MYKOLAS ROMERIS UNIVERSITY
Public Security Academy

DIGITAL TECHNOLOGIES IN THE CONTEMPORARY ECONOMY

COLLECTIVE MONOGRAPH

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INTRODUCTION

This collective monograph has been prepared based on the results of scientific research conducted in 2020–2022. These studies were carried out as part of the scientific activities of the Public Security Academy of MRU. Members of the collective monograph participate in the activities of the MRU Laboratory of Harmonious Innovations. The results of these studies show that digital technologies are a priority not only locally, but also internationally.

Digital technologies are taking over the world, and advantage is secured by the ability to quickly master them. There is no doubt that digital transformation will have a significant impact on almost any industry, including agriculture. This monograph was prepared in English, but a large, international team of authors participated in its preparation. The monograph consists of seven chapters, analyzing digitalization management solutions, innovative marketing, digital transformations, and digitalization as a factor of economic security in the face of global challenges. It also touches on and analyzes the issues of digitalization and society, along with the digitalization tools that are used in the public sector.

The purpose of this monograph is to reveal the use of digital technologies in the modern economy.

To achieve this goal, the following tasks were set:

1. Analyze the modernization of management processes in the digital economy (Natalia Mihai, Kateryna Polupanova, Daiva Bičkauskė, Žaneta Simanavičienė, Artūras Simanavičius, Saulius Kromalcas);
2. Identify digital transformations in the financial and banking sectors of the economy (Alfiya Dadakhanovna Akhrorova Fuzail Jumaboevich Boboev , Aleksey Mints, Pavlo Sidelov, Oleksandr Kalinin , Gulnora Yusupova, Mukhbira Komilova);
3. Analyze innovative marketing technologies in the digital economy (Ganna Iefimova, Oleksiy Pashchenko);
4. Describe digital entrepreneurship (Daler Garibmamadov, Nargis Mukimova, Nisso Berdieva, Galyna Shvets, Snieguolė Matulienė, Eglė Štareikė, Olena Khadzhynova, Pavlo Burak, Oleksandras Kalininas, Firuz Kodirov);
5. Reveal the theoretical foundations of the analytical support of digital transformations (Nataliia Havrylenko, Liliya Filipishyna, Kristina Filipishyna, Irina Korostova, Daiva Bičkauskė, Žaneta Simanavičienė, Audronė Žemeckė, Aurelija Puraitė);
6. Uncover digitalization as a factor of economic security and a global challenge (Karyna Borblik, Viktoriya Gonchar);
7. Show the role of society in the digitalization process (Larysa Hryshyna, Tetiana Gorokhova).

The sections of the monograph are formed in accordance with the tasks set. For the disclosure of each task, a scientific analysis of the literature is carried out and specific episodes of analysis are provided. Each issue is accompanied by a bibliography. The authors present the concepts of the phenomena under consideration and analyze them. The main research methods are the analysis of scientific literature sources, synthesis, induction, deduction, abstraction, analogy, and modeling. When conducting empirical studies, the organizational elements of a sociological study were used, questionnaire methods were employed, and the analysis of the results obtained was carried out using qualitative analysis and statistical methods. In the monograph, the authors review many classic works, present a detailed analysis of the problem, and reveal the essence of the digitalization of economic processes.

SECTION 1

MODERNIZATION OF MANAGEMENT PROCESSES IN THE DIGITAL ECONOMY

DIGITAL LOGISTICS: HISTORICAL BACKGROUND AND CURRENT KEY DEVELOPMENT TRENDS

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Abstract. *The current stage of global development is accompanied by the digital transformation of the economy, which is carried out under the influence of a significant number of digital innovations. Their result is the emergence of a new economic structure, new business practices, and new values of the business environment. This article is devoted to the study of the role and features of logistics development in the historical context and the definition of modern key trends and factors of influence in digital logistics. On this basis, a justification of the economic effects of the transformation of digital logistics is provided.*

The methodological bases of this research are general scientific techniques and methods. In particular, a systematic approach and the synthesis, logical and predictive methods of analysis are used.

A systematic review of literature sources and historical references to the stable relationship between previous industrial revolutions and logistics allowed us to identify changes in the role of logistics in business processes and trace the stages of the formation of digital logistics (Logistics 4.0) within Industry 4.0. Industry 4.0 represents today's comprehensive digitalization of industrial production. In general, digital logistics is a complex system consisting of numerous new technologies that are interconnected and can influence each other. Its elements include cyber-physical systems, IP networks, the Internet of Things platform, big data analytics, artificial intelligence, predictive maintenance, advanced robotics, cloud services, immersive technologies, 3D printing, and blockchain. All of these technologies play crucial roles in the functioning of modern logistics and the formation of the supply chain, and each of them has a significant number of advantages. In particular, the advantages of using the Internet of Things in logistics are determined by: the high potential of use; no losses during transportation and storage of goods; prompt prevention of damage or loss of cargo; climate control in storage areas; identification of road situation parameters; reduction of costs; and increase of economic effect. Artificial intelligence is changing the logistics market, making it more transparent, reliable, and efficient. Cost savings and high delivery speeds are two of the main factors contributing to the spread of drone applications in supply chains. The use of immersive technologies in supply chains allows suppliers to provide on-the-job training, navigation, warehouse planning, and digital interaction with customers and partners. The implementation of 3D printing provides: the acceleration of production and the simultaneous reduction of transportation, storage, import, and export costs; customer orientation; and the reduction of negative impact on the environment. The use of digital technologies by logistics companies meets not only their business interests, but also those of society and the national and international environment. Most importantly, it improves the satisfaction of consumer needs.

The review of the main characteristics of key digital logistics technologies allows us to substantiate the types of effects that digital logistics have in the business environment: technological, competitive, commercial, and socioeconomic.

Keywords: *Industry 4.0, digital infrastructure, digital logistics, digital transformation, digital technologies.*

Introduction

The modern world is developing at great speed. The acceleration of the transformation of business processes in all areas of activity is constantly growing. Today, most business entities are in the process of digital transformation (digitalization) or are already implementing it. In fact, while the term *digitalization* currently has an ambiguous meaning, the phenomenon of digital transformation itself is already taking place not only at the level of individual firms (micro-level), but also at the level of national and international economic systems. The logistics sector occupies a leading position in these processes.

The development of logistics in today's globalized and digitalized economy plays a significant integrating role. This is manifested in: reducing costs; expanding transport opportunities; increasing the safety, quality, and efficiency of transport and logistics services; creating conditions for increasing the additional cost of manufactured and transported goods and services; increasing consumer service requirements; and the corresponding spread of digital technologies. Modern digital technologies have changed the sequence of interaction between material and information flows, forming three ways of their interaction. First, the information flow is ahead of the material flow, i.e., the information flow receives information about the achievement of material flows (direct direction) or it contains information about the order (the opposite direction). Secondly, information accompanies the material flow and moves simultaneously with it – that is, information about the quantitative and qualitative parameters of a material flow is received through this flow, which allows one to quickly and correctly assess its state and make the necessary regulatory decisions. Third, the information flow falls behind the material flows – that is, information serves only to evaluate results. In essence, the definition of a supply chain is interpreted as a combination of the main logistics functions of a company and its partners from the beginning of the origin of any information or commodity flow to the delivery of products or services in accordance with the requirements of the final consumers.

Digital logistics should be distinguished and presented as a process of innovative optimization of logistics processes at the micro, macroeconomic and international levels. In this context, the search for new strategic directions for the innovative development of territories and their transport and logistics systems, as well as the development of mechanisms for the formation of "smart" contracts, projects, supplies, etc., are urgent tasks today.

The aim of this study is to consider historical prerequisites and current key trends in the development of digital logistics along with the factors of their development and, on this basis, to determine the economic effectiveness of digital logistics transformation.

The methodological basis of the research is composed of general scientific techniques and methods. In particular, a systematic approach and the synthesis, logical and predictive methods of analysis are used.

The research of the topic was carried out in the following logical sequence: the essence and features of logistics development in historical retrospect were determined; the key trends of digital logistics and factors influencing its digital transformations were analyzed; and the economic efficiency of digital logistics was justified.

A historical background of logistics: a literature review

The term *logistics* in Greek means the art of reasoning or calculating. As noted by G. Pavelek (1988), even during the heyday of the Roman Empire, there were employees – logistics specialists – whose duties included the functions of distributing food among the population of Rome, forming stocks, and exchanging stocks between provinces.

Historically, logistics developed as a military discipline. Even in the 9th century in the Byzantine Empire, it was believed that the tasks of logistics were to arm the army, provide it with military property, care for its needs, and, accordingly, prepare each act of a military campaign. That is to say, logistics specialists were engaged in work that was a significant component of combat success. Logistics in Napoleon's army was equally important. Historically, logistics was considered to include not only transportation, but also a wide range of issues such as planning, management and support, determining the location of troops, as well as the construction of bridges, roads, and so on. One French military specialist, historian, and theorist of the 19th century defined logistics as "the

practical art of managing an army" (Mocherny, 2001). However, as a military science, logistics was formed only by the middle of the 19th century.

Another explanation for the term *logistics* is related to mathematics. In ancient mathematics, logistics was synonymous with mathematical logic and was understood as the art of calculations and geometric measurements (Ivyt & Narushevich, 2004). In an identical sense, the concept of logistics was used by the German philosopher G. Leibniz, and was later enshrined as "mathematical logic" at the philosophical Congress in Geneva in 1904. It is the above-mentioned period that scientists define as Logistics 1.0 (Kassem et al., 2019; Shkrygyn, 2021). Since the 1950s, the term *logistics* entered the economic terminology of the USA and was considered "enterprise logistics."

The era of Logistics 2.0 then began to take shape. American scientist O. Morgenstern (1951) pointed out the possibility of applying the concepts of military logistics in economics, and defined logistics as "a part of the doctrine of the organization and economics of production, which covers procurement, production and distribution logistics." In the 1960s, logistics was already considered a business process, but it concerned only the physical distribution of goods in space.

At the first European Congress on Logistics in Berlin (March 1974), it was observed that "logistics is the doctrine of planning, managing and controlling the movement of material, information and financial resources in various systems" (Rachkovskaya, 2017, p. 36). If we take into account that planning and control are management functions, their enumeration along with management is considered redundant. The definition of the subject of logistics by three types of flows was subsequently reflected in the research of many scientists.

In the 1980s, enterprises began to establish interaction in the field of coordination of physical flows both within and outside their organizations, which became a prerequisite for the term *supply chain management* (Lummus & Vokurka, 1999; Amr et al., 2018). This term considers the management of flow processes in the interaction of enterprises at various stages, from the purchase of raw materials to arrival at the final consumer.

Thus, Logistics 2.0 focused on coordinating the interaction of parties belonging to the same chain. While Logistics 1.0 focused on activities such as purchasing, manufacturing, sales, and inventory management, Logistics 2.0, along with traditional logistics, included activities such as marketing, new product development, finance, and consumer services (Farahani et al., 2009), and considered ways to optimize the interaction of process participants. At that time, such coordination of parties' activities was considered innovative, so Logistics 2.0 is considered a revolution in the industry and a prerequisite for the formation of Logistics 3.0.

Logistics 3.0 was formed during the third industrial revolution in the early 1970s (Industry 3.0). This historical period was characterized by computerization, which enabled enterprises to quickly receive and process information flows efficiently, as well as to automate production processes. Revolutionary changes also took place in the logistics sector during this period, and supply chain management changed to flow management. Attention was then focused not only on the physical flow, but also on the processes that occur at the administrative levels of each party (cash flows, flows of services, personnel, flows of solutions and ideas, and all aspects that create value for the consumer).

Logistics forms a certain system – a network of interrelated activities, the purpose of which is to quickly manage the flow of materials and employees within the logistics channel (Stock & Lambert, 2005).

The 1980s were characterized by revolutionary changes in information technologies, the improvement of communications, and the modernization of transportation processes. In logistics, there is an understanding of the need to manage information flows on the way from the origin of the flow to the place of its consumption in order to meet the needs of consumers.

From the 1990s to the present, there has been revolutionary progress in the realm of information technologies and, in the conditions of Industry 4.0, Logistics 4.0 (Digital Logistics) is being formed.

Figure 1 shows the relationships between different epochs of logistics.

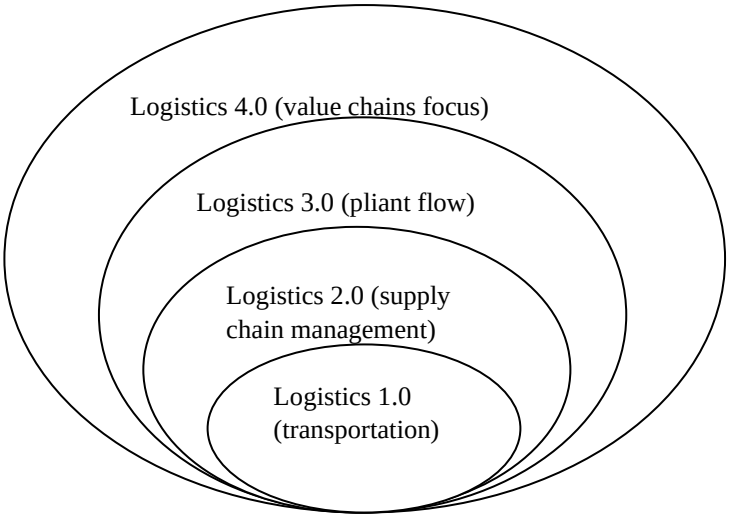


Figure 1. The relationships between different eras of logistics
Source: Amr et al. (2018)

Today, Industry 4.0 involves the comprehensive digitalization of industrial production. Its elements are: cyberphysical systems, IP networks, Internet of Things platforms, big data analytics, artificial intelligence, predictive maintenance, advanced robotics, additive manufacturing, and 3D printing. There are already a significant number of scientific papers from different countries on the definition of Industry 4.0, in which logistics is explored as one of the aspects without which many of the goals of the fourth industrial revolution cannot be achieved.

The modern digital economy, in which logistics networks operate, is characterized by the global nature of using network principles to coordinate the actions of society and markets. Logistics refers to those areas that are of systemic importance for the development of any country's economy in general. Digital technologies are becoming an integral attribute of the activities of logistics companies and their partners. Digital business ultimately requires the availability of digital supply chains, which also include the digitization of logistics. The digitization process is a requirement that revolutionizes the entire process (Schrauf & Berttram, 2016). Boundaries between participants in supply systems are being eliminated as digital business and digital platforms are being integrated into the physical and virtual world (Figure 2).

The study of literature sources made it possible to identify different approaches to the definition of the concept of "digital logistics" and its key characteristics (Figure 3).

Therefore, digital logistics are parts of the functions and operations of logistics that have undergone digital transformations using information and communication technologies. The digitization of logistics functions is considered an advantage for stakeholders, including customers and suppliers, as it provides innovative communication and information.

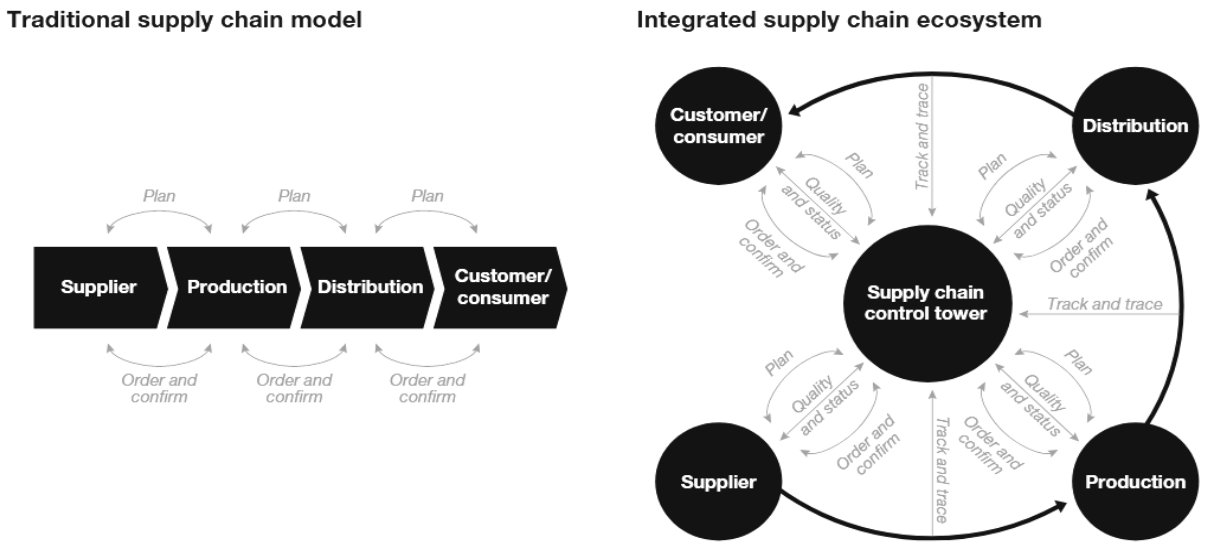


Figure 2. The complexity of the digital supply chain
Source: Schrauf & Berttram (2016)

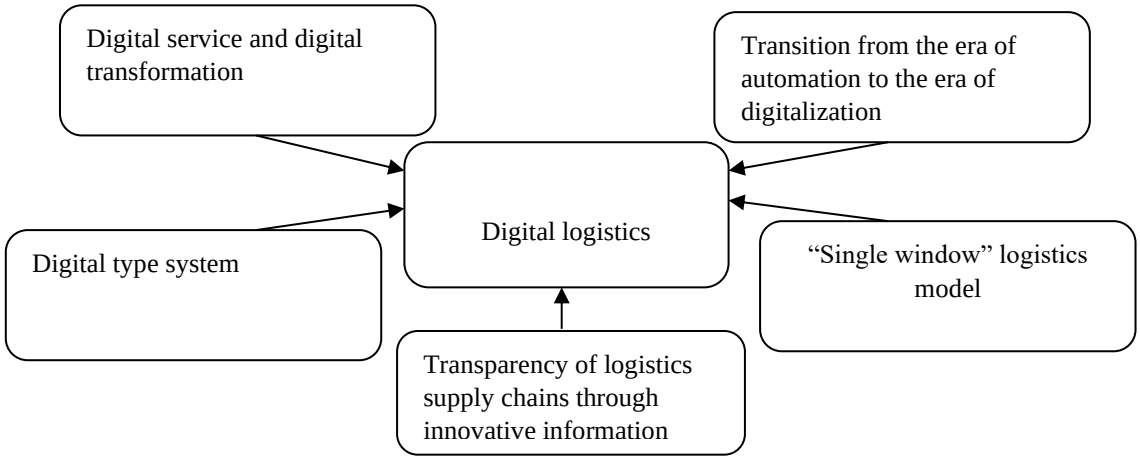


Figure 3. Key characteristics of the concept of digital logistics
Source: Shkrygyn (2021); Schrauf & Berttram (2016); Vasilenok et al. (2020)

Such types of electronic connections are advantageous for logistics management, because modern logistics "requires the creation of interorganizational information networks and the construction of Integrated Logistics Information Systems" (Lai & Cheng, 2016, p. 274). Digital logistics platforms allow small but more innovative companies to compete with business giants.

Gunasekaran and Ngai (2003) noted that digital logistics is the transfer of goods and services through Internet communications, such as the Internet or electronic data exchange.

Digital logistics involves the search for, storage of and method of transmission of information, as well as digital technologies that provide the identification and forecasting of needs, the optimization of routes, the directions of material and information flows, and the reduction of time in supply chains (Vasilenok et al., 2020, p. 74).

Thus, digital logistics (or Logistics 4.0) requires supply chain participants to interact simultaneously. Strandhagen et al. (2017) note that sharing significant amounts of information between supply chain actors will improve companies' logistics. The digitalization of the industrial supply chain has become a prerequisite for customer orientation, the individualization of services, and the activation of logistics and the supply chain. The goal of the digital supply chain is integrated planning and management of logistics systems and networks based on digital models, methods, and tools that are built on a common information and communication platform.

The introduction of digital logistics implies the availability of a developed digital infrastructure adapted to the business conditions of a particular country as a complex of technologies, products, and processes that provide computing, telecommunications, and network capabilities and work on a digital (rather than analog) basis.

The *basic components of the digital infrastructure* include a fixed: telecommunications infrastructure (backbone, distribution and local networks; public services infrastructure (electronic customs); transactional processing infrastructure (online payments, cashless tools, FinTech services); cybersecurity infrastructure; geoinformation infrastructure (linking digital data in spatial objects); life support infrastructure (transport services); open data infrastructure; interoperability infrastructure (API); data processing and storage infrastructure (cloud or virtual infrastructure); mobile telecommunications infrastructure (3G, 4G, radio and satellite technologies, Wi-Fi); e-commerce infrastructure (B2B digital purchase and sale platforms, e-contract, e-invoicing, e-supply chain); specialized infrastructure (special networks, video surveillance, satellite engineering systems); digital television infrastructure (terrestrial, cable, satellite); and European Isa standards (Digital Agenda, 2016).

Digital logistics should take into account such components as: logistics structure (which includes participants in the logistics process, inventory storage points, distribution centers, warehouse network); logistics processes and related activities (consumer relations management, service, and procurement); and information reporting systems (design, planning, control and coordination of information via the Internet and electronic data exchange). The use of these technologies will help integrate the activities of the parties into the logistics chain.

Key digital logistics technologies and advantages of their application

Cloud computing or Cloud Software/Services – this is a technology for providing convenient network services in the on-demand mode to a collectively used set of configurable computing resources (networks, servers, data warehouses, applications or services). The user can quickly use them for their own tasks while minimizing the number of interactions with the service provider or their own management efforts. Cloud services for businesses eliminate the need to purchase hardware and software or access external data centers at all, reducing ongoing costs. Organizations typically charge a fee for providing cloud services, but this approach allows businesses to focus on their own strategy.

A typical example of cloud services in a multimodal transport environment is the electronic logistics marketplace (ELM), which brings together ICT web systems that connect consignors, carriers, and customers for spot trade in transport services (open ELM), or for information exchange and long-term cooperation (closed ELM) (Wang, 2016)

Today, we distinguish the following service models:

- *Cloud Software as a Service (SaaS)* – a software delivery model in which a cloud solution provider hosts customer applications. At the same time, the customer accesses their applications via the Internet. The advantage is that the customer does not spend money on maintaining their own

computing infrastructure, but uses a subscription to the service, which is paid in proportion to the volume of use;

- *Cloud Platform as a Service (PaaS)* – a model that provides customers with access to the development tools they need to create and manage mobile and web applications without investing in infrastructure support. The cloud service provider hosts infrastructure and middle-ware components, and the customer accesses these services using a web browser;
- *Cloud Infrastructure as a Service (IaaS)* – provides customers with access to on-demand infrastructure services via the Internet. The advantage of this model is that the cloud service provider provides remote access to infrastructure components that provide computing resources, storage, and network bandwidth so that customers can perform their workloads in the cloud. A cloud service provider subscriber is usually responsible for installing, configuring, protecting, and maintaining any software in the cloud infrastructure.

Models of working with the cloud environment for different consumer groups are shown in Figure 4.

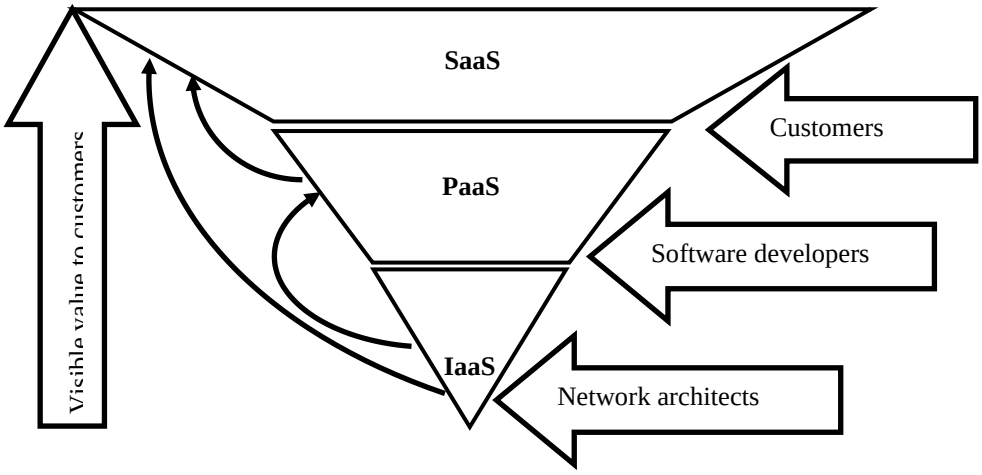


Figure 4. Cloud environment models for different consumer groups
Source: developed by the authors

Cloud services are widely used by IT companies and system integrators such as SAP, Oracle, Infor, IBM, GenerixGroup, and Visagio.

For example, GenerixGroup uses the Generix Supply Chain Hub SaaS platform, which combines the capabilities of processing physical cargo flows, digitalizing information flows and processes of interaction between companies and their partners in real time. Infor is a global provider of business software that creates sets of cloud solutions and deploys easy-to-use technologies that apply data analytics and are easily integrated into existing systems. Oracle offers PaaS solutions with ready-made software components that enable developers to add new features to applications (in particular, artificial intelligence, chat-bots, blockchain, and the Internet of Things). This also includes solutions for analysts, end users, and administrators of Internet technologies, database management, system management, and security.

Cloud logistics is rapidly becoming popular: 50% of logistics service providers already use cloud services, and 20% plan to do so. As data is transferred to the cloud, logistics services become available as part of payment on demand. This means that small businesses no longer need to spend money on comprehensive IT solutions – they only pay for what they need, when they need it.

Services such as Shipwire and Freightly provide real-time cloud-based transport management systems. They cover all logistics processes from purchasing to billing, making the whole process easier and cheaper for companies.

The *main advantages* of the use of cloud technologies in logistics are as follows:

- cloud services make the automation of business processes in the supply chain more accessible;
- cloud technologies enable supply chain participants to improve the speed and accuracy of implementing basic logistics business processes. In the case of an IT system failure, companies that do not use cloud services are forced to spend their own time on data backup and recovery, and this affects the speed of business processes;
- TMS systems provide automated operational accounting of the current location of vehicles and the condition of the road and cargo, as well as data on the facts of delivery and shipment. This allows users to optimize routes and load vehicles online, provide operational and final reports on the implementation of logistics operations, and generate indicators for evaluating their effectiveness;
- using cloud technologies, a single platform can be created for cargo owners and carriers. When placing an order, the cargo owner sets the main criteria (route, cargo type, weight, car type, etc.) and immediately sees offers from carriers that are members of the cloud platform;
- the availability of complete, reliable, up-to-date information on all inventory flows in the supply chain;
- accelerated turnover of goods, increased reliability of delivery, and increased level of service;
- cloud services are hosted on remote servers, so if the central supply chain company (or any of its counterparties) develops and its branches open, then there is no need to buy software – one can work in the cloud from anywhere in the world;
- cloud technology providers take care of the smooth operation of the IT system, providing automatic updates and rapid restoration of functionality in case of malfunction. Users of such services need not worry about the safety of information in case of failure (Antipina, 2018, p. 36).

Compared to other technologies, *cloud computing* is the most conscious technology of cargo transportation. For small and medium-sized businesses, it offers a high level of security and provides an opportunity to experiment and launch new services and products much faster.

The *Internet of Things (IoT)* is a dynamic network system where each technological device has an identity, physical attribute and virtual personalization, with self-tuning capabilities based on standard and communication protocols (Kramp et al., 2013, p. 2). The IoT makes it possible to connect technologies to a conventional device (home appliances, microwave, home theater, car, etc.) and use them online (Whitmore et al., 2015). It also offers significant potential for the public and private sectors, enabling innovative applications to overcome common problems that exist in many industries. Furthermore, it is able to collect and transmit information from all devices capable of connecting to the Internet via Wi-Fi, sensors, Bluetooth, GPS, cellular networks, technologies using radio frequency identification (RFID) chips, etc. Ben-Daya et al. (2019) define the IoT as "a network of digitally connected devices that can communicate with each other and facilitate the planning, control, and collaboration of supply chain processes and chain between partners."

In essence, the IoT is a combination between a technological innovation and a person's desire for constant and ever-increasing connection with everything that happens in the internal and external environment, as everything is concentrated in one device that extends to the entire environment.

Logistics was one of the first industries to use IoT technology to implement intelligent, networked and automated logistics operations, where the Internet acts as a necessary tool.

A model of association of logistics systems based on the IoT is shown in Figure 5.

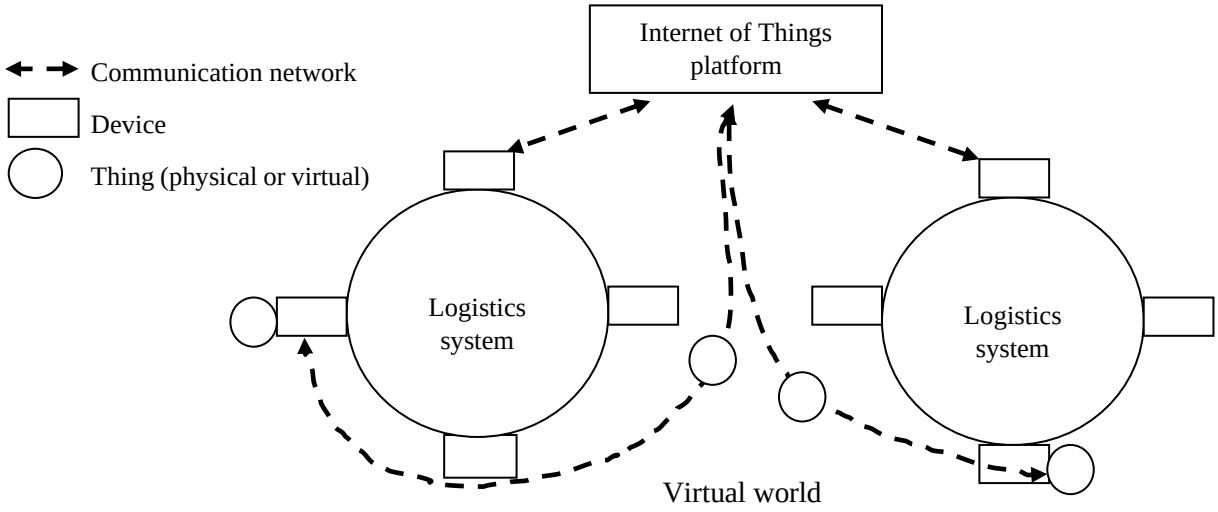


Figure 5. A model of the interconnection of logistics systems based on the Internet of Things
Source: Morozova (2021)

The IoT allows intelligent logistics management and combines transportation, storage, packaging, loading, unloading and other components of the logistics process into an integrated system with the lowest cost.

At the same time, the IoT not only allows different systems to be combined into a single whole, but also to effectively interact through various communication networks, creating elements of intelligent logistics. The IoT is expected to be a prerequisite for profound changes in the global supply chain through intelligent cargo movement. This will be achieved through the continuous synchronization of supply chain information and the smooth tracking of objects on the road in real time.

The areas of application on the IoT in logistics are as follows:

- connected transport (full transparency of movement, control of the driving mode, increasing the utilization of vehicles, and strengthening driver discipline);
- fleet management (adaptation of service to operating conditions, automatic dispatching, and integration with ERP systems);
- autonomous transport (driver support assistants, self-driving metro, autopilot of traffic on the highway, and promising systems of full autonomy);
- ensuring security (friend-foe identification, the prevention of fuel theft and misuse of vehicles, and the availability of data for investigation of events);
- asset tracking (control of the location and movement of goods, instant inventory of the warehouse and sales area, and visibility of goods throughout the entire supply chain);
- smart infrastructure (centralized management, monitoring the condition of pipeline elements, and monitoring the load and wear of an axle);
- warehouse automation (robots that move racks of goods, fully automatic warehouse systems, and promising autonomous forklifts);
- asset monitoring (tracking key parameters, instant responses to status changes, and data availability throughout the entire supply chain).

Logistics is the most promising area for IoT implementation. This is confirmed by the successful practice of using the IoT. In this vein, IBM and Colombian logistics operator AOS have

implemented a platform that uses the IoT to track and obtain information about each vehicle that transports goods. IBM Blockchain, Watson IoT, and IBM Cloud technologies were used to develop this system. AOS trucks are equipped with special IoT sensors for assigning RFID tags. Each label contains information about the carrier, cargo, location at a specific time, and availability of space in the truck – this is how the IoT improves transportation. The necessary information is recorded on the blockchain, which allows the company to quickly receive it, while providing the company with reliable protection against unauthorized access. This IBM solution reduces the impact of the human factor and significantly speeds up the processing of handling information (Ardas, 2019).
Thus, the *advantages of using the IoT* in logistics are:
- optimizing the use of company resources, as personnel, machinery and equipment are used more efficiently and economically, which reduces costs;
- reducing the negative impact of the human factor. Unfortunately, people cause most accidents. Losses, theft, forgery, and replacement of products during delivery – all of these problems threaten not only the company's revenue, but also its reputation. The IoT will improve delivery security and create a new job market;
- controlling transport. Through the use of the IoT in transportation, companies have information about the location of a particular cargo at any time, which allows them to accurately determine the delivery time, as well as monitor the condition and change the parameters of the cargo depending on the current situation.
- identifying road situation parameters, as monitoring weather conditions, roadway cover, and temperature allows companies to avoid problems with the loss of goods or irrational time spent on cargo delivery;
- controlling climate in storage areas;
- its high usage potential. Thanks to the introduction of the IoT in logistics, the field has experienced a revolutionary breakthrough in recent years.

