as to

develop recommendations for integrating these trends.

The study investigated how globalization processes affect the public administration of education and science in Ukraine; identified the main challenges and opportunities of digitalization in the system of public administration of education and science; proposed approaches and strategies that can be used to effectively combine globalization, digital and national aspects in the public administration of education and science.

2. LITERATURE REVIEW

In the current context, public administration of education and science is undergoing significant transformations under the influence of globalization, digitalization, and Ukrainization processes. Globalization has a significant impact on all aspects of education and science, including the public administration of these areas (Steger et al., 2023). In particular, it contributes to the spread of international standards in higher education, the development of cooperation between educational and scientific institutions at the global level. According to research, globalization is forcing national governments to adapt their governance systems to the requirements of the global market, which includes both infrastructure modernization and harmonization of the regulatory framework (Schmidt & Tang, 2020).

One of the aspects that researchers point out is the growing competition between countries for talents and resources, which leads to a change in priorities in public funding of the research and education sector. In this context, it is important to develop the so-called "soft power", which includes the promotion of national interests through culture and education.

The opponents of globalization affirm that it is a menacing phenomenon that damages the world and have a negative impact on society because of growing risks of homogenization and westernization of national cultures (Mohamed Hashim et al., 2022). In such a way, risks of public management are enhanced (Lee, et al., 2023). Meanwhile, education loses its national identity against the background of increased dangers of de-institutionalization. The national academia has also experienced considerable transformations under the impact of globalization and has become an indispensable part of the global science, taking an advantage of global knowledge in order to meet socio-economic needs. Therefore, the research-based public management is built on the individual scholars and their capacity to cooperate with other scientists and use the achievements of global science, which is directed at a constant development and a self-regulating nature (Kwiek, 2021).

Therefore, such transformations require the effective public management which adopts the theories of New Public Management and Good Governance. In this connection, public management stakeholders, such as public institutions, business, non-profit organization, shift from traditional linear management technologies to modern customer-oriented ones (Maxmudova, 2022).

In the 1990s, economists highlighted the need to move from the old management paradigm to the new global public management model (Dunleavy & Hood, 1994). It is noteworthy that digitalization-based public management of education and science is complicated by conservatism of educational and scientific institutions that prevent them from adapting to changes quickly. The construction of education and science public management models is complicated by global environment uncertainty because it is difficult to define knowledge and competences that will be in demand in the short term. Despite the unpredictability, in the post-industrial world, education and science should undergo significant changes in which society, human and social capital play a key role (Mironova et al., 2022).

In Ukraine, the diffusion of knowledge, culture, and behavior patterns results in the Renaissance of national traditions. As a result, education becomes Ukraine-centric. Moreover, the Ukrainian language is a stable trend in the society (Ivanenko, 2019). According to some Ukrainian scientists, as a tenet of the modern Ukrainian mindset, Ukraine-centrism has a democratic market orientation and political will, while "national selfishness" is considered

"a healthy macrotrend" of social development (Horbulin, 2019).

Other scholars assess the digitalization synergistic effect in the context of productions costs growth on the basis of economic and mathematical modeling, namely: correlation and regression analysis, predictive model digital manufacturing, optimization of linear programming problems (Sytnyk et al., 2022). In addition, when analyzing the notion of information educational system, some scholars suggest mathematical models to describe them and analyze their essence under the influence of society digitalization. For example, the dynamic deductive database theory and neural net theory help create mathematical models of human and community development strategies (Yuldashev et al., 2022).

The past five years have been a period of significant transformation in public administration, science, and education in Ukraine, driven by both internal reforms and external factors, including war and digitalization (Semenets-Orlova et al., 2022). In the context of the war, Ukraine has intensified its efforts to digitally transform public administration. This includes expanding electronic services, introducing electronic registries, and improving cybersecurity. In addition, digital technologies have been integrated into the electoral process and administrative services, which has significantly increased the efficiency and transparency of governance (Nehrey et al., 2023).

The processes of Ukrainization in education and science reflect the national policy of strengthening cultural identity and developing the national language. Studies show that the Ukrainization of the education system contributes to the preservation and development of the Ukrainian language and culture, as well as the formation of national consciousness among the younger generation. At the same time, the implementation of Ukrainization faces certain difficulties related to the need to ensure the quality of education against the backdrop of a changing linguistic environment, as well as integration into the global educational and scientific space. Some researchers emphasize the importance of finding a balance between national and global interests in public administration (Simakhova et al., 2022).

The education system in Ukraine has undergone significant changes due to the impact of the war. In particular, distance learning programs are being implemented to support teachers and students affected by the conflict. Educational initiatives, such as the "Osvita 4.0" program, aim to modernize the system through the use of digital technologies and support for innovation in education. UNESCO is actively supporting Ukraine by providing funding for the development of distance learning and psychological support, which is especially important in the face of the ongoing crisis. Plans are also being developed to rebuild Ukraine's educational and scientific infrastructure after the war ends.

These transformations reflect trends toward globalization and Ukraine's integration into the international educational and scientific space, while maintaining national identity through the Ukrainization of content and educational programs. The review of the state-of-the-art research allowed to determine multidimensional characteristics of globalization and digitalization of education and science as well as public management principles. Consequently, it is necessary to highlight that there is no unified optimization approach to modern public management of education and science; there are no criteria to determine its effectiveness; the micro- and macro-levels of public management are not related.

3. MATERIALS AND METHODS

The research methodology is based on a combination of quantitative and qualitative approaches, which allows for a comprehensive analysis of the impact of globalization processes on the development of education and science in Ukraine. In particular, the study collected and analyzed modern scientific sources related to education and science governance, in particular in the context of globalization, digitalization, and national identity. This includes a review of articles, books, reports, and other publications published over the past five years to identify key trends and challenges.

A comparative analysis of state digitalization management strategies in different countries is carried out to identify best practices and opportunities for their adaptation in Ukraine. Using differential calculus, a model for optimizing public administration of digitalization in education and science is developed. This model takes into account variables related to the costs of digitalization, the level of global partnership, the level of Ukrainization, digital competencies, and socio-economic benefits.

One of the key stages of the study was semi-structured interviews with representatives of government agencies, educational and research institutions, which provided qualitative information on the perception of digitalization and globalization in these areas, as well as a quantitative survey among education and research professionals aimed at identifying attitudes towards digitalization and its impact on professional activities (Lee & Ramirez, 2023). The study was conducted in a narrow sample of organizations, so the limitations are due to the insufficient scale of the survey, but even in this sample, it was possible to find general patterns and common features in the development of research and education organizations. The second limitation was a certain degree of subjectivity in the expert assessments of the respondents. The limitation of the differential model for optimizing decisions on the digitalization of a research and educational organization is the abstraction from the impact on business processes of other factors not included in the model, which necessitates empirical verification of the reliability of its results.

The survey was conducted on a confidential basis, without disclosing the names of the organizations, which was a condition of the offer. The sample consisted of 26 managers of state-owned research institutes and higher education institutions in Ukraine who evaluated the effectiveness of digitalization quantitatively (scores from 0 to 3, with intermediate answers of 0.5-2.5 for a more accurate assessment) and qualitatively (choice of answer). The results were synthesized to form a generalized picture of the impact of globalization and digitalization on education and science in Ukraine.

Based on the data obtained, recommendations for improving public administration of digitalization have been developed, taking into account national interests and global trends. The use and implementation of this research methodology allows for a multidisciplinary approach, creating the basis for the development of an effective state policy in the field of education and science management in the face of modern challenges.

