

Digitalization and its properties based on the example of its progress in Ukraine

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Abstract. This article examines digitalization and its progress in Ukraine - the specifics of development, the main characteristics and problems of digitalization in Ukraine. Definitions of such terms as digitalization, its advantages and weaknesses in the conditions of Ukraine are given. The prospects for the development of the state in this consistent direction are also considered. The results of the analysis prove the need for the development of the state and its economic sector in the direction of digitalization.

All subsequent studies in this direction should focus on the analysis of certain digitalization stages of its formation in Ukraine, each stage of its development is characterized, and the main characteristics of each of these stages are indicated, typical problems in the implementation of digitalization at the national level are indicated.

An important role in the study of digitalization is played by studies that are not directly related to these concepts, but play an important role. For example, cybersecurity studies analyzed by Dulyaba N. I., Obramych O. S., who learned the theoretical foundations of digital security.

The paper examines typical problems in the implementation of digitalization at the state level and studies the possible results of such implementation. It also emphasizes the need for further research in this area, the relevance and necessity of their implementation.

Within the framework of digitalization in Ukraine, the following software products are considered by: "Diya", "Helsi", "Trembita".

Keywords: digitalization, digital state, cybersecurity, "Diya".

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Introduction

Digitalization is one of the main ways of development of any modern society. It creates a progressive society that is able to effectively build better conditions for people. Digitalization facilitates accessibility to the areas of healthcare, education, etc. The Covid-19 pandemic and wars have proven the importance and necessity of digital technologies to ensure the movement of the population, meet their basic requirements and develop economies as a whole.

However, digital transformation is important not only in difficult times for society, but also in relatively calm and peaceful times, because it allows people, the economy and the state to carry out their daily activities remotely.

Digitalization is not limited solely to the use of new technologies, but also to changes in the mentality of society, its vision of its everyday life.

Many scientists have studied these tasks. Digitalization was studied by Dulyaba N. I., Obramych O. S. (Dulyaba and Obramych, 2023), Bashlai S. and Yaremko I., and many others. In addition, the legal side of this issue plays an important role, which was studied, for example, by Jean Lassegh and Antoine Garapon in the book "Digital Justice" (Lassegh and Garapon, 2021).

It follows that this topic has been considered by many scientists and researchers. Moreover, not only its economic direction was studied, but also aspects of protecting these digital data and mechanisms; both from the point of view of protecting information directly, i.e. cybersecurity, and protection from the side of compliance with legal norms and laws.

The purpose of writing this article is to analyze the state of digitalization in Ukraine, show its stages and describe the main problems that may arise in the process of its formation and development.

Results

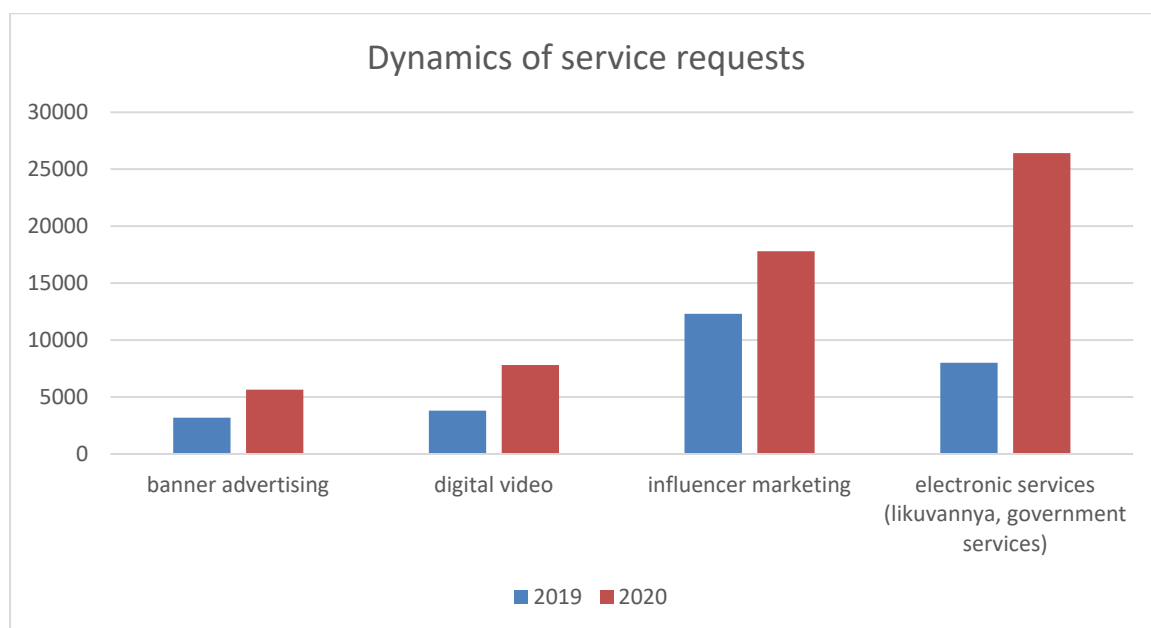
Digitalization is one of the most important directions of human development in the 21st century. It forms a progressive society and more effective governance mechanisms. It also facilitates access to the areas of healthcare, education and banking, improves the quality and increases the scope of coverage of public services, expands the types of cooperation of people, provides better access to the choice of necessary goods and services with the opportunity to choose the best offers from all available.