Artificial intelligence (AI) is a set of related technologies that make machines do things that mimic the human thinking process. AI can expand and strengthen human abilities and skills, and its technologies are a valuable business resource in today's environment of information technology. The use of AI helps to meet the demand of ordinary citizens for better-personalized goods and services and allows officials to save time on routine tasks, ensuring the search for creative and innovative approaches to improve services (Khmarska et al., 2021, p. 46).
Studying AI is based on the results of research on the theoretical principles of the functioning of neural networks, signal recognition, and images which were developed several decades ago. Technologies in the field of neurocybernetics were created by American scientists U. McCulloch, V. Pitts, and F. Rosenblatt (1958). The first successful results of neurocybernetics allowed scientists to move forward in the direction of solving individual problems of modeling human functions. The most significant breakthrough in the development of AI research occurred in the global scientific society in the mid-2000s. This was due to some factors: first, progress in the performance of information processing algorithms due to the development of deep learning technologies; secondly, the powerful growth of data of various types (text images, map data, etc.) and technologies, which provided almost unlimited opportunities for storing and accessing such data. Today, AI is increasingly penetrating various business models and processes of national and global economies. "These innovative digital technologies become more efficient and productive as they are together incorporated into new products and services. AI integrated services modify the job done, improves productivity and work conditions while minimizing human intervention during

the operation" (EGE 2018). In the near future, the use of AI technologies for the analytics of service solutions in the business and social spheres is expected to increase.

The key directions in the development of AI technologies in the modern world are reflected in Table 1.

Table 1. Key areas of the development of artificial intelligence

Source: developed by the authors

Direction	Explanation
Intelligent data management solutions	More and more business applications and VI systems have created advanced opportunities for the development of artificial intelligence, and the popularity of business solutions based on artificial intelligence is increasing every year.
Automating connected devices	Autonomous systems in industry, agriculture, and mining will continue to be expanded with partially or fully robotic systems that connect people, machines, and businesses.
Natural language management platforms	The ability of user interfaces to interact with humans will gain popularity in every type of business application. The main focus will be on increasing the understanding of human language and its generation.
Event-driven business systems	The enterprise will gradually implement event-driven business models. In these models, the cloud, IoT, and mobile communications will use artificial intelligence technologies.
Chat bots	Numerous companies are already moving towards AI chat bots and other virtual assistants to solve daily work tasks, quickly analyze customer and supplier requests, and be able to respond to customer requests in a timely manner.
Automation of business processes	The steady growth of data generated by the IoT will force companies to engage in machine learning for data processing and analysis.
Deep processing of big data	Artificial intelligence technologies allow companies to conduct a deep quantitative and qualitative assessment of large amounts of data at a high professional level and without human intervention. The mass use of such technologies will significantly change basic science.
Neuro-crowdsourcing and networking communities	Due to the unique market and the Neuromation synthetic data platform, market participants are expected to migrate from an open, unorganized market to an organized and automated platform service in the near future. In partnership with Neuromation, companies will develop the consumer, retail, medical, manufacturing and robotic sectors
Computer vision	Image analysis based on regular image decomposition (segmentation), using the example of deep learning or AI for object recognition. The main growth factors of the computer vision market are the need for quality control in absolutely all areas of activity, including for the development of national security. Computer vision algorithms are designed to detect behaviors (patterns), recognize emotions and relationships, identify differences, and understand intentions. Once this is achieved, cameras will be able to provide real-time visual data for analysis for various purposes.

In logistics, AI is already widespread thanks to the introduction of advanced technologies such as Amazon automated warehouses, Einride autonomous trucks, Zipline drones, Starship last-mile delivery robots, and others. These types of technologies can potentially replace some types of manual work that do not require complex skills (for example, sorting in a warehouse, delivering the last mile, driving trucks, etc.)

In its current state, AI helps logistics specialists in real-world logistics operations by using intelligent alerts based on predictive analysis. For example, from sources such as MarineTraffic, companies can get real-time and estimated arrival time (ETA) status information for each vessel in the world based on satellite data (Swan, 2015).

In order to improve the efficiency of the logistics business, AI technologies can: extract the relevant part of data and link it with internal data, which can be very complex due to its poor quality;

determine what events matter from a huge amount of data; formulate decision-making proposals and inform specialists regarding planning the proposed solution at the right time and place; predict the arrival time of trucks depending on traffic conditions; predict container repair requirements based on impact detection GPS trackers; predict damage to cargo and insurance requirements based on temperature sensors; predict the illness days of warehouse employees based on public holidays and weather conditions, etc.

Therefore, the use of AI in logistics aims to speed up all processes, ensuring their accurate and smooth execution. The use of paper, office supplies, opaque supply chains, remote cargo transportation – all of these are the realities of our time, which lead to significant costs in energy, materials, money, and time. AI changes the logistics market, making it transparent, more reliable, and efficient.

Robots, drones, and autonomous systems. The concept of robotics was defined by Brady (1985) as a reasonable relationship between perception and action. Since this connection is reasonable, the role of AI in robotics is very important, because it is AI that solves the problem of working with real objects in the real world of robotics research. Brady (1985) noted that "robots have vision, strength, and tactile sensation, proprioceptive senses of the robot's inner state. The arms, wheels, grippers, and legs are the mechanical parts that allow the robot to function." That is, from a technical point of view, a robot consists of two components: a mechanical one that performs certain work operations, replacing a person in production processes; and a software one that controls the robot in automatic or automated mode.

Until recently, robotics technology did not have a sufficient impact on logistics, but today, in the context of the COVID-19 pandemic, the use of robots has significantly intensified. The main economic reason for the introduction of robots in various production operations is that their execution without direct human participation is cheaper when comparing the timing and quality of work performed.

In logistics, robots have come to be used to perform common and repetitive tasks that require complex programming to configure and implement. Over time, the areas of application of robots in logistics operations and supply chain management have expanded. Most of this work is in such functional areas of logistics as warehouse logistics and production. Numerous warehouse and shipping companies are taking advantage of IT and implementing robotics, automated systems, and AI in their business models. If this is the use of robots at logistics infrastructure facilities (logistics centers, public warehouses, distribution centers, cross-docking in terminals, etc.), then robotic equipment is very diverse: from fully automatic and highly mechanized warehouses to robots that perform individual operations of warehouse cargo handling.

Unlike the manufacturing sector, logistics copes more effectively with the problem of adapting various orders from a large number of customers. Since orders in the delivery sector are unique in terms of sorting, packaging, and delivery, the process equipment must be equipped with intelligent functions. This helps firms to better focus on delivery, take into account the requirements of each customer, and improve the level of service by delivering the necessary goods to the right place at the right time. Furthermore, large order volumes encourage companies to use automated and intelligent systems for delivery in order to reduce lead times (Wen et al., 2018).

The rapid development of artificial intelligence and robotics has created prerequisites for the use of intelligent warehousing in logistics and drones for the delivery of goods. Due to this, companies are able to reduce the time spent on delivering goods and significantly improve the quality of customer service. Among the companies that produce drones for industrial use, including logistics, are DJI, Delta Drone, Flytrex, Flirtey, Matternet, Project Wing and others. Well-known companies such as Amazon, Google, Dodo, DHL, UPS, etc. are implementing drones in logistics. They are

mainly used at present for delivering parcels weighing up to 8–10 kg and over short distances, on a segment of the route which is called the last mile in logistics, but they do not stop there.
For example, Amazon, the largest e-commerce company in the USA, has acquired a patent for a large, high-flying airship that can be used to dispatch drones and then deliver goods to Amazon customers. Since 2013, work has been carried out on the Amazon Prime Air project, which provides for the delivery of goods to customers using octocopters (drones with 8 propellers).
Additionally, 3PL provider Geodis, together with Delta Drone, has developed a fully automatic inventory replenishment and inventory kit using drones. The kit consists of a ground robot and a silent ATV drone with four high-definition cameras. This intelligent solution allows users to calculate and report data on product balances in real time, as well as process data and integrate it with the warehouse information system.
Along with this, the use of drones has a number of disadvantages:
- privacy and security. Using drones to deliver goods around a city (first and last miles) is the most tangible and impressive future benefit for logistics, but it is also a source of problems. Due to the fact that privacy and security issues are growing in densely populated cities, the most difficult aspect, from a moral point of view, is creating the necessary conditions for logistics infrastructure and integrating them into the urban transport network;
- legislation. There are a number of bills that restrict drone flights in different airspace;
- "issues in the air." There are cases when drones collide with birds in the air, which fall into their blades.
- "issues on earth." States today face the problem of vandalism and theft of drones. In addition, users can track the drone only by its last location, since there are always blind zones if cameras are used;
- "fighting with nature." A car, train, or person can withstand weather conditions to some extent, but the weight of drones is too small to withstand wind or rain.
Despite a number of challenges in using drones, cost savings and high delivery speeds are two of the main factors contributing to the spread of drone use in supply chains. Commercial drones are still being developed and used, but they are already considered a technology that will disrupt the usual order of operation of product delivery services in the future.

Blockchain technology was first proposed by Nakamoto (2008) in his work "Bitcoin: A Peer-to-Peer Electronic-Cash System." At the heart of the creation of blockchain technology, the idea is that there should be no centralized control of information or even censorship at the network level, but at the same time, networks should be open to everyone, and all users should be able to make anonymous transactions. Blockchain is a distributed database where data storage facilities are not connected to a general server. This database stores an ever-growing list of ordered records, called blocks. Each block has timestamps and a link to the previous block. The use of encryption ensures that users can only change those parts of the blockchains that they own – in the sense that they have private keys, without which writing within a file is impossible. In addition, encryption ensures that copies of the distributed blockchain are synchronized across all users. Thanks to the wide application possibilities of blockchain technology, many large companies have improved their business models or operating modes and received many new features. Currently, blockchain technology has passed four stages in its development (Figure 6).
Achieving excellence in the organization of the supply chain involves cooperation with a large number of parties, as well as complex information and financial flow. This leads to a delay in cost, non-transparency of agreements, and non-standard situations. Such problems can also arise due to processes that are manually regulated by control authorities.

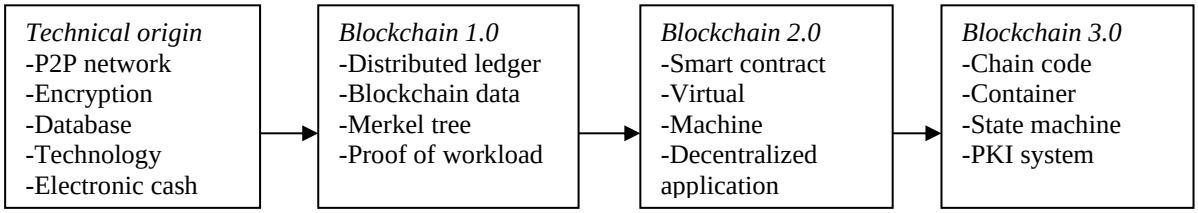


Figure 6. The development stages of blockchain technology
Source: Swan (2015)

For example, logistics companies often have to draw up paper documentation when passing through customs processes. Accordingly, this makes it difficult to track the passage of goods along the supply chain, check the goods that are being transported, and be able to quickly respond to unforeseen circumstances, causing issues in the organization of international trade. Blockchain technology can help to overcome a large number of logistics issues and improve the efficiency of the logistics process. Being a transparent public register, blockchain is able to offer clients and auditors simple and effective tools for tracking the entire route.

A significant number of companies around the world have already implemented and are using blockchain technology in their work. For example, the BASF Corporation, together with the blockchain startups Quantoz and Ahrma, created, on the basis of blockchain technology, platforms for tracking cargo delivery and commissioning smart containers that send information about the status and integrity of the order and the loading process. Kuovala Innovation has implemented smart contracts on its own Kinno platform (a computer algorithm designed for concluding and maintaining commercial contracts in blockchain technology). This approach assumes that the user places an order for sending cargo equipped with an RFID tag, and that other system participants set delivery terms. The winner of the contest receives a contract, which is registered and tracked in the blockchain. Payment based on smart contracts is made automatically. Smart contracts are able to provide better reliability of the agreement than lawyers and traditional law, as well as completely eliminate ambiguity in the interpretation of the terms of the agreement. The Ukrainian online platform A2B Direct is the so-called “cargo Uber,” which allows users to track cargo movement around the clock and provides a full cycle of electronic document management.

One of the most important aspects of blockchain is that it can only provide its advantages provided that all participants in the logistics chain have access to the network (Figure 7).

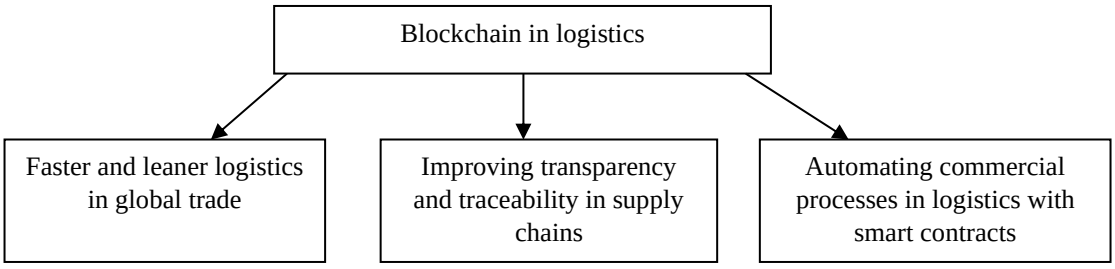


Figure 7. Key blockchain use cases in logistics
Source: developed by the authors

The main features of the implementation of blockchain technology are the following: ensuring the uninterrupted supply of information between partners and improving the quality of processes at the

same time; increasing the degree of trust among all elements of the chain; and simplifying the process of making and transmitting decisions at each stage, mainly through providing single access to digital information, which provides an opportunity to collectively predict the process and activities.

The *advantages of implementing of blockchain technology in logistics* include:

- the ability to track goods from the place of production to the final consumer and protect buyers of products from non-original goods and deception, which allows the buyer to be confident in the decision to purchase goods;
- dispersal, which allows all elements of the logistics chain to participate in real time by tracking the movement of transport or purchased goods, processing the necessary package of documents in the form of smart contracts, and destroying illegal elements during the delivery process;
- security, due to the use of cryptography and the absence of the possibility of making changes to the delivery process by elements.

Immersive technologies and 3D printing. Immersive technologies blur the line between the physical and digital world, creating a sense of immersion.

Related terms are:

- Virtual Reality (VR) – creating a virtual environment that is provided to the human senses in such a way that the human perceives the environment as if they are in it;
- Augmented Reality (AR) – a type of virtual reality in which virtual objects are superimposed on a real environment (Azuma et al., 2015). AR must meet three requirements: combine virtual and real objects in a real environment, work interactively, and register real and virtual objects in real-time;
- Mixed Reality (MR) – a technology that combines VR and AR. This allows a person not only to navigate in the surrounding space, but also to create this space, filling it with important or useful information.

The main differences between VR, AR, and MR are shown in Table. 2.

Immersive technologies work in conjunction with cloud storage and the Internet of Things (IoT). Those devices that are worn by humans (for example, glasses, helmets) generate large amounts of IoT-related data, which must be stored and processed in real-time. This requires the use of cloud storage and cloud computing. Augmented reality devices should also read information about the environment and send it to a cloud-based analytical system.

Table 2. Key differences between VR, AR and MR

Source: McMillan et al. (2017)

	Virtual Reality (VR)	**Augmented Reality (AR)**	**Mixed Reality (MR)**
Display device	Special headset or smart glasses	Headsets optional	Headsets optional
Image source	Computer graphics or real images produced by a computer	Combination of computer-generated images and real-life objects	Combination of computer-generated images and real-life objects
Environment	Fully digital	Both virtual and real life objects are seamlessly blended	Both virtual and real life objects are seamlessly blended
Perspective	Virtual objects will change their position and size according to the user's perspective in the virtual world	Virtual objects behave on basis of the user's perspective in the real world	Virtual objects behave on basis of the user's perspective in the real world

Presence	Feeling of being transported somewhere else with no sense of the real world	Feeling of still being in the real world, but with new elements and objects superimposed	Feeling of still being in the real world, but with new elements and objects superimposed
Awareness	Perfectly rendered virtual objects cannot be distinguished from the real deal	Virtual objects can be identified by their nature and behavior, such as floating text that follows a user	Perfectly rendered virtual objects that cannot be distinguished from the real world

Currently, research on the use of immersive technologies in logistics is quite limited. However, their impact on logistics is obvious. Prospective areas of the application of immersive technologies in supply chains are: providing on-the-job training, real-time instruction, navigation, warehouse planning, warehouse order acquisition, dynamic traffic support, and digital interaction with customers and partners. The integration of augmented reality with technology such as voice selection makes it possible to increase labor productivity and change the way we perform official tasks (Merlino & Sproġe, 2017).

3D printing is a process used to create a three-dimensional object using various materials via a highly specialized printer. It can be carried out in various ways, but is based on the principle of the layer-by-layer creation (growing) of a solid object from the bottom up.

More than a hundred materials can be used for 3D printing today, including plastic, glass, metal, wax, various adhesive mixtures, clay, human tissue, and so on. This technology can be used for the production of spare parts, bio-structures, and jewelry. Expanding the possibilities of using different materials allows the scope of application of 3D printing to be expanded.

Currently, the usage volumes of 3D printing on a global scale are very small – only 0.02% – meaning that this technology does not have a significant impact on the logistics sector. However, according to a study published on the website of the German company Ernst & Young Global Limited, the degree of penetration of 3D printing technology worldwide has grown from 24% to 65% in recent years. The market leaders are currently South Korea and China where, respectively, 81% and 78% of companies use 3D printing. Third place in the world in terms of the penetration of 3D printing technology is Canada, with 77%.

Recently, there have also been warnings that the rapid development of 3D printing and especially its spread in industry can negatively affect the logistics and transport industries. In the near future, 3D printers will become more accessible to everyone. Due to the fact that many goods can be produced at home, there will be a reduction in the volume of cargo transportation that uses different types of transport, and the need to use warehouses will decrease. However, it is possible that these warnings will not be justified, because 3D printing requires a special working material that serves as the basis for making these objects. This material will still need to be delivered using a logistics chain – whether from the manufacturer to the retailer or directly to the customer. The disappearance of the logistics sector may not be discussed, then, but changes will occur in any case.

Wieland (2014) showed how much shorter the supply chain becomes when 3D printing is applied (Figure 8).

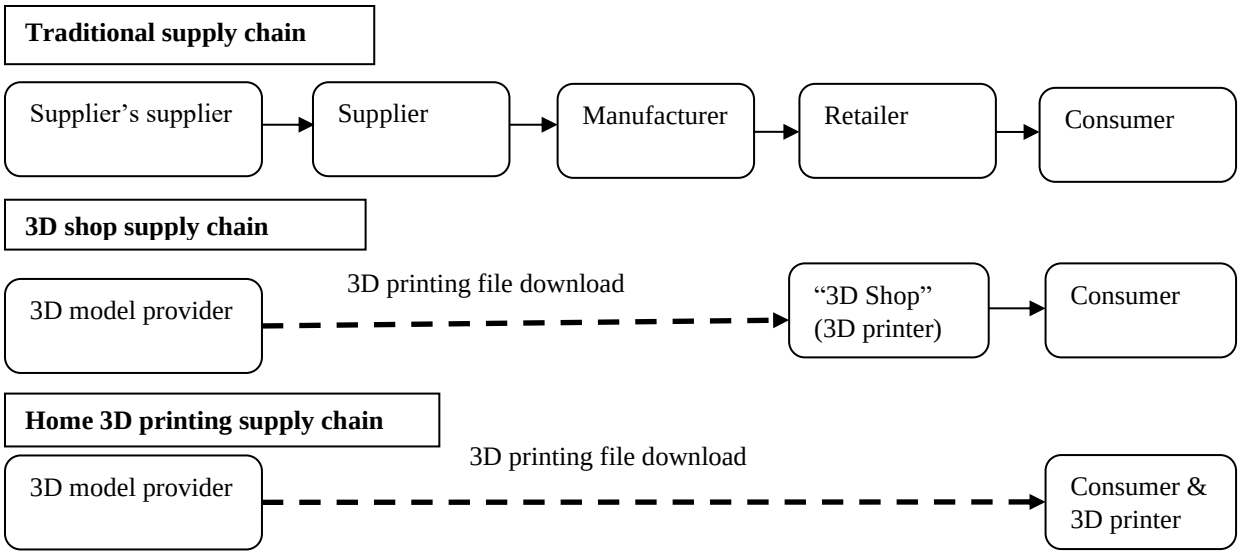


Figure 8. Supply chain with 3D print shop
Source: Wieland (2014)

The *advantages of using 3D printing* in logistics are numerous:
- accelerating production and at the same time reducing transportation and storage costs;
- potentially reducing import or export costs, sea freight, and brokerage costs due to localized production;
- avoiding large and expensive equipment in factories;
- retaining a customer focus. The consumer can individually modify the desired product and sometimes participate in prototype testing, at no additional expense;
- improving production efficiency by reducing material and energy costs;
- reducing the negative impact on the environment. The number of trucks on the roads that carry goods to customers will decrease and, accordingly, the number of emissions into the atmosphere will decrease.

The economic benefits of the mass implementation of *3D printing* in logistics are quite significant. This technology can significantly affect the relationship between manufacturers and sellers, which in some sectors may cease to exist altogether, or may lead to the creation of warehouses for manufacturers who don't have their own inventory. The manufacture of products for individual orders directly on the spot and close to the consumer will reduce inventory and transit costs.

As a result of direct communication with the consumer via digital technologies, significant business expansion, the development of the ability to model human behavior, and the direct interaction of companies with the consumer will allow logistics to function most effectively within the three-component environment-business-person interaction.

Conclusions

The digital transformation of logistics can be characterized as a new mechanism for the accelerated systemic development of economic systems, built on effective information connections and optimized, value-based data flows necessary for solving operational and strategic business tasks

The economic efficiency of logistics today depends on the use of digital technologies that allow us to apply new technological solutions, optimize the technological process, and improve economic performance by implementing previously unattainable measures. Logistics processes during all periods of development have been accompanied by information flows, but only digital logistics has allowed us to move to a new stage of relations between the parties in the supply chain. Fast information exchange, computerized business solutions, and the ability to process and analyze large amounts of information in real time provide a new level of business relations and customer orientation.

Ultimately, digitalization increases: the efficiency of logistics processes in the field of customs and border clearance (speed, simplicity, and predictability of formalities); the quality of infrastructure related to trade and transport; the simplification of the organization of international transportation at competitive prices; the quality and competence of logistics services provided by market operators; and the tracking of the passage and timeliness of cargo delivery. The integration of geo-positioning systems that allow users to monitor the location of vehicles and radio frequency coding (RFID) systems into logistics creates a new arena for digital logistics. Internet of Things technologies based on data received from sensors allow users to reload containers in time and to select the best transportation routes.

The transformation of conventional logistics systems into smart (digitally visible) logistics systems and the optimization of logistics processes creates various effects.

Technological effects. Digital logistics increases the level of progressiveness of the technologies used. Due to the improvement of the quality of the technological processes of the logistics business, the service time and speed of cargo delivery are reduced.

Competitive effects. Those logistics companies that use digital technologies to service the supply chain are well above other companies, have a larger share of the logistics market, and, accordingly, attain increased profits. The customer base increases due to the high quality of service, reduced waiting times for documentation processing, and so on.

Commercial effects. Thanks to the digital transformation of logistics, traffic volumes are increasing, new information services are emerging, productivity is increasing, resources are being saved, and the share of logistics costs are being reduced.

Socioeconomic effects. Thanks to digitalization, the organizational structure of companies is being improved, working conditions are being improved, the volume of paper documentation and the number of management personnel are being reduced, and transportation management decisions are becoming more efficient.

Thus, this study shows that digital transformation has opened up significant opportunities for the development of digital logistics and the optimization of the supply chain.

Prospects for further research are to determine the factors of influence and the impact of digital logistics on the innovative development of business processes at the regional, national, and international levels.

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THE IMPROVEMENT OF THE LOGISTICS SYSTEM THROUGH THE INTRODUCTION OF BLOCKCHAIN TECHNOLOGY

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Abstract. *The purpose of this article is to analyze the current state of the operational security of the seaport and the feasibility of the digitalization of operational processes. Statistics and research of global companies confirm the relevance of this study. The research is based on theoretical methods, involving the analysis of previous publications based on the area, statistics, and technological features of the operational activities of the seaport. In the article, the author has considered the prospects for the introduction of digital technologies, namely blockchain technology, in the process of organizing the processing of ships by seaports in Ukraine. Analysis of the statistical indicators of Ukraine's international activity provides insight into the importance of the transport sector for stable economic development. In addition, global research proves the possibility of introducing a blockchain in any area of human economic activity. The author of the article identified that blockchain is already used in various fields in the world, such as finance, logistics, identity cards, retail and e-commerce, and healthcare. The author analyzed and structured the technological map of ship processing with the clarification of time intervals to understand its effectiveness and practical necessity. The author chose a typical operation of scheduling ships to study the possibilities of implementing a blockchain. The list of required information and documents corresponds to the items of the technological system. The analysis of the technological map allowed to determine that 72 hours – 5 units – are need to perform the ship processing planning operation. Contractors must add a list of parameters of the vessel, cargo, and some documents for the safe operation of the seaport. The author provided a graphical interpretation of the ship processing process before the introduction of innovations and the possible ship processing process after the introduction of blockchain technology for comparison. According to the results of the study, the author has identified areas for improving the level of economic security of the seaport. Thus, it is planned that the introduction of innovation will: reduce the time cost for processing information, documents, and requests; reduce monetary costs for processing information, documents, and inquiries; increase the level of security of operational activities of seaports; and increase the level of competitiveness of Ukrainian ports in international transport operations.*

Keywords: *blockchain, seaport, economic security, innovative development, digitalization of the economy, logistics.*

Introduction

The international nature of the work of seaports and the globalization of economic processes lead to a high level of risk in their economic activities. The lag of the enterprise, from general tendencies to the digitalization of the economy, can lead to such consequences as the total decrease of competitiveness of the seaport against the development of other transport branches, the disturbance of the internal economic mechanism of work of the enterprise, and the presence of negative interference from the outside.

Maltsev and Shapovalov (2018) used balanced innovative development based on an integral indicator in their article to justify the strategic development plan of a seaport. Its evaluation is carried out in the form of functions from five variables that influence the implementation and realization of innovation strategies: economic and financial criteria, organizational criteria, innovation criteria, social criteria, and the innovation climate. Kibik and Kravchenko (2012) argue that the strategy for competitive development depends on specific circumstances that are formed under the influence of internal and external factors. To form and maintain competitive positions, the enterprise must be constantly systematic and proportionate in order to develop in all directions and spheres of activity. Miroshko (2007) proves that the substantiation of economic development

of sea trade ports should include an assessment of the geographical location, the natural and climatic conditions, the level of economic, technical, and innovative development of the port, social factors, and local features of activity.

Morkunas, Paschen, and Boonc (2019) explained how blockchain technology works, including how blockchain transactions work, how conditions are explained, and how different types of blockchain technologies are described. Research by Belchior, Vasconcelos, Guerreiro, and Correia (2021) shows that blockchain interactions are much broader than cryptocurrencies and interchain asset transfers. Their article describes assistive technologies, standards, uses, open issues, and directions for future research, paving the way for research in this area.

The study of Tilniak and Kornaha (2019) proved that blockchain technology could effectively solve the problem of the trust risk of intermediaries in the retail chain, reduce transaction costs, and increase the effectiveness of synergies in the environment with many agents. Their paper discusses the feasibility of using blockchain technology for transport logistics and the impact of blockchain technology on the system that exists in transport logistics. Tijan, Aksentijevic, Ivanić, and Jardas (2019) explored the decentralized storage facility represented by blockchain technology and the possibility of its development in sustainable logistics and supply chain management. Although the benefits of blockchain technology have been most widely explored in the financial sector, major logistics issues such as border delays, product damage, errors, and multiple data entry can also be minimized through the introduction of blockchain technology.

Addressing the issue of improving the economic security of the seaport requires the study of the possibility of introducing digitalization in the economic processes of the port. Analysis of the possibility of implementing blockchain technology in typical port processes and the substantiation of the feasibility of such changes determine the main objectives of the study.

The main body of the paper

Blockchain technologies are considered a mechanism of the decentralized validation of operations based on modern cryptographic algorithms of decentralized computing resources, which are used to validate transactions recorded in the blockchain. Cryptocurrencies, common today, are the clearest example of the use of blockchain technologies, but their potential is much wider. The areas of application of these technologies can also include accounting for financial transactions, storing various records, improving work efficiency with economic counterparties, and more.

Since 2018, European companies have been actively supporting the development of blockchain technologies, which is confirmed by the growth of investment in this area. IBM predicts that investment in blockchain-based solutions will grow from $1.5 billion in 2018 to reach $60 billion by 2024.

Research conducted by the International Data Corporation (IDC) gives a relative assessment of the use of blockchain technology in various areas of economic activity. Thus, in addition to finance (43%), these technologies are used in the areas of production (20%), services (11%), distribution (10%), infrastructure (8%), and the public sector (8%) (Figure 1).

Experts identify five main areas of the use of blockchain technology (TADVISER, n.d.).

1. Finances. This includes financial and insurance services in international markets, trading in shares and securities, and the safekeeping of assets in public and private markets.
2. Logistics and supply chain management. Logistics is a complex process that requires hundreds of stages from the starting point to the final destination. The processes of placement,

transportation, storage, payment, drafting, and negotiation of contracts are time-consuming, require the attention of employees, and are exposed to risks at each stage.

3. ID. Digital identity was one of the first problems with the Internet, and remains difficult. However, the World Wide Web Consortium is standardizing the format of digital signatures, and publicly available blockchain technologies will be able to provide the decentralized registration and public keys needed to verify digital signatures.

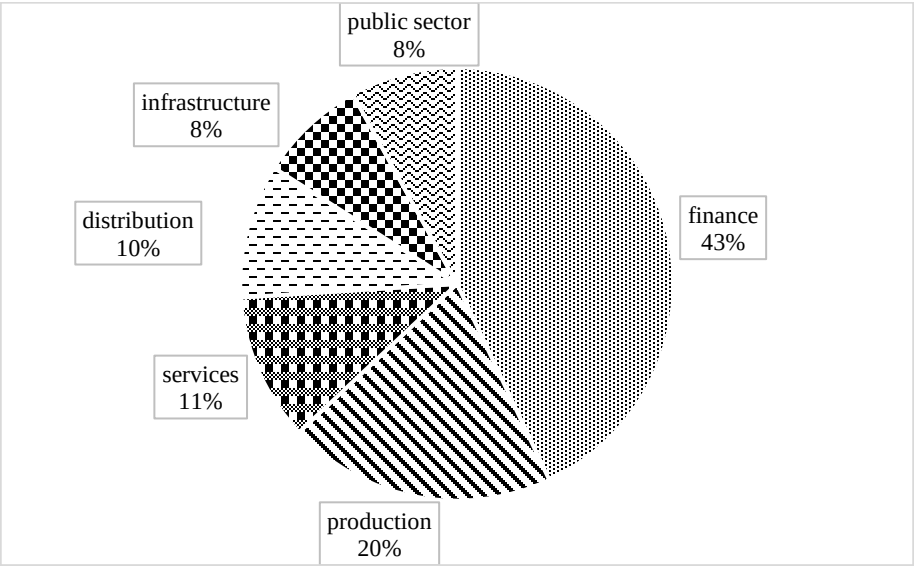


Figure 1. Areas of the use of blockchain technologies
Source: TADVISER (n.d.)

4. Retail and e-commerce. The use of blockchain technologies in the retail and e-commerce sectors will facilitate direct communication with customers, which will allow companies to better understand their needs and behavior.

5. Health care. Blockchain technologies in the health sector will be used to manage medical data, develop drugs, process complaints and bills, and for medical research.

The place of logistics in the top 5 industries for the use of blockchain technologies indicates the prospect of their introduction into the transport industry of Ukraine. Figure 1 also shows that global experience shows the introduction of blockchain technologies in all areas of the seaport, such as financial support, insurance, infrastructure, work with the public sector, provision of services, and the maintenance of industrial production.

