MECHANISMS OF THE OVERCOMING THE DIGITAL INEQUALITY OF THE POPULATION IN UKRAINE: INTEROPERABLE GOVERNANCE, EDUCATIONAL TECHNOLOGIES OF ARTIFICIAL INTELLIGENCE AND GEOINFORMATIONAL STARTUPS

Mechanizmy pokonywania nierówności cyfrowej wśród ludności na Ukrainie: zarządzanie interoperacyjne, technologie sztucznej inteligencji i startupy geoinformacyjne

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Abstract: The article deals with the theoretical substantiation of the mechanisms of overcoming the digital inequality of the population in Ukraine, among which the main ones have been defined as follows: creation of interoperable governance systems, introduction of educational algorithms of artificial intelligence and application of geo-information technologies (startups). Digital inequalities are classified as technical, inclusive, educational and economic. It has been proven that digital education of the future must be based on individual contextual learning, which is based on technological capacity, inclusion and interaction of teachers and students within personalized curricula. It has been substantiated that there is the necessity to create in (or at) public authorities centers of interoperable governance – organizational and technological complexes of intellectually organized workplaces of public officials, experts-analysts and specialists-communicators who carry out modeling, analysis, forecasting, graphic visualization of the situation by means of digital software, technical and communicational tools to support decision-making based on neural network technologies and artificial intelligence algorithms. A model of interaction (movement) of informational and communicational flows and influences of a typical center of interoperable governance has been developed. The use of the visual representation of spatial data and digital services of geo-information systems is recommended on the example of the EasyWay startup, a digital logistics system of public transport routes to ensure the effectiveness of the centers of interoperable governance.

Key words: digital governance, digital inequality, centers of interoperable governance, artificial intelligence, transportation geo-information startups.

1. Introduction

The development of intellectual management encourages research in the sphere of application of interoperable systems and algorithms of artificial intelligence in the activities of central, regional and local authorities to simplify and improve the life of residents of the country, region and city. Instead, the digital inequality of Ukraine's population is pushing startup developers and new technological solutions to come up with new mechanisms and digital algorithms. Artificial Intelligence (AI) is partly or fully capable of replacing a manager, a civil servant, an analyst, or a teacher and provokes many heated discussions about the future of these professions, which are creative, non-standard, and at this stage crucial for further social development. The competencies of such specialists are essential for the development and further use of intelligent control systems, in particular those involved in the digital infrastructure of a modern city. However, efficient use of public transport requires convenient and interoperable startups and geo-information systems that can inform residents about the routes and arrival times of rolling stock for stops online, and control the transportation of passengers by the relevant departments of municipalities. The purpose of the article is to define scientific substantiation of the mechanisms of overcoming the digital inequality among the population in Ukraine

2. Literature overview

The list of authors of research on the implementation of AI algorithms in various spheres of society includes B. Jack Copeland (Copeland, 1993), Katrina Wakefield (Wakefield, 2019), Brian Tomasik (Tomasik, 2018), Bernard Marr (Marr, 2018), Bernard Marr (Marr, 2018) or Tanya Filer (Filer, 2019). However, regarding the use of AI in educational processes, it is worth highlighting the research of Jenny Anderson (Anderson, 2019), Mark Haw (Haw, 2019), or Rich Motoko (Motoko, 2016). The topic of digital governance is actively discussed by many scholars around the world, among whom Monika Tenenbaum-Kulig (Tenenbaum-Kulig, 2019), Klaus Schwab (Schwab, 2016), Scott Brennen, Daniel Kreiss (Brennen, 2014), Patrick Dunleavy, Helen Margetts, Simon Bastow (Dunleavy, 2010) are worth noting.

The issue of interoperability of service activities of public authorities has already been considered by us in previous studies (Karpenko, 2020). Yet, the lack of science-based mechanisms to overcome digital inequality in Ukraine remains an unresolved part of the overall scientific problem.

3. Methodology

The study uses scientific methods of comparison, systematic analysis and synthesis of theoretical data, as well as abstraction, formalization and generalization of the results. A comprehensive interdisciplinary approach has been used to justify the ways to overcome digital inequality in Ukraine. The comparative method was applied in the process of elaboration of the world source base on the problems of application of artificial intelligence algorithms in the field of education. The method of morphological description and modeling was used in the design of systems of interaction (movement) of information and communication flows and impacts of typical Centers of Interoperable Governance.