The research stages are as follows:

a) consideration of the dominant trends in public administration of education and science in Ukraine against the background of globalization, digitalization, and Ukrainization;
b) substantiation of transformation of administration mechanisms taking into account the impact of new trends in the globalized environment development;
c) the qualitative analysis of the dynamics of economic growth, globalization and digitalization indices, education and science costs, and the digitalization scale;
d) the analysis of the relationship between the dynamics of the educational institutions number and government globalization and digitalization indices for 2003-2022;
e) the analysis of the dynamics of EGDI of Ukraine for 2003-2022;
f) conducting a sociological survey by interviewing managers of 26 scientific and educational institutions to determine their management mechanism effectiveness in the context of globalization, digitalization, and Ukrainization;
g) grouping respondents' assessments into clusters of education and science management efficiency;
h) developing the decision matrix of education and science public management and their digitalization criteria;
i) developing the public management optimization model of digitalization in education and science based on the differential calculus;
j) introduction of the digitalization costs multiplier as an element of macroeconomic calculations of the public costs multiplier through the

empirical detection of a direct relationship between the economic growth dynamics and the digitalization scale.

4. RESULTS

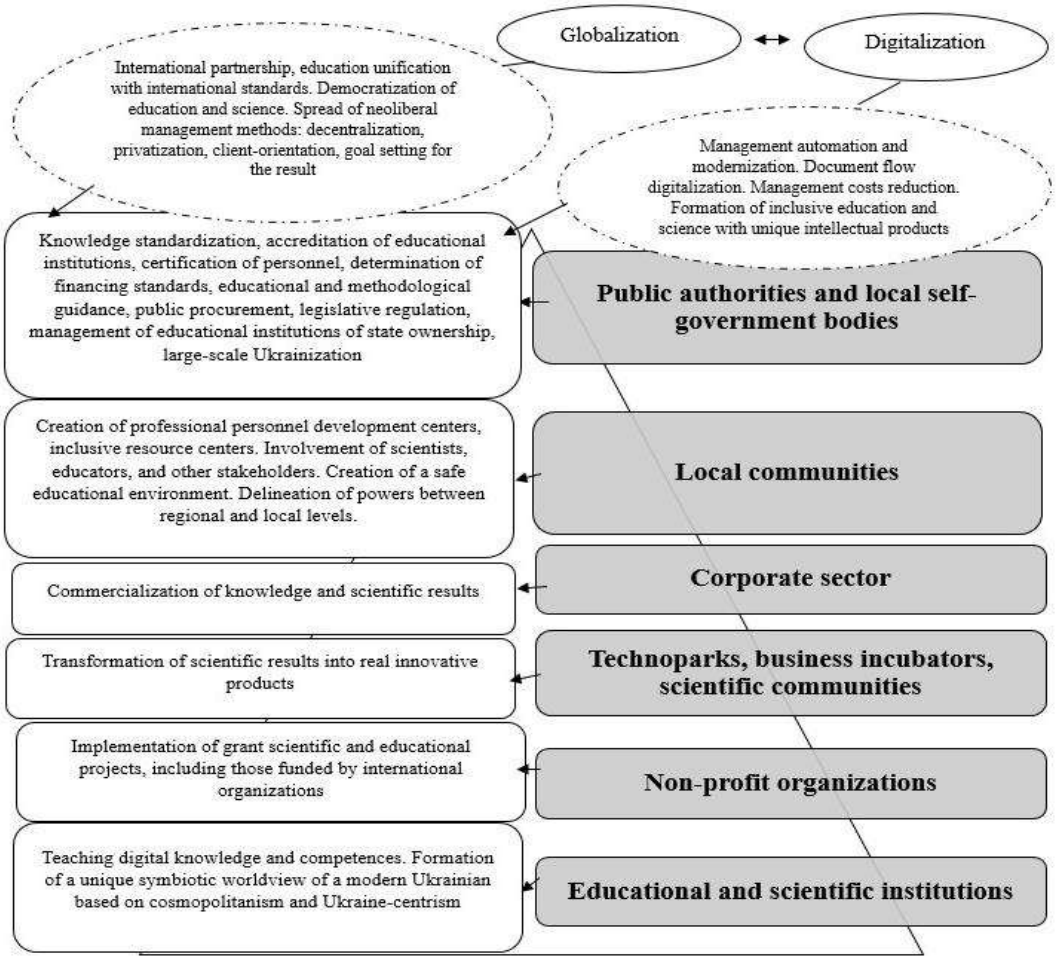
4.1 Trends in public management of education and science in Ukraine under the influence of globalization, digitalization, and Ukrainization

It is worth mentioning that there is certain dualism of trends in Ukraine. On the one hand, there are crises caused by global bifurcations such as risks of lagging behind developed countries in the socio-economic development, uncertainty of the integration future, digital gap, weak digital infrastructure. On the other hand, there is an internal problem caused by insufficient funds, unpreparedness of the institutional environment, material and technical infrastructure, non-compliance of workers' qualifications with demands of time. In addition, as the result of the war 15% of education and science facilities has been destroyed or damaged, while the number of internally displaced persons from among students has increased (Bilovodska et al., 2021).

Apart from that, the war has led to the budget deficit growth from 197.9 billion UAH in 2021 to 911.1 billion UAH in 2023, demonstrating 4.5 times increase (Minfin, 2023). Nevertheless, despite all economic and political troubles of the wartime, digitalization of education and science are implemented through the creation of modern web-platforms (for example, Science and Business), scholarly chatbots, the national information URIS, and the National Repository of Academic Texts, the National portal of international scientific and technical cooperation (Ministry of Education and Science of Ukraine, 2022).

Moreover, public management of education and science uses digital projects on formation of digital decisions ecosystem in order to improve personnel training and knowledge production in the digital space equipped with digital infrastructure and competences. In particular, the Ministry of Education and Science of Ukraine developed such projects as Self-reflection on Effective Learning by Fostering the Use of Innovative Educational Technologies, the National Multisubject Test (NMT), electronic education documents in Diya, the Unified State Electronic Database on Education (USEDE), Laptop for every teacher; Educational chatbot, Ukrainian online-school, etc. Besides, in the context of globalization, Ukraine participates in international educational and scientific projects, for example, Horizon 2020, EUREKA, Science for Peace and Security (SPS) Program, Erasmus (Ministry of Education and Science of Ukraine, 2023).

Figure 1 illustrates the modern public management mechanism in education and science.



Source: compiled by the author

Figure 1: Modern public management mechanism in education and science in Ukraine

4.2 Analysis of the dynamics of economic growth, globalization and digitalization indices, education and science costs, and digitalization scale of educational and scientific institutions

The time period selected for the analysis is explained by the introduction of EGDI in 2003 and the need to compare the parameters simultaneously and determine correlations between the data. Since EGDI is published every second year, the data from intervening years are duplicated with the earlier one.

The analysis uses data for 2003-2022 collected from official sources, such as the State Statistics Service of Ukraine, the State Treasury Service, the KOF global indices, and the EGDI digital government development index. All this data is presented in the form of a table, which allows for both quantitative and qualitative analysis of the dynamics of changes. The qualitative analysis of the relationship between trends was based on generally accepted indicators, namely Real GDP (Used to assess the impact of economic development on public sector spending on science and education.), Expenditures % of GDP (Assesses the amount of funding for science as an important factor in the development of the scientific sphere), Expenditures (Determines the level of investment in the educational sector.), Scale of digitalization of professional, scientific and technical institutions (thousand units) (allows to assess the level of implementation of digital technologies in scientific and educational institutions), KOF Globalization Index (reflects the level of Ukraine's integration into the world economy and society), EGDI Digital Government Development Index (measures the level of government digitalization, which is important for the overall level of digitalization in the country).