The importance of logistics in the European economy is confirmed by the statistics of the Statista (2022) analytical platform on the amount of investment in logistics systems of countries, and we can observe trends of their increase (Figure 2).

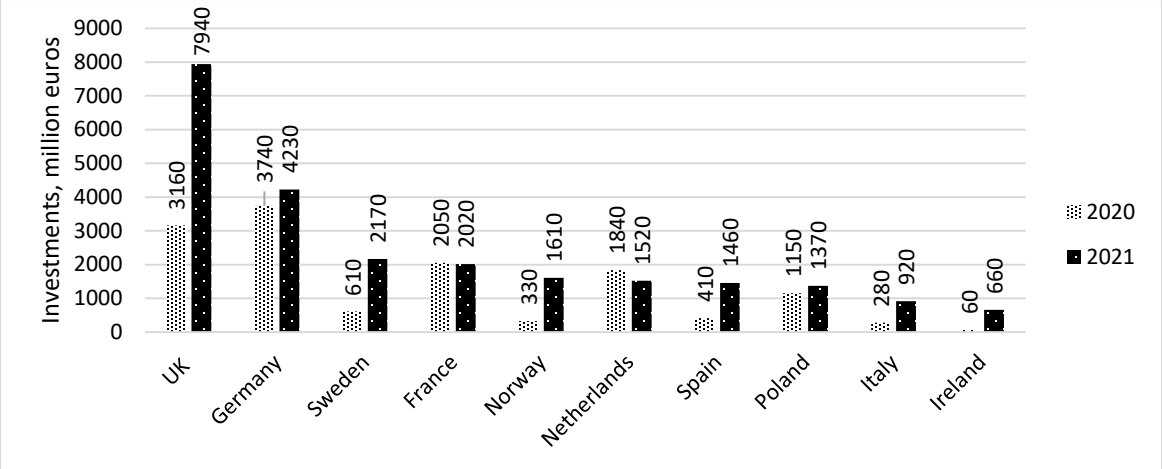


Figure 2. The amount of investment in the development of European logistics for the first half of 2020 and 2021, respectively (million €)

Source: Statista (2022)

However, the situation with investing in the development of Ukrainian logistics is much worse. While the USPA has recalculated a larger part of their revenues (approximately 75%) to the state to fill gaps in the national budget, this means that such resources cannot be used for the improvement of the Ukrainian port sector. It is quite clear that private investments remained aside because of the unstable political situation in Ukraine, deep-rooted corruption, and unpredictable and non-transparent internal and external public policy.

Ukrainian seaports certainly have the physical capacity to enter the top 100 global rankings, as it is estimated that Ukrainian container terminals can process around 3 million TEUs (or around 26 million tons of containerized cargo), but only around 25% of them are currently in use. In practice, all container transportation passes through three ports in the Black Sea, Odesa, and the South (MIU & WBG, 2019).

The competitiveness of Ukraine as a transit route or as a destination/departure point for container traffic at this time is unsatisfactory. However, increasing the use of production capacities can be a promising direction for improved reliability of the transit route through Ukraine, which confirms the statistical data on the foreign economic activity of Ukraine (Figure 3).

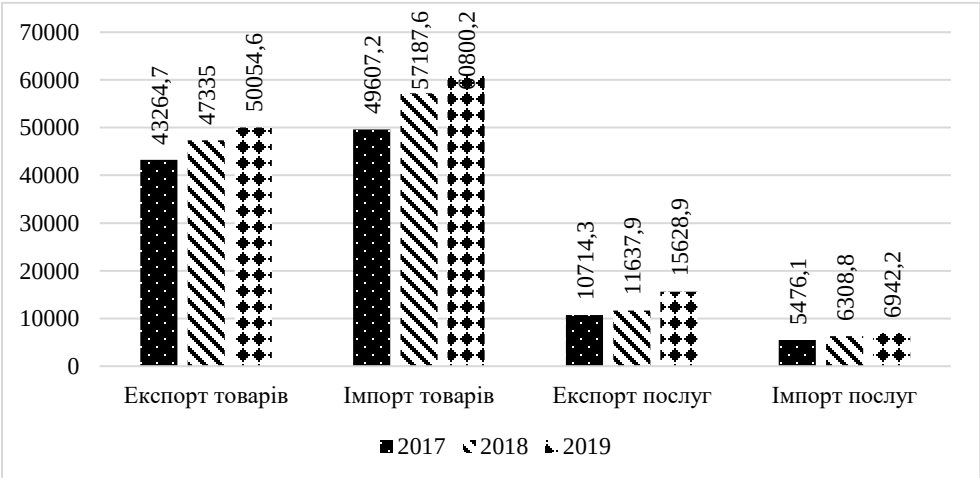


Figure 3. Data on the foreign economic activity of Ukraine for 2017–2019, million $

Source: State Statistics Service of Ukraine (2019)

The statistics show a positive balance of services, in contrast to the negative balance of goods. Interestingly, transport services account for more than half of the structure of exports of services ($9,109.9 million); services in the field of telecommunications account for $2,576.0 million; services for the processing of material resources – $1,640.2 million; business services – $1,278.2 million; and other types of services – $1,024.6 million (Figure 3).

Statistical data confirm the prospects for the development of transport services, including the transportation of goods and passengers by sea.

Sustainable transport and logistics issues have become part of the political dialogue around the world, not only in high-income countries but also in many emerging economies. Key issues typically include the need to increase energy efficiency, reduce emissions and reduce congestion, and the need to combat many other "megatrends" related to society, the environment, technology, and/or the market.

The strategy of sustainable logistics development defines the concept of sustainability as one that usually covers three dimensions, illustrated by the separate examples below. This list also means that sustainable processes are focused on efficiency in all these dimensions. It is important to realize that sustainability as a general concept cannot be reduced only to environmental issues or environmental sustainability (MIU & WBG, 2019). The strategy of sustainable logistics development is composed of:

- economic sustainability, including efforts to achieve and maintain the fiscal sustainability of the public sector and the economic profitability of logistics operations in the public sector;
- social sustainability, including improving road safety and other types of safety, labor protection issues and fair remuneration for work, and avoiding congestion and delays;
- environmental sustainability, including approaches to minimizing the impact of emissions and other external influences associated with human and transport and logistics operations, as well as the artificial and natural environment.

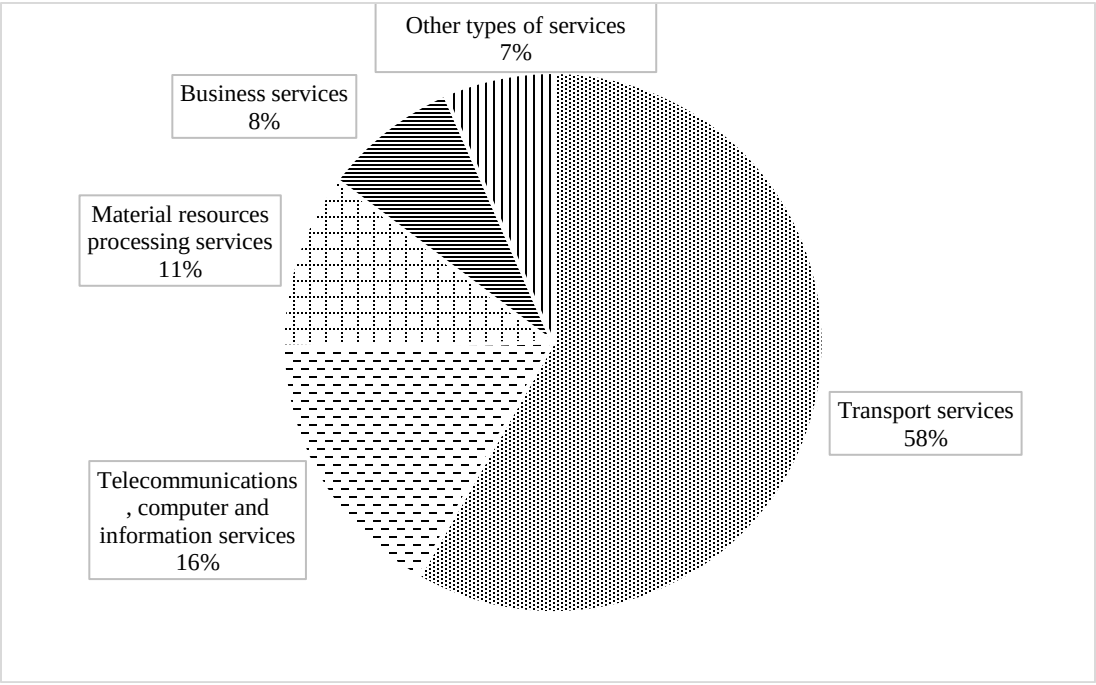


Figure 4. Structure of exports of services by type
Source: State Statistics Service of Ukraine (2019)

The introduction of blockchain technology in logistics systems will help to increase the level of competitiveness and direct the port industry towards sustainable development. David Rutter (2019), the founder and CEO of the financial and technological research company R3 CEV LLC, identified three main steps based on the results of a study of blockchain technologies: "simplify – connect – transact." That is, we are talking about improving the efficiency of supply chains by reorienting the algorithms of seaports.

The solutions to the following groups of problems of the logistics industry must be considered:

- improving mobility, accessibility, and connectivity for all users via better spatial planning, the provision of passenger transport through the mechanism of public obligations for the provision of services, and the activation of underutilized transport potential, such as inland waterways;
- technological problems such as the search for efficient technologies of alternative and/or renewable energy sources, the use of IT and "big data" in transport planning and traffic management and the use of modern IT solutions for logistics and chain operations.

For an example of the latter, consider a typical operation of scheduling ships, shown in Figure 5 (USPA, 2021).

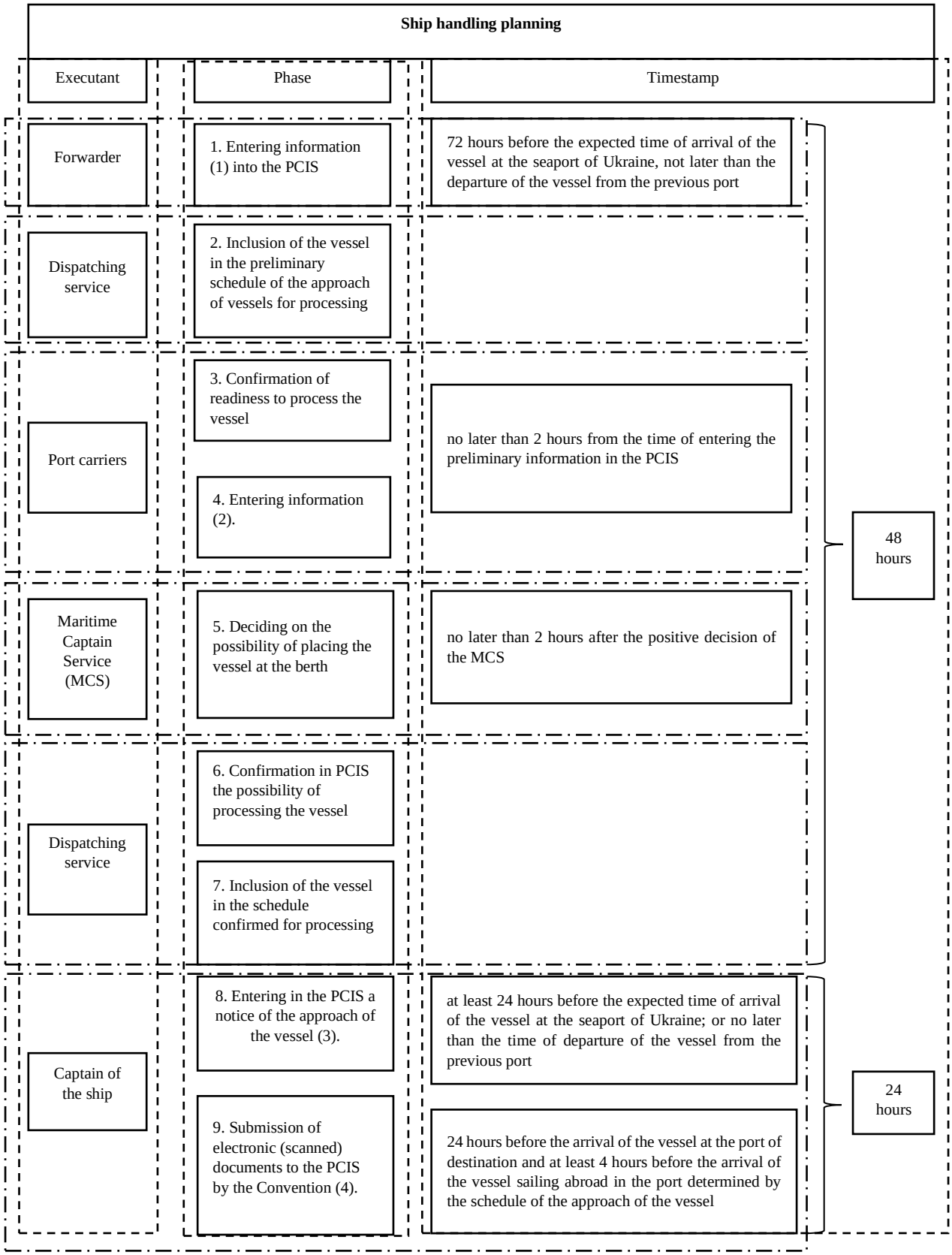


Figure 5. Technological map of ship handling planning

Source: USPA (2021)

Thus, 72 hours, or 5 units, are needed to complete the ship handling planning operation and add to the port community information system (PCIS) a list of ship parameters, cargo, and some documents for the safe operation of the seaport. The categories of information in the technological system are deciphered in Table 1.

Table 1. The list of required information and documents corresponds to the items of the technological system
Source: USPA (2021)

Category of information	List of information
1	- IMO number, name of the expected vessel; - name of the port operator (or port operators, if the ship is planned to be installed at several terminals); - name and quantity of cargo planned for processing; - maximum length and width of the vessel; - maximum draft; - suggested lay day canceling date.
2	- berth number; - lay day canceling date; - additional conditions for placing the vessel at the berth; - terms of readiness of cargo parties for loading.
3	- general declaration; - ship's role; - list of passengers; - declaration of ship's supplies; - classification certificate; - registration certificate; - international measurement certificate; - international trademark certificate; - other documents at the request of the seaport captain's service, in the cases provided for by legislation, depending on the type of vessel, the presence of restrictions, established by the classification society, the nature of the cargo; - waste notification.
4	- declaration of cargo; - declaration of personal belongings of the ship's crew; - the manifesto of dangerous goods; - maritime sanitary declaration; - ship's sanitary certificate; - a document defined by acts of the universal postal union, accompanying international postal items (if any); - information on the presence (absence) onboard the ship of goods whose importation into the customs territory of Ukraine is prohibited or restricted, including currency values available to crew members, medicines, which include narcotic drugs, potent drugs, psychotropic and toxic substances; - information on the presence (absence) onboard the ship of dangerous goods, weapons, ammunition; - obligations of the master of the vessel to re-export the vessel (for vessels flying a foreign flag); - obligations of the master of the vessel purchased abroad.

Moreover, moments of repetition and cancellation of operations are allowed, which complicates the operation of the port and reduces its efficiency. With the existing ship processing planning algorithm, all stages are performed consistently and over a long time.
The operation of the ship-handling planning process at the present stage is a linear sequential process, which is provided in Figure 6.

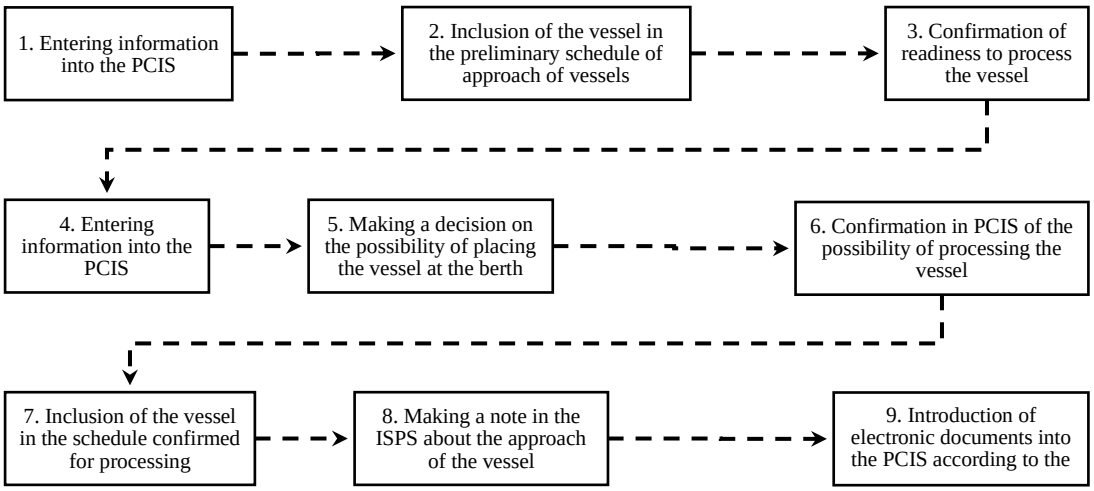


Figure 6. The ship processing planning process: current state before the introduction of blockchain technologies
Source: USPA (2021)

Barclays, the Royal Bank of Scotland (Bits.media, 2019), and R3 (www.r3.com) tested blockchain technology in real estate. According to their results, the term of purchase and sale can be reduced from three months to three weeks, leading to savings of almost $160 billion per year.
Similarly, the use of technology will affect the implementation of transport services. Improvements in the ship handling planning process are presented in Figure 7.

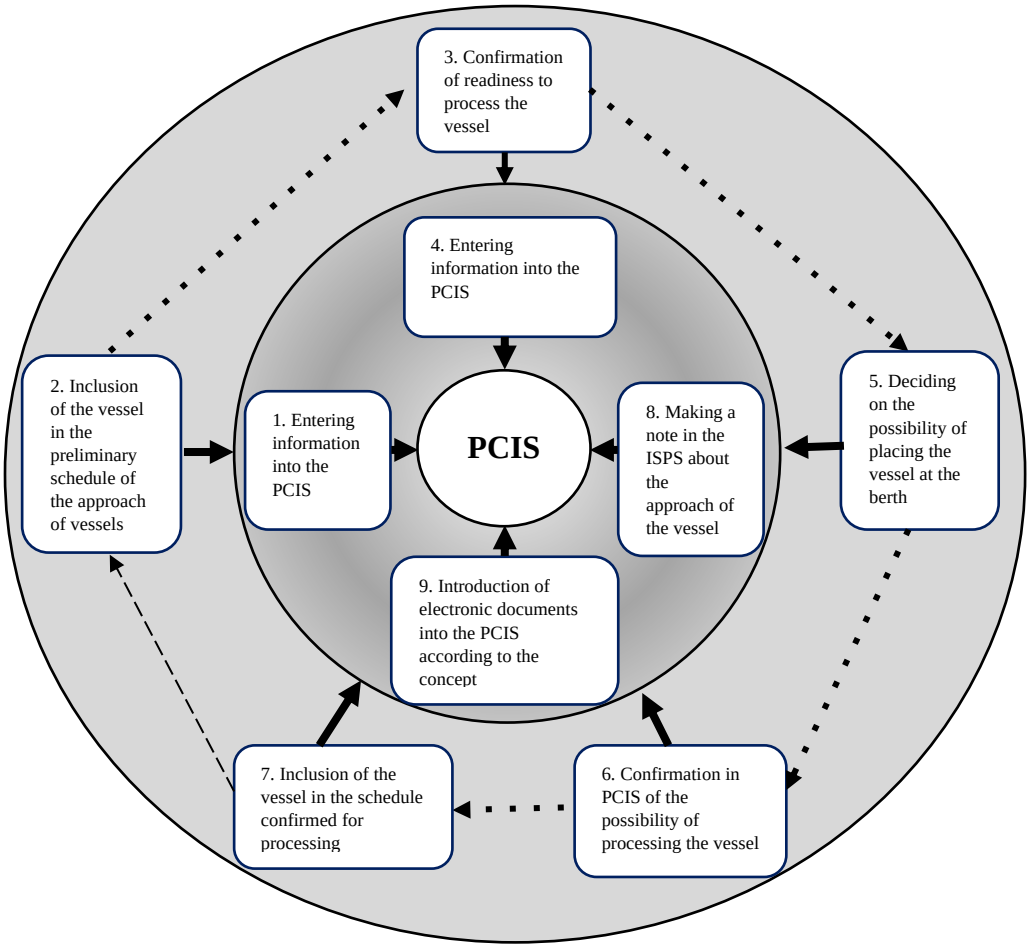


Figure 7. The process of planning the processing of the vessel: possible state after the introduction of blockchain technologies
Source: USPA (2021)

At the heart of this chart is the Port Community Information System (PCIS), which brings together all users and the necessary stages of ship handling.
The center circle of the chart contains the information that the system must receive and store. It is assumed that – in contrast to the current system of claim 1, claim 4, claim 8, and clause 9 being entered into the system some time before their receipt by the addressee, i.e., the seaport unit – this will happen immediately after the formation of the necessary information by the relevant economic entities. It is important to remember that all downloaded information is secure through the use of blockchain technology.
The outer circle of the diagram includes processes that wait for a response from system users. These processes have to wait for information to be entered and some data to be analyzed. Given that ISPS will be more secure, the necessary information is expected, responses to requests or the time spent on their processing can be automated, and the risk of error is minimized.

Conclusions

The international nature of the operation of seaports in the context of globalization, crisis processes, and digital transformation requires seaports to transform the functioning of the enterprise. In the

field of economic security, blockchain technologies are becoming more widespread. The most striking example of the use of blockchain is the creation of cryptocurrency. However, their use is not limited to the financial sphere. Their use also extends to logistics and supply chain management, identity cards, retail, and healthcare. Thus, the main practical results of the implementation of blockchain in the ship handling system include:

- reducing the time spent on processing information, documents, and requests;
- reducing monetary costs for processing information, documents, and inquiries;
- increasing the level of security of the operational activities of seaports;
- increasing the level of competitiveness of Ukrainian ports in international transport operations.

The analysis of statistical data allows us to proclaim the relevance of the study, and to provide conclusions regarding the prospects of implementing the results of the study in practice.

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ANALYSIS AND PERSPECTIVES OF THE LEVEL OF DIGITALIZATION OF ENTERPRISES IN THE EU MANUFACTURING SECTOR

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Abstract. *The impact of technological advances is being felt in all industry sectors; thus, there is no doubt that digital transformation will significantly affect the Lithuanian manufacturing sector. In order to assess the extent to which companies in the Lithuanian processing industry are digitalized, an in-depth descriptive analysis of installed digital technologies in these companies was executed. The goal of this analysis was to determine whether Lithuanian companies in the processing industry have been sufficiently digitalized and are ready to completely adopt the principles of Industry 4.0 in the installation of digital solutions within all segments of value-chain creation. Research on the digital tools and technologies that have already been applied in these companies was performed during the phase of analysis. A comparative analysis of EU countries was also performed, during which countries were analyzed by criteria such as changes in production outputs and number of employees, changes in the share of manufacturing in GDP, share of high-tech sectors in total manufacturing output, level of capacity utilization, share of employees in the manufacturing sector in total employment, personnel costs, and wages. There was also an attempt to define the most digitalized processes of operation and the least (or non-) digitalized processes of operation in companies. After the assessment of the current digitalization level in the company, there was an attempt to clarify the strengths and problematic challenges as well as the underlying reasons for these challenges. After the above-mentioned data was collected, recommendations on which additional tools and means to apply in order to encourage the process of digitalization in these companies were formulated and passed on to the companies.*

Keywords: *digitalization, employment, manufacturing sector, competitiveness.*

Introduction

The European Commission (2017) has underlined the importance of a strong and high-performing industry for the future of Europe's economy, and the need to bring industry's weight in the GDP of the EU back to 20% by 2020. The European Parliament states that 80% of all innovation and

exports come from industry, as do many jobs. For this reason, the main focus of EU policies must be strengthening Europe's industrial base. Despite numerous efforts, Europe's role in the global data and platform economy is limited, and the uptake of digital technology by SMEs is low: 90% of SMEs and 60% of large companies are lagging behind (Roland Berger Strategy Consultants, 2015).

The OECD (2018) report shows that not only routine manual workers are at risk, but also the places of highly skilled workers whose work can be replaced by software. More productive workplaces with simple working algorithms featuring unambiguously definable procedures are more threatened, but also those jobs whose tasks can be replaced by software solutions (accounting, administration). On the other hand, there are jobs that do not require high qualifications, yet they are not easily artificially substituted (OECD, 2018).

There is no doubt that digitalization has been completely revolutionizing the present era, and digital transformation is expected to have a vast impact on almost any industry as it can bring new opportunities for SMEs by improving the entire value chain (Kilimis et al., 2019). In the scientific literature, authors emphasize the importance of industry digitization (Wang et al., 2016; Qin et al., 2016). They state that companies need to implement the latest technology, and that digitalization will have a monumental impact on the global economy, so vast and multifaceted that it will make it hard to disentangle one particular effect from the next (Schwab, 2016).

Digitalization can be defined as a "a change in all job and income creation strategies, application of a flexible management model standing against competition, quickly meeting changing demands, a process of reinventing a business to digitalize operations and formulate extended supply chain relationships; functional use of Internet in design, manufacturing, marketing, selling, presenting and data-based management model" (Schallmo et al., 2018).

In order to generate specific steps/recommendations in regard to the digitization of Lithuanian industry, it is useful to study existing cases of industry digitization in other EU member states.

Literature review

Industry is the part of the economy producing material goods that is mechanized and automated (Lasi et al., 2014). According to the Global Manufacturing Risk Index (Cushman & Wakefield, 2018), Lithuania is rated amongst the top 5 global manufacturing destinations in the world. While Lithuanian manufacturing is currently enjoying a period of dynamic growth, the combination of rapid increases in labor costs and lagging productivity, together with the dominance of low-tech sectors in the Lithuanian manufacturing structure, have put significant pressure on the competitiveness of the Lithuanian manufacturing sector. The majority of entrepreneurs recognize the concept of Industry 4.0 as a significant opportunity for development and improvement in competitiveness (Ślusarczyk, 2018). The strengthening of the digitalization processes in EU industry may put additional competitiveness pressures on Lithuanian manufacturing businesses. In order to maintain the competitiveness of Lithuanian industry, steps towards the digitalization of industry have to be implemented. Digitization offers the potential for quality improvement, flexibility and productivity (Hoellthaler et al., 2018).

Lithuania stands quite tall regarding the size of its manufacturing sector, which occupies a leading position (higher than the EU average of 15%), and has managed to sustain or increase the share of manufacturing in its GDP (Eurostat, 2017). In regard to the structure of the manufacturing sector, Lithuanian manufacturing is heavily dominated (80% of total production) by the medium-low and low-tech sector (Eurostat, 2014), while in many other countries' economies, half of their manufacturing output is generated by the medium-high and high-tech sectors.

Lithuania has the lowest share of high-tech industry in manufacturing output in the whole of the EU, but currently has a higher rate of capacity utilization than in 2007. However, the Lithuanian rate of capacity utilization in manufacturing is much lower than in other countries (Eurostat, 2017). Lithuania did not register substantial differences in trends in total employment and employment in the manufacturing sector. Growth in manufacturing output and labor in this sector was observed; however, this can be a sign of lagging investment in digitalization by Lithuanian manufacturers. The country also lags behind in terms of wages in the manufacturing sector: hourly wages during 2017 in the manufacturing sector were 3.5 times lower than the EU average (Eurostat, 2017).

Obviously, the situation regarding Lithuania having the lowest share of high-tech industry in manufacturing output in the whole of the EU has to change, and the manufacturing sector has to improve this by investing in business structure improvements and reorienting towards the creation of this type of enterprise (Bičkauskė et al., 2020)

There are signs that businesses in Lithuania underinvest in digitalization processes. However, in order to remain competitive, companies will have to rethink their strategies concerning future investments.

Experts highlight four areas in which digitization technologies will have the greatest impact: productivity, revenue growth, employment and investment (Rußmann et al., 2015). Increasingly affordable hardware and software solutions accelerate the transition towards the smart and interconnected factories envisioned by Industry 4.0 (Almada-Lobo, 2016).

Stoldt et al. (2018) highlighted that companies can implement two strategies to digitalize their business: transform their processes and production sites incrementally; or implement radical change by exchanging entire processes and systems with fully digitalized ones. According to Stoldt et al. (2018), SMEs typically do not have the economic strength to sustain such a revolution but are eager to employ novel technologies in their factories to raise their competitiveness.

Digital transformation can potentially create new possibilities for SMEs (small and medium enterprises) and encourage new ways of development and growth. According to Sommer (2015), however, only large companies can benefit from Industry 4.0, while SMEs can, adversely, become victims of the standards of Industry 4.0. For most SMEs, it is hard to understand which digitalization technologies to choose and acquire, and how to secure the financial incentives and means for the digital transformation of their operations. Raymond (2005) determined several operational indicators that, as SMEs may expect, can be significantly enhanced if companies invest into digitalization technologies: better quality, increased productivity, reduced costs of operation and greater flexibility.

When talking about the biggest challenges of digitalization, Peillon and Dubrue (2019) offered a reasonable classification of potential digitalization obstacles for SMEs. This classification includes technological problems (related to financial and technical resource limitations), organizational obstacles (related to the unwillingness of staff to change), obstacles related to human resources (such as the constant lack of sufficiently qualified employees) and client-related obstacles (such as customers' fear of losing their sensitive information and compromising the security of their IT systems). Moeuf et al. (2018) mentioned the following production activity goals for SMEs: flexibility to adapt to the changes of a constantly changing market, cost reduction, increase in productivity, quality improvement, and shortening of delivery time. According to Moeuf et al. (2018), flexibility is the most commonly determined goal of operational activities by the majority of market researchers, and can offer surprising benefits for their practices. This is because it is flexibility that is a common characteristic of SMEs, allowing them to distinguish themselves among other companies.

Bayo-Moriones et al. (2013) offered a similar list of indicators after their study on the application of new digital technologies to industrial enterprises, which was additionally supplemented by a criterion of shortened delivery time.

All the above-mentioned operational activity indicators are important in order to assess the impact of Industry 4.0 on the flexibility, costs, productivity, quality and delivery time frame of SMEs. Regardless, SMEs identify themselves as lagging behind the innovations of digitalization since the process of digital technology application remains slow, and companies bear the risk of being excluded from the digital delivery chain. Moreover, SMEs tend to formulate faulty preconceived notions about the complexity and high price of digitalization (Kilimis et al., 2019).

According to Rüttimann and Stöckli (2016), SMEs will be overburdened by the increased need for financial investments in digitalization, while the installation and integration of Industry 4.0 into the operational processes of large enterprises will considerably enhance their flexibility. This will help the latter to dominate the larger share of the customized individual product market – a segment which is currently dominated by SMEs.

Trends in manufacturing output

While Lithuania lags behind in terms of innovative output in manufacturing, the Lithuanian manufacturing sector stands out among other economies in terms of the rapid growth of production output. In the previous 5 years alone, Lithuanian manufacturing output rose by a third, mainly driven by increasing sales in export markets. Despite the fact that Lithuania has enjoyed very rapid growth in manufacturing output compared to other selected economies, the dominance of the low and medium-low tech sectors in manufacturing restricted the turnover per person employed in Lithuanian manufacturing. For example, in 2011–2015, the turnover per person in Lithuanian manufacturing stayed the same, while the actual production output grew rapidly. Therefore, in general, while Lithuanian manufacturing companies are producing more and more goods, typically they do not earn more revenue per person employed. Other economies managed to sustain a gradual increase in turnover per person employed.

Statistics on capacity utilization draw a particularly interesting picture when comparing Lithuania to other countries (see Figure 1). Lithuania currently has a higher rate of capacity utilization than in 2007 (before the global financial crisis). This is an optimistic sign, given that a rising rate of capacity utilization typically implies that manufacturing companies are planning to invest in additional capacity.

Manufacturing companies in many other countries are using production capacity to a much higher level than in Lithuania. Actually, in comparison to other EU economies, Lithuania is in the group of countries with the lowest rate of capacity utilization in the manufacturing sector – despite the fact that the Lithuanian manufacturing sector is enjoying very dynamic growth in production output.