4. Description

One of the contemporary challenges in public administration is digitalisation of this field, which should ensure interoperability and effective communication between digital components, such as devices, networks and data warehouses. This process is also intended to ensure interoperability and to establish effective links in the system of power-business-civil society interaction.

Information and communication technologies contribute not only to the development of society, but also create new social disparities, which are embodied by the differentiation of digital inequality of people. In our opinion, the main factors for digital inequality are:

– *technical factor* – determines the access to the Internet and digital technologies (including the field of public administration);
– *inclusive (personal) factor* – determines the ability (physical, social, religious, etc.) of people to use digital means;
– *educational factor* – determines the level of digital competence (literacy), that is, the competence of people to use information and communication technologies;
– *economic factor* – determines the level of the digital economy, i.e. the country's ability to develop and spread modern digital technologies among numerous layers of society.

The digital transformation of traditional forms of interaction between public authorities and citizens has to help to solve the problem of social inequality, and the governance must prevent digital stratification of society (digital inequality). Overcoming the digital divide involves not only enhancing digital competencies, but also addressing public access to information and directly to digital technology. The increase in the number of digital users in Ukraine is influenced

not only by the level of technical infrastructure development, but also by the state and development of the educational system, since the citizens who possess the necessary digital competencies provide the basis for shaping the digital society and improve the indicators of digital economy. Ukraine has not solved the problem of modernization of the system of vocational, higher education, retraining institutions, taking into account the training of specialists for the needs of digital governance, digital economy and "Industry 4.0" (Karpenko, 2020).

At present, the secondary education and higher education systems in universities around the world are undergoing transformations: enlargement (merging of educational institutions), discontinuation of some areas of study (closing specialties and eliminating educational programs), insufficient number of highly qualified teachers and financial difficulties (Haw, 2019). All these factors not only affect the quality of education received, but also encourage the management of educational institutions to find alternative methods of training, retraining and specialization of young people. One of such options is to replace the lecturers with artificial intelligence. Ten years ago, it would have seemed like science fiction, because teaching is a very creative specialty that is considered too complicated for computer algorithms.

However, assuming the mere replacement of the standard approach to learning, we can see many new opportunities for learning, including through AI. A huge database (knowledge) has been already obtained from online digital learning courses (Motoko, 2016). Therefore, it is obvious that artificial intelligence training will not take place in "24/7" online classes, but in virtual classrooms.

AI algorithms create customized learning plans that optimize the outcomes of each user of educational services, study and analyze patterns of student behavior (for example what content is viewed more often and longer, what mistakes are made, and even at what time of day people learn more productively. Data will be the basis for determining performance, which can be measured by exam scores, student satisfaction levels, or job opportunities (Haw, 2019).

The development of AI has not yet reached this level, but now its algorithms are becoming a reliable aid for teachers. British education expert A. Seldon (Seldon, 2018) predicts that in developed countries jobs will replace teachers as early as 2027, though smart machines will never be able to become a complete replacement for humans.

Belgium has become one of the first countries in the world to launch large-scale implementation of AI assistants in 2019 at the national level, which will help modernize secondary and higher education in the country over the next 5 years. This was made possible by an agreement between the Belgian Government and the owner of British startup Century Tech, which uses regional learning at 700 municipal schools in Flanders to use learning science, neuroscience, and data to personalize learning for kids. Century Tech is a digital artificial intelligence platform that, based on the character and interests of the student, forms his or her individual learning plan. The goal is to move from a one-size-fits-all model of education where teachers try, but often struggle to teach varying levels in the classroom to one in which an AI platform helps tailor lessons to each individual student. Through the program, students take tests to determine their temperament, nature, range of interests, the most convenient format of work and the "gaps" in the acquired knowledge. After testing, the program identifies the student's strengths and weaknesses and recommends (optimally defines) individual learning plans (Anderson, 2019).