Table 1: Dynamics of economic growth, globalization and digitalization indices, education and science costs, and digitalization scale of educational and scientific institutions for 2003-2002 (qualitative analysis of trend relationships)

Year	Real GDP (trillions USD)	Public expenditures on science (% GDP)	Consolidated budget expenditures on education (% GDP)	Digitalization scale of educational and scientific institutions (thousand units)	KOF Globalization Index	E-Government Development Index (EGDI)
2003	50,1	1,35	5,6	-	59,73	0,4620
2004	64,9	1,37	5,9	-	61,03	0,5325
2005	86,1	1,30	6,1	-	61,89	0,5325
2006	107,8	0,99	6,15	-	63,55	0,5456
2007	142,7	0,87	6,2	-	66,05	0,5456
2008	179,9	0,85	6,7	-	68,79	0,5728
2009	117,2	0,82	7,3	-	70,18	0,5728
2010	136,0	0,75	7,4	-	70,49	0,5181
2011	163,2	0,65	6,6	-	73,09	0,5181
2012	175,8	0,67	7,2	-	73,24	0,5653
2013	183,3	0,70	7,2	-	73,64	0,5653
2014	133,5	0,60	6,3	-	74,63	0,5032
2015	91,0	0,55	25,7	-	76,12	0,5032
2016	93,3	0,48	5,4	-	76,62	0,6076
2017	112,2	0,45	6,5	2,522	76,54	0,6076
2018	130,8	0,47	5,9	2,636	75,96	0,6165
2019	153,8	0,43	5,8	2,685	74,45	0,6165
2020	155,6	0,41	5,7	2,655	72,70	0,7119
2021	200,1	0,35	6,6	2,638	72,87	0,7119
2022	160,5	0,30	7,0	2,597	73,00	0,8029

Source: compiled by the author on the basis of data from State Statistics Service of Ukraine (2020); State Treasury Service of Ukraine (2022); KOF Globalization Index (2023); GMK Center (2021)

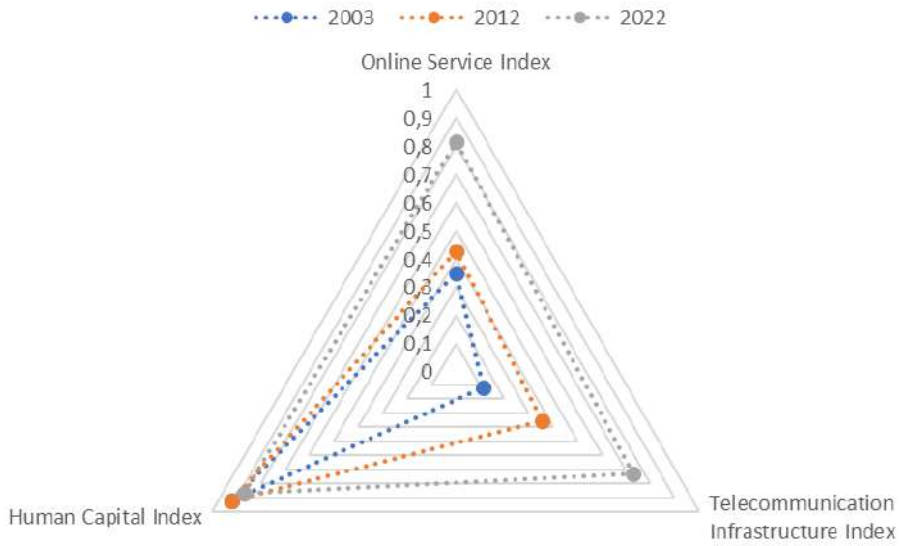
Table 1 summarizes the dynamics data of economic growth, globalization and digitalization indices, education and science costs, and digitalization scale for 2003-2022. Thus, the determination of the correlation coefficient for this period demonstrates a negative link between changes in GDP and public expenditures on science (correlation coefficient = -0,6), a weak positive link between GDP and public expenditures on education (correlation coefficient = 0,6), strong reciprocal links between KOF Globalization Index and public expenditures on science (correlation coefficient = -0,9), EGDI and public expenditures on science (correlation coefficient = -0,7), the lack of influence of globalization level and government digitalization on education costs (correlation coefficient = 0,1). In other words, there is no tendency towards a powerful positive impact of globalization and digitalization on the intensity of expenditures on education and science. At the same time, there is a medium positive impact of globalization and digitalization on the economic growth dynamics (correlation coefficient = 0,5). However, during the period of significant economic growth in 2003-2008, strong negative correlations between expenditures on education and KOF Globalization Index and EGDI are identified (correlation coefficient = -0,7 – -0,9). Moreover, there is high sensitivity of education costs to the analyzed indices (correlation coefficient = 0,9-0,94).

Consequently, the correlation analysis demonstrates reciprocal relations between the economic growth dynamics and budget expenditures on education and science that indicates a gradual decrease in state involvement in education and science financing in favor of expanding participation of other market subjects of public management (business, technoparks, educational and scientific institutions) against the background of a positive influence of globalization and digitalization on GDP.

The analysis of the impact of the economic growth, KOF Globalization Index, and EGDI

on the digitalization scale in 2017-2022 (the number of digitalized educational institutions correlated with the amount of digitalization financing) shows a moderate positive link between GDP and the digitalization scale in educational and scientific institutions (correlation coefficient = 0,5), a moderate negative link between globalization and the digitalization scale (correlation coefficient = -0,5), and almost no link between digitalization of the government and educational institutions.

In addition, the analysis of the EGDI dynamics for 2003-2022 demonstrates a strong tendency towards the intensification of telecommunication infrastructure and online services creation (Figure 2). On the contrary, the Human Capital Index indicates a relatively more developed level than telecommunication infrastructure and online services, along a slight shortage of its indicators from 0,92 in 2003 to 0,867 in 2022.



Source: UN E-government Knowledge Database (2022)

Figure 2: Dynamics of the structure of EGDI of Ukraine for 2003-2022

The analysis of the influence of globalization, digitalization, and economic growth on the education and science development parameters shows the absence of logical trends against the background of increasing uncertainty of the market environment. It is very difficult to design a universal public management model of education and science, plan and predict public expenditures on these spheres under such turbulent conditions. Due to the difficulty of identifying the exact patterns between globalization, digitalization, and expenditures on education and science, the algorithm for predicting, planning, and managing such costs is complicated.

The economic growth caused by an increase in digitalization costs of education and science shall be calculated as the aggregate sum of additional socio-economic gains of digitalization (DG) in individual institutions:

$$\Delta GDP_{DC} = \sum(\Delta DG_1, \Delta DG_2, \dots, \Delta DG_n),$$

where n – a number of institutions.