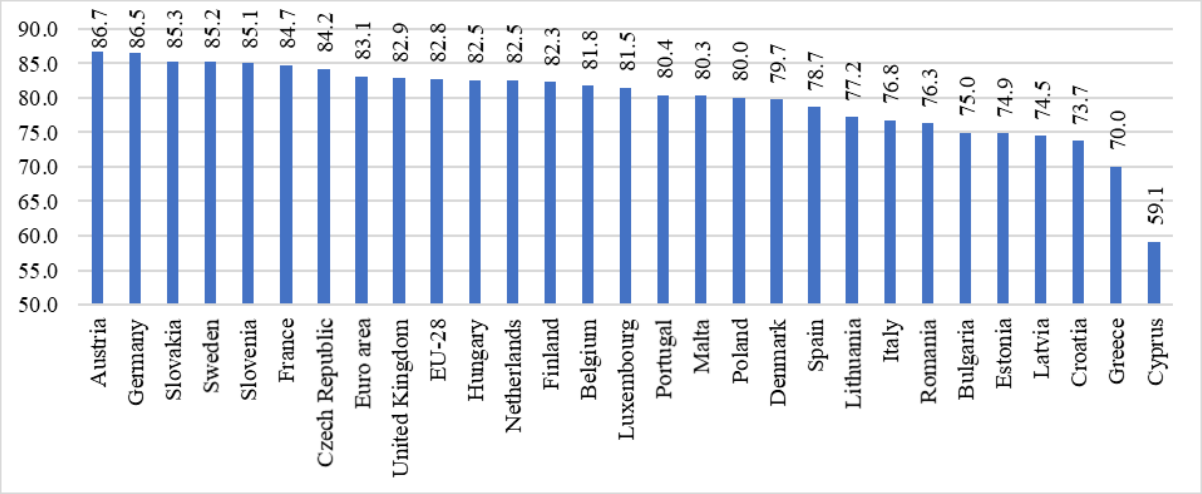


Figure 1. Level of manufacturing capacity utilization in 2017, %
Source: Eurostat (2017)

Human capital becomes more important, because not only does more have to be done with lower human resources, but organizations also need motivated employees (Bal et al., 2010). Human capital that is skillfully managed and integrated in workplaces has a positive effect on the organization's results (Foster, 2010). As regards employment in manufacturing, it is interesting to observe the long-term trend in the share of employment in manufacturing within total employment – and the trend in digitalization is clearly evident here (see Figure 2).

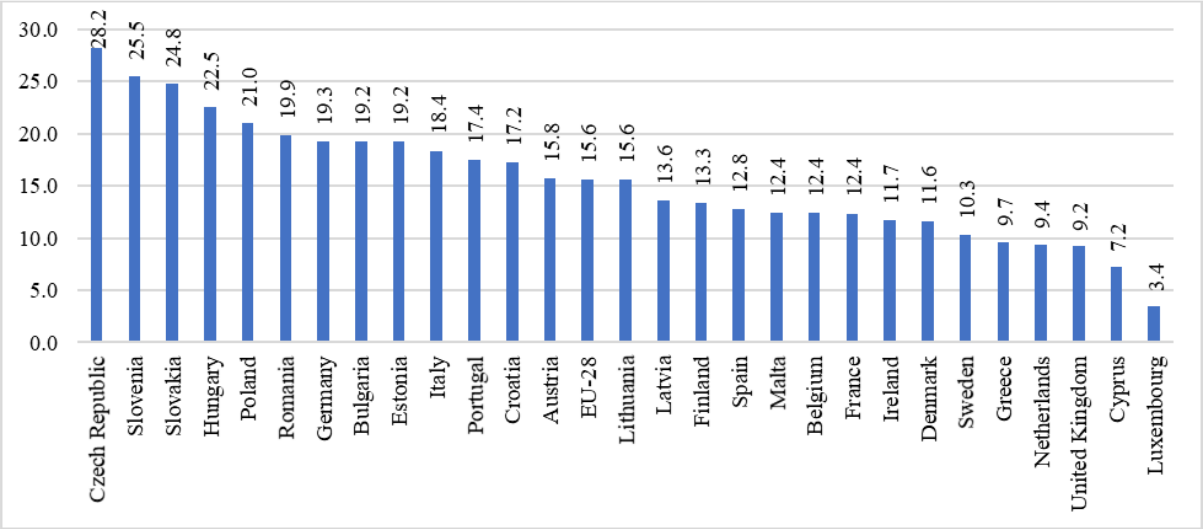


Figure 2. Share of employees in the manufacturing sector in total employment in 2017, %
Source: Eurostat (2017)

In regard to the share of employment in the manufacturing sector as a percentage of the total number of employees in the whole economy, the Czech Republic, Slovenia and Slovakia are the leaders among the economies in Europe. Almost one quarter of all employees are occupied in the manufacturing sector in these countries. As Kamal-Chaoui (2018) said, the question is whether advanced automation and digitalization will reduce the number of available jobs, or just transform the traditional professions into new digital professions.

Digitalization trends in the manufacturing sector are also clearly visible when comparing the change in the number of employees between 2010 and 2017 in the total economy and in the manufacturing sector. In some of the selected economies, a substantial difference in employment trends in industry and in the total economy can be observed. Lithuania did not register substantial differences in trends in total employment or employment in the manufacturing sector. In Lithuania, the total number of employees in 2017 rose by 6.6% compared to 2010, while the number of employees in the manufacturing sector rose by 7.2%. Of course, rapid growth in manufacturing output is a very important reason for this; however, it can also be a sign of low investment in digitalization by Lithuanian manufacturers.

Lithuania substantially lags behind the other countries in terms of wages in the manufacturing sector: hourly wages in the Lithuanian manufacturing sector in 2017 were 3.5 times lower than the EU average (Figure 3). A key factor behind such visible differences in salaries is the significant difference in the structure of manufacturing from the innovation point of view. Lithuanian manufacturing is still strongly dominated by low-tech (Figure 4) sectors and contract manufacturing businesses. In the report above, it was also shown that 85% of employees in the manufacturing sector are employed in the medium-low and low-tech sectors in Lithuania. Data from Eurostat also shows that Lithuania lags substantially behind other EU member states in employment in high-tech industry, as observed in the graph below.

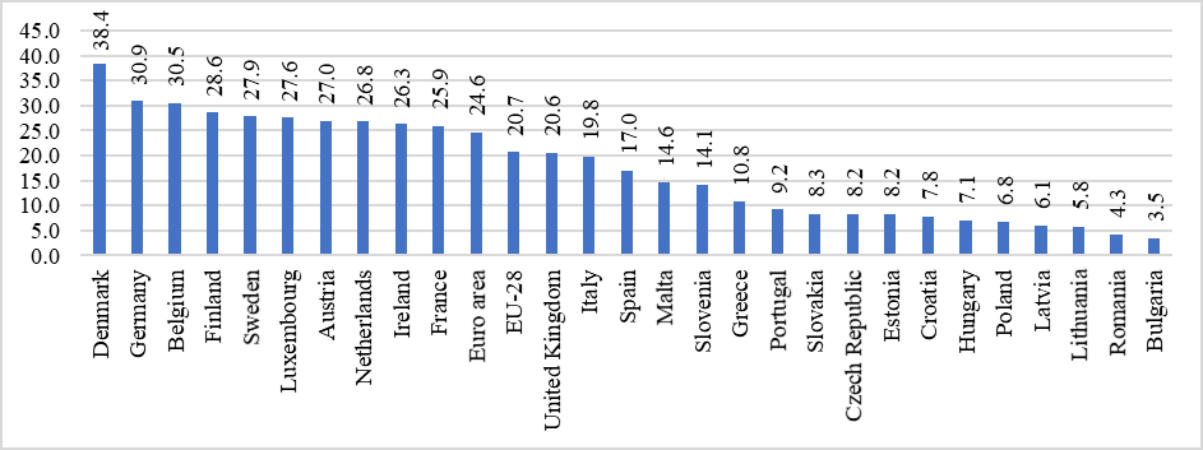


Figure 3. Manufacturing salaries in 2017, €/hour
Source: Eurostat (2017)

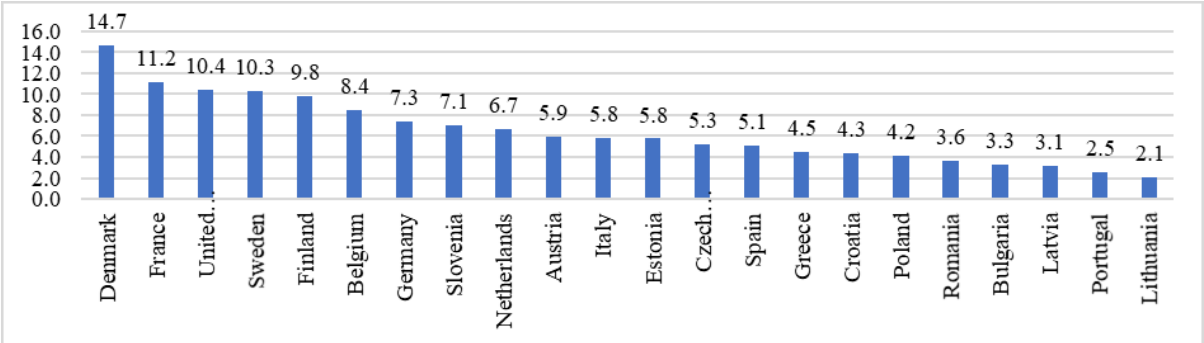


Figure 4. Share of total manufacturing employment occupied by employees in the high-tech manufacturing sector in 2014, %
Source: Eurostat (2014)

Data from Eurostat shows that labor costs account for 14.4% of the total expenditure of the Lithuanian manufacturing industry, but their share is rising rather rapidly: in 2011, for example, this figure stood at 9.5%. In 2010–2015, however, the wages and the share of personnel costs in total manufacturing expenditure in Lithuania both rose by 27% – perhaps a sign that Lithuanian manufacturing companies are underinvesting in digitalization.

Data and methodology

To assess the level of digitalization of Lithuanian companies in the manufacturing industry, an in-depth descriptive analysis of the digital technologies already applied in those companies was conducted. The main goal of the analysis was to determine whether Lithuanian companies in the processing industry have been sufficiently digitalized and are ready to fully adopt the principles of Industry 4.0 in the installation of digital solutions within all segments of the creation of the value-chain. The survey on the determination of the level of digitalization consisted of 50 questions grouped into 10 topics, with each topic containing 5 questions. The ten topics of the survey were divided into separate groups based on certain operational processes in the companies. As a result, the answers to the survey questions provided data about the level of digitalization in the concrete processes of enterprises' operational activities. Five blocks of questions in each topic provided information on whether the operational activity of a certain enterprise is executed by the use of particular digital tool that is built-in in order to digitalize the control of that particular operational activity.

The topics of this questionnaire were designed to evaluate the level of digitalization in the following operational activities of the companies: management of customer relations, management of product warrantee cycle, management of local network, quality assessment (digitalized), execution and monitoring of production, planning of production and resources, digitalization of production, management of inbound logistics and warehouse, digitalized maintenance and servicing of equipment, and management of laboratory or design information. The question block mainly focused on whether the management of these processes is digitalized, whether they use certain IT systems and/or sensors, data harvesting and analyzing databases, and digitalized technical equipment which execute and control the enterprises' production. With the help of these question blocks, there was an attempt to collect all the relevant data on the general level of digitalization, the level of digitalization of the enterprise's operational activities, and particular digital tools (both already installed and in the process of being installed). This was conducted in order to assess the relevancy and profitability of these tools to the Lithuanian manufacturing companies that participated in the questionnaire.

Concurrently, research on the digital tools and technologies already installed in the companies that responded to the questionnaire was being conducted. This analysis also enabled us to determine the most digitalized operational activities in these companies, as well as to define the least digitalized or non-digitalized spheres of value chain creation. After the determination of the current level of digitalization in the particular company had been made, the question of the strongest and weakest points of digitalization in the company was raised and answered, and a search for the potential reasons for weaknesses in digitalization was conducted. In the end, a valuable and specific data set was collected concerning these enterprises, and appropriate recommendations were created for them. The key objective of these recommendations was to propose the installation of additional tools and the application of other means so as to activate existing digitalization processes in these companies.

Digitalization levels

The digitalization level in the companies studied was determined by using the table of digitalization levels provided by the digitalized auditioning methodology (see Table 1). Table 1 describes the four levels of enterprise digitalization which are used to determine the level of enterprises' digitalization of their operational processes. This is assessed by the number of different digital tools already installed in the creation of the value chain in that particular enterprise, beginning with marketing, product research, acquisition of resources, planning of processes, production, testing, logistics and finishing with sales, warrantee services, and recycling.

Table 1. Levels of digitization of enterprises according to implemented technologies

Level of digitalization	Description of the nature of the level
Weak	The company has not implemented digital technologies or there is no need for their implementation
Middle range	The company has somewhat used various information communication technology tools to automate various processes
Good	The company uses the digitalization of various processes and is moving towards the development of Industry 4.0 in the areas necessary for the company
Excellent	The company is moving robustly towards Industry 4.0 technologies and several of the horizontal and vertical value chain processes have been digitized to the required level through various ICT solutions (both software and hardware)

Based on the digitalized auditioning methodology, there are three key interrelated parts to enterprise development, productivity and competitiveness: the level of enterprise process digitalization, the level of flexibility, and the level of production line automation.

The optimal digitalization level is achieved when various digital technologies within a company completely run and control its whole chain of production. This includes: marketing, product research, purchase of resources, planning of processes, manufacturing, product testing, logistics, sales, warrantee services, and recycling. The optimal level of flexibility is achieved when high-quality and affordable customized products are made, which can be delivered to customers within a short period of time. Flexibility is divided into several forms: flexibility of production lines; flexibility of production; flexibility of quantities; flexibility of production delivery routes; flexibility of production processes; flexibility of product; and flexibility of development. This notion of flexibility and its scope is very important when seeking complete productivity and effectiveness in a company, and it should be involved in as many stages as possible in the production processes of the enterprise. The level of automation depends on how many automated tools are being used within production operations (CNC, robotics, resource management systems, etc.). Therefore, the efficiency of enterprises' operations, especially when the enterprise is in its expansion phase, depends on the number and variability of digital tools installed and integrated into the value-chain creation processes and, as such, encourages flexibility within all spheres of production – from production lines to the product itself.

A high level of digitalization has a positive impact on the competitiveness and productivity of enterprises. However, during the digitalization of operational processes, one must bear in mind that companies must be prepared to adapt themselves to the new normal of the relationship between a machine and a human. Industry 4.0 brings new paradigms of smooth human-machine interaction that might be complicated to accept, especially in terms of enterprises' current preparedness with regard to the number of employees and their qualifications. Even though automated production

machines interact with production planning systems autonomously, it is important to observe that the integration of a human specialist into this renewed process requires a new, re-orientated vocational paradigm (Krupitzer et al., 2020). Therefore, the tasks of specialists will change according to the changing technologies in the enterprise, the number of specialists needed will change, and there will be a new need for specialists with higher qualifications suitable for the management and control of newly digitalized innovative production processes in the enterprise.

The research data sample

A questionnaire was sent to 50 enterprises which were chosen as the data sample of this research, from which 43 answers were received. The enterprises in the questionnaire represent the following sectors: food and beverages, tobacco producers (25% of all enterprises in the questionnaire); furniture manufacturers (5%); toy, jewelry, and musical instrument makers; machine and equipment installers and maintenance service providers (16%); wood, paper and paper product producers or publishing and printing service providers (9%); electrical equipment producers (9%); common metal and metal product producers (excluding motor and machine makers) (9%); scientific research and applied technology producers (5%); construction companies (4%); chemical product producers (2%); rubber and plastic product producers (2%); other machine producers (2%); transport equipment producers (2%); transport and warehousing service providers (2%); informatics and connection services providers (2%); and real estate operators (2%). The largest share of these were represented by middle-sized enterprises (51%), with 50 to 249 employees. The lesser portion was represented by small (16%), very small (12%), very large (12%) and large (12%) companies.

Results and discussion

The level of digitalization among enterprises in the Lithuanian manufacturing industry is very different. Results within the research data sample varied from level 1, where 12% digitalization is reached within the operations of the company, to level 3, where 67% of all operational activities are digitalized. The general level of industrial digitalization among Lithuanian enterprises in the manufacturing industry varies from 2 to 27.4%. These values of the indicator of the digitalization level indicate that these enterprises have already installed informational-communicational technological tools and devices designed to automatize their production processes.

The main underlying reason for why the level of digitalization among the enterprises in the questionnaire does not reach the higher margin is that these enterprises receive many individual production orders and contracts. These individual production contracts and orders are of limited scope and quantity; thus, it is a very complex and costly process to automate their production with current technological tools and devices. Therefore, in the case of fulfilling these individual orders, it is far more beneficiary to employ higher numbers of employees with lower qualifications rather than to automate production lines with the help of digitalization.

The companies in the questionnaire perceive the importance and benefits of automation and industrial digitalization, and have plans regarding which processes they would digitalize. Some are ready for these changes because they understand that digitalization will secure their competitiveness in the future market. However, the main challenges that stand in their way towards more extensive digitalization are the resistance of their staff and the lack of change management skills among their managers. Another important reason is uncertainty as to whether the digitalization of industrial processes will pay off over time. This deters businesses from

digitalization because they simply do not know whether their profits would sufficiently increase after investment into industrial digitalization. The final reason for avoiding digitalization among the companies that responded to the questionnaire was the lack of knowledge about the most suitable digitalization tools and technologies for each particular enterprise. For these reasons, an analysis of the digital tools already installed at these enterprises was executed in parallel with the evaluation of activity indicators. This consisted of comparing these indicators to assess whether they were larger in the companies with higher levels of digitalization than in those with zero levels of digitalization.

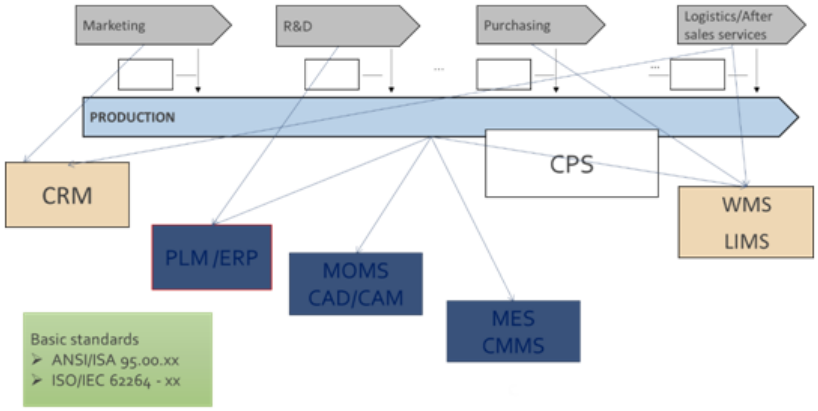


Figure 5. Digitalization value chain

In Table 2, the topics of the questionnaire are provided. These topics were given in logical sequence according to the operational processes of the enterprise, beginning with activities in value-chain creation (see Figure 5). This includes the management of the company, the planning and execution of orders, and key operational activities such as the organizing of production and its management. During the assessment of the level of an enterprise's digitalization based on the topics of the questionnaire, a relatively consistent estimate of the digitalization of the enterprise's operational process was derived. When analyzing different spheres of production operations, the strong and weak aspects of the enterprise's digitalization level within the creation of the value-chain were determined.

Table 2. Level of digitization of enterprises by business processes

Digitalized processes	Min	Max	Average level	Std error	Median
1. Digitalization in customer relationship management (CRM)	0.0%	100.0%	**36%**	28.1%	35.0%
2. Digitalization in technology planning, product lifecycle management (PLM)	0.0%	100.0%	**45%**	26.6%	45.0%
3. Vertical and horizontal value chain integration through computer networks	0.0%	100.0%	**46%**	23.0%	50.0%
4. Digitalization in computer aided quality control (CAQ)	0.0%	70.0%	**15%**	19.0%	10.0%
5. Digitalization in production monitoring, using a manufacturing execution system (MES)	0.0%	90.0%	**31%**	22.8%	30.0%
6. Digitalization in production planning, enterprise resource planning (ERP)	0.0%	100.0%	**26%**	26.0%	20.0%
7. Using hardware for digitizing manufacturing (towards cyber physical systems – CPS)	0.0%	70.0%	**17%**	20.1%	10.0%
8. Digitizing inbound logistics and warehouse management (WMS)	0.0%	70.0%	**16%**	19.7%	10.0%

9. Digitizing the equipment maintenance process (CMMS)	0.0%	100.0%	**20%**	23.3%	15.0%
10. Digitizing quality assurance and laboratory information management (LIMS)	0.0%	100.0%	**23%**	25.7%	20.0%

Table 2 illustrates that the most digitized value chain processes in enterprises are as follows: customer relationship management (36%); technology planning, product lifecycle management (45%); and vertical and horizontal value chain integration through computer networks (46%). This shows that companies are focusing on embedding digital tools in key value creation processes that drive sales, help develop new products, manage orders efficiently, perform production efficiently, and help to increase company productivity and reduce costs.

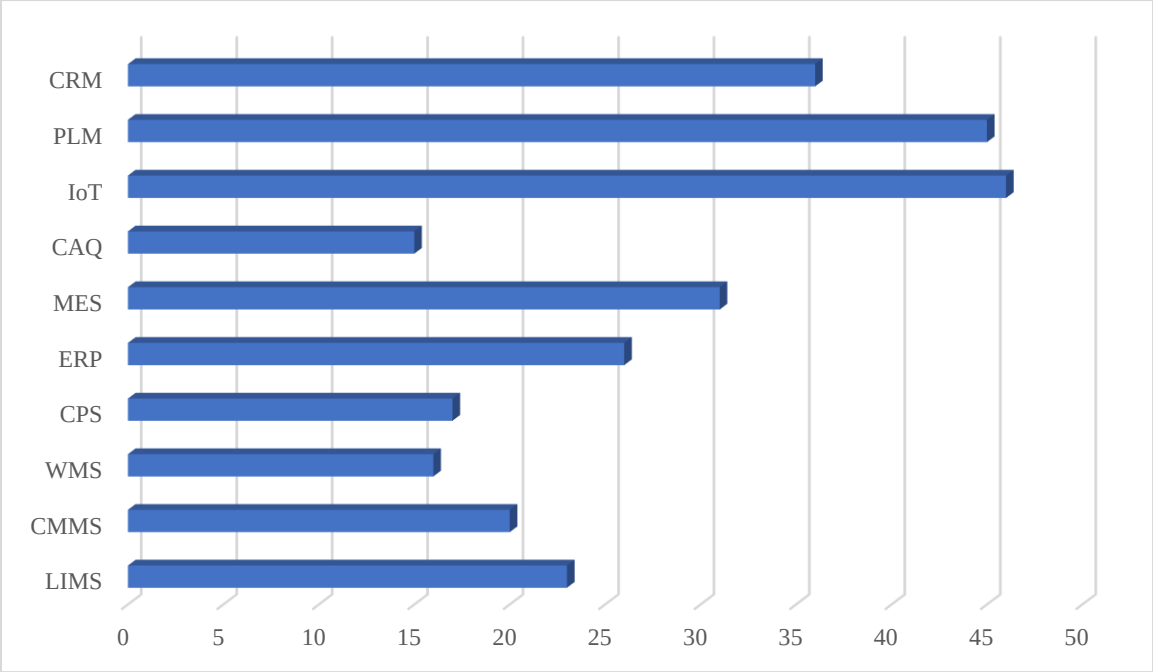


Figure 6. Percentage of digital tools installed in enterprises

As a result, it can stated that the most commonly installed digital tools in the abovementioned enterprises' operational processes are as follows (see Figure 6): digitalization of customer relationship management (CRM); digitalization of product lifecycle management (PLM activity integration through computer networks – LAN, IoT, Internet); digitalization of manufacturing execution system (MES); and digitalization of enterprise resource management (ERP). These digitalization tools are chosen because of their inter-synchronization features as well as their synchronization with other enterprise IT systems and production tools. CRM helps to increase sales and to enhance relationships with an enterprise's customers. Moreover, it helps to define key target markets and the demand for particular products. PLM is useful in collecting the information basis – from the creation to the mass production of the particular product – which is extremely important when creating new products according to clearly expressed customer needs. Computer networks and data exchange systems (LAN/IoT) enable the digitalized management of production orders, simultaneously managing related information through different departments and employees, thus ensuring the integration of operational processes. Due to this level of integration, orders for production are delivered smoothly and efficiently. Next, a manufacturing execution system (MES)

is used, which manages production operations and simultaneously collects information which enables staff to execute efficiency analysis in the production line. An enterprise resource management digitalization tool (ERP) enables staff to more efficiently plan orders for production and production operations, thus reducing the cost of operations. All of these above-mentioned digitalization tools support enterprises in their attempts to digitalize everyday business operations and ease the workflow of the employees in the company.

When comparing these enterprises in terms of whether they have or have not already installed these commonly applicable digitalization tools, obvious differences in performance indicators come into sight. Companies with pre-installed customer relationship management (CRM) tools are middle-sized entities, with annual turnovers of €5–€10 million and 75%–100% of their annual turnover coming from export. The key production areas of their activities are manufacturing transport equipment, electrical appliances, metal products, and food products. Companies which have not installed such tools are also middle-sized, with annual turnovers of €10–€20 million and 50%–75% of their annual turnover coming from export. Their key production activity areas are food production, wood processing, and paper production. The main difference between these two groups of enterprises is the fact that the non-existence of a CRM tool means, on average, 29% more employees working in the company. This means that CRM requires fewer employees to do the same job and, as such, saves the costs of the enterprise's operations. However, enterprises with no CRM produce products (food and wood, paper production) where orders are often individualized and require manual work and personal order management when working with clients.

Therefore, after analyzing digitalization levels in the Lithuanian manufacturing enterprises that took part in the questionnaire, it was determined that general the level of digitalization among these enterprises is average (the second-lowest of the four possible categories). These enterprises have installed informational-communicative technology tools designated to automatize their operations. The most frequently digitalized processes within the creation of these enterprises' value chains are the management of customer relationships, technological planning and product lifecycle management, the integration of vertical-horizontal value-chain elements, the monitoring of manufacturing, the management, monitoring, and execution of production, and enterprise resource management. The latter factor indicates that companies tend to install digitalization tools in those processes which have the most considerable impact on product sales, new product creation, the efficient management of orders, the efficient execution of production, and planning, in such a way that the overall efficiency of the enterprise increases and costs decrease. As a result, the above-mentioned digitalization of the determined processes has a tremendous impact on the enhancement of the productivity, competitiveness and operational efficiency of enterprises.

The most popular tools to digitize the above-mentioned processes are listed below, along with their benefits.

1) Customer Relationship Management (CRM):

- reduces the need for human resources to carry out the company's activities;
- increases sales;
- encourages innovation and the creation of new products;
- ensures the development and competitiveness of enterprises.

2) Product Lifecycle Management, Process planning (PLM):

- increases productivity;
- increases export volumes;
- facilitates working conditions for human resources;
- ensures product quality.

3) Computer Networks and Data Exchange (IoT/M2M):

- increases turnover.

4) Manufacturing Execution System, Production monitoring (MES):

- increases productivity;
- standardizes work procedures and optimizes performance;
- increases competitiveness;
- increases turnover and export volumes.

5) Enterprise Resource Planning (ERP):

- increases productivity;
- reduces costs.

To sum up, the following positive changes in performance indicators can be commonly distinguished among companies who have already applied one of the mentioned digitalization tools: fewer actual employees are needed; the productivity of existing staff increases significantly; and production size and quantities increase. These positive changes increase the turnover of companies and strengthen their competitive advantage in the market.

Conclusions

Lithuania stands quite tall regarding the size of its manufacturing sector (see Figure 3), and occupies a leading position in this regard (higher than the EU average of 15%). Lithuania has also managed to sustain or increase the share of manufacturing in its GDP. In regard to the structure of the manufacturing sector, Lithuanian manufacturing is heavily dominated by the medium-low and low-tech sectors, while in many other countries' economies half of their manufacturing output is generated by the medium-high and high-tech sectors.

Lithuania had the lowest share of the high-tech industry in manufacturing output in the whole of the EU, but currently has a higher rate of capacity utilization than it did in 2007. However, the Lithuanian rate of capacity utilization in manufacturing is much lower than in other countries.

Lithuania has not registered substantial differences in trends in total employment and employment in the manufacturing sector. Growth in manufacturing output and labor in this sector was observed. However, this can be a sign of lagging investment in digitalization by Lithuanian manufacturers. The country also lags behind in terms of wages in the manufacturing sector: hourly wages during 2017 in the manufacturing sector were 3.5 times lower than the EU average. However, both wages and the share of personnel costs in total manufacturing expenditure rose by 27% in 2010–2015, which is a sign that Lithuanian manufacturing companies are underinvesting in digitalization.

Obviously, the situation where Lithuania has the lowest share of high-tech industry in manufacturing output in the whole of the EU has to change. The manufacturing sector has to improve this by investing in business structure improvements and reorienting towards this type of enterprise creation.

There are signs that businesses in Lithuania underinvest in digitalization processes. However, in order to remain competitive, companies will have to rethink their strategies concerning future investments.

During the analysis, it was observed that there are major challenges deterring enterprises in the Lithuanian manufacturing industry from taking steps towards a higher level of industrial digitalization.

1) Employee resistance and the lack of knowledge regarding how to manage essential changes. Newly installed digitalization tools often change the order of work, methods of work, and security requirements, creating the need for employee re-qualification processes.

2) The lack of financial resources and the slow return of investments. SMEs do not tend to invest into industrial digitalization because the profits from this come over a long period of time, and it is slow in general. Smaller SME turnovers also make an impact on their decisions as to whether to invest in digitalization.
3) The lack of knowledge when choosing solutions for digitalization. Enterprises often have different technologies installed in separate fields of operations; however, they lack knowledge of how to unify all of them with an efficient digitization tool which could synchronize different tools and manage all operations centrally.
4) The constant shortage of qualified specialists. Companies tend to think that every new digitization tool that they install will additionally require skillful specialists who can work with it and, as a result, it will cost the company extra.
After assessing the problems and challenges expressed by the companies participating in the survey, recommended solutions for the application of additional measures and/or the implementation of tools for the activation of digitization processes are presented in Table 3.

Table 3. Recommended solutions for increasing the level of digitization of enterprises.
Source: created by the authors

Measure	Description
Raising employee awareness	1. Develop an understanding of why digitization is relevant to the growth of the company. 2. Develop an understanding of change management and how to use it. 3. Expand the understanding of process management and improvement and the concept of digitization using case analysis.
Attracting EU support	1. Take advantage of the opportunities provided by EU support for the development of digitization in production companies.
Consulting experts	1. Consult scientists on the selection of appropriate digital tools. 2. Carry out an audit of the level of digitization of the company.
Providing specialized training	1. Organize training on how to use IT tools such as CRM, CAD, LEAN, etc. 2. Use the opportunities provided by EU support for staff training.

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SECTION 2

DIGITAL TRANSFORMATIONS OF THE FINANCIAL AND BANKING SECTORS OF THE ECONOMY

TRENDS IN THE DIGITALIZATION OF THE ECONOMY OF TAJIKISTAN AND ITS BANKING SECTOR

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Abstract. *Based on a thorough analysis, this article identifies current trends in the digital transformation of the global economy and shows their role in the realization of economic potential. Particular attention is paid to the formation of new forms of e-business during the COVID-19 pandemic. According to the system of indicators used in global practice, various countries are rated based on the level of digitalization of their economy. The leading countries in the implementation of digital technology in various sectors of the economy are outlined, and the advantages and disadvantages of the digitalization of their economies are identified. The negative consequences of the initial stage of digitalization of the economy in labor-abundant regions, which include the countries of Central Asia, are substantiated, along with their social significance. The results of research on the digital transformation of European and Central Asian economies are presented, through which it is revealed that the countries of Central Asia, with the exception of Kazakhstan, are at the initial stage of their digital development. The existing barriers to the digitalization of the economy of Tajikistan are assessed, and the reasons for its low level are indicated. Among the main factors are limited access to the Internet and the weak digital literacy of the population. The authors note that the cost of a basic package of Internet subscriptions is equivalent to 16% of the average monthly income in Tajikistan. The results of the study of indicators of the digitalization of the Tajikistan banking sector, which are characterized by the positive dynamics of the digital banking market, are presented. The authors note the development of payment infrastructure and significant growth in the volume of transactions. Finally, measures to maintain trends in the development of digital banking services, including reasonable recommendations for credit institutions to maintain the priority of technological solutions, implement measures to improve financial literacy, and expand the product line of digital banking services with appropriate government support, are proposed.*

Keywords: *digital economy, rating, indicator, income, investment, digital technology, market, index, financial literacy, electronic payments, bank payment cards, electronic wallets, digital banking services.*

Introduction

At the present stage of development of the global community, the introduction of digital technology is one of the key drivers of economic growth. Under the influence of digital technology and related new business models, not only individual sectors of the economy but also its structure and inter-industry interactions are being transformed. Digital transformation is becoming an objective necessity. The purpose of this study is to prove the pronounced impact of the achieved level of digital transformation on economic and innovation potential, social progress, effective management and implementation of democratic procedures, education, human development, and economic and national security. This is achieved based on the study and synthesis of the best practices of world leaders in digital transformation.