Table 1. Dynamics digitalization in world and in Ukraine estimated on base indicators

Factors	2021 year										
	USA	Singapore	Denmark	Sweden	Hong Kong SAR	Switzerland	Netherlands	Republic Korea	Norway	Finland	Ukraine
General	1	2	3	4	5	6	7	8	9	10	58
Knowledge	1	2	6	4	7	3	14	10	16	15	38
Technological environment	7	1	9	6	2	11	8	12	3	10	59
Openness future	2	12	1	7	10	5	4	3	6	9	61

Source: developed by the author based on source data (Klymenko, 2020).

The Covid-19 pandemic and war have shown the need to introduce digitalization to meet the majority of the needs of the population, and develop the economy in situations where old methods (direct access) become ineffective or impossible.



Source: developed by the author based on source data (Obsjag runky internet-reklamu Ukraine, 2021).

Digital technologies are now being implemented as part of business processes, and their widespread implementation is visible in all areas of life, since:

- significant reduction in the cost of its implementation compared to previous periods, which
- is associated with the development of technologies - equipment, software, cloud data storage technologies;
- the use of digitalization reduces costs and increases productivity and efficiency of decision-making;
- can be used to create unique products that are fully adapted to customer requirements.

In the service sector, digitalization allows people to carry out activities from any corner of our planet: conduct video conferences, purchase products, receive services. Digitalization can help solve social problems by facilitating access to basic services in the fields of healthcare (electronic healthcare system) and education (distance learning), the provision of financial and legal services.

Digitalization is not limited solely to the use of technology. It is characterized by a change in culture integrated into all areas of work, and a transformation in the management of various tasks. Cost minimization (document digitization, which leads to overall process optimization), decentralization, increased efficiency and productivity, fast, more effective decision-making in a short time, increased environmental friendliness, production of quality products, reduction of time and costs for the production of goods, improved product quality and rapid response to market changes.

An important role in the learning of digitalization was played by studies that are not directly related to these works. For example, the theoretical foundations of digital security were considered in cybersecurity studies conducted by Dulyaba N. I., Obramych O. S. (Dulyaba and Obramych, 2023). Also, a very important role is played by the legal part of the studies, which were studied, for example, by Jean Lasseg and Antoine Garapon in the book "Digital Justice" (Lasseg and Garapon, 2021).

1. Stages of digitalization development in Ukraine.

The following stages of digitalization development in Ukraine can be distinguished (Lyashenko, Vyshnevsky, 2018):

- The first stage (1990-2000). Characteristic for this stage is the formation of a structure for the purpose of widespread access to the global Internet and its use not only for communication or doing business, but also for a different range of needs - for example: science, education and in state structures. In 1998, the Law of Ukraine "On the National Program of Informatization" was adopted. This document determined the directions for solving issues related to ensuring information needs in state, economic, environmental, technical, scientific and cultural activities.