However, there is another example that demonstrates the impossibility of removing a person from the learning process. For example, in Ohio (USA), in 2000, a private online school called The Electronic Classroom of Tomorrow (ECOT) was set up, where students independently completed online assignments without teachers. In 2016, this experiment was considered unsuccessful, as most students simply lost interest in online education, while others who spent less than an hour preparing for the exam received poor grades in the final exam. Based on these data, experts have identified that a very important point in learning is the presence of a human factor (that is, a teacher) that will encourage and motivate students to learn (Motoko, 2016). However, the current education system is imperfect too, because there are 25 to 35 students per teacher in a class. It also has a negative impact on the educational process, because in 45 minutes it is difficult to give personal attention to each student, to explain new material and to work out mistakes and incomprehensible moments from the past topic. This approach encourages students to seek help from tutors, which again brings us back to the need to find a learning option where we can find a balance between standard classroom teaching and AI-based learning.

Digital education of the future is, first and foremost, individual contextual learning based on technological capacity, inclusion and interaction between teacher and student, lecturer and student within a personalized curriculum.

Another important way of overcoming digital inequality is to build interoperable governance systems while ensuring the inter-barrier compatibility of its components. Such digital governance systems

should function to ensure the principle of accessibility of public services for each citizen and consist of mechanisms for the interaction of service providers with the technical, inclusive and educational factors of digital inequality to bridge the existing digital divide. The following can be used to build effective interoperable governance systems:

– *a system approach*, created on separate systems, as a single whole, connected with the external environment, which works with all possible tasks;

– *a situational approach*, according wheather it is necessary to take into account specific external and internal factors that comprise the system at the moment and are valid at a given moment;

– *a combined system-situational approach*, when using the political, economic, social, and resource structures that are integrated with each other, embrace the internal, interconnected elements of the system, and they are united with this environment to respond to specific situations.

It should be borne in mind that the combined approach involves making interoperable governance decisions in the digital governance system for each unique situation, based on a systematic consideration of the situation taking into account many details and making optimal decisions based on their analysis. For example, a well-known brand of combined system-situational approach to management decision-making is the Case Study method, which was started by Harvard Business School (HBS), which is based on the study of simulated situations and making good management decisions based on their comprehensive and detailed analysis. In essence, it is about mastering governance competencies in the context of uncertainty through the involvement of analysts' intelligence, knowledge, experience and intuition. Each situation is a combination of some elements (conditions, circumstances, states, etc.) that determine the dynamics (changes) of both the elements that make up the situation and the objects that are "immersed" in the situation. Situation assessment is always a subjective analysis and generalization (synthesis) of data, which depends on its means and methods, events and processes (occurring or occured), the set of characteristics of "immersed" objects and the relationship between them, which are in permanent cause and effect relationships.

Therefore, when building interoperable governance systems, the informational and communicational components of the relationship between the situation, its analysis, means of information and response play an important role. Communication from the communicator (the media) to the recipient (individual recipient or social group of recipients) is disseminated through communication channels.

The process of transmitting information to a group of people at the same time through special technical means involves both mass (broadcasting of the message) and personal communication (providing information on request) and receiving feedback from the recipient. The aforementioned necessitates the creation of *Centers of Interoperable Governance* (CIG), organizational and technological complexes of intellectually organized workplaces of public officials, expert-analysts and communication specialists, who carry out modeling, analysis, prediction, graphical visualization of the situation with the help of digital software-technical and communicative means of providing support for decision making based on neuro network technologies and artificial intelligence algorithms. With the help of CIG, communication will be established between different authorities, citizens, NGOs and business structures.

At the same time, CIG, as a separate functional tool, allows:

– creating a system of internal communications of the authorities;

– expanding monitoring activities and governance decision making with the help of external channels;

– organizing communicative logistics of governance actions;

– ensuring equal access to information and learning about overcoming digital inequalities;

– increasing the trust in public authority.

The main task of CIG is to build an exact situational reflection of the state that arises in the sphere of activity of the public authorities, on the basis of which a local responsible performer (structural unit, structural subdivision, organization, etc.) makes an interoperable administrative decision on the basis of a communicative "picture". This display gives you complete information about the current state of controlled objects, both for internal communications and external requests, taking into account the issue of digital inequality. In addition, CIG is also tasked with administered information and communication flows and governance influences.