The research objectives are as follows:

- to identify current trends of digital transformation in various countries and identify world leaders;

- to examine the interdependence between Tajikistan's lag in the growth rate of goods and services produced and provided by information and communication technologies and its lag in other sectors of the economy;
- to identify the impact of sustainable development of the digital environment on improving Tajikistan's competitiveness in the international arena and the quality of life of its citizens;
- to identify the current level of digital transformation of Tajikistan's economy, to identify barriers, and to justify measures to overcome them.

This article uses general theoretical methods of scientific knowledge, including synthesis, deduction, induction and analysis, as well as a set of statistical and index methods.

The information base of the article is composed of data from international organizations, statistical data of Tajikistan, and the results of the research of foreign scientists.

The main body of the paper

In today's environment, almost the entire global community is striving for digital transformation. According to the definition provided by the World Bank (2018), a *digital economy* is a "system of economic, social and cultural relations based on the use of digital ICT." In the CIS countries, this direction is called the digital economy, in Germany it is Industry 4.0, and in the USA it is the Industrial Internet Consortium. The Japanese government, with the active participation of the Keidanren Japanese big business association, has developed a strategy – Society 5.0. In fact, these are different names for the same process – the transformation of the economy through the use of digital technology, such as big data, the Internet of Things or artificial intelligence.

The digital economy was estimated to be worth $12.9 trillion in 2017, or 17.1% of global GDP. The record performance of the digital economy was mainly due consumers' focus on the Internet. On average, if all countries increase their investments in ICT infrastructure by 8% every year, by 2025 this will realize new economic potential equivalent to $23 trillion for all countries. By 2025, the digital economy will increase from 17.1% to 24.3% of world GDP (Huawei Technologies, 2018).

The COVID-19 pandemic accelerated the transition to the digitalization of society. According to the SaaS Quantum Metric, during the pandemic, the volume of e-commerce reached $3.5 trillion. Investment in digital technology generates returns that are almost 7 times greater than any other form of investment: on average, a $1 investment in ICT infrastructure today will bring $20 in profits in the future (in the medium term).

Some researchers have observed that: "The development of the digital economy will provide an opportunity for communication, exchange of ideas and experience. Areas on the Internet will be able to combine efforts to create a business, finding co-workers, partners, resources and markets. Digital technologies can also play a key role in training employees, sharing knowledge, and implementing innovative ideas, including in the social sphere."

However, along with benefits, the digitalization of the economy "creates a new humanitarian problem in the form of a change in the structure of employment, a significant part of which will be associated with the mass production of information goods and services for various purposes. Introduction and use of modern ICT already leads to a significant reduction of jobs and growth of unemployment, and in the future will lead to social stratification, new forms of social inequality will appear, among which information, educational and intellectual inequality will dominate, and all of that will become a serious social problem" (Tolstykh, 2020).

The USA and China are considered to be the first informal leaders of the digital race. In China, digital technologies are clearly contributing to economic growth and are becoming a new

driving force for economic development. In 2020, the entire digital economy in China reached a total value of 39.2 trillion yuan (about $6 trillion), which amounted to 38.6% of the country's GDP. This exceeded the 2019 figure by 2.4%, or 3.3 trillion yuan (Cyberspace Administration of China, 2019).

The volume of payments through mobile payment services in China reached 38 trillion yuan, almost 50 times the scale of this indicator in the USA. According to Tencent research, China's digital economy has created around 2.8 million new jobs – 21% of all newly added positions. Alibaba alone creates more than 15 million vacant jobs per year in the retail business ecosystem. The digitalization of industry in China is growing rapidly, and the digital economy has reached a figure of 18.3% of industrial value added. The volume of the digital economy in China from 2005 to 2021 increased from 2.6 trillion yuan to 40 trillion yuan, and the share of the digital economy in GDP during this period increased from 14.2% to 40%. The digital economy accounts for different yet still large shares in three major parts of the national economy: 40.7% in services, 21% in industry, and 8.9% in agriculture (China Academy of Information and Communications Technology, 2021).

The USA ranks first in the World Digital Competitiveness Ranking, second in the Global Cybersecurity Index, eighth in the Network Readiness Index, and 10th in the Digital Development Index (Abdrakhmanova et al., 2020).

The development of the digital economy in many countries of the world is evaluated on the basis of various indicators approved by the relevant international organizations, institutions or special research institutes. Therefore, this paper determines the rating of countries by the level of digitalization of the economy on the basis of widely recognized indicators (Table 1).

Table 1. Rating of countries by the level of digitalization of the economy

Source: compiled by the authors based on European Commission (2018); IMD World Competitiveness Center (2017); Huawei Technologies (2018); Cornell University et al. (2018); Chakravorti & Chaturvedi (2017).

Country	IDI 2017	DESI 2018	WDCI 2018	DEI 2017	NRI 2016	EGDI 2018	EPART 2016	GCI 2018	GII 2018	Mean
UK	5	7	10	8	8	4	1	5	4	5.7
Sweden	11	2	3	2	3	6	27	3	3	6.7
Finland	22	3	5	3	2	5	10	6	7	7.0
Denmark	4	1	4	4	11	1	22	7	8	7.8
Germany	12	14	18	17	15	15	27	14	9	15.7
Estonia	17	9	25	21	22	13	55	22	24	23.1
Lithuania	41	13	29	–	29	23	17	24	40	27.0
Poland	49	24	36	35	42	36	14	38	39	34.8
Czech Republic	43	17	33	27	36	50	76	29	27	37.6
Latvia	35	19	35	28	32	45	84	–	34	39.0
Russia	45	–	40	39	41	35	32	36	46	39.3
Hungary	48	23	46	32	50	46	91	30	33	44.3
Bulgaria	50	26	43	41	69	52	43	43	37	44.9
Kazakhstan	52	–	38	–	39	39	67	45	74	49.7
Romania	58	28	47	–	66	75	60	39	49	52.8
Belarus	32	–	–	–	–	38	76	42	86	57.0
Armenia	75	–	–	–	56	87	84	–	68	74.0
Kyrgyzstan	109	–	–	–	95	91	67	–	94	92.4
Tajikistan	-	-	-	-	114	131	-	77	101	105.7

Abbreviations: ICT Development Index (IDI); Digital Economy and Society Index (DESI); IMD World Digital Competitiveness Index (WDCI); Digital Evolution Index (DEI); Boston Consulting Group Economic Digitalization

Index (e-Intensity); Networked Readiness Index (NRI); The UN Global E-Government Development Index (EGDI); E-Participation Index (EPART); Global Connectivity Index (GCI, Huawei); The Global Innovation Index (GII).

The data in Table 1 show that Tajikistan is still at an early stage in addressing the formation of the digital economy. In addition, some of the indicators that characterize the level of development of the digital economy in Tajikistan have not yet been calculated by international organizations, institutions or special research institutes.

It is especially noted that initial stages of the transition to the digital economy can have negative impacts for the countries of Central Asia, where the system of personnel training is not yet sufficiently oriented and adapted to digital technology. In the initial stages, the digital economy will exacerbate the problem of employment in the labor market. Indeed, the formation of the digital economy in Central Asia is in its early stages, as shown in Figure 1.

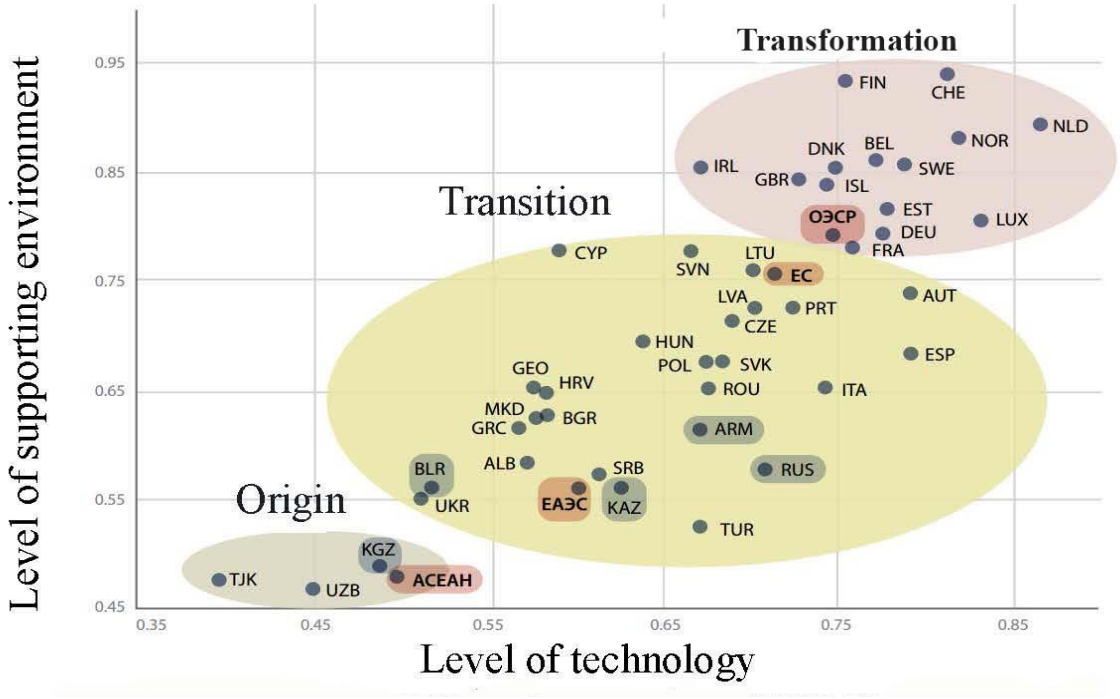


Figure 1. Digital economy development in Europe and Central Asia
Source: compiled by the authors, based on World Bank Group (2018)

The main problems that will be created by the digital economy can be expressed in the emergence and increasing dependence of subjects on companies in the field of information and communication technologies, the concentration of power in the market, the emergence of monopolies, the capture of the market by transnational companies, the violation of the stability of the monetary and credit system, etc. The introduction of digital technologies, increasing the requirements for the professional qualities of the workforce, transforms the structure of the labor market.

The digital transformation of the economy is accompanied by the transformation of the labor market. According to the US Bureau of Labor Statistics, in 2014–2024, the economy will need around 100,000 new specialists in ICT annually, while the projected annual number of college graduates in the information area is only 60,000 people.

The main barriers to the implementation of digital technology are psycho-emotional and moral, the professional and technological skills of staff, the uneven and asynchronous pace of systemic changes, the deformation of digital infrastructure, the risks of digital products and services, the

fragmentation of IT departments and business structures, and the mismatch of business goals and the objectives of digital transformation (Mityaeva & Zavalo, 2019).

Russia is at the level of 4% of GDP for digital financing, and intends to catch up with the leading countries by 2025. The level of digitalization of public services in Germany is 46%, in France 67%, and in the Netherlands 77%.

In Uzbekistan, where the digitalization of all sectors is being actively implemented, the number of people with access to the Internet has reached 22.5 million, or 67% of the population. To develop the digital economy in the country, the Digital Trust Fund was established. There are plans to implement measures to develop the concept of Digital Uzbekistan by 2030.

Tajikistan has adopted a number of conceptual and policy documents, including the Concept of Electronic Government Formation in the Republic of Tajikistan (2012–2020) No. 6431, approved by the Government of the Republic of Tajikistan on December 30, 2011, and Presidential Decree of the Republic of Tajikistan No. 1174 "On State Strategy of information and communication technologies for the development of the Republic of Tajikistan" dated November 5, 2003.

The Concept of Digital Economy of the Republic of Tajikistan (December 30, 2019) states that "Digitalization of the economy will create a new model of economic growth, attract international investment, give impetus to the transformation of existing and development of new types of production, strengthen the export orientation and at the same time meet domestic demand through import substitution."

The message of the President of the Republic of Tajikistan, Emomali Rahmon-Majlisi Oli, "On the main directions of domestic and foreign policy of the republic" dated January 26, 2021, notes the need for appropriate measures to promote "the strengthening of the institutional framework of the digital economy, development of information and communication infrastructure throughout the country, digitalization of the national economy and accelerate the implementation of the e-government."

In 2016, international experts estimated the share of the digital economy in the GDP of Tajikistan at 0.6%, in accordance with the statistical data. According to the rating of the World Economic Forum, Tajikistan ranked 104th among 141 countries in 2019, including 121st place for "Penetration of information and communication technologies." Despite the low indicators of ICT development in Tajikistan, the share of innovative products is slowly growing. Demand for modern digital data management technologies is forming. Over the 2010–2020 period, Tajikistan has slightly improved its indicators. Tajikistan slightly improved its performance in the index of e-government development, from 0.3477 to 0.4649, and the country has moved from 112th place (among 138 countries) to 109th place (among 134 countries) in the index of readiness of the network society.

According to the World Bank, Tajikistan ranked last among Central Asian countries in terms of the number of secure Internet servers per 1 million people. Tajikistan ranked as one of the last among Central Asian countries in 2019, and the country ranked 106th in the global cybersecurity index in 2018 among 134 countries.

These data indicate a low level of digitalization of the economy of Tajikistan. The country is not included in the International ICT Development Index. In 2019, the total volume of paid services in the field of information and communication was only 0.25% of GDP, which had decreased by 0.8% compared to the previous year. In 2017, only 2.514 million residents of the republic, or 28.15%, were Internet users, while the global average is 53%, and in the CIS this reaches 71.3%.

According to the World Bank (2018), only 17% of people in Tajikistan use the Internet on any device, compared to 28% in the Kyrgyz Republic, 44% in Uzbekistan and 55% in Kazakhstan. Permanent Internet access in Tajikistan remains limited to large urban areas, where residents pay

one of the highest prices in the world for Internet service. The cost of a basic Internet subscription package is equivalent to 16% of the average monthly income. Because of underdeveloped Internet access and high prices, only 57% of firms in Tajikistan currently use e-mail to communicate with their clients, and less than 40% of firms have a website.

Many experts view the digitalization of the economy as a threat to the country's economic security. They believe that the growth of digitalization will lead to a reduction in the need for human resources, increased competition in the labor market due to higher general requirements for the special IT competences of employees, and an increase in unemployment. The imperfection of the regulatory framework of digitalization of the economy may lead to a range of fraud, a lack of protection of personal information and commercial resources, etc.

Kaspersky Lab specialists indicate that financial fraud is the most widespread threat to information security: "about 20% of Russian Internet users have fallen victim to cybercriminals at least twice while making banking transactions and online purchases, losing money in the process" (Tarasov, 2014).

The current state of development of the digital banking market in Tajikistan over the past few years has had a positive trend. The growth of digital banking services demonstrates the growing interest of credit institutions in this product and the possibilities of stimulating sustainable economic growth, increasing the general accessibility of the financial system, and providing fiscal and social effects. It should also be noted that the market of digital banking services has increased significantly in recent years, contributing to the growth of non-cash payments. Between 2016 and 2021, the number of bank payment card holders increased (see Figure 2).

Analysis of Figure 2 shows that in 2021 the number of payment cards had grown by 215% compared to 2016. According to the statistics of the National Bank of Tajikistan, as of 31 December 2021 credit financial institutions had issued 3.48 million bank payment cards, which is 24.4% more than in 2020. Of these, 73.8% were National Payment System (NPS) Korti Milli payment cards, 11.4% were local payment cards of credit organizations, 8.5% were cards of international payment systems (VISA, Master Card and Union Pay) and 6.2% were co-brand payment cards (Union Pay – (NPS) Korti Milli). Out of the total number of bank payment cards issued, 25% accounted for Dushanbe city, 28% the Sughd region, 27% the Khatlon region, 17% the Districts of Republican Subordination and 3% the Gorno-Badakhshan Autonomous Oblast.

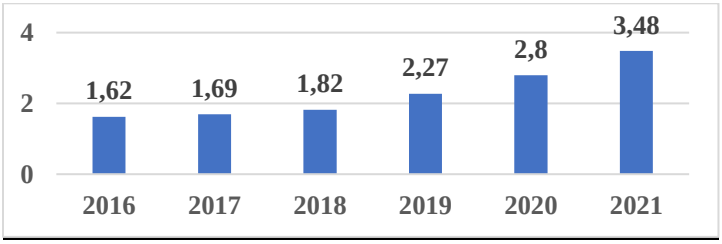


Figure 2. Total number of payment cards in Tajikistan (in millions)
Source: compiled by the authors based on data from the National Bank of Tajikistan (www.nbt.tj)

Active growth in the number of bank payment cards requires appropriate infrastructure to service them. It should be noted that the relevant infrastructure – a network of ATMs, electronic terminals (at cash points) and POS terminals – in the analyzed period received significant development (see Table 2).

Table 2. Number of ATMs and terminals in Tajikistan (POS and POS)

Source: compiled by the authors based on data from the National Bank of Tajikistan (www.nbt.tj)

Device name	2016	2017	2018	2019	2020	2021
ATMs	799	685	678	878	1,285	1,412
Electronic terminals at the CP	1,755	1,381	1,485	1,813	1,899	1,848
Point-of-sale terminals	700	1,944	3,014	3,535	3,811	3,030
Total	**3,254**	**4,010**	**5,177**	**6,226**	**6,995**	**6,290**

Credit financial institutions have installed a total of 1,412 ATMs and 4,878 electronic terminals for servicing bank payment card holders. Out of this number of electronic terminals, 1,848 units are installed in cash advance points and 3,030 units in trade and service enterprises. The analysis of the data in Table 2 shows the steady growth of the payment infrastructure. The number of ATMs increased by 76.7%, or 613 units, during the period under review. Electronic terminals (in cash advance offices) increased by 5.3%, or 93 units, and the number of POS terminals increased almost 4.3 times, or by 2330 units. In total (all devices), growth was 93.3%.

Despite growth, the number of ATMs and POS terminals remains insufficient. For example, in Kyrgyzstan the number of ATMs is 1,800, and the number of POS terminals is more than 12,000, despite the fact that the population of this country is around 30% less than the population of Tajikistan. If we compare the number of ATMs per 100,000 people in our country to this figure in Germany, we see that in Tajikistan there are 20 ATMs per 100,000 people, while in Germany there are 120.

The active issue and use of bank payment cards in the country has contributed to the growth of the payment infrastructure and the search for new, cheaper, more easily adaptable technologies, such as QR payments. It should be noted that in the period from 2019 to 2021 the volume of QR payments in Tajikistan increased by almost 6 times (see Figure 3).

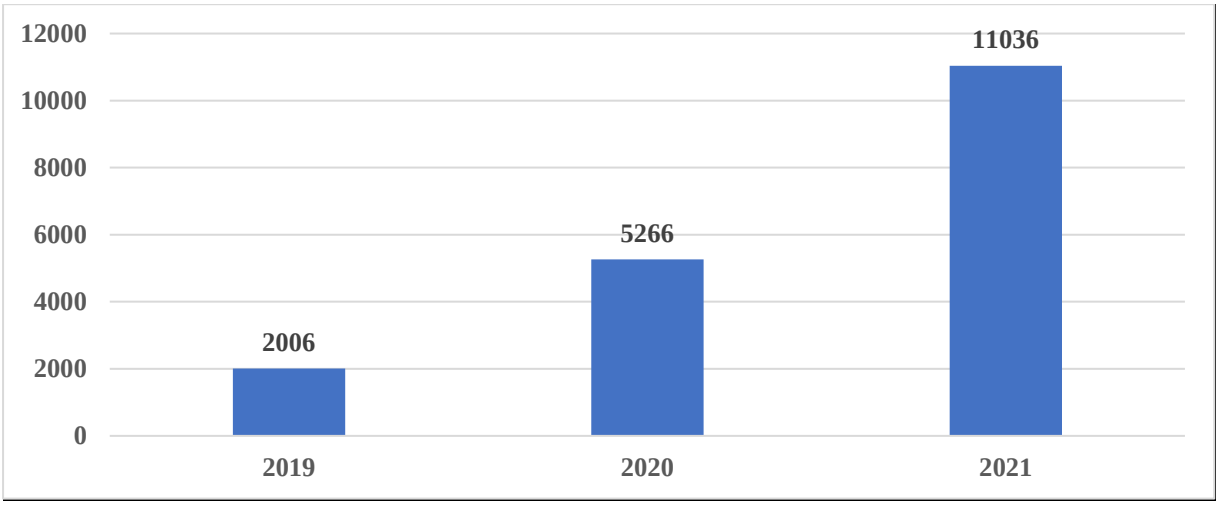


Figure 3. The volume of QR-payments in Tajikistan (thousand somoni)

Source: compiled by the authors based on data from the National Bank of Tajikistan (www.nbt.tj)

Analysis of Figure 3 indicates the active growth of QR payments, which, in the authors' opinion, is associated with a number of factors:

- the active implementation by credit organizations of Tajikistan of QR payment technologies;
- the convenience and ease of use;
- the demand on the part of businesses (small and medium-sized businesses).

As of December 31, 2021, 11,036 units of QR payments were installed in trade and service enterprises in the country, which is 2.1 times more than for the same period of the previous year. In 2021, 29.3 million non-cash transactions in the amount of 3,694.7 million somoni were conducted through electronic means of payment, which is 31.7% more in number and 91.3% more in volume of transactions compared to the same period in 2020. During this period, the ratio of cash withdrawal operations and non-cash payment for goods and services with electronic means of payment was 90% to 10%, 1.6% more than in 2020.

During the COVID-19 pandemic, many users switched to the online payment format.

In addition to the issuance of bank payment cards, the active growth of the payment infrastructure, and the introduction of new payment solutions, a significant increase in the volume of transactions was noted. Over the 2016–2021 period, the volume of transactions grew by 332% (see Table 3).

Table 3. Transactions involving electronic payment instruments in Tajikistan (billion somoni)

Source: compiled by the authors based on data from the National Bank of Tajikistan (www.nbt.tj)

Year	2016	2017	2018	2019	2020	2021
Cash withdrawal	6.86	7.94	9.96	11.83	21.14	33.37
Payment for goods and services	0.28	0.39	0.51	0.85	1.93	3.69
Total	**7.14**	**8.33**	**10.47**	**12.7**	**23.07**	**37.06**

The surge in transaction volumes is primarily due to the active use of P2P transactions (cross-border transfers) and the beginning of the COVID-19 pandemic.

The introduction of electronic money transfer technologies is a new trend in the domestic banking system. Starting from 2018, credit financial institutions began to actively provide their customers with this method of cashless payment. Currently, 15 credit financial institutions provide e-wallet services to the population. The growth dynamics of the number of e-wallets in 2018–2021 is shown in Figure 4.

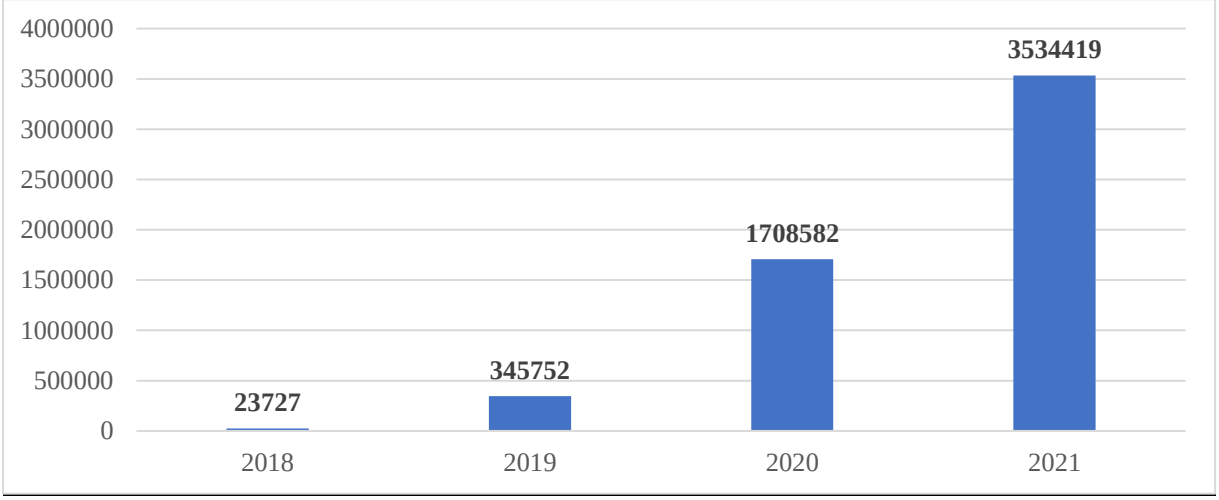


Figure 4. Growth dynamics of the number of e-wallets in 2018–2021 in Tajikistan (units)

Source: compiled by the author based on data from the National Bank of Tajikistan (www.nbt.tj)

As of December 31, 2021, the total number of e-wallets of credit financial institutions amounted to 3,534,419 units. Compared to the same period in 2020, the total number of e-wallets of credit financial institutions increased by 1,825,837 units (2.1 times). By using e-money, clients have the opportunity to pay for a number of services in a cashless way through e-wallets using smartphones. During 2021, 17.2 million non-cash transactions in the amount of 1,020.8 million somoni were

conducted through electronic wallets, which exceeded the figures of 2020 by 61.0%. With all of the known restrictions introduced in a number of countries from the beginning of 2020 and the inability to access branches of credit organizations to carry out standard operations such as money transfer, many companies, including local ones, began to promote or provide their services online, which led to the need for online payments.

Thus, the development of digital banking can be a driving force of the country's socioeconomic reforms and a catalyst for economic growth. We assess the analysis of the current state of the digital banking market as satisfactory. To maintain trends in the development of digital banking services, credit institutions need to maintain the priority of technological solutions, actively participate in measures to improve the financial literacy of the population, and expand the product line of digital banking services. This, in turn, requires effective measures to improve the situation and strengthen the role of the state in improving the regulatory framework, tax legislation and providing benefits and support for digital banking services.

Conclusions

For the development of digital technology in the banking sector, credit institutions need to:
- maintain the priority of technological solutions;
- actively participate in measures to improve the financial literacy of the population;
- expand the product line of digital banking services;
- take effective measures to strengthen the role of the state in improving the regulatory framework and tax legislation;
- provide benefits and support for digital banking services.

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DIGITAL PAYMENT CARD FRAUD: NEW VECTORS AND DETECTION

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Abstract: *This research explores gross losses from payment card fraud worldwide and considers the main modern methods of fraud. The issue of payment fraud will be exacerbated by the digitalization of economic relations, in particular the introduction by banks of the concept of "Bank-as-a-Service," which will increase the burden on payment services.*
The aim of this study is to show effective methods for detecting fraud in digital payment systems using automated machine learning and big data analysis algorithms.
Approaches to expanding the information base to detect fraudulent transactions are proposed and systematized. The choice of performance metrics for building and comparing models is substantiated.
The use of automatic machine learning algorithms is proposed to resolve the issue, which makes it possible in a short time to go through a large number of variants of models, their ensembles, and input data sets. As a result, our experiments allow us to obtain a quality of classification based on the AUC metric at a level that exceeds the effectiveness of the classifiers developed by traditional methods, even as the time spent on the synthesis of the models is much less and is measured in hours. The ensemble of models makes it possible to detect up to 85.7% of fraudulent transactions in the sample. The accuracy of fraud detection is also high.
The results of our study confirm the effectiveness of using automatic machine learning algorithms to synthesize fraud detection models in digital payment systems. In this case, efficiency is manifested not only by the resulting classifiers' quality but also by the reduction in the cost of their development, as well as by the high potential of interpretability. Implementing the study results could enable financial institutions to reduce the financial and temporal costs of developing and updating active systems against payment fraud, as well as improve the effectiveness of monitoring financial transactions.

Keywords: *payment card fraud, fraud prevention, PSD2, spotting fraudulent transactions, artificial intelligence, automatic machine learning, AutoML solutions.*

Introduction

Payment card fraud affects everyone. Almost $50 billion are lost yearly to card fraud (Nilson Report, 2020) and identity theft (Tedder & Buzzard, 2020) worldwide. Although financial institutions are locked in an escalating arms race against cybercriminals and scammers, losses still have to be accounted for. Consumers end up paying for money lost to fraud out of pocket, in the form of vendor and transaction fees, while corporations and governments spend billions more investigating and handling fraud cases.

The main body of the paper

Modern fraud prevention is expensive. Digital ID checks cost around $2 per document, companies spend millions on KYC (know your customer) and AML (anti money laundering), and still the number of fraudulent transactions is growing. Banks have been relying on passive measures to counteract fraud based on past breaches or fraud behavior history, and only some have invested in proactive or predictive fraud prevention.

Card-based payment systems worldwide generated gross fraud losses of $28.65 billion in 2019, amounting to 6.8¢ for every $100 of total volume (Nilson Report, 2020). To understand what financial institutions can do to improve their fraud prevention efforts, the current protection mechanisms need to be examined. Payment cards that hold a set of credentials or cardholder data act as keys to a customer's bank account and enable two types of transactions: card-present and card-not-present.

Payment card fraud basics

Card-present fraud is when a payment card is physically used to make purchases or withdraw money from ATMs by entering a PIN. For decades, scammers have been using cameras, sensors, ATM skimmers, and other devices to make copies of cards and extract PINs.

In one case, a waiter was discovered using a portable magnetic stripe reader in his shoe to copy customers' cards while walking to the register. In another scam, criminals used NFC readers to steal small amounts from people's cards on the subway. By coming close to pockets and bags, they were able to charge cards without people noticing.

Phone confirmations for larger amounts and RFID blocking wallets can partially counter card-present fraud. Card-not-present transactions are more complex as they happen remotely, where a cardholder does not present a card to a merchant in person. The CVV code on the back of the card is most often used to confirm that the person paying has physical access to the payment card, but 2FA methods via SMS OTP (one-time password) and in-app authentications are becoming more widespread.

Scammers can intercept OTPs, consumer sessions, cardholder data (PAN, EXP, NAME, CVV), and even steal app credentials. The Lazarus Group from North Korea is notorious for using military-grade cyber expertise to steal money using man-in-the-middle software and cloned credit cards to withdraw cash from ATMs – so much so that an estimated 75% to 80% of all ATM cash-out losses get repatriated to North Korea (Nilson Report, 2020).

Banking: Old vs. new

PSD2 – the revised European Payment Service Directive that covers the whole of the EU, brought into law in 2018 – aimed to fix the lack of an open banking regulatory environment, improve security, and protect customers, among other goals. Before banks started to adopt OpenAPI, companies found it extremely difficult to integrate with banks using ancient file exchange systems. PSD2 standardized how payment and financial institutions interact with each other and with third-party providers. The directive enabled AISPs (Account Information Service Providers) to access information from multiple financial institutions with a customer's permission. AISP services, for example, can aggregate data from different accounts in different banks and show it to a consumer in one place or application.

PISPs (Payment Initiation Service Providers) can go a step further and make payments on behalf of consumers. PISPs can pay incoming utilities, Internet, and service bills that a consumer receives automatically. Although AISPs and PISPs are still in the early stages of development and adoption,

similar initiatives are already being implemented worldwide.
In 5–10 years, OpenAPI initiatives will reach their potential and unlock the benefits of digital banking. Truly interactive banking experiences are a significant benefit for consumers, but these changes open the industry to completely new attack vectors that need to be accounted and prepared for.

Spotting fraudulent transactions using AI & ML
Global cataclysms of the 21st century quickly changed consumers' behavior, and this led to a crash in financial anti-fraud systems. Models used to predict consumer behavior, supply, and demand had to be retaught to account for new patterns and spikes.
Let us assume that, as a financial institution, a customer's payment card was compromised during the COVID-19 pandemic. What can be done to spot fraudulent transactions early on? One course of action is to take a data set, mark confirmed fraudulent transactions with a chargeback or other documented problem, and analyze it to determine correlations.
For most areas, obtaining a comprehensive data set is not a problem. However, privacy laws protect banking and transaction data from being disclosed. General Data Protection Regulation (GDPR) in the EU provides customers with the right to be forgotten, and Big Tech companies are already being sued for billions for breaching privacy laws (Brando, 2018). In terms of machine learning, if a consumer asks for their data to be deleted, does that request apply to the results of calculations based on their data? How far the law reaches will be discussed for years to come.

Raw data
As a result, there are very few data sets with real customer data in the public domain. A relatively large 150 MB data set from Kaggle – with hundreds of thousands of anonymized transactions from European credit card users recorded in 2013 (Machine Learning Group, 2013) – is used to research how to prevent payment card fraud in this research. Locating useful information in a raw data set is a very resource-intensive task that usually requires multiple data scientists and analysts.
A technology executive with a heavy managerial workload cannot spare weeks to clean, spot anomalies, and balance the data set. Under this scenario, a relatively new Automatic Machine Learning (AutoML) approach could take on all of the routine and repetitive tasks that come with in-depth data analysis and extract insights from raw data (Heller, 2019).
There are many AutoML solutions to choose from today. Giant AWS SageMaker, Google AutoML, AutoAI with IBM Watson Studio, Microsoft Azure ML, and Oracle AutoML are complemented by the smaller, but no less interesting, DataRobot, Auto Weka, AutoML-Freiburg-Hannover, and H2O Driverless AI. The latter of these solutions is preferable because it can run on a local server or even a laptop instead of relying on the cloud (H2O Driverless AI, 2021).
Whenever financial data is involved, most regulators restrict its movement to prevent data transfers outside the country or into the cloud. Another important point is that cloud-based solutions are often limited by the amount of processable data. Some products restrict tables to one million rows and add other restrictions to encourage users to purchase expensive enterprise-level licenses.
Even though H2O is a commercial project, there is also a free version. This does not have a helpful GUI, but that should not be a problem for skilled hands. As a result, H2O Driverless AI with an educational license was used for this research.
The data set itself was a CSV file with only a few readable variables: time, amount, and class – whether a transaction was fraudulent or not. The rest were anonymized to protect the privacy of consumers (Figure 1). This makes it more interesting as one can observe how the system behaves with many unknown variables.