- The second stage (2000-2010) is a period of transition from passive user use of the Internet to the creation of mechanisms for protecting information (both your own (user information) and that to which the user is given access), as well as the general systematization and organization of sources of information to which access is given. This stage is characterized by significant development in promoting the acquisition of skills for working with the Internet, and active development and updating of existing software and hardware. However, despite everything, this stage also had insufficient support from the state, both at the technical and information level and in terms of the legal basis of this issue.

Because of this, in 2007, the Law "On the Basic Principles of the Development of the Information Society in Ukraine for 2007-2015" was adopted. This law formulated the following strategic goals of digitalization:

1. Improving public administration and local self-government through the development and widespread implementation of information and computer technologies.

2. Ensuring the growth of information literacy of citizens and the protection of their information rights.

3. Integration of domestic and global information infrastructure and expanding the list of "electronic" services in the fields of education and science, health and environmental protection, culture and social protection.

- The third stage (2010-2020) - the introduction of electronic accounting of government affairs and the provision of standard public services in the form of electronic services. However, at the beginning of this stage, the development of the information society in Ukraine did not meet the needs and capabilities of the country, and the development of the information sphere was slowed down. Within the framework of this stage, such an important order was adopted as the order "On Approval of the Strategy for the Development of the Information Society in Ukraine". This document was aimed at improving the regulatory framework for the development of the information sphere, the introduction of electronic documentation and electronic accounting of government affairs, the development of measures to improve the information literacy of citizens, and their awareness of the basic rules of information security.

In 2014, the State Agency for Electronic Governance was founded. This state executive body was created to fully develop the digitalization of the public sector in Ukraine. The priority tasks and projects of "digitalization" in Ukraine by 2020 are listed in the document "Digital Agenda of Ukraine-2020" (Digital Agenda of Ukraine, 2020), which was developed in 2016. The authors identified the following strategic goals, approaches to implementation and tools to stimulate the development of digitalization in the following areas:

- economy;
- public administration;
- education, national cybersecurity;
- socio-economic activity (public services).

In 2016, Ukraine launched a healthcare reform with direct use of digitalization called eHealth. eHealth allows you to receive electronic prescriptions for medicines, form and close a sick leave without visiting a doctor.

Another example of the introduction of digital technologies in Ukraine is the launch in 2017 of an auction systems that uses blockchain cryptographic technology. Using blockchain means working without intermediaries, making information about trades available to any person, reducing transaction costs, and preventing corruption. The operation of an online auction using cryptographic technology has allowed for about 14 thousand trades worth over 3 billion hryvnias in just one year (SETAM, 2025).

In September 2019, the Cabinet of Ministers of Ukraine created the Ministry of Digital Transformation based on the reorganization of the State Agency for Electronic Governance. The functional responsibilities of this entity were: the formation and implementation of state policy in the field of development of the digital society and economy, electronic governance, electronic services, digital innovations and IT industry.

- The fourth stage (2020-present) - this stage is characterized by the active use of AI (artificial intelligence), cloud technologies (Cloud Technology), drones, cobots (Collaborative robot - these are robots, the characteristic feature of which is a high level of interaction with a person), the widespread implementation of "smart" systems, such as - "smart city", "smart home", "smart enterprise" and others. During this period, digitalization in the educational sector has become widespread.

Digitalization of education is manifested in the use of various electronic and software tools to improve the quality of the educational process and ensure access to the relevant necessary educational materials for students and teachers. Digitalization of the educational process is manifested in the organization of online courses, webinars, conferences organized using appropriate software and conducting assessment tests of knowledge not in written form, but through testing organized using software. One of the largest and most authoritative educational platforms in Ukraine is Prometheus.

At this stage, Ukrainians began to use electronic services of state institutions more actively. A significant impetus to this was provided by the global Coronavirus pandemic and the war in Ukraine. Among the most popular services are the following:

- obtaining certificates of business activity;
- documents related to construction;
- pension fund services;
- employment centers;
- receiving housing subsidies.