The structure of CIG consists of:

– variety of conditions – the objects of control that are subjected to the governance influence of a public authority;

– conditions regulator – the structure responsible for the contractor in the area of whose responsibility the situational state of the controlled object lies;

– complex situational-communicative system – a unit or structure of public authority that performs systematization (gathering, fixing and analysis of information on the state of the controlled

object both in the current and in a crisis situation), coordination (governance influence directed at regulators state of crisis) and communication with recipients (recipients of information), taking into account the principle of access to all informational conditions in any way and providing feedback, external monitoring and controlled object conditions (Figure 1).

tralized storage and control of spatial information, which eliminates excess of information and prevents data conflicts. Thus, the use of GIS in CIG reduces the intellectual load on the user (through the use of AI algorithms), and consequently, increase the efficiency of the system.

One example of the integration of CIG and urban geo-information systems is the introduction in 2011
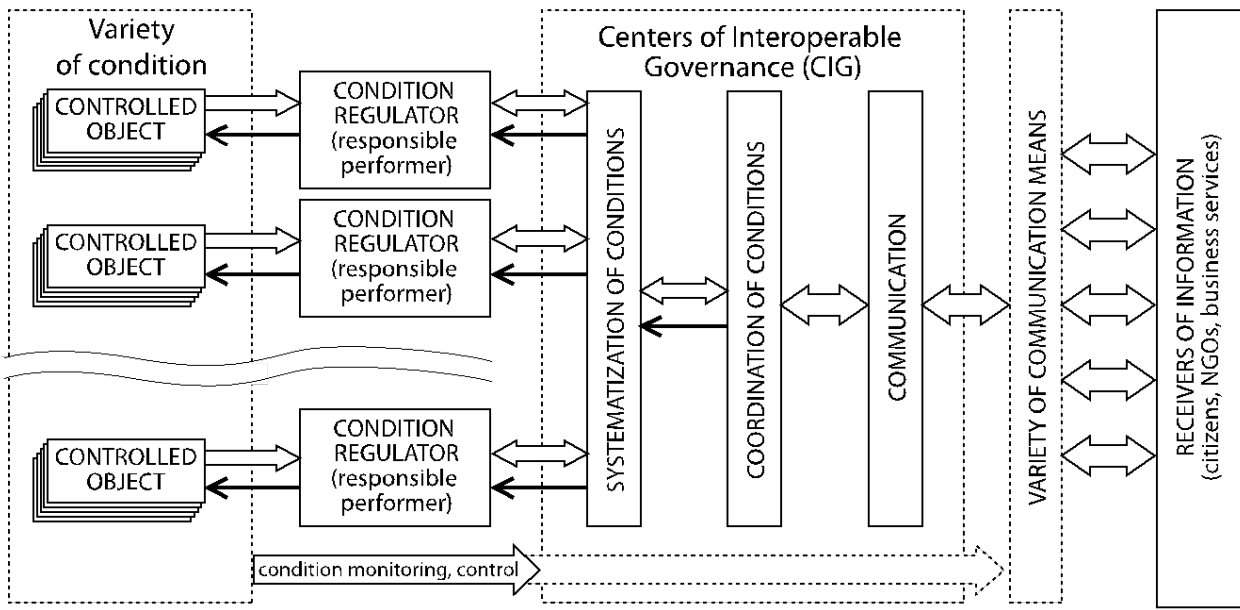

Fig. 1. Model of interaction (movement) of information and communication flows (=>)and impacts ( ) of a typical Center of Interoperable Governance.

Source: Own elaboration.

The CIG can be both a subsystem module in digital governance systems and can function separately for monitoring, analysis, systematization, coordination and communication within the governance of a public authority.

To ensure the efficiency of CIG functioning, visual representation of spatial data and digital Services of Geoinformation Systems (GIS) by means of interactive mapping should be used, which allows scaling the location of a set of situational processes. Displaying a set of interrelated objects on an interactive map in real time, providing each of the objects with information in different metrics in the form of diagrams, tables, graphs instantly gives an opportunity to evaluate the performance of these controlled objects. Moreover, based on the information stored in GIS repositories, it is possible to identify quickly trends in these indicators over time and to predict the dynamics of development of these objects. In this approach, GIS does not store object-oriented information itself, but is merely a processor for cen-

of the Ukrainian startup EasyWay, an interactive public transit route search engine using Google, Yandex and Here's mapping services. This digital service is a social project that provides residents with logistical information on all city public transport routes and stops, creating the shortest traffic path, taking into account financial and time costs. This geo-informational startup has been implemented in more than 60 cities of Ukraine and is already in use in Poland, Croatia, Moldova, Bulgaria, Serbia and Belarus (Figure 2).