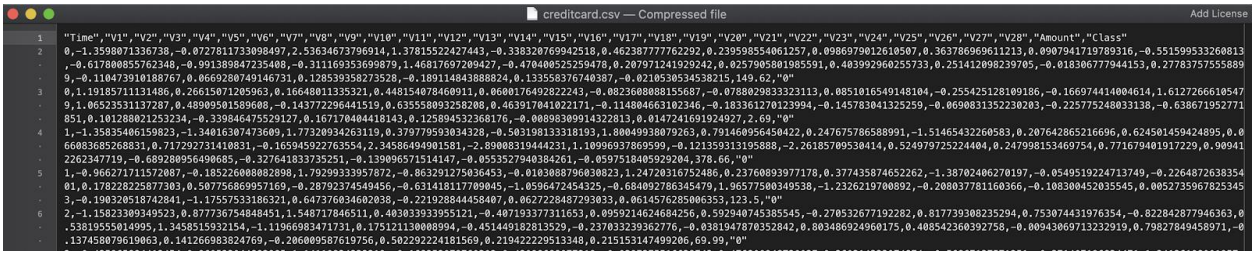


Figure 1. Raw credit card fraud detection data set

Source: Machine Learning Group (2013)

Data preparation

Raw data from the information systems of banks or payment organizations contain a technical minimum of information about transactions, which includes a relatively small set of parameters, including:

– date and time;

– the amount of the transaction (in the transaction currency and the currency of the account);

– the currency of the transaction;

– customer ID;

– the merchant/terminal ID through which the transaction was made;

– the type of identification procedure carried out;

– the authorization code, or the issuer's bank response if the transaction is rejected.

For a series of reasons that are detailed below, this set of parameters is not sufficient to effectively identify fraudulent transactions. This necessitates additional data preparation procedures. Thus, when using machine learning methods, additional information, which is usually contained in related relational databases, should be immediately added to the input sample. This is because machine learning methods are focused on analyzing data arranged in flat tables.

In order to effectively detect fraud, in addition to the information available in the databases of the bank or payment organization, it is necessary to add to the data external information (for example, a posteriori assessment of various risks associated with the transaction). The process of adding such information is termed feature augmentation. Its necessity is due to the fundamental limitations inherent in methods focused on line-by-line data analysis, which were formulated for the first time by Minsky and Papert (1969) for perceptron neural networks, but are also true for most other machine learning methods:

– the inability to generalize their characteristics to new stimuli or new situations;

– the inability to analyze complex situations in an external environment by decomposing them into simpler ones;

– the limitations in problems related to the invariant representation of images.

Expanding the feature augmentation by adding information that clarifies the current situation reduces the impact of the specified restrictions. This information can be of several kinds:

– additional information that is not contained in the transaction's original data, but expands knowledge about it (for example, associated risks);

– information that can be obtained as a result of vertical data analysis (for example, the average, maximum, minimum parameter values);

– information obtained from empirical analysis models, which are usually formulated as a condition or consequence (for example, signs of transactions subject to mandatory financial monitoring). In fact, such models can be considered micro-expert systems.

An analysis of research in the field of monitoring and detection of fraudulent transactions (Dal Pozzolo et al, 2013; Fu et al., 2016) has made it possible to formulate the following list of additional parameters for building a machine learning information base:
– the assessment of the risk of the terminal/merchant in which the transaction took place;
– the assessment of the merchant's risk in which the previous transaction was made;
– the assessment of the risk of the merchant category;
– the estimates of geographic risk (continental, country, regional);
– assessing the risk of the card issuer;
– assessments of other risks (related to the age and gender of the client, language group, place of the previous transaction, transaction amount, etc.);
– the total amount of customer transactions for the period under review;
– the minimum amount of a customer's transaction for the period under review;
– customer data (age, gender, etc.);
– additional transaction parameters (the use of special identification technologies, time, information about accepting, or rejecting the transaction, etc.).
Thus, the original data set can be expanded from 8 parameters to 25–30 (depending on the availability of information in the bank's databases and the available risk assessment capabilities).
In practice, building a representative information base for investigating fraudulent transactions involves solving the problem of finding a large enough sample of reliable evidence for analysis. The issue is due to the fact that employees of banks and payment organizations consider the transaction data of their customers as confidential, and provide them for research only to commercial developers, subject to contractual terms.
The only data set with real-world data containing parameters similar to the above is the Credit Card Fraud Detection data set (Machine Learning Group, 2013). This data set contains actual credit card payments from customers of Western European banks, and has the following parameters:
– the data set contains 284,807 transactions, including 492 cases of fraud identified post-factum (Figure 1). This represents only 0.172% of the total sample. Thus, the data sample is heavily unbalanced. This skew is typical of real data of digital payment systems and is due to the fact that the actual number of fraudulent transactions is relatively small;
– the sample contains 30 inputs and 1 output variable. Of these, only 3 variables (Time, Amount, and Class) contain name-appropriate transaction data that are not subject to additional conversions. The remaining variables are converted into dimensionless values for the preservation of confidentiality, as demanded by European law, and their titles are replaced with conditionals (V1, V2, ..., V28);
– there are no missed values in the data set;
– there are no cardholder identifiers, so all transactions can be considered independent of each other.
It should also be noted that, in accordance with the 2016 ruling of the European Union (GDPR), personal data can be provided only in a fully anonymized form, which does not allow their deanonymization. Therefore, the data set used is processed using the main component method; most of the variable names have been replaced with conditional ones. Despite some discomfort in interpreting the results, this can be interpreted as positive as part of the study's goal, as it reduces the subjectivity of assessments.

Setting up AutoML in H2O Driverless AI
For the experiments, the following configuration was used: IBM System X 3300 M Server with 12 Cores, 32 GB RAM, and Ubuntu Linux 18.04 LTS. This system is somewhat of an old workhorse,

without a GPU, but this provides a clearer picture of the performance of the process. After importing the data set into H2O, the system automatically analyzed the type and structure of data and suggested the best preliminary models, classificators, and analysis tools based on what was inside the data set. In this case, the data set was highly unbalanced, so H2O recommended the Log Loss scorer (Wikiwand, 2018).

Immediately after importing the data set, H2O quickly showed the problem and unbalanced areas. After confirming a wide variety of settings, the system began to analyze the data. The GUI showed preliminary results during the process, which could be explored and changed before full analysis was completed (Figure 2). Overall, it took around five days to process the data in this setup.

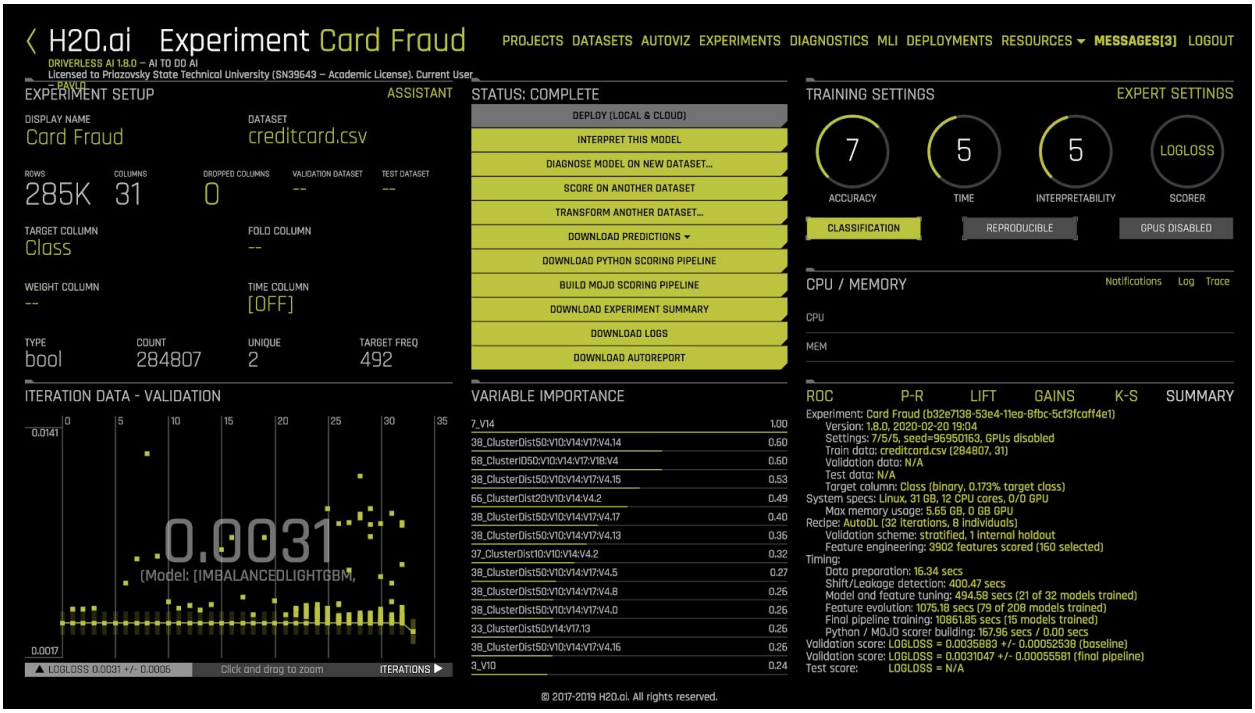


Figure 2. The results of the experiment in H2O Driverless AI
Source: Authors' own experiments

After completing the experiment, H2O offered a choice of models ready to be deployed on the cloud, servers, or datacenters. This enables almost seamless continuous delivery, or delivery after pressing a single button. Both options are very beneficial because updating such systems is a complex process that requires specialist skills.

Model interpretation

In this step, the selected system automatically processes the models that were built by themselves. In this experiment, another day and a half was required, and the system returned results that showed the influence, dependence, importance, and weight of different variables in the data set (Figure 3 and 4).

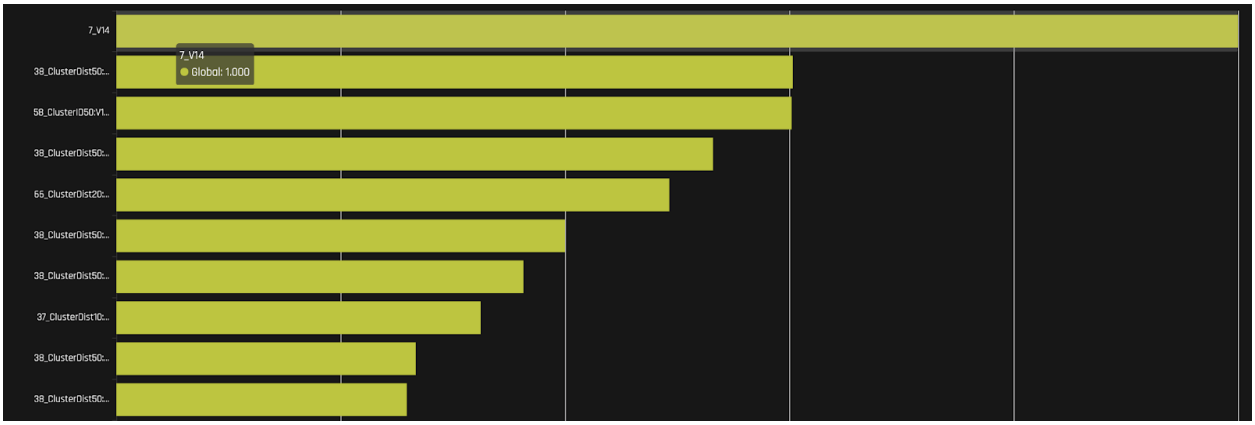


Figure 3. The results of model interpretation
Source: Authors' own experiments

Figure 3 demonstrates the importance of variable V14, which needs to be examined further. The rest of the results (Figure 4) consisted of other synthesized cluster functions. Using these results, it is possible to go through each function separately and analyze whether it is essential or not.

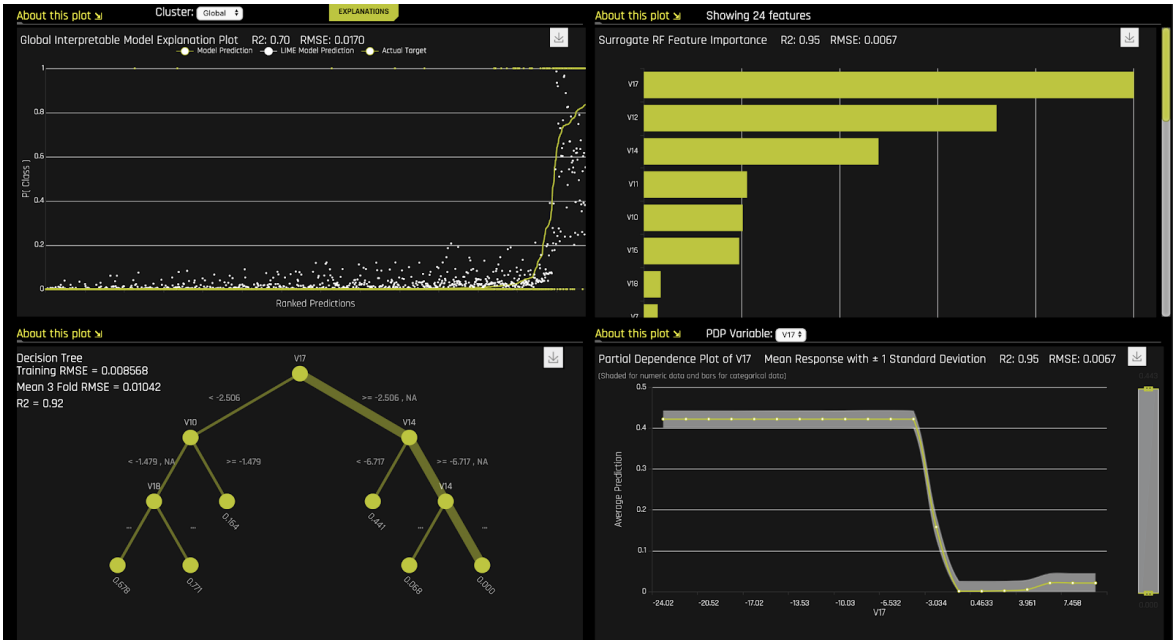


Figure 4. The results of model interpretation
Source: Authors' own experiments

Through these results, it can be observed how the system taught itself, made decisions, and approached maximum results – and where it was incorrect. H2O shows different patterns and possible interpretations of different values and how the system sees relationships between other variables and results in the data set. The analysis of peaked variables then showed a possible relationship between time, amount, and some merchant attributes.

There were two additional experiments where fields that came up in the first experiment were excluded to observe and ensure whether the result would remain the same without them. Overall, the new experiments were successful. Sometimes, there were differences in the variables' influence, and in other cases, H2O synthesized new functions.

AutoML results

We conducted several experiments on the automatic synthesis of the ensembles of models to identify fraudulent transactions in digital payment systems. The main differences between the conditions of the experiments were the use of different metrics for determining the quality of classification, as well as in the volumes of data analyzed. The methodology of these experiments is described by Kolodiziev et al. (2020).

The confusion matrix of the results of the first experiment is given in Table 1.

Table 1. Confusion matrix for Experiment 1

Source: Authors' own experiments

		Transaction genuine class	
		P	*N*
Predicted transaction class	*P*	388	67
	N	104	284,248

It follows from the analysis of Table 1 that the given experiment analyzed 284,807 transactions, of which 492 were fraudulent in reality. At the same time, the model correctly identified 388 fraudulent transactions (78.9% of the total amount). The remaining 104 fraud transactions (21.1%) were interpreted by the system as genuine. In addition, 67 genuine transactions were interpreted by the system as fraudulent.

The Receiver Operating Characteristic Curve chart and the appropriate Area Under Curve (AUC) value are shown in Figure 5.

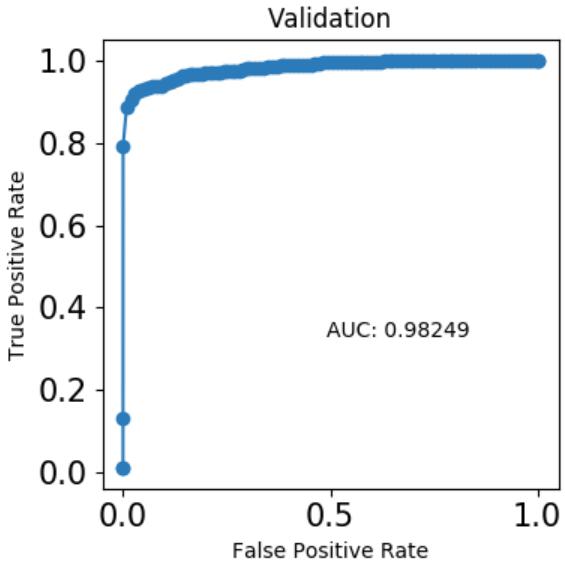


Figure 5. ROC curve for Experiment 1

Source: Authors' own experiments

The value of AUC = 0.98249 is good in itself, but when analyzing the unbalanced data set the final

decision on the choice of the classifier can be made only after the AUC values are compared to all classifiers.
The main differences of Experiment 2 from Experiment 1 were:
– accuracy was the main metric for the quality of classification in the synthesis of models;
– to reduce the calculation time, the input sample of data was reduced to 100,000 lines.
The confusion matrix of the experiment's results is given in Table 2.

Table 2. Confusion matrix for Experiment 2
Source: Authors' own experiments

		Transaction genuine class	
		P	*N*
Predicted transaction class	*P*	191	46
	N	32	99,730

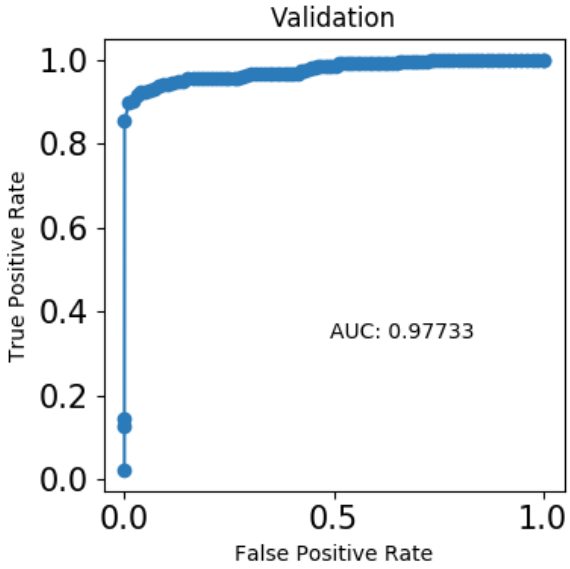


Figure 6. ROC curve for Experiment 2
Source: Authors' own experiments

The analysis of Figure 6 shows that the AUC metric for Experiment 2 (0.97733) was slightly lower than for Experiment 1 (0.98249), but this difference is negligible.
The comparative analysis of the effectiveness of the models' ensembles – synthesized during Experiment 2 and Experiment 1 by calculating the *Precision* and *Recall* characteristics (Kolodiziev et al., 2020) – produced the following results:

$$Precision_1 = \frac{388}{388 + 67} = 0.85,$$

$$Recall_1 = \frac{388}{388+104} = 0.79,$$

$$Precision_2 = \frac{191}{191+46} = 0.806,$$

$$Recall_2 = \frac{191}{191+32} = 0.857.$$

Thus, in the second experiment, we managed to achieve some better (by 8.5%) recall metric results, showing how many fraudulent transactions were able to be identified from the total number of transactions.

The precision metric, which shows how many transactions that received the fraud label were indeed fraudulent, was 5.1% worse for the second experiment than that for the first.

From the point of view of the bank or payment organization, the result for the recall metric is somewhat more important than the result for the precision metric. Thus, in practice, the ensemble of models obtained as a result of Experiment 2 is likely to be selected.

Another progressive feature of modern software is the ability to generate a Microsoft Word .doc file as a report with all of its findings and the lifecycle of the analysis, which can be printed out and read at any time. This shows everything that the system did, methods, how long it took, how effective it was, shifts, and importance. This saves at least a week of human analyst work.

The generated model can be turned into a java or python application that will generate a set of APIs and import a raw data set with transaction variables, and the system will show whether the transaction is fraudulent or not and how sure it is in that decision. This may be used to decide whether to allow the processing of a transaction or to stop it immediately.

These tools can be used by top-level management, CTOs, and even marketing departments to generate valuable insights into business operations and answer the following question: When is the best time to push a notification about a new product – is it when consumers make the most transactions, or the opposite?

AutoML can help find answers and improve business decision-making through data analysis.

This solution is not a magic bullet against all fraudulent transactions or the only correct method for rolling out such a model. This experiment has provided enough information regarding what is inside AutoML, what can be worked on, and what else can be explored. However, it is reassuring that a different research team that spent six months working on the same data set reached the same conclusions that this research determined in around a week.

New attack vectors

Payment card fraud is limited by card expiry dates, limits, and security notifications. The method explained above can help find and stop fraudulent transactions made by perpetrators, but what if customers unwittingly transfer money to criminals by themselves?

Currently, according to the European Central Bank, the majority of fraudulent transactions with payment cards are carried out without the presence of a card (Figure 7).

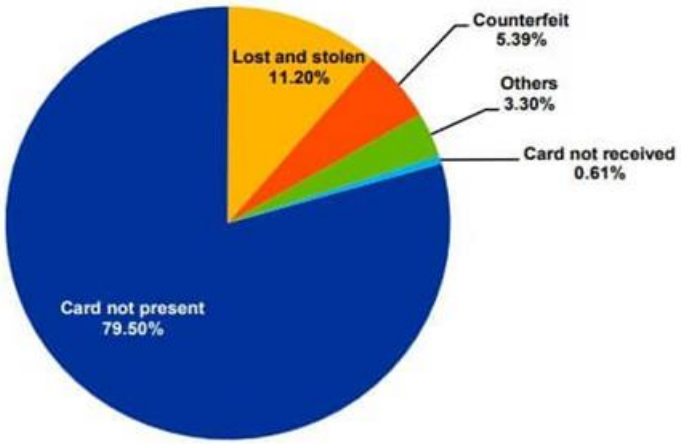


Figure 7. Value of fraud types as a share of total card fraud using cards issued within SEPA
Source: European Central Bank

The COVID-19 pandemic forced many financial and credit institutions to reconsider their approach to doing business. Previously, many organizations had their own physical points of service and customer identification widely distributed in all major cities – in banks, offices of credit organizations or simply in crowded places such as shopping centers.
Under the conditions of strict quarantine and subsequent restrictions, companies met their customers online and began to offer remote methods of service and identification. This innovation reduced the level of checks on customer profiles and documents, which gave rise to a new wave of fraudulent attacks on financial and credit institutions.
Organizations that issued instant credit cards or loans in the form of payment cards with a credit limit were attacked. Conventionally, attacks can be divided into several categories.

First-party fraud
In this case, the scammer uses fake income documents to secure a higher credit limit or a cash loan. Documents confirming the place of residence can also be forged in order to confuse and throw off the exchange system of creditors who exchange data on unscrupulous borrowers, as well as complicate the search for a borrower by collection organizations (Figure 8).
Typically, such a scam can be carried out once, taking loans in a short time from many available organizations, and then disappear by turning off the phone.
After the name and surname of such a client enters the bases of unscrupulous borrowers exchanged by credit organizations, repeated loans will no longer be issued.

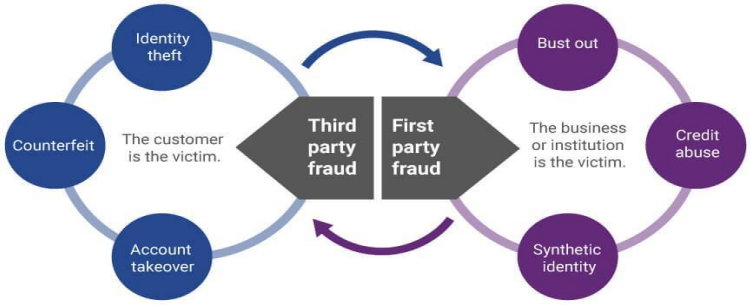


Figure 8. First-party fraud and third-party fraud
Source: Authors' own development

Third-party fraud

This method implies that the loan is obtained on behalf of a person whose documents were stolen in digital or physical form (Figure 8).

An attack from a third party is most often obtained in the form of a transfer to the card number of a criminal, because a credit institution cannot obtain the name of the real owner by the card number, and banks do not disclose such information. Or, if the attacker has access to the victim's online banking, the received loan in the form of wire transfer funds is withdrawn to a front organization or an individual who is engaged in cashing out.

Contacting the police and searching for an individual or the owner of a one-day company who received the victim's funds can take several years and not produce results. At the same time, the victim's credit reputation also suffers, because most likely the victim will find out that a loan was opened for them when the debt has already been sold to a collection agency and the client's profile is included in the database of unscrupulous borrowers – from which it is almost impossible to remove oneself without going through the courts and other bureaucratic institutions.

Such an attack can be multiplied by an attacker as many times as possible to steal the victim's documents or access their account.

Synthetic personalities

This type of attack involves taking loans and credit for a person who never existed. This is the most technologically advanced method in the attacker's arsenal.

With the development of artificial intelligence and machine learning systems, it became possible to fully synthesize the profile of a living person, including their photo, video and voice.

This attack vector uses fake IDs that attackers acquire on the black market and utility bills that confirm the fact of residence, and also synthesizes account statements from well-known banks confirming the solvency of the borrower.

The relevance of the problem is illustrated in Table 3, which shows a significant increase in the number of cases of this type of fraud.

Table 3. The synthetic identities problem

Source: Collected by authors from different sources

Type of identity theft	Number of reports in 2020	Change from 2019
Government documents or benefit fraud	406,375	1,663%
Credit card fraud	393,207	44.7%
Other identity theft	353,152	63.7%
Loan or lease fraud	204,967	95.8%
Employment or tax-related fraud	113,529	149.2%
Phone or utilities fraud	99,539	19.2%
Bank fraud	89,476	52.4%

The attack is carried out in two stages.

First, an account is opened for a synthetic person in a financial institution. In the second stage, loans are received from another company – sometimes from the same one that opened the account, but such cases are rare. Companies rarely issue loans immediately to clients with new profiles without a credit history, but they are always ready to receive a transfer from another financial institution in the form of a loan.

Thus, the attacker deceives two financial institutions at once – the one that opened the account and

the one that issued the loan.
After receiving a loan, the withdrawal scheme is similar to the third-party fraud scheme – the funds are transferred to a company or a person who is an accomplice of the attacker.
The problem with this attack is that the actual borrower does not exist at all, and the number of attempts by the attacker is limited only by how many synthetic profiles are missed by the systems or personnel of both companies that are being attacked.
This method of attack is the most dangerous at the moment, because as techniques are constantly being improved, it becomes more and more difficult to identify synthetic personalities.
Let us consider several examples. In 2019, an executive of a UK-based energy firm thought he was speaking on the phone with his boss, the CEO of the firm's German parent company, who asked him to send €220,000 to a Hungarian supplier (Stupp, 2019). The caller said that the request was urgent, directing the executive to pay within an hour, which he did. Instead of his boss, the executive spoke to a voice recording generated by artificial intelligence-based software that successfully impersonated the CEO.
The live facial biometric data that many digital-only banks rely on to authenticate their customers is not fraud-proof either. Cybercriminals have found a way to recreate 3D models of faces using recorded videos that can be used to log in by generating head tilts and turns on demand.
Social engineering plays a significant role in modern fraud cases. A man behind an Instagram account with 2.5 million followers flaunting his opulent lifestyle told people that they could earn as much as him by sending him money (Dawkins, 2021). He was arrested after stealing over $400 million from individuals and businesses worldwide (Karimi, 2020).

Table 4. The minimum cost of a new identity
Source: compiled by the authors based on Anderson (2020)

	USA	**Canada**	**Australia**	**UK**	**Europe**
New identity: passport, ID card and birth certificate	$1,152	$1,175	$1,355	$1,255	$1,125
Education: high school diploma and bachelor`s degree	0.1699 BTC	0.1699 BTC	0.1699 BTC	0.1699 BTC	0.1699 BTC
Finance: bank account, credit card and 5,000 of counterfeit currency	$115+ 0.0984 BTC	$115+ 0.0984 BTC	$115+ 0.2593 BTC	$115+ 0.1162 BTC	$115+ 0.0894 BTC
Total	$1,267+ 0.2683 BTC	$1,290+ 0.2683 BTC	$1,470+ 0.4292 BTC	$1,370+ 0.2861 BTC	$1,240+ 0.2593 BTC

There are many examples of money flippers on social media who promise to turn $100 into $1,000, $500 into $5,000, and so on (Akpobi, 2020). Suffice to say that people do not receive their investments back. If the recipient is not blacklisted, has a business, and receives money regularly, training a system to detect such type of fraud is challenging, if not impossible, for now.
Payment card and identity fraud are closely tied to criminal activities that aim to launder money and conceal identities. Modern compliance and AML investigations check social media accounts for suspicious posts and activities. To get around these checks, criminals buy inexpensive accounts created and maintained for a few years to develop a plausible online identity.
People who want to take on a different identity can buy a passport and a new identity with social media accounts, diplomas, and other documents for relatively little cost (Table 3). On the on hand, it is easier to obtain a new identity than ever before. On the other, regulators and service providers are tightening security and making it more difficult to evade their checks.
In the attempt to balance convenience and security, security is losing. Customers do not like long

passwords and additional verification methods. Frankly, they do not care if their information leaks because "they have nothing to hide and don't have that much money anyway." AutoML has the potential to slow down the advancement of financial fraud, and the only question that remains is: for how long?

Conclusions

The AutoML approach could take on all of the routine and repetitive tasks (such as data set clean, spot anomalies, and balance) that come with in-depth data analysis, and can extract insights from raw data. This technology can drastically reduce data analysis time.

Our experiments involved data on the actual credit card payments of customers in Western European banks. The data set contains 284,807 observations, including 492 cases of fraud, representing 0.172% of the total sample. Thus, the data sample is highly unbalanced, which is typical of the considered problem.

The result of our experiments, carried out by using automatic machine learning algorithms that make it possible, in a short time, to sort a large number of variants of models and the composition of input data, is the quality of classification – in terms of the AUC metric, from 0.97733 to 0.98249. This is a strong result and exceeds the effectiveness of the classifiers developed by traditional methods. The ensemble of models has allowed us to detect up to 85.7% of fraudulent transactions in the sample. At the same time, the accuracy of detecting fraudulent transactions is also fairly high (79%–85%).

New ways of payment fraud are constantly emerging. The use of AutoML methods allows the adaptation of the security systems of banks and payment organizations to be accelerated, and losses from fraud to be reduced.

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THE ROLE AND ANALYSIS OF VENTURE FINANCING IN THE DIGITALIZATION OF THE ECONOMY

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Abstract*. The increase in business digitalization is inextricably linked with the emergence of new innovative companies. Technological projects successfully implemented on the market are the basis for the development of high technology and one of the most effective elements of accelerating innovation processes. The mechanism of influence of different types of diversification indexes on the level of capitalization of the enterprise depending on the economic cycle was analyzed. This analysis revealed that during the COVID-19 pandemic, the most attractive sectors of the economy for venture capital were information technology, telemedicine and online education. This study focuses on the importance of investment in technological projects, which are the main factor in the competitiveness of enterprises, industries and national economies as a whole. It provides examples of successful venture projects in Ukraine and analyzes the effectiveness of the development of their technological areas by various companies in the non-technological sector. The types of technology investments were considered in terms of the classification of venture investment funds, the differences in the strategies of venture funds and traditional private equity funds in technological companies, as well as the development of corporate technology projects or startups. The study also considered the processes of diversification of enterprises in the face of the ever-increasing influence of the technology sector in other industries. The study discusses the features of venture financing of innovative projects in modern economic conditions. By examining different types of technology investment strategies, the introduction of innovations into existing business processes was analyzed. An analysis of the structure of the distribution of investment flows in the most popular areas of venture capital distribution was carried out. The dependence of the level of diversification of the company and its activities regarding the distribution of funds for the development of high-tech areas was studied. Recommendations regarding the development of the Ukrainian market for technological investments are provided, and the method of research of the investment directions of diversified enterprises in the introduction of innovations is offered.*

Keywords: *digitalization, economics, venture financing, startup, innovations*.