4.3 Decision matrix of education and science public management and criteria for digitalization management

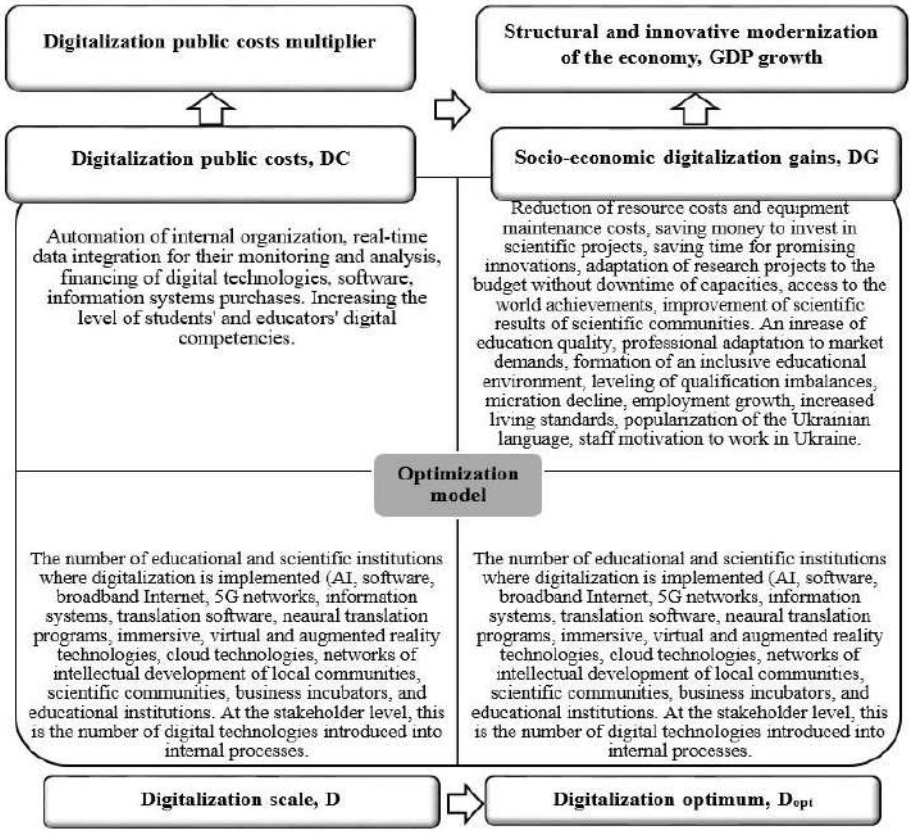
The management decision matrix of consists of a set of clear criteria for evaluating the appropriateness of a particular management measure, carried out by a certain stakeholder. It includes digitalization, global participation in projects or events, projects on Ukrainization of the communicative interface. The stakeholder who implements decisions on science and education in business processes should evaluate the following criteria: costs, socio-economic gains, aggregate effect, scale, and optimum (a clearly defined solution scale for stakeholder needs).

Table 3: Decision matrix of education and science public management

Criteria / Stakeholder	Government G	Local communities LC	Business B	Technoparks, scientific communities T	NCO	Educational and scientific institutions ESO
Costs	GC	LCC	BC	TC	NCC	ESC
Gains	GG	LCG	BG	TG	GG	GG
Aggregate effect	GAE	LCAE	BAG	TAE	NCAE	ESAE
Scale	GS	LCS	BS	TS	NCS	ESS
Optimum	G_{opt}	LC_{opt}	B_{opt}	T_{opt}	NC_{opt}	ES_{opt}

Source: Compiled by the authors on the basis of the public management mechanism

Figure 4 demonstrates the criteria for management decisions on digitalization that will be used in the optimization model.



Source: Compiled by the author

Figure 4: Criteria for digitalization management decisions in the optimization model

4.4 Grouping respondents' assessments into clusters of education and science management efficiency

The sociological survey of managers of national educational and scientific institutions was conducted from October 10, 2023 to November 07, 2023. The purpose of the survey was to determine the dominant factors of effective management of education and science and general trends in the development of educational and scientific institutions in the context of globalization, digitalization, and Ukrainization.

In the course of forming the primary sample, 122 higher education institutions (HEIs) and 64 research institutions voluntarily agreed to participate in the random sampling from the set of HEIs in the State Register of Educational Entities and the State Register of Scientific Institutions, for a total of 186 organizations. Letters were sent to the email addresses of the directors of research institutes and rectors of

universities with a proposal to participate in the study of public management effectiveness of their institutions in terms of globalization, digitalization, and Ukrainization. The letter contained a questionnaire with detailed questions that required quantitative and qualitative answers (see Appendix 1).

The initial sample was formed randomly from a set of universities of the State Register of Subjects of Educational Activity and the State Register of Scientific Institutions. Thus, a primary sample of managers from 122 universities and 64 research institutions was collected. Out of 186 letters sent, 72 letters of refusal came in response for one reason or another, 34 letters with agreement, of which 8 were found to be incorrectly filled out (error of 23,5%) and 80 proposals were ignored. The secondary sample contained 26 scientific and educational institutions. Analytical processing of the experiment results and charting was carried out using Excel.

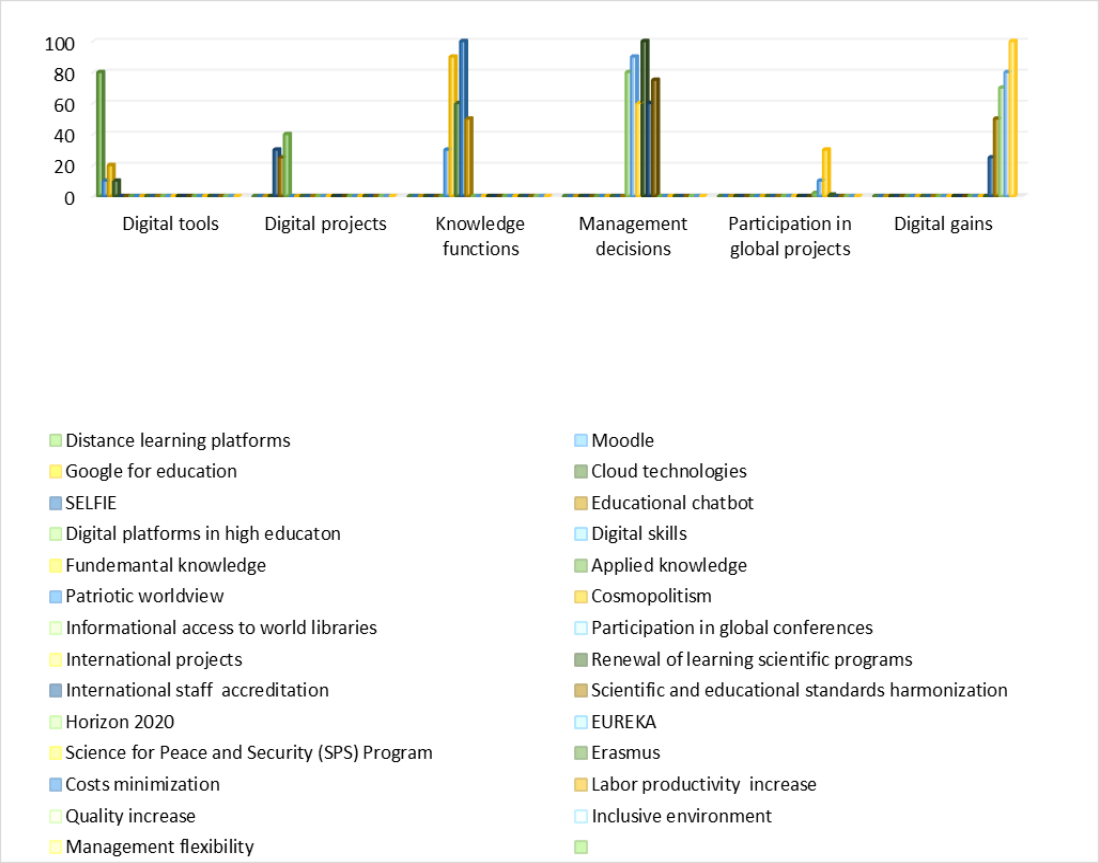
Table 2 presents factors of public management mechanisms efficiency in educational and scientific institutions in the context of globalization, digitalization, and Ukrainization.

Table 2: Survey results of managers of educational and scientific institutions

Organization	Digitalization scale	Digitalization costs	Digital skills	Global participation	Ukrainization	Social & economic effects, SEE
1.	1,5	1	2	2	2	2
2.	2	2	2,5	3	3	3
3.	0,5	0,5	1	1,5	1	0,5
4.	2,5	1,5	3	3	3	3
5.	1	1,5	2,5	2,5	2	2,5
6.	2	2	3	2,5	2,5	3
7.	0	0	1,5	0,5	2	0,5
8.	1,5	1,5	2,5	2	2	2,5
9.	2,5	2,5	3	3	3	3
10.	2	2,5	3	2	3	3
11.	1,5	1	2	1,5	1,5	1,5
12.	2	2	2,5	1,5	1	1,5
13.	0,5	1	1,5	0	0,5	0,5
14.	1	1	2	1	2	1
15.	1,5	1	3	2,5	2,5	2,5
16.	2	2	3	3	3	3
17.	2,5	2	3	2	2	2,5
18.	0,5	0	1	0,5	2	0,5
19.	1,5	1,5	1,5	2	2	2
20.	3	2	3	3	3	3
21.	2	2,5	3	2	3	3
22.	1	1	2	1,5	1,5	1
23.	2,5	2	2,5	1,5	1	2,5
24.	0,5	1	1,5	0	0,5	0,5
25.	1	1	2	1	2	1
26.	3	2	3	2,5	2,5	3
SEE-Correlation coefficient	0,86	0,84	0,90	0,90	0,76	-

Source: Calculated by the authors on the basis of respondents' quantitative assessments

Based on the allocation of key clusters of a qualitative assessment of the education and science management effectiveness, respondents' assessments are grouped and presented in the percentage of institutions that confirm the use of management tools in their system (Figure 5).