EasyWay has a web interface, API access, as well as a widget integrated with the official sites and portals of the city, the mobile version of which works with Android and iOS. In cities where an open GPS transport monitoring system is implemented – real-time users of the service can see information about a list of all modes of transport, a map of the routes on which they travel, and display interactive bus, trolleybus or tram in real time and orientated waiting time.

Belarus
Minsk

Poland
Krakow

Moldova
Balti
Bender
Kishinev
Tiraspol

Croatia
Zagreb

Serbia
Belgrade

Bulgaria
Burgas
Pleven
Plovdiv
Sofia
Varna

Ukraine

Alushta	Izyum	Nikopol
Alchevsk	Kamyanske	Odesa
Berdychiv	Kamianets-Podilskyi	Oleksandriya
Berdyansk	Kerch	Poltava
Bila Tserkva	Kyiv	Rivne
Bilhorod-Dnistrovskyi	Kharkiv	Sevastopol
Boryspil	Kherson	Severodonetsk
Brovary	Khmelnytskyi	Simferopol
Chervonograd	Konotop	Slovyansk
Cherkasy	Korosten	Sudak
Chernivtsi	Kramatorsk	Sumy
Chernihiv	Kremenchuk	Ternopil
Chornomorsk	Kryvyi Rih	Trostyanets
Dnipro	Kropyvnytskyi	Truskavets
Donetsk	Lugansk	Uzhhorod
Drogobych	Lutsk	Uman
Druzhkivka	Lviv	Vinnytsia
Dzhankoy	Makiivka	Yevpatoriya
Feodosia	Mariupol	Zhytomyr
Gorodok	Melitopol	Zaporizhzhia
Horlivka	Mykolaiv	
Ivano-Frankivsk	Nizhyn	

Fig. 2. Geography of introduction of the digital service "EasyWay" in the countries of Eastern Europe.

Source: Own elaboration based on data from www.eway.in.ua (2020).

5. Conclusions

As a result of the research, the authors proposed mechanisms for overcoming digital inequality of the population in Ukraine, made their theoretical substantiation, and provided recommendations for their practical implementation. Among them:

– implementation of artificial intelligence digital education algorithms, which should be based on individual contextual learning, which will be based on technological capacity, inclusion for each and the interaction of teachers and students within personalized training programs.

– creation of Centers of Interoperable Governance (CIS) in (at) public authorities of organizational and technological complexes of intellectually organized workplaces of public officials, experts-analysts and specialists-communicators, who carry out modeling, analysis, forecasting, graphic visualization of the situation by means of digital software-technical and communicative means of providing support for decision making based on neural network technologies and artificial intelligence algorithms.

– application of geo-information technologies (start-ups) to carry out interaction (movement) of information and communication flows and influences of Centers of Interoperable Governance, for the effective functioning of which it is recommended to use visual representation of spatial data and digital services on the example of startup "EasyWay" – digital logistics system of public transit routes.

In the context of providing the foundations for the digitalization of Ukrainian society, special attention is paid to the development of the communicative component. This will ensure that all citizens of Ukraine enjoy the benefits of the digital world without any technical, organizational or financial constraints and will reduce their time in the so-called "digital divide". The development of digital infrastructure requires improvement in accordance with international requirements and standards of investment infrastructure of the regions, which will provide an opportunity to stimulate attractive foreign investment.

Digitalization is becoming a key factor affecting all social processes, both everyday and global. The experience of developed countries proves that Ukraine could follow, step by step, moving towards the creation of ubiquitous digital governance, which becomes the next stage of technological transformation of public administration after informatization, e-government and digitization through the integration of the physical, digital and biological worlds. Based on the above, we can predict that the introduction of intelligent control based on digital cyber-physical systems that combine material, biological and virtual objects will be the main driver of the Fifth Industrial Revolution ("Industry 5.0").

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