Introduction

In today's world, information and digital technologies are becoming powerful drivers in all areas: manufacturing, trade, logistics, medicine, education and more. Every day, we are witnessing numerous examples of how digital technologies contribute to peace, human rights and sustainable development for the benefit of society as a whole (Nigam et al., 2020). Venture capital is recognized as one of the priority mechanisms in financing innovation activities. Global practice has shown that the emergence of venture capital has led to the significant intensification of innovation processes, and venture capital itself is increasingly becoming a factor in accelerating the development of scientific and technological progress (Lerner & Nanda, 2020).

The purpose of this work is to analyze the impact and importance of venture financing for the development of the digitalization of a country's economy.

In the process of writing this work, the author used general and special methods, which made it possible to systematically study venture financing and technological development in the digital economy.

The main body of the paper

The global economy has been affected by digitalization and the widespread introduction and dissemination of information technologies. The digital economy is a set of social relations formed by the use of electronic technologies, electronic infrastructure and services, the technologies of large data analysis and forecasting to optimize production, distribution, exchange, and consumption in order to increase the socioeconomic development of states.

Digitalization has stimulated an influx of investment support for startups. Between 2011 and 2020, the amount of venture capital invested at all stages increased fivefold. Even the COVID-19 pandemic saw an increase in venture capital. At the same time, private funds have been active for a long time and the amount of corporate investments has been increasing. A fall in the average investment in this area was recorded only in the segment of public investment. There are several very important reasons to consider the possibilities of private capital or venture capital in Ukraine. Many of the country's former problems have already been solved, and there are many who jump to provide creative opportunities within risk factors that are at least reasonable. Today, the backwardness of the venture capital industry in Ukraine is due to a weak legal framework, an imperfect stock market, the non-transparent financial activities of companies, a lack of guarantees for investors, a lack of experts in venture fund management, and a lack of tax benefits for venture capital. Successful experience in developing a venture capital system and a mechanism approved in other countries can and should be used in Ukraine, but practical examples of the US experience should be taken into account – such as venture capital being postponed in its purest form, without changing the infrastructure environment, legal environment, etc. In Western European countries, however, this model was not successful and did not produce the necessary economic effect.

Creating a favorable investment climate and improving the legal framework will increase the amount of venture financing of the Ukrainian economy, and recommendations can be made to make proposals to improve the tax regulation of venture funds. These recommendations consist: in determining the tax base of income tax on non-property assets on the basis of a special agreement; in establishing a special regime of taxation of wage payments in companies that are professionally engaged in venture fund management; in the development of tax benefits for industrial corporations that invest in venture funds that invest in the main profile of industrial corporations; in tax benefits and preferences for small and medium enterprises – including VAT on the sale of new products; in insurance premiums for small and medium-sized innovative enterprises from the property tax of the organization related to new equipment used in the production of knowledge-intensive products; in land tax benefits for research organizations and innovative enterprises; in exemptions from taxation of income from the implementation of exclusive rights and additional preferences for innovative enterprises when issuing an account and annual accounting of intellectual property, which is the basis of innovation; and in subsidies for the payment of interest on bank loans aimed at purchasing new processing equipment and creating modern facilities used in the production of knowledge-intensive products.

It is proved that technologies and technological investments are aimed at improving the development of the following economic categories: making organizational management more efficient; improving other sectors of the economy (the ability to optimize processes such as the capabilities of the Internet have changed industries as such retail, and have given impetus to the development of the delivery of goods); influencing macroeconomic indicators (investments in technology are usually made through public funding, also often through the interaction of teams from different countries, which is positively reflected in the country's foreign trade balance); improving financial markets; developing social initiatives; developing technology – today, thanks

to the development of technology, tourism, ease of telecommunications, transparency of social activity, accessibility of media content have become very popular among all social groups; and developing regulatory procedures – today, with the development of technology, businesses' control over their activities increases, facilitating the social control of businesses, which encourages them to be more responsible and to promote the globalization of socioeconomic processes.

There is a growing level of mutualism among individual companies and even industries around the world. As such, the areas of responsibility of the organization to which attention should be paid in case of the decision to introduce technologies in the business process are defined.

In today's world, there are a huge number of techniques and methods of promoting and selling goods and services. The main task of any business is to meet the needs of its customers and shareholders by strengthening its economic potential and competitiveness (Mason & Harrison, 2017). However, with each passing day, competition between enterprises is intensifying and there is a need to use increasingly sophisticated technologies to improve the marketing, financial and operational level of competitiveness of the organization. Particular attention can be paid to multidisciplinary enterprises, for which today most technological investment is used as a marketing tool to attract additional investors.

Today, technology is one of the most important factors in the competitiveness of enterprises of different forms of ownership and areas of activity. Diversified businesses are one of the most common ways of doing business in many countries around the world. The most important aspect of the company's sustainable development is the ability to create value for shareholders and be able to develop in a competitive environment.

Technological investments are aimed at improving the development of the following economic areas:

1. Organizational management, which helps to optimize many processes that require less time spent by workers such as accounting and internal communication.
2. Improving other sectors of the economy (the ability to optimize processes such as via the capabilities of the Internet has changed industries such as retail, and has given impetus to the development of the delivery of goods).
3. The ability to influence macroeconomic indicators (investments in technology are usually made through public funding, also very often via the method of interaction of teams from different countries, which has a positive effect on the foreign trade balance of the country).
4. Improving financial markets (in many cases, the financing of innovation processes and new technologies is through the attraction of capital or venture capitalists or financing by so-called "angel investors," which gives impetus to the protection of investors, mutual funds, banking, insurance, consulting, etc.).
5. Developing social initiatives (social habits can change with the further development of technology, so today due to the development of technology they have become very popular (Koski et al., 2020) among all social groups. These habits include tourism, ease of telecommunications, transparency of social activity, and the accessibility of media content).
6. Regulatory procedures (today, with the development of technology, the possibility of the business controlling its activities increases, facilitating the social control of the business, which encourages it to be more responsible).
7. Contributing to the globalization of socio-economic processes (increasing the level of mutualism among individual companies and even industries around the world).

The technological factor is able to increase the economic potential of enterprises.

The technology sector includes everything from large, well-known companies to small players who work largely behind the scenes. This category also includes emerging companies of all sizes,

startups, multibillion-dollar technology and consumer brands, and various conglomerates (Conti et al., 2019).

In a broad sense, this category includes enterprises engaged in the research, creation and distribution of goods or services based on technology. This can be anything from computers to software, TVs to websites. Hardware is a physical device – a computer, TV, smartphone, etc. Software is computer code or platform that makes these devices work.

Investing in the technology sector offers investors many opportunities. In fact, this sector offered the highest profits of all rated market sectors in 2017 – 34.28%.

However, these strong profits mean that the technology sector has many risks. Technology is changing rapidly, and one-time leaders can quickly fall behind or even stop. In addition, promising emerging companies can see huge spikes, only to disappear quickly.

Technology is an exciting space that includes trends from artificial intelligence (AI) to smartphones, blockchain, self-driving technologies, constant trends in software as a service (SaaS), the Internet of Things (IoT), media streaming and others. This is an area full of opportunities, but also a certain risk.

Every organization will need to become a digital organization in the near future, but our research shows that most still have a long way to go. Organizations need to upgrade their technology to take part in an unprecedented opportunity for digital transformation (Bonini & Capizzi, 2019).

Today, we can determine that the four best technological areas in which the company should invest are:

- cybersecurity;
- IoT technology;
- cloud services;
- artificial intelligence (AI).

Implementing technology in business processes is quite a difficult process and often involves significant financial and time costs, so businesses should identify areas of responsibility for the organization to pay attention to when deciding to implement technology in business processes, or investing in the technology sector. These areas are as follows:

1. Staff readiness.

Analyzing talent technology, technology size, and quality serve as a barometer for talent readiness. Careful evaluation and management of the talent fund ensures consistent technical and strategic skills throughout the technology implementation period. It also requires businesses to ask important questions about opportunities. For example, do they have sufficient access to people, both inside and outside the organization, who understand the technology and apply it to the business and industry context?

2. Research on the availability of capital.

The amount of capital invested in technology development and its application in different sectors measures the adequacy of capital in relation to technology. Venture capital investment, for example, is one of the indicators of money transferred to startups and incubation centers for future development. Mergers and Acquisitions (M&A) are another excellent barometer and a worthy source of market analysis for the degree of development of the business, and the attractiveness of technologies being developed and implemented.

3. Ecosystem maturity.

The business must share the same vision of artificial intelligence enhancement supply chains as its major distributors. Ecosystem assessment should also include the study of existing standards and protocols, such as current technology applications and uses (Corredoira & Di Lorenzo, 2019).

Research is needed on how these regulatory standards promote or hinder the integration of technologies.

4. Intensity of adaptation.

Evidence of successful technology integration within existing or related industries can also guide businesses' investment decisions. It is estimated that the average industry spends significantly on digital technology that can help companies to decide how much to invest and for what outcome. Research is also needed to determine the projected increase in the cost of implementing the technology in the market.

5. The potential value of technology.

Value potential is focused on assessing the return on investment in digital and other technologies, which sets expectations for both managers and shareholders.

Quantifying the expected profits of the top and bottom lines can serve as a useful guide in the entire process of implementing technological investment.

The directions that are the most popular among investors are determined on the basis of the analysis of European venture investments (Table 1).

If diversified companies want to stay relevant and successful in future digital transformation projects, then technology investment should be prioritized. Even the largest public asset conglomerates in many countries are focused on technology investment.

Now consider the amounts of investment in technological innovation of these companies (Table 1). It should be noted that they are very different. Furthermore, it is difficult to compare the level of investment in technology conglomerates such as Berkshire Hathaway and Alphabet, because the former never positioned itself as a technology company and the latter, on the contrary, started as a specialized Internet search company (Google).

Table 1. The most popular areas of investment of venture capital funds

Source: developed by the author

No.	Direction	Features	Fraction
1	Software (mostly SaaS)	Financial software, business software, software for operational processes, mobile software	36.2%
2	Biotechnology	Creation of new drugs, focus on a new generation of antibiotics	17.3%
3	Media and entertainment	Social media, video hosting, interactive media	9.5%
4	Medical equipment	New generation of prosthetics, laser technology	7.1%
5	IT services	Outsourcing of IT processes	6%
6	Energy sector	Horizontal drilling, shale drilling investments, traditional energy, green energy	5.8%
7	Consumer goods and services	Eco-food and FMCG products	3.9%
8	financial services	Online banking technology, insurance	2.6%
9	Equipment	3D printers, robotics	2.1%
10	Telecommunications	Internet of Things, new means of communication	2%

Table 2 shows the capitalization, number of staff and technological sectors in which the investments of these enterprises are directed.

Traditional conglomerates such as Danaher, Honeywell, GE, and Berkshire Hathaway today have a dual view of technology investment. First, they try to use technology in their traditional businesses to gain a competitive advantage by reducing costs or increasing productivity. Also, these companies direct retained earnings as financial investments in high-tech enterprises under the strategy of venture capital funds. This allows them to bring additional income to their shareholders by increasing investment capital.

Such investments also play a very important marketing role in attracting investment. Because technology investments have associations with high profitability in the psychology of investors, this allows such diversified companies to position themselves as technology investors and attract the attention of a younger generation of investors, who are also able to significantly increase their shares and thus further profit their shareholders. Table 2 provides an overview of the largest conglomerates in the world that actively invest in technology.

Table 2. Public conglomerates that actively invest in technology, 2018

Source: Forbes (2021)

Corporation	Capitalization, billion $	Staff, pers.	Turnover, billion $	Net income, billion $	Assets, billion $
Johnson & Johnson [NYSE: JNJ]	366.2	135,100	81.6	14.7	153
3M [NYSE: MMM]	126.1	93,516	32.8	5.3	36.5
Berkshire Hathaway [NYSE; BRK]	516.4	389,000	247.8	4	707.8
GE [NYSE: GE]	81.4	283,000	121.6	−22.4	317.7
Alphabet [NASDAQ: GOOG]	863.2	98,771	137	30.7	166.3
The Walt Disney Co. [NYSE: DIS]	238.1	201,000	59.4	11	99.9
Danaher [NYSE: DHR]	90.7	71,000	20.1	2.4	47.8
Honeywell [NYSE: HON]	123.1	114,000	40.3	6.7	58.6

The effect of technology can be felt through business. Scientific discoveries make little or no sense if there are no competent business units to produce for people what science has discovered. The organization of a diversified business must not only attract huge amounts of capital, but the proper use of funds for useful purposes is also mandatory. This requires efficient and effective financial management together with qualified and competent financial managers.

Table 3. The main areas of activity of diversified enterprises and areas of their technological investment

Source: Forbes (2021), World Bank (2022), UkrMetallurgProm (2020), Fedorov (2018)

Corporation	Main areas of activity	Technological investments
Johnson & Johnson [NYSE: JNJ]	Production of cosmetic and sanitary products	Medical equipment
3M [NYSE: MMM]	Building materials, passive fire protection equipment, dental products, car care products	Electronics
Berkshire Hathaway [NYSE; BRK]	Financial services, confectionery production, publishing, jewelry business, production of furniture, carpets, building materials, etc.	Energy
GE [NYSE: GE]	Power plants (including nuclear reactors), gas turbines, aircraft engines, medical equipment, also manufactures lighting equipment, plastics and sealants	Engineering
Alphabet [NASDAQ: GOOG]	Internet, computer software, telecommunications, healthcare, biotechnology	Online search, IT
The Walt Disney Co. [NYSE: DIS]	Hollywood studios, theme parks, water parks, as well as television and radio networks, cruise liners	Interactive media and entertainment
Danaher [NYSE: DHR]	Industrial products	Engineering
Honeywell [NYSE: HON]	Space systems, automatic and control systems, engineering services, transport systems.	Aerospace engineering

For multidisciplinary companies, technological change can have many consequences. Technological changes can create new products and accelerate the aging of existing ones. Thus,

technological changes affect the boundaries and structure of the industry, the replacement and differentiation of products, and the ratio of price and quality between products.

The bottom line is that the pace of technological progress is accelerating, and survival, regardless of the size of the company, will depend on being aware of and connecting to the ecosystem of existing technologies such as management decisions, marketing, supply chains and others. This also depends on whether the company controls this process or is a simple follower. It is important that companies carefully evaluate potential technology options and allocate funds to help their businesses evolve over time.

Although customer-centric business is changing the types of technologies that organizations need to invest in, it is also transforming the composition of internal marketing teams and requires different skill sets.

Businesses must fight for competitive positions. It is difficult to hire new marketers with the necessary talents and technical skills, but this type of management can create gaps in the sets of tools that are sought to fill these roles.

Retraining is definitely on the agenda for many marketers, as 40% say they will focus equally on recruiting and retraining the available workforce. There is an important lesson in understanding the real long-term value of an invested employee as opposed to simply investing in employees.

Of course, hiring and retraining is not just about having the skills to use new technologies. Soft skills are also growing in importance.

This is a departure for both employers looking to invest in their internal skill sets and employees – or future employees – making themselves available to work in tomorrow's marketing world.

This shows that technological innovations are becoming more widespread, and their implementation is becoming less costly both in terms of investment and in terms of staff and time.

Ukraine remains an integral part of the global technology and innovation market and a participant in investment agreements. The volume of venture investments and M&A transactions among Ukrainian IT companies and startups decreased significantly in 2020 and amounted to $167 million, compared to $658 million in 2019. At the same time, the number of transactions increased from 25 transactions in 2019 to 46 in 2020. Local investors, including CU Ventures, Horizon Capital, TA Ventures, Genesis Investments, SMRK VC Fund, Fedoriv Group, SMRK VC Fund, Quarter Partners, Pragmatech and others, remain active investors in Ukrainian startups.

The main positive and significant news for the Ukrainian IT industry in 2020 was the continuation of optimistic dynamics of growth in exports of Ukrainian IT services. In 2020, this figure was for the first time at a record high of $5 billion, which is almost 20% ($853 million) higher than the previous year ($4.2 billion). In general, compared to 2013, the IT industry is confidently showing positive dynamics year by year – today, the share of IT in total exports of the country has reached 8.3% (1.58% in 2013). Also, the export of IT services has already outpaced the export of chemical products in volume, reaching the level of exports of mineral products and approaching the indicators of exports of metallurgical products (DLF, 2021).

This is against the background of falling national GDP (−4.2% in 2020, compared to the previous year), as well as the falling consolidated index of production of goods and services by main economic activities (SIP; −4.4% over the same period) (all statistics according to the Ministry of Economy). The indicators for 2020 in other sectors that are crucial for the Ukrainian economy are as follows: industry – 5.2%, agriculture – 11.5%, transport – 14.2%.

Growth dynamics is a key factor that attracts a lot of attention to the Ukrainian IT industry both domestically and abroad.

Through the mediation of the venture business in Ukraine, the volume of funding has been constantly growing in both new industries and traditional sectors of the national economy, where

venture capital previously did not participate in financing. The preferences of venture investors for more liquidity and less risk are changing. Its expansion into traditional spheres of financial activity has begun – including 188 derivatives, government securities and domestic local bonds.

In Ukraine, a significant part of venture capital is used for financial investments not related to innovation. These involve, first of all, granting loans to business entities, investing in government securities, domestic local bonds, real estate, bank metals, etc. Such a venture capital investment mechanism, associated with risk diversification, is reminiscent of self-insurance, where investors protect themselves from significant financial losses.

Venture capital has not yet become an effective mechanism for financing innovative business in Ukraine. The extended reproduction of venture capital is not aimed at the development of the national innovation and technology enterprises of Ukraine. There is an urgent problem of reorienting venture funds to finance innovative projects.

Methods of research into the investment directions of diversified enterprises regarding the introduction of innovations are numerous.

Because corporate entrepreneurs play a key role in corporate innovation and enterprise growth, a nation's economic growth depends largely on enterprise growth. The productive contribution of the entrepreneurial activity of society varies depending on the relative payments from the types of entrepreneurial activity. Thus, to promote economic growth, society and politicians must create an environment for productive entrepreneurship.

Table 4. Growth of assets of venture funds of Ukraine in 2019–2020, million UAH

Source: Report of the National Commission on Securities and Stock Market for the relevant years / National Commission on Securities and Stock Market (https://www.nssmc.gov.ua/)

Assets	**2019**	**2020**
Shares of Ukrainian issuers	−4,517.6	−661.2
Other investments	10,431.6	9,012.1
Real estate	2,640.7	−306.1
Government securities	126.4	2,763.8
Rights requirements	−1,374.7	2,023.5
Corporate rights (except securities)	2,830.6	1,083.1
Loan	21,335.1	35,816.6
Accrued but unpaid interest	2,784.6	3,481.8
Enterprise bonds	5,201.5	158.5
Derivatives	370.3	1,891.8
Total	42,126.9	75,817.5

Modern researchers of economic processes pay much attention to stimulating the development of innovative enterprises. The international rankings of both countries and individual enterprises indicate the importance of the innovation component in their activities. We can say that today employment in innovation helps to increase the investment attractiveness of enterprises and countries. From the point of view of management, it is very difficult to focus solely on innovation. Any company is based on the effective interaction of three components: finance, operations and marketing policy, and it is very important to maintain balanced governance in these three areas. Therefore, there is a need to study how innovative enterprises are able to attract investment, how it affects their operations management, and what marketing tools they use to communicate with investors and consumers. An important issue in technology management is the financing of technological development and innovation. A feature of innovation financing is the need for constant refinancing of various projects aimed at improving the efficiency of the business

processes, products and services of the enterprise. The problem of financing is present in all enterprises. Even in large firms, managers who aim to implement certain innovations (technological, operational, marketing, etc.) often report that the innovative projects they would like to implement cost much more than the funds they operate with. This is partly an explanation for the constant increase in investment in innovation.

From the point of view of investment theory, innovative investments have a number of characteristics that distinguish them from traditional investments. First and foremost, a 50% or more share of R&D in this investment is the salary of highly educated scientists and engineers. Their efforts create an intangible asset and form a knowledge base from which to make a profit in the coming years – so much so that this knowledge is not fixed, it is embedded in the human capital of employees, and therefore it is lost if they are fired. This fact is important for R&D investment. Because part of a firm's resource base disappears when such employees leave or are laid off, firms seek to smooth out R&D costs over time to avoid the need for employee dependence.

The second important feature of R&D investment is the degree of uncertainty associated with its output. This uncertainty is usually greatest at the beginning of a research program or project, suggesting that the optimal R&D strategy is similar to the other options, and should not in fact be analyzed in the usual way. R&D projects with a low probability of success in the future may need to be continued, even if they do not pass the expected rate of return. Uncertainty here can be extreme – not an easy question of a well-defined distribution with mean and variance. There is evidence that the distribution of profits from innovation sometimes takes the form of a Pareto distribution when variance does not exist. In this case, standard risk adjustment methods will not work.

The natural starting point for the analysis of any type of investment financing is the "neoclassical" marginal profit margin, modified accordingly to take into account the peculiarities of R&D. This condition sets the marginal return on capital equal to the rate of return on taxation of investment in this capital, because financial markets provide capital at an interest rate that depends on corporate tax, depreciation rates and the tax regime of a particular asset. The formulation of investor costs draws attention to the following determinants of R&D financing:

1. A tax regime, such as tax credits, that should not be subject to government interference.
2. Economic depreciation, which in the case of R&D is more correctly called obsolescence. This amount is sensitive to the realized speed of technical changes in the industry, which in turn is determined by such things as market structure and the pace of development of subsequent products and services. Thus, it is difficult to interpret it as an invariant parameter in this context.
3. The marginal cost of adjusting the level of R&D program.
4. The required rate of return of the investor.

The last point was the subject of considerable theoretical and empirical interest to economists in industry and corporate finance. Two broad theories need to be observed: the focus should be on the role of asymmetric information and moral hazard in raising the required rate of return higher than that normally used for conventional investment; and the focus should be on the requirements of different funding sources and their different tax rates.

There is a contrast between stock market-oriented markets (such as the USA and the United Kingdom) and banking capital-oriented markets (such as much of continental Europe and Japan) that view venture capital as a combination of system strengths as it provides strength incentives for the manager-entrepreneur, typical for the stock market system, and monitoring of the informed investor, typical for the system focused on bank loans. They emphasize the importance of an active stock market, especially for new and young firms, to provide an exit strategy for investors in venture capital firms and allow them to move on to finance new startups. Thus, there is an industry

of VC that promotes innovation and growth and requires the existence of an active IPO market (initial public offerings).

In order to prove the role of innovation for diversified enterprises, 25 public enterprises with a turnover of more than $1 billion were analyzed. Table 5 represents the most innovative enterprises. The innovativeness of these enterprises is determined by the percentage of their market capitalization that is higher than their net cash flow. This technique was chosen because of the difficulty of identifying the innovative component of the activity. Table 5 also shows the growth rate of sales for the last 12 months of 2019.

Table 5. Innovation award of the world's leading companies

Source: Forbes (2021)

No.	Company	Country	Sales growth	Innovation award
1	ServiceNow	USA	39.02%	89.22%
2	Workday	USA	36.07%	82.84%
3	Salesforce.com	USA	24.88%	82.27%
4	Tesla	USA	67.98%	78.27%
5	Amazon.com	USA	30.80%	77.40%
6	Netflix	USA	32.41%	71.23%
7	Incyte	USA	38.93%	70.59%
8	Hindustan Unilever	India	11.49%	67.2%
9	Naver	South Korea	19.36%	64.62%
10	Facebook	USA	47.09%	64.42%
11	Monster Beverage	USA	10.67%	64.26%
12	Unilever Indonesia	Indonesia	2.25%	63.91%
13	Adobe Systems	USA	24.56%	62.38%
14	Celltrion	South Korea	45.25%	62.3%
15	Autodesk	USA	1.33%	62.04%
16	Regeneron Pharmaceuticals	USA	20.82%	61.11%
17	Vertex Pharmaceuticals	USA	46.2%	60.93%
18	Amorepacific	South Korea	−6.86%	60.81%
19	AmerisourceBergen	USA	4.29%	58.69%
20	Illumina	USA	14.74%	58.33%
21	Marriott International	USA	34.10%	58.15%
22	Alexion Pharmaceuticals	USA	17.32%	58.04%
23	CP All	Thailand	12.67%	57.32%
24	Red Hat	USA	21.09%	57.00%
25	Tencent Holdings	China	53.83%	56.77%

Investors are willing to overpay for shares of innovative companies much more than for more conservative companies. Absolute dominance belongs to the USA in this regard. It is very interesting that there are no companies from Europe in this table. In fact, there are innovative companies in European countries, but they are either quite small against the background of technology giants from the USA and Asia, or their financial performance is not as impressive as the performance of the companies represented above. Also, most of their innovations are highly dependent on infrastructure. The USA and Asia have the best infrastructure for technology companies, which is why most new players in the industry are trying to be closer to their competitors and the overall startup ecosystem.

With regard to Asian countries, it is possible to argue about the importance of government programs for the development of innovative enterprises. This path is quite debatable, because it is

not always market-based. The investment attractiveness of European startups is lower because, on the one hand, they are not as strongly supported by the state as Asian competitors and, on the other hand, they do not have such a developed infrastructure of venture capital funding as American companies.

It should also be noted that because the European market is quite segmented and regulated by a large number of local authorities in each country and in terms of tax law, European companies are in a less competitive environment. There is a need for more universal state regulation, or rather its absence in this area.

It should also be noted that in many cases, American companies engaged in innovation are largely overvalued, as evidenced by low profits or losses. Investors are more motivated for the future competitive position of these companies in the market. Very interesting is the tendency that in essence most technology startups are by nature monopolies. Most IT companies are focused on the global scale. There is no need to stimulate competition in, say, social networks, because they are effective in a society where everyone will be a user. The same can be said about software development companies.

Table 6 shows the financial indicators of asset value, profit, sales, number of staff and years of establishment. To understand the further vectors of investment by Ukrainian diversified enterprises, Table 7 also provides the areas of activity of these enterprises.

It is possible to distinguish that there are companies from rather traditional spheres of business such as hotel chains, retail trade, and consumer goods. This leads to the conclusion that it is very difficult to constantly generate fundamentally new industries that can be characterized as innovative. Hotel chains are constantly introducing new methods of operational management, the same can be said about the field of consumer goods, and all of these companies are focused on the formation of a very strong marketing policy. Despite the strong marketing activities of technology and pharmaceutical companies, they are actually less dependent on marketing than the FMCG industry (consumer goods, often light and food industries, are those represented in traditional hypermarkets). High-tech companies are constantly competing with each other in their developments. When a company has a promising development, it will be primarily protected from competition by its copyrights, patents, licenses, etc. Then, when promoting in the market, it will usually use marketing technologies that will be useful, and the company's market share is likely to grow, but in the case of new technologies that make the use of goods and/or services more efficient, the company will quickly lose market share.

This is after the 1980s, when the deregulation of financial markets took place and young people realized that it became possible to use investors' funds through contact with venture funds.

Table 6. Performance indicators of innovative enterprises in 2018

Source: Forbes (2021)

No.	Company	Sphere of activity	Year founded	Assets, million $	Profit, million $	Sales, million $	Staff
1	ServiceNow	IT and software	2004	3,900	−27	2,600	8,154
2	Workday	IT and software	2005	5,500	−418	2,800	10,500
3	Salesforce.com	IT and software	1999	30,700	1,100	13,300	35,000
4	Tesla	Car production	2003	8,100	−976	21,500	48,817
5	Amazon.com	Technological conglomerate	1994	162,600	10,100	232,900	647,500
6	Netflix	Online media	1997	26,000	1,200	15,800	7,100
7	Incyte	Biotechnology	1991	2,600	109	1,900	1,367
8	Hindustan	Consumer goods	1931	n/a	630	4,800	18,000

	Unilever						
9	Naver	IT and software	1999	n/a	696	3,650	8,105
10	Facebook	Social networks	2004	97,300	22,100	55,800	35,587
11	Monster Beverage	Consumer goods	1985	4,700	993	3,800	3,142
12	Unilever Indonesia	Consumer goods	1933	n/a	n/a	2,800	6,000
13	Adobe Systems	IT and software	1982	19,500	2,700	9,500	21,357
14	Celltrion	Biotechnology	1991	3,300	243	892	n/a
15	Autodesk	IT and software	1982	5,500	−81	2,600	9,600
16	Regeneron Pharmaceuticals	Biotechnology	1988	11,700	2,400	6,700	7,400
17	Vertex Pharmaceuticals	Biotechnology	1989	6,200	2,100	3,000	2,500
18	Amorepacific	Consumer goods	2006	5,300	312	4,500	6,267
19	Amerisource Bergen	Pharmaceutical distribution	2001	39,300	1200	172,900	21,000
20	Illumina	Biotechnology	1998	7,000	826	3,300	7,300
21	Marriott International	Hotel chains	1927	23,700	1,900	20,800	176,000
22	Alexion Pharmaceuticals	Biotechnology	1992	13,900	78	4,100	2,656
23	CP All	Retail	1988	11,500	616	15,700	n/a
24	Red Hat	IT and software	1993	5,600	434	3,400	13,360
25	Tencent Holdings	Technological conglomerate	1998	47,200	11,900	47,200	54,309

There has also been a significant increase in the supply of capital in world markets and falling margins in traditional business areas. Therefore, in the 1980s there was a very favorable situation for continuous innovation and the interest of financial markets in financing this activity despite high risks, because of the confidence that even a small share of investment in these companies will be successful and returns will be so high as to compensate all costs to other companies.

However, most foreign investors in 2020 invested their assets in the agriculture and processing industry of Ukraine (22% and 21%). Real estate transactions were also popular at 18%, as was investing in information and telecommunications at 10%. FDI has a significant geographical diversification of exporting countries (OECD, 2021).

The largest investors in Ukraine's economy in 2020 were: Switzerland – $480.5 million; the UK – $282.9 million, and Luxembourg – $214.4 million. It is worth noting that 2020 was one of the worst in recent years in terms of investment in Ukraine's economy.

The degree of diversification of enterprises was grouped and the following classification was obtained: non-diversified (single line of business); vertically integrated (presence of controlled technological chain); differentiated (wide choice of product groups or goods in one industry); diversified (presence of indirect economic relations from different industries); and conglomerate (presence of unrelated businesses in the portfolio without dominance, as an extreme degree of diversification). There was some disparity within diversification among the fact that diversification is also a source of profit, assets and income. For each group, the index of diversification was created based on income, net profit and assets, as well as its impact on the capitalization of the enterprise. The multiplier is calculated as the weighted average of enterprises in different industries and countries based on those that are most successful in terms of annual income, net income, and asset value – in each individual industry and diversified. This impact was calculated for each type of diversification index, as well as for private and public types of enterprise. The study did not take into account state-owned enterprises, nor enterprises that are natural monopolies. An intended

feature of the study was to establish a link between the effectiveness of managing the expansion of private and public enterprises at different stages of the economic cycle. Hence, it is possible to set the recommended range of degrees of diversification,

The mechanism of influence of different types of diversification index on the level of enterprise capitalization depending on the economic cycle was analyzed, which takes into account different types of diversification index calculation, enterprise publicity and economic cycle in the national and global economy (Table 7).

Table 7. The mechanism of interdependence of components of diversification in terms of investment attractiveness

Source: Forbes (2021), World Bank (2022), UkrMetallurgProm (2020), Fedorov (2018)

	Degrees of diversification	IDR	MID RPRi	MID RPUBi	BC	IDP	MID RPRi	MID RPUBi	BC	IDA	MID APRI	MID APUBI	BC
1	Non-diversified (Single line of business)	>0.9	3–4	5–6	alws	>0.85	3	7	alws	>0.8	3	7	alws
2	Vertically integrated (Presence of a controlled technological chain)	>0.85	4–5	7–8	lift	>0.5	6	9	alws	>0.6	6	9	lift
3	Differentiated (Wide choice of product groups or products in one industry)	>0.7	4–5	4–5	alws	>0.65	5	6	alws	>0.5	5	6	alws
4	Diversified (Existence of indirect economic connection of subsidiaries from different industries)	>0.4	4–5	7–8	lift	>0.3	5	7-9	alws	>0.4	5	7–9	lift
5	Conglomerates (Presence of unrelated businesses in the portfolio without dominance. This is an extreme degree of diversification)	<0.2	5–6	3–4	alws	<0.12	5	4	alws	<0.25	5	4	alws

** IDR - index of income diversification; MIDRPRi – a multiplier that gives IDR to the assessment of capitalization for private enterprises; MIDRPUBi – a multiplier that gives IDR to the assessment of capitalization for public enterprises; IDP – net income diversification index; MIDPRi – a multiplier that gives IDP to the assessment of capitalization for private enterprises; MIDPPUBi – a multiplier that gives IDP to the assessment of capitalization for public enterprises; IDA - asset diversification index; MIDAPRi – a multiplier that gives IDA to the assessment of capitalization for private enterprises; MIDAPUBi – a multiplier that gives IDA to the assessment of capitalization for public enterprises; BC – the state of the economic cycle of the economy.*

To determine the general direction of market movement, it is necessary to analyze several key fundamental indicators. These are primarily general macroeconomic indicators, such as production growth, inflation, sales, budget deficit, and money supply.