Source: Calculated by the authors on the basis of respondents' qualitative assessments

Figure 5: Patterns of implementing digital tools in public management of education and science (% of institutions out of their total number)

The sociological survey determined the key factors of socio-economic gains of public management and the high correlation of links between them. These effects seem to be most susceptible to digital competences factors and global participation (correlation coefficient = 0,9). The analysis of digital technologies used in public management of educational and scientific institutions and its socio-economic gains revealed the following general patterns. Thus, in the digital tools cluster, 80% of institutions use distance learning platforms to optimize management decisions. In the digital projects cluster, 40% of institutions use digital platforms in high education. In the knowledge functions cluster, the majority of the respondents chose providing fundamental knowledge (90%) and cultivating patriotic worldview (100%). In the management decisions cluster, the main responses are participation in international conferences (90%), access to global digital libraries (80%), implementation of digital tools (75%). In the global participation cluster, less activity is observed: only 30% of institutions participated in the Science for Peace and Security (SPS) Program, 2% of institutions took part in Horizon - 2020, 10% - in EUREKA, and 1% - in Erasmus. Finally, in the socio-economic gains cluster, 70% of respondents confirmed an increase in the quality of educational and scientific products, 80% of them indicated formation of an inclusive environment, and 100% of respondents declared an increase in management flexibility.

The management decision matrix for educational and scientific institutions stakeholder requires the optimization of all criteria. If Dopt is the digitalization optimum,

$$DG = f_{DG}(D)$$

then where D is the digitalization scale of public management if education and science, fDG(D) is the dependence function of socio-

economic gains from digitalization expressed in money terms via the GDP growth. The digitalization scale is understood as the minimum required number of digitalized educational and scientific institutions that gives the effect of reducing fluctuations and uncertainty of a global environment by improving public management decisions by the governmental authorities. If D=0, then digitalization gains (DG) are 0. Similarly, the digitalization costs is determined by the digitalization scale:

$$DG = f_{DG}(D)$$

where D is the digitalization scale, fDC(D) is the dependence function of digitalization costs in money terms. If D=0, then DC=0.

The digitalization aggregate effect (DAE) is calculated as the difference between its socio-economic gains and its implementation costs: DAE=DG–DC. It logically depends on the digitalization scale; however, if D=0, the digitalization aggregate effect is absent:

$$DAE = f_{DAE} = f_{DG}(D) - f_C(D)$$

The net digitalization effect (NDE) of education and science gives the growth in socio-economic gains through the decrease in the uncertainty of a global environment. However, taking into account additional expenditures on digitalization, the net digitalization effect is calculated as follows:

$$\Delta NDE = \Delta DG - \Delta DC$$

Meanwhile, additional socio-economic effect and additional expenditures on digitalization depend on the minimum required growth of digitalized educational and scientific institutions and their actual amount:

$$\Delta DG = f_{\Delta DG}(D, \Delta D)$$
$$\Delta DC = f_{\Delta DC}(D, \Delta D)$$

where fΔDG (D, ΔD) and fΔDC (D, ΔD) are the dependences of the growth in socio-economic gains and digitalization costs on the digitalization scale.

The net digitalization effect of public management of education and science is also the dependence function of the actual digitalization scale D on its growth ΔD:

$$\Delta NDE = f_{\Delta NDE}(D, \Delta D) = f_{\Delta DG}(D, \Delta D) - f_{\Delta DC}(D, \Delta D)$$

Abstracting from discrete functions (1), (2), (3), in case of the infinitesimal of the growth in the number of digitalized educational and scientific institutions:

$$dD = \lim_{D \to 0}(D)$$

Functions (5)-(7) are applied to calculate the differential of socio-economic effects, additional expenses, and additional net digitalization effect of public management of education and science.

Then, these functions are as follows:

$$dDG = f_{DG}(D) * dD$$
$$dDC = f_{DC}(D) * dD$$
$$dNDE = f_{DG}(D) * dD - f_{DC}(D) * dD = \left(f_{DG}(D) - f_{DC}(D)\right) * dD = f_{\Delta NDE}(D) * dD$$

where fDG(D), fDC(D), fΔNDE(D) are derivatives of functions (1), (2), (3):

$$f_{DG}(D) = dF_{DG}(D)/dD$$
$$f_{DC}(D) = dF_{DC}(D)/dD$$
$$f_{\Delta NDE}(D) = dF_{\Delta NDE}(D)/dD = f_{DG}(D) - f_{DC}(D)$$

The additional socio-economic effect (5) is not a linear function of ΔD because based on the differential calculus, the growth in the number of digitalized educational and scientific institutions will cause the growth in the additional socio-economic effect only to a certain maximum margin – the extremum of function fΔDG – and then will lead to a fewer additional effect than the previous one. So, there is a certain maximum effect of

digitalization DGmax, which can be potentially achieved by adopting the optimal public management decision:

$$DG_{max} = F_{DGmax}(D) = \lim_{\to 0} F_{DG}(D)$$

Under the assumption that DG = fDG(D) is a monotonically rising value with an attenuation and asymptotic inclination to the maximum DGmax, this dependence will be expressed by the exponential function:

$$F_{DG}(D) = DG_{max}\,(e^{\alpha D} - 1)/e^{\alpha D}$$

where α is the elasticity coefficient that reflects the impact of the digitalization scale per a standard unit (for example, a purchase of additional software by the state research institute) on its socio-economic effect (for example, an increase in the speed of access to global information resources, science automation, saving time, etc.).

Therefore, it is obvious that the dependence function (16) meets the condition for zero socio-economic gains from digitalization if the digitalization scale is equal to 0:

$$F_{DG}(0) = DG_{max}(e^{\alpha * 0} - 1)/e^{\alpha * 0} = DG_{max}(1 - 1)/e^{0} = DG_{max}(1 - 1)/1 = 0$$

It also meets the dependence condition (15) that shows socio-economic gains of educational and scientific institutions from implementing an infinitely large number of digital technologies:

$$\lim_{D\to 0} FDG(D) = \lim_{D\to 0}\{DG_{max}(e^{\alpha D} - 1)/e^{\alpha D}\} = DG_{max} \lim_{D\to 0}\{e^{\alpha D}/e^{\alpha D}\} = DG_{max}$$

At the same time, the dependence of the growing dynamics of socio-economic effects of digitalization on its scale is a derivative of function (16) and has the following form:

$$fDG(D) = dFDG(D)/dD = d(DG_{max}(e^{\alpha D} - 1)/e^{\alpha D})/dD = \alpha * DG_{max}/e^{\alpha D}$$

Upon reaching its extremum, the function expressed by formula (19) is monotonically decreasing since an increase in the digitalization scale for each subsequent standard unit will cause smaller socio-economic gains than the previous ones. Meanwhile, the dependence of digitalization costs on its scale (6) is not linear. However, the difference between the function of digitalization costs and the function of gains consists in the fact that the digitalization costs (expenses on purchasing and installing each unit of a digital technology) will be higher than the previous ones, while digitalization costs will be infinitely high when implementing the infinitely large number of digital technologies:

$$F_{DCmax}(D) = \lim_{D\to\infty}\big(F_{DC}(D)\big) = +\infty$$

Therefore, the dependence of the digitalization costs on its scale (2) is an infinitely increasing function – the exponential function:

$$F_{DC}(D) = x * (e^{yD} - 1)$$

where y, x – elasticity multipliers that are empirically calculated for an individual educational and scientific institution and show the impact of changes in the digitalization scale on its costs growth and the correlation between changes in the digitalization scale and its costs.