In 2022, an agreement was signed between the mobile operator Kyivstar and the largest provider in the field of electronic medicine in Ukraine – Helsi (UNIAN, 2022).

The intensity of digitalization development in Ukraine is indicated by such factors as - Ukraine's export of digital services in the first half of 2022 amounted to 3.74 billion US dollars, which is 23% more than in the corresponding period of 2021. In order to develop the IT sector, Ukrainian technological initiatives and startups attracted 350 million US dollars in the first half of 2022. Ukrainians actively use online services. Thus, in 2020, only 53% of the population used them, in 2021 already 60%, and in 2022 – 63%. The share of users of electronic government services through the "Diya" application has increased fourfold: in 2020 – 13%, in 2021 – 30%, 2022 – 52%. The results of the study show that the age gap in receiving e-services is decreasing. It should be noted that not only the share of the young "digital" population is growing, but also middle-aged people and pensioners. In Ukraine is a significant share of Internet users: in 2022 – 78% of the population, in 2023 – 82% (Ministry of Digital Information of Ukraine, 2025).

As noted above, digitalization includes not only the business side, but also the arrangement of state structures.

In Ukraine, on February 6, 2020, the digital application "Diya" was created.

2. “Diya” as a main example of digitalization in Ukraine

Diya (abbreviation of the words Derzhava i Ya) is a state mobile application, a brand of digitalization in Ukraine, developed by the Ministry of Digital Transformation of Ukraine (Mintsyfr) by order of President Volodymyr Zelensky (Ministry of Digital Information of Ukraine, 2025). Already in 2024, the number of users was over 21 million Ukrainians (Sudova-Yurydichna Gazeta in Ukraine).

This program allows you to store a digital version of your driver’s license, passport, international passport, as well as transfer their copies when receiving banking or postal services, checking into a hotel, and other situations. Also, through Diya, you can receive such state services as eMalyatko (at the birth of a child), register a business or individual entrepreneur online, pay taxes, or file declarations. This application also provides the ability to sign documents, change the place of registration, receive National Cashback, and much more. As of 2022, 72 services were available on the portal, and 9 services and 15 digital documents were available in the application. As of 2025, the number of services is already 94 divided into 20 areas.

The idea of creating this application was formed in 2019 by the President of Ukraine as part of the “State in a Smartphone” initiative.

Ukraine in 2024 took fifth place in the world in terms of the level of development of digital government services, according to the E-Government Development Index study. This is an international rating that assesses the level of electronic ordering and the involvement of citizens in interacting with the state through digital applications and services.

Table 2: Ranking of countries by level of public services

Place	Country
1	South Korea
2	Denmark
3	Estonia
4	Saudi Arabia
5	Ukraine
6	Singapore

Source: developed by the author based on source data (Ukraine ranks 5th in the world in the development of digital government services, 2024).

The main risk to digitalization is the problem of cybersecurity.

Types of cybersecurity threats (Dulyaba, Obramych, 2023):

- malware (specially designed software designed for unauthorized penetration into systems
- and causing damage. It is highly adaptable and uses complex masking techniques);
- ransomware;
- phishing (emails or text messages that can trigger a system infection with a virus);
- user negligence;
- spyware;
- cryptolockers.

Modern malware has advanced functionality and includes:

- keylogging (control of keystrokes);
- screenshot capture;
- clipboard monitoring;
- network traffic interception;

- access to cameras and microphones.

Data hacking methods:

- brute-force. Attackers systematically try combinations of logins and passwords until they
- find the correct one. Modern brute-force attacks use GPU acceleration to increase the speed of selection and reduce the number of attempts;
- MITM. A hacker intercepts traffic between two parties (for example, a user and a server)
- while remaining undetected. This allows them to steal data and even modify the information being transmitted;
- session hijacking. If an attacker gains access to the token or cookies of an active session,
- they can log in as the victim without needing to know the password. Often used in conjunction with phishing or MITM attacks;
- rootkits. Stealth malware that disguises itself in services, giving the hacker complete
- control, and can intercept system calls, hide processes, and remain invisible to antivirus software;
- basic hacker tools;
- kali Linux is a specialized penetration testing distribution that includes hundreds of utilities
- for scanning networks, cracking passwords, and exploiting vulnerabilities;
- metasploit Framework is a powerful tool for automating attacks that allows you to find and
- exploit vulnerabilities in software and network services;
- burp suite is a web security analysis program that is often used to find, for example, SQL
- injections or XSS in web applications.