Accordingly, it is clear that if the institutions do not have new digital projects, then additional expenditures on digitalization are equal to 0:

$$F_{DC}(0) = x(e^{y0} - 1) = 0$$

Thus, since the infinitely large digitalization scale is required to take effective management decisions, expenditures on such large-scale digitalization are calculated by the following formula:

$$\lim_{D\to\infty} F_{DC}\,(D) = \lim_{D\to\infty}\{x(e^{yD} - 1)\} = x \lim_{D\to\infty} e^{yD} = +\infty$$

Simultaneously, the dependence of the growth in expenditures on purchasing an additional unit of digital technologies on the actual digitalization scale in the institution is a derivative of the function and expressed in the following way:

$$f_{DC}(D) = dF_{DC}(D)/dD = d\big(x(e^{yD} - 1)\big)/dD = xd(e^{yD} - 1)/dD = x * y * e^{yD}$$

The dependence function (24) is a monotonically rising value: the expenditures on purchasing each subsequent unit of digital technologies will cause higher growth in additional digitalization costs than the previous ones. So, the cumulative socio-economic effect from the digitalization scale, taking into account the functions (3), (16), (21), is expressed as follows:

$$F_{DAE}(D) = DG_{max}(e^{\alpha D} - 1)/e^{\alpha D} - x(e^{yD} - 1)$$

Consequently, the cumulative digitalization effect from its zero scale is equal to 0:

$$F_{DAE}(0) = DG_{max}(e^{0D} - 1)/e^{0D} - x(e^{y0} - 1) = DG_{max}(1 - 1)/1 - x(1 - 1) = 0$$

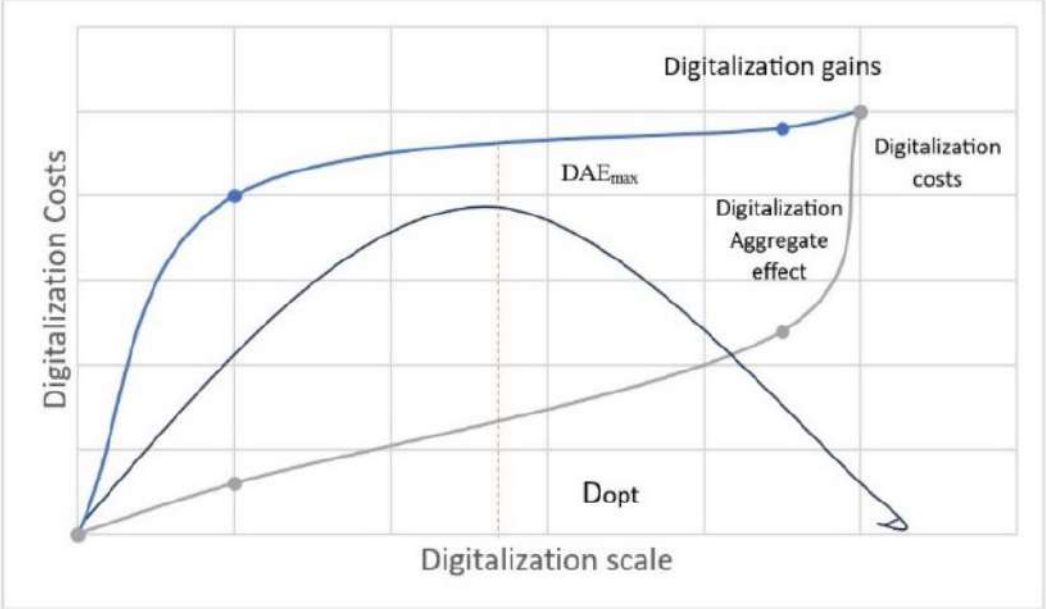
Meanwhile, the cumulative digitalization effect from the use of the infinitely large digitalization scale is expressed as follows:

$$F_{DAEmax}(D) = \lim_{D\to\infty}\big(F_{DAE}(D)\big) = F_{DGmax}(D) - F_{DCmax}(D) = \\ = \lim_{D\to\infty}\{DG_{max}(e^{\alpha D} - 1)/e^{\alpha D} - x(e^{yD} - 1)\} = DG_{max} - \{+\infty\} = -\infty$$

It is interpreted as the maximum loss ratio of the use of the infinitely large digitalization scale in management decisions. Under conditions of using each subsequent unit of digital technologies, the dependence of the cumulative digitalization effect growth as a derivative of the function is transformed into the following function:

$$f_{DAE}(D) = dF_{DAE}(D)/dD = d\{DAE_{max}(e^{\alpha D} - 1)/e^{\alpha D} - x(e^{yD} - 1)\}/dD = \\ = \alpha DAE_{max}/e^{\alpha D} - x * y * e^{yD}$$

Figure 6 illustrates the dependence of the digitalization costs, socio-economic gains, and the cumulative digitalization effect on the digitalization scale when making public management decisions.



Source: compiled by the author.

Figure 6: Dependence of the digitalization costs, socio-economic gains, and the cumulative digitalization effect on the digitalization scale at the level of institution

In order to calculate the optimal digitalization scale Dopt, which will allow to achieve the maximum cumulative digitalization effect, it is necessary to determine critical points of the function (25), where its first derivative (28) is equal to 0:

$$F_{DAE}(D_{cs}) == \alpha DAE_{max}/e^{\alpha D} - x * y * e^{yD} = 0$$

Dcs is the digitalization scale in the critical point of the function (28).

Therefore, the modified equation (29) is as follows:

$$D_{cs} = \left(\ln\sqrt{\alpha DAE_{max}/xy}\right)/y$$

when the system condition is met:

$$\left\{\begin{matrix}\left(\sqrt{\alpha DAE_{max}}/xy\right) > 0 \\ \left(\alpha DAE_{max}/xy\right) \geq 0\end{matrix}\right\} => \alpha DAE_{max}/xy > 0$$

Empirical coefficients α, x, y have positive values. So, the inequation (31) is satisfied. Consequently, the function (28) will have only one critical value in the critical point, which is calculated by the equation (30). Dcs will reach the optimum and cause the maximum cumulative digitalization effect only when the second derivative of the function is negative (28):

$$D_2F_{DAE}(D_{cs})/dD^2 = df_{DAE}(D_{cs})/dD < 0$$

The derivative of the function (27) is calculated by the following formula:

$$Df_{DAE}(D)/dD = d(\alpha DAE_{max}/e^{\alpha D} - xy * e^{yD})/dD = -DAE_{max}/e^{\alpha D} - xy^2e^{yD}$$

Empirical coefficients α, x, y and variable parameters of the equation (33) have positive values, and so, the condition (32) is satisfied, the rejection limit of the function (25) will be

the optimum and will result in the maximum cumulative digitalization effect when making management decisions.