Dark Web forums are places where hackers exchange exploits, sell stolen data, and offer hacking services.

3. Components of a digital state

A digital state is about data exchange between registers. Each state body, with the consent of a person, must take data from the state register.

In general, there are three main components that connect the state and the citizen and allow them to interact on the digital plane:

- data exchange between registers;
- the ability to identify citizens;
- equal access to digital services.

In Ukraine, there are 350 state registers that were created at different times, with different technologies and under different laws. Most of them were outdated and were in the form of Excel spreadsheets.

During our work, we digitized and updated data registers. Since this is the basis of any online service.

An important component of the digital state is the "Trembita" system, thanks to which the registers exchange data. This is an analogue of the Estonian product X-Road, adapted to the

realities of Ukraine. "Trembita" is a system that creates a connection between registers and their information systems, and implements mechanisms for secure data exchange.

It should be noted that with the digitalization of state authorities, there is often a temptation to hold "digital" elections.

In Ukraine, according to research, this is how they feel about it:

The third of Ukrainians (33%) support the idea of introducing electronic voting in elections, in particular in presidential elections, according to the results of a survey by the Razumkov Center. However, the relative majority of respondents (42-43%) expressed a negative opinion about online voting.

Electronic voting received the greatest support among young people aged 18 to 29, where 52% of those surveyed support such an initiative, while only 27-30% are against it. Among people aged 60 and older, 55-57% do not support this idea, and only 17% support it. When asked about the technical support for voting, 31% of respondents believe that it can be conducted through the "Diya" application, another 15% see the need to create a separate specialized service. At the same time, 37.5% said that voting should not be held electronically, and 16% were undecided.

The survey was conducted by the Razumkov Center from June 15 to 20, 2024 among 2,016 respondents in territories controlled by the government of Ukraine and where there are no hostilities. The theoretical sampling error is up to 2.3%.

Diya does not store personal data, since the application was created in 2019-2020 already during the war.

As part of cybersecurity, the Bug Bounty program was conducted twice, in which ethical hackers tested the application and searched for vulnerabilities for a reward of 1 million hryvnias.

The main advantages of digitalization include (Bashlai, Yaremko, 2023):

- simplification of financial transactions;
- increasing the role of electronic and digital sources of information;
- introduction of electronic document management;
- open and accessible market;
- development of remote work opportunities;
- reduction of the cost of goods and services;
- reduction of the level of bureaucracy;
- increase in the level of production;
- transparency of data sources;
- controllability of data;
- remote provision of services;
- remote trade;
- remote cooperation of the state and its citizens (provision of services by the state and the
- possibility of remote control by the state of its citizens, for example through electronic reporting).