The condition Dcs≥0 is satisfied only when √(αDAEmax/xy) ≥0, hence

$$\left\{\begin{matrix}\alpha DAE_{max}/xy \geq 1\\ \alpha DAE_{max}/xy \geq 0\end{matrix}\right\} => \alpha DAE_{max}/xy > 1 => \alpha DAE_{max} => xy$$

If αDAEmax = xy, the rejection limit D is as follows:

$$D_{cs} = \ln\sqrt{(\alpha DAE_{max}/xy)}/y = \ln(\sqrt{1})/n = 0/n = 0$$

If the critical digitalization scale is equal to 0, then the optimal management decision is a flexible situational solution that does not require the additional digitalization costs. If the condition Dcs≥0 is not satisfied, the dependence function of the cumulative digitalization effect on the digitalization scale (25) is monotonically decreasing, while the maximum cumulative digitalization effect will be obtained at the lower limit of the domain of this function if D=0. Thus, the digitalization optimum that will lead to maximization of the cumulative management effect is calculated by the following system of equations:

$$D_{opt} = \begin{cases} ln(\sqrt{\alpha DAE_{max}})/xy, & \alpha DAE_{max} > 0 \\ 0, & \alpha DAE_{max} \leq xy \end{cases}$$

In this case, the cumulative effect from introducing the optimal digitalization scale will be maximum and is calculated as follows:

$$FDAE_{max}(D_{opt}) = D_{max}(e^{\alpha D_{opt}} - 1)/e^{\alpha D_{opt}} - x(e^{\alpha D_{opt}} - 1)$$

Based on the development of digitalization costs DC, its socio-economic gains DG, the cumulative digitalization effect of educational and scientific institutions ΔGDPDC, and the application of the limit method of the differential calculus as the element of the public costs multiplier, it is advisable to introduce the digitalization costs multiplier (mD) as a ration of GDP growth to digitalization costs to the growth in digitalization costs:

$$M_D = \Delta GDP_{DC}/\Delta DC = \sum(\Delta DG_1, \Delta DG_2, \dots, \Delta DG_n)/\sum(\Delta DC_1, \Delta DC_2, \dots, \Delta DC_n)$$

where n is the number of educational and scientific institutions that participate in social production.

4.5. Recommendations to improve public management of education and science

Based on the research results and analysis, it is expedient to provide several recommendations for strengthening the public management of education and science in Ukraine in the context of globalization, digitalization, and Ukrainization. In particular, first of all, it is necessary to prioritize investments in digital infrastructure in education and science. This includes continuing the development of digital platforms (e.g., Science and Business, URIS), implementing distance learning tools and ensuring that every educational institution has access to reliable and modern technological tools.

Hence, it is possible to claim that there is a direct link between economic growth, globalization, and public spending on education and science. In this connection, the Ukrainian government needs to create a sustainable funding model, which will involve several stakeholders (government agencies, educational organizations, the private sector, and international organizations). This model should integrate contributions from the private

sector, international organizations and the government to ensure stable financial support for education and science, especially in light of the budget deficit caused by the war.
The analysis shows the relatively low participation of Ukraine in international educational and scientific projects such as Horizon 2020 and Erasmus. Therefore, it is recommended to encourage educational and scientific institutions to increase their participation in such global projects. This can be facilitated by raising awareness of the academic staff and students, reducing administrative barriers, and providing institutional support for international cooperation. The analysis suggests an extremely high correlation between digital competencies and management efficiency. Therefore, there should be a national initiative to teach digital skills to both educators and students. This initiative would include integrating innovative digital tools into curricula and administrative processes, ensuring that educational institutions are equipped to use digital platforms and technologies effectively.

The survey results highlight the importance of management flexibility in educational and scientific institutions. Decision-makers must apply flexible, adaptive management techniques that can respond to rapid changes in the digital and global environment. This includes implementing flexible budgeting mechanisms and adjusting strategies to solve new problems in real time. In accordance with national priorities, the Ukrainization of digital platforms and interfaces used in public management of education and science should continue. Ensuring that these tools are available in the Ukrainian language will not only promote national identity, but also increase accessibility and usability for local stakeholders.

Thus, to maximize the socio-economic benefits of digitalization in education and science, a predictive model should be developed to determine the optimal scale of digitalization (D_{opt}). This model will help decision makers identify critical points where the socio-economic benefits of digitalization are maximized while minimizing costs. It would ensure the efficient use of limited resources. By implementing these recommendations, Ukraine can strengthen public management of education and science, ensuring the readiness of these sectors to overcome the challenges and opportunities posed by globalization and digitalization.

5. CONCLUSIONS

The new public management paradigm in Ukraine should be based on a radical transformation of internal mechanisms, aimed at social changes, innovative modernization of the economy, an increase in the production of high-tech products competitive in world markets, an increase in income, an increase in employment and a reduction in labor migration. From now on, globalization and digitalization in education and science should be organically combined with Ukraine-centrism in making management decisions.

The core of the transformed public management paradigm is a new generation of people with a symbiotic worldview, while the superstructure contains a transformed public management mechanism. The new generation will be capable of constant learning, problem solving, intercultural communication, exporting Ukrainian institutions to the cultural spaces of other countries. In this regard, optimal management decision matrix should be located in the center of the public management mechanism.

The introduced of digitalization optimum indicators and the costs multiplier for education and science should be taken into account when calculating the planned and forecast indicators of government expenditures in macroeconomic strategies of public management. The developed optimization model will allow educational and scientific institutions to improve the management decisions efficiency, establish a maximum level of costs acceptable to them, which will give maximum socio-economic gains at the level of institutions and the state. All hypotheses are confirmed.

Prospects for further development are an empirical study of the public management decision matrices in education and science based on a massive sample of all the stakeholders and an empirical verification of the optimization model results. In the future, it is also planned to study the multiplier effect of

education and science digitalization costs on production growth and economic growth in other fields related to science and education.

REFERENCES

Bilovodska, O., Mykhalchyshyn, N., Komarynets, S., Seniv, L., Humeniuk, V., & Kantsir, I. (2021). Globalization impacts on the structure of Ukraine's economy: Innovations challenges for management in digitalization, social and economic transformations. *Journal of Information Technology Management*, *13* (Special Issue: Advanced Innovation Topics in Business and Management), 20-34. https://doi.org/10.22059/jitm.2021.82600

Cabinet of Ministers of Ukraine. (2023). Resolution No. 1322 of December 15, 2023 "On approval of the Strategy for the establishment of Ukrainian national and civic identity for the period until 2030 and approval of the operational plan of measures for its implementation in 2023-2025". https://www.kmu.gov.ua/npas/pro-skhvalennia-stratehii-utverdzhennia-ukrainskoi-na-a1322

Clarke, A. (2020). Digital government units: what are they, and what do they mean for digital era public management renewal? *International Public Management Journal, 23*(3), 358-379. https://doi.org/10.1080/10967494.2019.1686447

Corydon, B., Ganesan, V., & Lundqvist, M. (2016). *Transforming government through digitalization.* McKinsey & Company. www.mckinsey.com/~/media/McKinsey/Industries/Public%20Sector/Our%20Insights/Transforming%20government%20through%20digitization/Transforming-government-through-digitization.pdf

Dunleavy, P., & Hood, C. (1994). From old public administration to new public management. *Public Money & Management, 14*(3), 9-16. https://doi.org/10.1080/09540969409387823

GMK Center. (2021). How much does Ukraine spend on scientific research and innovations? https://gmk.center/ua/infographic/ukraina-z-2013-roku-skorotila-vdvichi-vitrati-na-naukovi-doslidzhennya/

Horbulin, V. (2019). *My way into the Wonderland. Not just travel notes.* Bright Books.

Ivanenko, V. (2019). *Ukrainization as fact and factor of systemic changes*. Ukraina Inc Publishing.

KOF Globalisation Index. (2023). https://kof.ethz.ch/en/forecasts-and-indicators/indicators/kof-globalisation-index.html

Kubalskyi, O. (2022). Social turbulence as the scientific phenomenon: Operational and strategic change. *Philosophy and Cosmology, 29*, 17-25. https://doi.org/10.29202/phil-cosm/29/2

Kwiek, M. (2021). The globalization of science: The increasing power of individual scientists. In P. Mattei, X. Dumay, E. Mangez & J. Behrend (Eds.), *The Oxford Handbook of Education and Globalization* (pp. 726-759). Oxford University Press.

Lee, Ch.-Ch., Lin, Ch.-W., & Lee, Ch.-Ch. (2023). Globalization, government regulation, and country risk: International evidence. *The Journal of International Trade & Economic Development, 32*(1), 132-162. https://doi.org/10.1080/09638199.2022.2079710

Lee, S. S., & Ramirez, F. O. (2023). Globalization of universities as organizational actors? In K. Sahlin, & U. Eriksson-Zetterquist (Eds.), *University Collegiality and the Erosion of Faculty Authority. Research in the Sociology of Organizations, Vol. 86.* (pp. 87-104). Emerald Publishing Limited. https://doi.org/10.1108/S0733-558X20230000086004

Markevych, K. (2021). Digitalization: advantages and ways to overcome challenges. *Razumkov Centre.* https://razumkov.org.ua/statti/tsyfrovizatsiia-perevagy-ta-shliakhy-podolannia-vyklykiv

Maxmudova, D. (2022). Optimization of public administration: international experience and national practice. *Asia Pacific journal of marketing & management review, 11*(12), 230-235.

Minfin. (2023). Implementation of the state budget of Ukraine. https://index.minfin.com.ua/ua/finance/budget/gov/2022/

Ministry of Education and Science of Ukraine. (2022). Main achievements in the field of education and innovations in 2020-2022.

https://mon.gov.ua/ua/news/golovni-dosyagnennya-u-sferi-nauki-ta-innovacij-2020-2022

Ministry of Education and Science of Ukraine. (2023). Digital transformation of education and science. https://mon.gov.ua/ua/tag/cifrova-transformaciya-osviti-ta-nauki

Mironova, N., Koptieva, H., Liganenko, I., Sakun, A., & Chernyak, D. (2022). Modeling the selection of innovative strategy for development of industrial enterprises. *WSEAS Transactions on Business and Economics, 19*, 278-291. https://doi.org/10.37394/23207.2022.19.26

Mohamed, H. M., Tlemsani, I. & Matthews, R. (2022). Higher education strategy in digital transformation. *Education and Information Technologies, 27*, 3171–3195. https://doi.org/10.1007/s10639-021-10739-1

National Institute for Strategic Studies. (2020). Ukraine-2030: Future changes strategy. https://niss.gov.ua/sites/default/files/2020-12/ukraine-2030-1.pdf

Nehrey, M., Kostenko, I., & Kravchenko, Y. (2023). Digital Transformation in Ukraine During Wartime: Challenges and Prospects. https://link.springer.com/chapter/10.1007/978-3-031-24475-9_33

Qiu, Zh. (2023). The development direction of educational leadership in the context of globalization. *Journal of Education and Educational Research*, 2(1), 69-73. https://doi.org/10.54097/jeer.v2i1.5416

Schmidt, J. T., & Tang, M. (2020). Digitalization in education: challenges, trends and transformative potential. In: M. Harwardt, P.J. Niermann, A. Schmutte, & A. Steuernagel (Eds.), *Führen und Managen in der digitalen Transformation* (pp. 287-312). Springer Gabler. https://doi.org/10.1007/978-3-658-28670-5_16

Semenets-Orlova, I., Rodchenko, L., Chernenko, I., Druz, O., Rudenko, M., & Poliuliakh, R. (2022). Requests for public information in the state administration in situations of military operations. *Anuario De La Facultad De Derecho.Universidad De Extremadura, 38*, 249-270. https://doi.org/10.17398/2695-7728.38.249

Simakhova, A. O., Artyukhov, A. E., & Shmarlouskaya, H. A. (2022). Problematic issues of digitalization of education in Eastern Europe. *CTE Workshop Proceedings, 9*, 1–15. https://doi.org/10.55056/cte.64

State Statistics Service of Ukraine. (2020). Economic statistics / Science, technology and innovation. https://www.ukrstat.gov.ua/

State Treasury Service of Ukraine. (2022). Data on implementation of local budget in 2003-2022. https://www.treasury.gov.ua/file-storage/2022-3

Steger, M. B., Benedikter, R., Pechlaner, H., & Kofler, I. (2023). *Globalization: Past, present, future.* University of California Press. https://doi.org/10.1525/luminos.172

Sytnyk, H. P., Zubchyk, O. A., & Orel, M. H. (2022). Conceptual understanding of the peculiarities of managing innovation-driven development of the state in the current conditions. *Science and Innovation, 18*(2), 3-15. https://doi.org/10.15407/scine18.02.003

Tight, M. (2021). Globalization and internationalization as frameworks for higher education research. *Research Papers in Education*, 36(1), 52-74. https://doi.org/10.1080/02671522.2019.1633560

UN E-government Knowledge Database. (2022). EGDI-index of Ukraine. http://publicadministration.un.org/egovkb/en-us/Data/Country-Information/id/180-Ukraine

Yuldashev, O. K., Khomiachenko, S. I., & Yuldashev, S. O. (2022). Organizational and legal model of competency-based education as a means of the transition to innovative economy. *Danube, 13*(2), 107-118. https://doi.org/10.2478/danb-2022-0007

Appendix 1

Sample survey form

1. Rate the digitalization scale according to your institution size over the last three years on a scale from 0 to 3.
0 – zero
1 – limited
2 – medium
3 – significant
2. How do you assess the financing of digital technologies and software purchases for your institution over the last three years?
0 – financing is absent
1 – up to 500 thousand UAH
2 – from 500 thousand UAH up to 1 million UAH
3 – over 1 million UAH
3. Rate your employees' digital competences level on a scale from 0 to 3.
0 – zero
1 – slight
2 – medium
3 – significant
4. If Ukrainization is understood as active popularization of the national culture and language outside the institution and the transition of office communication to the Ukrainian language, rate the dynamics of Ukrainization of your organization over the past 3 years.
0 – remained at the same level
1 – increased slightly
2 – increased tangibly
3 – increased significantly
5. Rate the socio-economic gains of digitalization for your institution over the last three years on a scale from 0 to 3.
0 – zero
1 – slight
2 – medium
3 – significant
6. Rate the degree of participation of your institution in global scientific and educational projects over the past three years.
0 – absent
1 – passive
2 – medium
3 – active
7. Which digital technologies and software tools have your institution implemented in its activities over the last 3 years?

- Distance learning platforms (Zoom, BigBlueButton).
- Moodle technologies
- Google for Education services
- Cloud technologies

8. Which national digital transformation projects has your institution participated in over the last 3 years?

- Self-reflection on Effective Learning by Fostering the Use of Innovative Educational Technologies (SELFIE)
- Educational chatbot
- Digital platforms in higher education

9. What are the functions of cultivating new knowledge, inclinations, and competencies that your institution performs in the context of globalization?
- Acquiring digital skills
- Providing substantial scientific knowledge
- Focusing on providing flexible applied knowledge
- Cultivating patriotism
- Forming cosmopolitan worldview

10. What management decisions have been implemented in the management system of your institution over the last three years in the context of globalization?
- Expanding access to world digital libraries
- Participation of specialists in international scientific and practical conferences
- Participation in global scientific and educational projects
- Updating curricula in accordance with the latest science achievements
- Systematic accreditation of specialists at the international level
- Harmonization of educational and methodological, scientific and intellectual support of education and science with the international standards

11. Which global scientific and educational projects has your institution participated in over the last 3 years?
- Horizon 2020
- EUREKA
- Science for Peace and Security (SPS) Program
- Erasmus

12. Provide specific socio-economic digitalization gains for your institution for the last three years.

- Expenditure minimization
- Labor productivity growth
- quality growth of educational services and scientific products
- Formation of an inclusive educational environment
- Management decisions flexibility