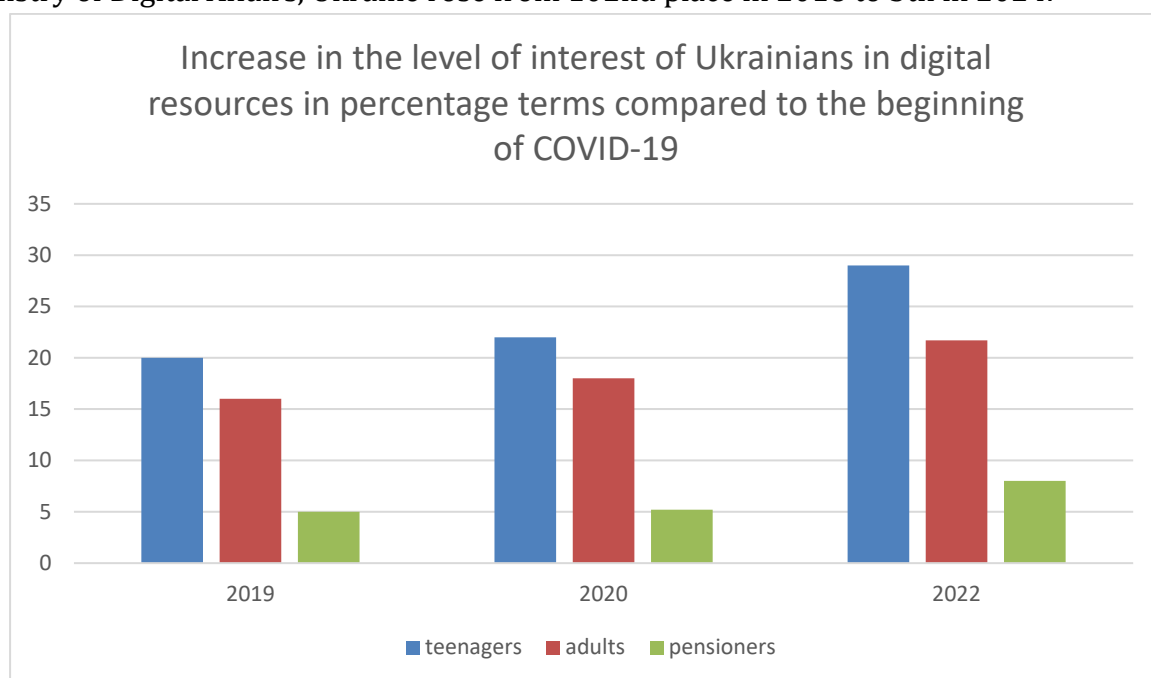
The disadvantages of digitalization include (Saldanha, 2019):

- level of cybersecurity of the Internet;
- verification of the authenticity of information (the problem of fakes);
- sufficiently high development of the IT sector for the development and maintenance of

- software (software);
- state spending on organizing and supporting initiatives for the digital transformation of
- state bodies, society and business;
- possible unemployment due to the closure of vacancies due to the outdated mechanism of
- work processes.

4. Adaptation to the challenges of war

The war changed the vector of the Ministry of Digital Affairs' work. Ukraine's experience in digitizing the public sector in crisis situations is important. Despite all the challenges of a full-scale war, digitalization is gaining new momentum in Ukraine. During the work of the Ministry of Digital Affairs, Ukraine rose from 102nd place in 2018 to 5th in 2024.



Source: developed by the author based on source data (Filipchuk L., Lomonosova N., 2020).

Thus, during full-scale military operations, a large number of new services oriented to modern realities were implemented, including:

- providing assistance under the "eSupport" program for persons who lost part of their salary
- (income) due to the temporary suspension of work or economic activity as a result of hostilities during martial law in Ukraine (now the service has been discontinued);
- restoring lost documents;
- grants to support veterans and their family members, businesses that suffered during the
- war, etc. (with the ability to apply online) ;
- providing assistance to IDPs;
- compensation for damaged or destroyed property, etc.

Currently, most digital services are focused on the needs of citizens who suffered from the war. The Ministry of Digital Affairs has refocused itself and changed its priorities to provide precisely those services that are critically important for people in difficult situations.

Conclusions

Digitalization and its development are an extremely important direction of development of Ukraine both for the country as a whole and for its citizens. Their development must be ensured at all levels: both at the state level and at specific enterprises. Not only the informational, but also the technical and legal bases must be clear. All this is necessary in order to ensure successful and stable growth of economic and other indicators, as well as reducing the risks of failure to implement relevant decisions and initiatives.

It should also not be forgotten that digitalization helps to ensure the stability of development, both in the sphere of the economy and the state as a whole in adverse conditions, such as pandemics, natural disasters or wars. Since they allow to work, carry out production and circulation of goods and services both directly and remotely. So, I believe that the development of digitalization in Ukraine is moving at a successful pace, is very promising and necessary, as indicated by numerous works of scientists, both domestic and foreign, taking into account both "peaceful" times and emergency situations.

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