The result should be an answer to the following question: are the conditions for growth of the issuer's profit created at the macroeconomic level?

Then, the analysis of industries is carried out in order to rank them according to the potential for growth (decline), and the main factors that are decisive for a particular industry are identified. At the final stage, the most promising issuers should be selected from those that are the most attractive

from the investor's point of view. Here, special attention should be paid to accounting standards, which present the main financial and economic indicators of the issuer.
Thus, in the digital economy, education, medicine and IT projects are a priority for venture capital investors. In the COVID-19 pandemic, these sectors became even more developed.
Venture capital is one of the most effective mechanisms for financing innovation and scientific and technological progress. Venture financing helps to create new products, technologies, services or management decisions, and is unique because it provides a number of related additional services (management, marketing, consulting, etc.). Venture structures are becoming intelligent centers for innovation, whose experience is valuable and contributes to the diffusion of innovation into the business environment.

A special role in stimulating the development of venture entrepreneurship in Ukraine belongs to the state, which should create appropriate institutional conditions by providing state aid to venture business, encouraging the creation of venture funds, improving the legal framework and tax system for venture fund taxation, and promoting financial markets.
For the effective functioning of venture funds in Ukraine, it is necessary to create a system of appropriate guarantees from the state to provide for participation in venture funds of insurance companies and amend the Law of Ukraine "On Joint Investment Institutions (Mutual and Corporate Investment Funds)," taking into account current trends in the development of global venture capital.

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FEATURES OF USE OF MODERN FINANCIAL TECHNOLOGIES IN THE ACTIVITIES OF CREDIT ORGANIZATIONS

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Abstract: *This article describes the characteristics of the FinTech industry and presents the cycle, geography, key elements and stages of development of FinTech 1.0, FinTech 2.0, and FinTech 3.0. The impact of improving the quality and quantity of information technology, changing consumer habits, as well as the need to improve the efficiency of financial and non-financial institutions in the development of FinTech is revealed. An analysis of the main advantages and disadvantages of the development of the FinTech industry in the world shows that FinTech is a sector of the economy that includes companies that use technology to provide financial services more efficiently. Opportunities and disadvantages of financial technologies are also grouped into cloud technologies, artificial intelligence, blockchain, machine learning, the Internet of Things, big data, intelligent communications, application programming interface, cryptography, biometrics, etc.*

The description and types of regulation and control technologies are given, in which RegTech is divided into specific technologies: transaction monitoring technology; risk management technology; reporting technology; and control technology (SupTech). The latter is a technology with automated processing of reports and other received data from financial market entities related to monitoring and analysis of market and operational risks of digitalization, regulatory requirements, etc. The authors grouped FinTech classifications by industry, subject of management and types.

The structure of the banking system of Tajikistan was analyzed and it was concluded that the main reason for the reduction in the number of credit organizations in Tajikistan in recent years is unpreparedness for the radical changes taking place in the world and the ongoing economic crisis – the COVID-19 pandemic – which had a significant impact on the activities of domestic credit organizations. Due to the fact that clients of credit organizations did not receive loans during this period, the financial condition of many organizations deteriorated, as a result of which they were declared bankrupt.

The main indicators of the balance of credit organizations, the financial stability of the banking system of Tajikistan, and the number of means of payment used are analyzed, and it is concluded that the banking system, like any economic system, is constantly evolving, and its structural elements must work together. Currently, the banking system is undergoing changes under the influence of new financial technologies. To determine the level of digitalization of the banking system, the indices of digital financial services for 2018–2021 were calculated and analyzed, which confirmed its low level.

The influence of factors on the share of payment orders received by credit institutions via the Internet and the share of payment orders received by credit institutions via messages using mobile subscriber devices was determined by the regression method.

The study also identified the prospects for the impact of blockchain technology on GDP and, in conclusion, recommendations are provided for the introduction of financial technologies in the activities of organizations in Tajikistan.

Keywords: *financial technologies, financial institutions, digital transformation, banking system, credit organizations, financial infrastructure.*

Introduction

The financial sector as a basis of any economic system provides the movement of currency between participants in financial and economic relations. Financial institutions act as intermediaries in operations for the placement and attraction of financial resources, collecting funds from some business entities and providing them to others.

The current stage of development of the financial sector is characterized by the introduction of new technologies (Karpova, 2018) that allow new ways to manage cash flows without resorting to the help of intermediaries. These type of high-tech services are called FinTech.

The main body of the paper

FinTech is an ever-evolving segment at the intersection of financial and technology services. Technology start-ups and new market entrants are introducing it in innovative approaches to products and services that are now used in the traditional financial services sector. FinTech can be described as a process that involves the use of technology to offer a financial solution. FinTech has emerged as a lucrative business opportunity (Filippov, 2018), filling untapped markets that have become more attractive to financial institutions, especially in a post-crisis period. On the other hand, such competitive strength leads to new financial innovations. Moreover, FinTech is a symbiosis of finance and new technologies using mobile applications and algorithms, and with the rise of a younger generation interested in finance and investment, FinTech makes it easier to collaborate using mobile devices.

FinTech usually involves a startup (Finstorm, 2015) that uses advanced and new technologies in the field of mobile payments, money transfer, lending, capital raising, etc. Some experts note that an essential feature of all FinTech startups is increasing the efficiency of the financial system. The FinTech industry has gone through three stages in its development (Table 1).

Table 1. The main stages of development of the FinTech sphere

Source: composed by the authors

Stage	**1866–1967**	**1967–2008**	**2008–present**
Period	FinTech 1.0	FinTech 2.0	FinTech 3.0
Geography	Global/Developed	Global/Developed	Global/Developed
The main elements	Infrastructure/Computing	Traditional/Internet	Mobile/startups/new participants
Jumping momentum	Network	Digitization	Financial crisis 2008/smartphone

In the first phase (FinTech 1.0), the financial services sector, which was closely related to technology, remained an analog sector. Since 1967, the development of digital technologies associated with communication and transaction processes has contributed to the transformation of finance from analogue to digital. In 1987, financial services in developed countries became significantly more mainstream and digitalized on the global stage.

In the second phase (FinTech 2.0), products and financial services were provided by the traditionally regulated banking industry using technology.

The last decade can be described as a milestone in the evolution of financial technology (FinTech 3.0), with new technology start-ups and companies offering financial products and services to organizations and people.

Over the past 10 years, we have seen the explosive growth of financial technology. The rise in FinTech firms and banking startups was fueled by the 2008 global financial crisis, which forced banks to cut costs and pull out from some markets, creating a FinTech vacuum. In the entire history of observations, the highest volume of financing in FinTech companies was observed in 2018. According to Mazitova and Prihodko (2020), the total investment in FinTech at the beginning 2018 was over $41.8 billion, total financing at the end of 2019 was $37.6 billion, and the 5-year growth rate of FinTech investor activity from 2013 to 2018 was 13%. Taking into account all of these data, we can observe that the interest of investors in making deals with FinTech technology in recent years has remained unchanged – even increasing from year to year.

Currently, the global market for technology solutions for the financial sector is one of the fastest-growing markets in the world. This means that projects that yesterday seemed fictional are today already at the final stage of testing or even being put into operation.

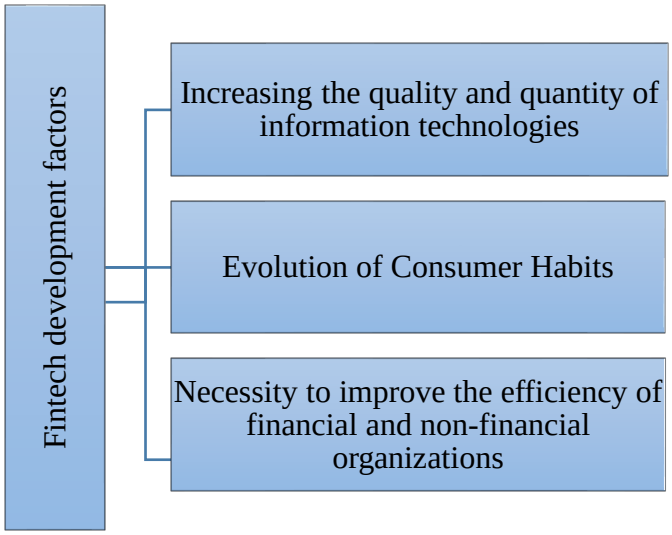


Figure 1. Factors of FinTech development
Source: Laura & Kukhnin (2018)

The factors determining the emergence, development and widespread use of financial technologies are:

1. Increasing the quality and quantity of information technology. Qualitative growth is reflected in the fact that the capacity of ICT has increased to such an extent that it can perform the most complex financial transactions more quickly and safely. Consumers can operate and perform transactions with their accounts 24 hours a day, anywhere and in real time. Quantitative growth is conditioned to the almost complete availability of technologies, their coverage of most of the population of the planet and the possibility of their use around the world. Access provides both financial and technological benefits.
2. Evolution\changes in consumer habits. An increasing number of consumers consider it normal and acceptable to purchase a wide range of goods and services via the Internet, including financial ones.
3. Necessity for financial and non-financial organizations to improve their efficiency. Financial institutions are seeking to reduce their costs by introducing distance and automated services, improving the quality of services and adapting the service delivery model to changing consumer

needs. With the help of FinTech, non-profit organizations hope to achieve a higher level of monetization of their target audience by offering a growing number of services.

In their research, Haddad & Hornuf (2019) noted that the dynamics of the number of created FinTech startups in the country is influenced by factors such as: the level of development of the capital market in the country; the availability of technology; the stability of the financial system; the number of mobile subscribers; the size of the labor market; the unemployment rate in the country; the business environment, etc.

FinTech companies are constantly improving their financial services to make them more accessible to businesses and consumers. By making financial services easier to use and more accessible, businesses and consumers will also improve their business. Various studies and special reports have looked at the opportunities and challenges offered by FinTech for the financial sector from a variety of perspectives, including those related to consumer and investor protection, market orientation, competition, and access to financial services (see Table 2).

Table 2. The main advantages and disadvantages of the development of the FinTech industry in the world

Source: composed by the authors, based on Sedykh (2019)

Advantages:	Disadvantages:
- availability of a developed digital and traditional financial infrastructure, which gives opportunities for the easy implementation of innovative projects; - availability of qualified and creative staff capable of introducing new technologies; - user loyalty to non-traditional financial services, including banking and non-banking segments; - high interest of investors in innovative FinTech projects in developed markets; - effective government regulation for the development of FinTech projects.	- underdeveloped or unevenly developed digital and financial infrastructure; - lack of qualified personnel; - low level of technological and financial literacy of the population; - low level of public confidence in financial technologies and the trend towards traditional financial service formats; - the growth of cyber threats and the active fight against cybercriminals; - lack of market transparency, which creates significant risks for local and foreign investors; - insufficient development and monitoring of the legal and regulatory framework in the field of financial technologies.

Thus, FinTech is a sector of the economy that includes companies that use technology to provide financial services more efficiently.

Currently, the FinTech sector is actively developing all over the world in terms of employment, investment, and the number of FinTech companies. All-new types of financial technologies will help optimize economic costs, reduce cybercrime, minimize paperwork and create a reliable financial market environment (Komilova & Yusupova, 2021).

The following table lists the opportunities and shortcomings of financial technologies:

Table 3. Opportunities and disadvantages of financial technologies

Source: composed by the authors

List of financial technologies	Advantages:	Disadvantages:
Cloud technologies	- availability of all data from any device; - reduction of costs for the purchase of powerful computers and servers and the absence of the need to use the services of IT specialists;	- cloud-based work requires Internet connection; - the user cannot always configure the software to be used for personal needs;

List of financial technologies	Advantages:	Disadvantages:
	- the necessary tools for working through the web service are provided automatically; - services are paid for only when they are needed, while payment is made only for the necessary package of services; - provide maximum reliability.	- it takes a lot of money to build a personal cloud, which is not appropriate for new ventures; - the cloud is a data store that attackers can access by exploiting a system's vulnerability.
Artificial intelligence	- no human error; - zero risk; - 24/7 access; - machines with AI can quickly make decisions; - AI machines have no emotions.	- AI machines are expensive; - machines with artificial intelligence are not creative; - machines with AI reduce jobs; - machines with AI do not understand morality.
Blockchain	- decentralized; - reliable; - transparent; - universal.	- scale of complexity; - the possibility of fraudulent activities.
Machine learning	- identification of trends and patterns; - no human intervention is required; - continuous improvement; - for processing multidisciplinary data and large volumes of data; - widespread usage.	- receiving information; - time and resources; - interpretation; - high sensitivity to mistakes.
Internet of Things	- efficiency and safety; - assistance in making social and economic decisions; - reduce time costs and increase income.	- the need for preliminary preparation; - from the very beginning there are problems of compatibility and data integration; - confidentiality; - the possibility of failure or error.
Big data	- business improvement processes; - detection of fraud; - improve customer service.	- privacy and security; - the need for technical expertise.
Smart contracts	- independence; - safety and reliability; - saving time and money; - accuracy.	- technological risks; - it is impossible to take into account subjective conditions; - absence of a regulatory system.
Application programming interface	- can be anywhere; - works fast; - takes into account nuances.	- difficult change process; - not standardized; - may be poorly designed.
Cryptography	- confidentiality; - authentication; - unity of information; - reliability.	- unavailability of complex encrypted information; - selective access control; - does not protect against vulnerabilities and threats arising from improper system design; - the security of cryptographic methods is based on the complexity of computational mathematical problems.
Biometrics	- identification can be provided to access accounts without visiting the bank by using a mobile phone camera and talking to a voice recognition program;	- availability of biometric identifiers for copying and carrying out attacks on most specific biometric systems; - the need for certain conditions for biometric identification;

List of financial technologies	Advantages:	Disadvantages:
	- facilitating access to banking services for people with limited mobility and citizens living in remote areas; - the cost of accepting one client for the bank reduces by 60%; - many transactions will eventually be transferred to an online format.	- the situation may be related to the violation of biometric identifiers or unreadability; - for many specific biometric systems, biometric scanners are very expensive; - compliance with regulatory requirements for the protection of personal biometric data.
RPA	- provides connectivity to older systems; - projects are clearly structured; - conflict resolution; - modeling of business processes.	- does not improve the process; - is very sensitive to changes; - is without integration.

Moreover, it is proposed to distinguish among financial technologies, regulatory technologies (RegTech) and management technologies (SupTech) (see Table 4).

Table 4. Types of regulatory and control technologies

Source: composed by the authors

No.	Technologies	Description	Type
1	Regulatory technologies (RegTech)	Used by organizations operating in the financial market to optimize processes related to the implementation of regulatory and supervisory requirements. In particular, among the regulatory technologies, banks distinguish:	– specific technologies aimed at investigating clients and other persons involved in monetary transactions, including the initial acceptance of services, as well as disclosing proceeds of crime, terrorist financing and financing the proliferation of weapons of mass destruction.
			– circulation monitoring technology aimed at identifying deviations and violations in the processes associated with the transfer of funds, foreign exchange operations, as well as operations with financial instruments.
			– risk management technologies focused on the automation of risk management. From the point of view of market risks, such technologies include automation of the evaluation of financial instruments, cash transactions, control of the established limit, and so on. In terms of operational risks, they can improve the efficiency of internal procedures, protect against fraudulent activities, and so on.
			– related reporting technologies, where calculations are carried out automatically, which reduces the cost of operating information systems.
2	Control technologies (SupTech)	Implemented in the practice of regulatory and supervisory bodies in financial markets to improve their efficiency. Such technologies are associated with automated processing of reports and other information received from financial market entities, monitoring and analysis of market and operational risks, digitization of regulatory requirements, and so on.	

Thus, economic entities are primarily interested in the elaboration, implementation and development of RegTech, since these technologies allow companies, on the one hand, to reduce costs, and, on the other hand, to ensure compliance with government requirements. The development of SupTech depends entirely on the interest of regulators in updating approaches in

the field of regulation and control. Based on all of the above, the classification of FinTech is presented in Table 5.

Table 5. FinTech classification

Source: compiled by the authors on the basis of Sitnik (2019)

Classification	FinTech
By field	1. Payments and remittances 2. Lending and personal financing 3. Capital management and operations in financial markets 4. Insurance
According to the subject of management	1. Regulatory Technology (RegTech) 2. Control Technologies (SupTech)
By type	1. Cloud technologies 2. Artificial intelligence 3. Blockchain 4. Machine learning 5. Internet of Things 6. Smart contracts 7. Application Programming Interface (API) 8. Big data technologies 9. Biometrics 10. Cryptography etc.

Thus, it can be concluded that there are various types of financial technologies that help organizations operate more efficiently. Today, for the effective operation of modern financial instruments, it is necessary to have an electronic infrastructure for both the state and individual market participants – therefore, all types of financial technologies are used in all areas.

In the modern world, banks continue to play an important role in the development of the economy. By accumulating capital, concentrating its direction and reducing risks, banks create an important basis for expanding and accelerating production. In the context of the globalization of world markets, the efficient operation of commercial banks in Tajikistan remains the most important condition for the successful economic development of the country and largely determines the pace of economic development in Tajikistan.

With the strengthening of economic ties, the improvement of the economic situation, and the drive to attract of foreign experience, it becomes necessary to introduce and use innovative financial technologies and modern methods and models of financial management aimed at increasing efficiency and competitiveness and expanding the scope of activities. However, in order to proceed directly to the description of the internal processes of commercial banks today, it is first necessary to analyze the overall picture of the banking system. The banking system is an institutional body that unites all elements of the banking sector that are interconnected, as well as their activities in relation to each other, the state and society as a whole.

Thus, it should be noted that one of the conditions for the effective functioning of the modern economy is the presence of a clear and structured banking system. This is one of the most important elements of the economic system of the state. The banking system of Tajikistan is an integral part of the financial sector and plays an important role in the implementation of the country's monetary and economic policy. In this regard, one of the main tasks of the banking system is to promote financial intermediation by attracting free funds from the population and other legal entities and directing them through lending to business entities.

The banking system of Tajikistan is two-tier, consisting of the upper level – the National Bank of Tajikistan – and the lower level – financial and credit organizations, including banks, non-bank

credit organizations, as well as microfinance organizations operating in the country under the license of the National Bank of Tajikistan (see Figure 2).

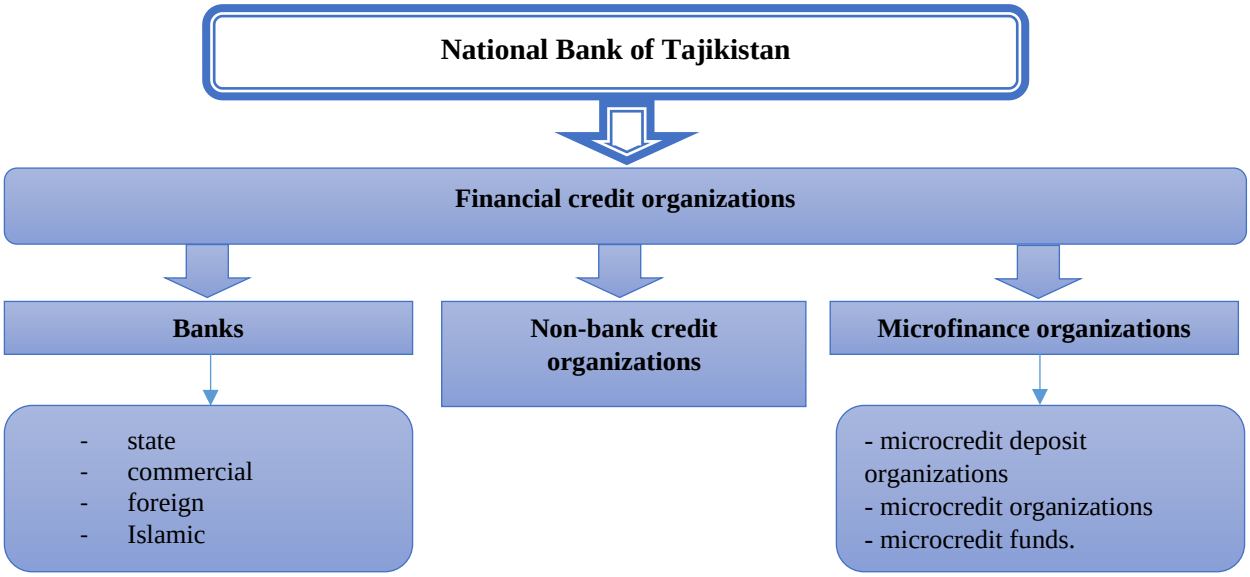


Figure 2. Structure of the banking system of Tajikistan
Source: compiled by the authors

In accordance with the Law of the Republic of Tajikistan "On Banking Activities," credit institutions are legal entities that perform all or some banking operations stipulated by the law and other legislative acts of the Republic of Tajikistan on the basis of a license from the National Bank of Tajikistan.

A bank is a credit institution whose main purpose is to make a profit, which has authorized capital established for it by the National Bank of Tajikistan and the right to carry out at least three operations: attracting deposits and savings, lending, and opening and maintaining bank accounts.

Non-bank credit organizations are credit organizations that have the right to perform certain banking operations. The list of banking operations for non-bank credit organizations is established by the legislation of the Republic of Tajikistan and the National Bank of Tajikistan.

One of the main differences between credit institutions is their authorized capital. In accordance with instruction 176 "On procedures for regulating the activities of credit organizations," the authorized capital of a commercial bank should be more than 50 million somoni, non-bank credit organizations 30 million somoni, and microcredit financial organizations 6 million somoni.

In accordance with the Law of the Republic of Tajikistan "On the National Bank of Tajikistan," one of the goals of the National Bank of Tajikistan is to ensure the stability of the state banking system. Therefore, the National Bank of Tajikistan has the exclusive right to regulate and supervise financial credit institutions in accordance with the laws of the Republic of Tajikistan "On the National Bank of Tajikistan," "On Banking," "On Islamic Banking," "On Microfinance Organizations" and other sectoral laws in order to maintain the stability of the banking system and payment system, protect the interests of depositors and creditors, and regulate and supervise financial and credit institutions.

Financial and credit institutions are one of the links between industry and trade, agriculture and the population. In addition, financial institutions provide cash management services, farm lending, and

mediation in the redistribution of capital, increase the efficiency and productivity of production, and provide banking services and products through their wide networks, including branches and banking service centers in various regions of the country. All of this contributes to the financial coverage of the country.

Table 6 analyzes the structure of the banking system of Tajikistan for the 2016 to 2020 period.

Table 6. Structure of the banking system of Tajikistan

Source: composed by the authors

Structure	**2016**	**2017**	**2018**	**2019**	**2020**	**2016–2017**	**2017–2018**	**2018–2019**	**2019–2020**
1. Financial credit institutions (total)	104	84	79	75	69	−20	−5	−4	−6
1.1 Banks	18	17	17	17	19	−1	0	0	2
1.1.1 Traditional banks	18	17	17	16	18	0	17	−1	2
1.1.2 Islamic banks	–	–	0	1	1	–	–	1	0
1.2 Microfinance organizations	86	67	62	58	50	−19	−5	−4	−8
1.2.1 Microcredit deposit organizations	38	27	25	22	18	−11	−2	−3	−4
1.2.2 Microfinance institutions	14	7	6	6	5	−7	−1	0	−1
1.2.3 Microcredit funds	34	33	31	30	27	−1	−2	−1	−3
2. Structural subdivisions of MO (total) *	1,857	1,670	1,668	1,828	1,935	−187	−2	160	107
2.1 Branches	437	343	332	328	356	−94	−11	−4	28
2.1.1 Islamic Banking Window	–	–	–	–	2	0	0	–	2
2.2 Banking service centers	1,420	1,327	1,336	1,420	1,579	−93	9	84	159
2.3 Cashier service points	4	0	9	0	0	−4	9	−9	0

According to the Table 6 data and analysis, as of December 31, 2020, a total of 69 financial institutions operated in the territory of Tajikistan, including 18 traditional banks, 1 Islamic bank and 50 microfinance institutions. Compared to 2016, this indicator decreased by 35 financial institutions. In particular, a decrease was observed in 2017, which led to a sharp reduction in the number of credit institutions by 20 units. The main reason for the decline of credit organizations in the territory of Tajikistan is unpreparedness for the radical changes taking place in the world and the low competitiveness of domestic banks.

One of the reasons for this is the current economic crisis and the COVID-19 pandemic, which have had a significant impact on the activities of domestic credit institutions. The consequences of the pandemic showed that not all credit institutions were able to provide remote services during the isolation period, since the main income of credit institutions comes from providing loans to various industries, enterprises and the public. Due to the fact that clients of credit organizations did not receive loans during this period, the financial condition of many organizations deteriorated, as a result of which they were declared bankrupt.

During the reporting period, the number of microfinance organizations decreased to 36, and in 2017, 11 microcredit deposit organizations and 7 microcredit organizations ceased their activities. The main reason for this was that these organizations did not provide a wide range of modern services, which indicates their low competitiveness. In modern conditions, credit organizations in developed countries widely use advanced financial technologies in their activities. In the market of domestic credit institutions, individual elements of these technologies are provided only by commercial banks such as OJSK Bank Alif, OJSC Bank Eskhata, CJSC Spitamen Bank, CJSC Bank Arvand, and CJS MDO Imon International.

Therefore, it is difficult for microfinance organizations to compete with such banks in modern conditions, which leads to their bankruptcy. Over the past 5 years, the number of MCO branches has decreased by 81 units, while the number of banking service centers has increased by 159 units. Since 2020, two Islamic Bank windows have been operating in the country. An increase in the number of branches and other structural subdivisions helps to increase the population's access to credit resources. Table 7 shows the main indicators of the credit institutions of Tajikistan for a 5-year period.

Table 7. Main indicators of the balance sheet of credit institutions (million somoni)
Source: composed by the authors based on data from the National Bank of Tajikistan (2021)

No.	Name	2016	2017	2018	2019	2020
1	GDP	54,471.1	61,093.6	68,844	77,354	82,543
2	Assets of financial institutions	21,187	20,932	21,201	21,976	26,307.4
3	As percent to GDP	39%	34%	31%	28,4%	32%
4	Loans issued, total	8,000.6	7,896.1	8,179.1	9,555	1603.3
5	Investments	1,604	2,172	2,427	2,232	2,672.06
6	Liabilities of financial credit institutions	15,690	15,207	15,287	15,749	19,131.7
7	Deposits of financial institutions:	9,244	9,283	9,724	9,682	11,414.2
7.1	- demand deposits	3,313	4,274	4,885	4,699	5,931.44
7.2	- other deposits	5,931	5,009	4,838	4,964	5,482.79
8	Balance equity of credit institutions	5,497	5,725	5,591	6,226	7,175.74

GDP is one of the main indicators that determine the condition of economic development of the country. In Tajikistan, GDP is growing from year to year, which indicates the sustainable development of the state economy.

Over the past 5 years, this figure has grown by 28,072 million somoni, and in 2020 it amounted to 82,543 million somoni. More than 30% of GDP was accounted for by the assets of credit institutions. This indicates that credit institutions play a significant role in the formation of GDP, which contributes to the economic development of the country.

Table 8 analyzes the dynamics and structure of the main indicators of credit institutions of Tajikistan. As a result of the analysis, it was revealed that the assets of credit institutions for the period from 2016 to 2020 tended to increase, growing by 24.2%, but due to a decrease in the number of credit institutions by 20 units, assets diminished by 255 million somoni.

Investments accounted for more than 10% of assets and over the past 5 years, and increased by 1,068.06 million somoni, or 66.6%. This indicates that credit institutions have free resources to make real and portfolio investments in order to develop their activities. Banks such as OJSC Bank Eskhata, CJSC Bank Arvand and CJS MDO Imon International provided preferential loans for business development.

One of the main elements of the active part of the balance sheet of credit institutions is the provision of loans, which account for more than 70% of the income of credit institutions. In the territory of Tajikistan, the bulk of interest income falls on the issuance of loans. Therefore, the provision of as many loans as possible will contribute to the development and stimulation of the activities of enterprises and individuals, the state, and credit organizations themselves. Over the past five years, lending has decreased by 6,397.3 million somoni, or 80%. The supply of loans declined mainly during the COVID-19 pandemic. Credit institutions were not ready for such changes and were unable to provide their services remotely during the lockdown. If domestic credit organizations, like in other developed countries, used modern financial technologies to provide online services,

the deterioration of their financial situation would not have been so significant. In response to the problems of recent years, which affected the activities of almost all domestic organizations, credit organizations have actively started to implement modern financial technologies in their activities. The use of the elements of the digital economy leads to a decrease in costs and an increase in profits.

Table 8. Analysis of key balance sheet indicators of credit institutions

Source: calculated by the authors

No.	Indicator	2016–2017			2017–2018			2018–2019			2019–2020		
		Abs. (mln. som)	Rel. (%)	Ver. (%)	Abs. (mln. som)	Rel. (%)	Ver (%)	Abs. (mln. som)	Rel. (%)	Ver. (%)	Abs. (mln. som)	Rel. (%)	Ver. (%)
1	Assets of credit institutions	−255	−1.2	100	269	1.3	100	775	3.7	100	4,331.4	19.7	100
1.2	Loans issued, total	−104 .5	−1.3	37.7	283	3.6	38.6	1,375.9	14.4	43.5	−7,951.7	−83	6.1
1.3	Investments, total	568	35.4	10.4	255	12	11.4	−195	−8	10.2	440.06	19.7	10.2
2	Liabilities of credit institutions	−483	−3.08	100	80	0.5	100	462	3	100	3,382.7	21.5	100
2.1	Deposits of credit institutions	39	0.42	61	441	4.8	63.6	−42	−0	61.5	1,732.2	17.9	61.5
2.1.1	- demand deposits	961	29	50.2	611	14	50.2	−186	−4	48.5	1,232.4	26.2	48.5
2.1.2	- other deposits	−922	−15.5	49.8	−171	−3	49.8	126	2.6	51.3	518.79	10.5	51.5
3	Balance equity of credit institutions	228	4.15	100	−134	−2	100	635	11	100	949.74	15.3	100

The obligations of credit institutions amounted to 3,171.7 million somoni in this period, an increase of 20.2%. The main element of the liabilities of domestic credit institutions is attracted deposits. Therefore, the more deposits attracted or demanded for a period, the more opportunities for credit institutions to provide loans to the population. Figure 3 shows the dynamics of the main indicators of the financial statements of credit institutions:

Deposits of credit organizations increased by 2,170.2 million somoni in this period, i.e., by 23.5%, and accounted for more than 61% of the liabilities of credit institutions. The analysis showed that attracting deposits in credit institutions is widespread, and domestic credit institutions provide loans to the population not at the expense of their own capital, but at the expense of attracted deposits, which is beneficial for their operations. Also, according to the Table 8 data, we can see that the capital of credit institutions during the 5-year period increased to 4,721.28 million somoni, i.e., by 86%.

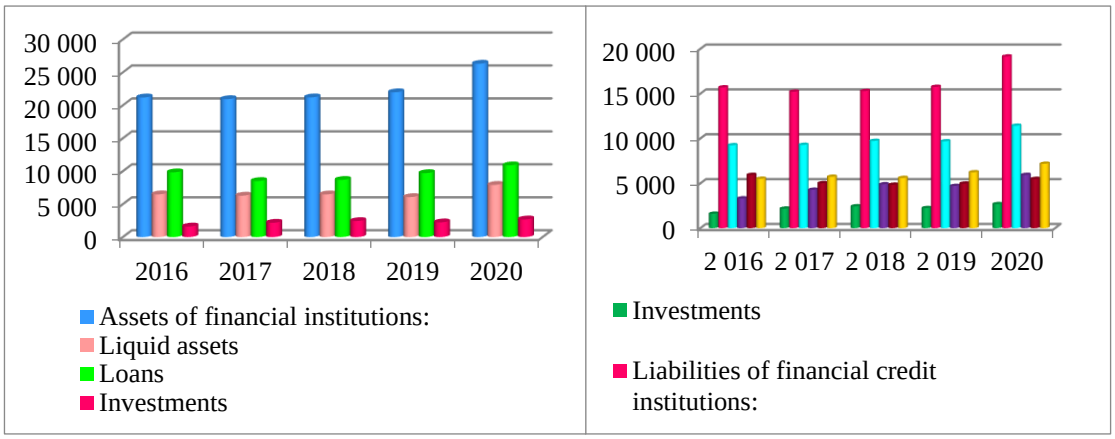


Figure 3. Dynamics of key balance sheet indicators of credit institutions
Source: composed by the authors based on data from the National Bank of Tajikistan (2021)

Based on the abovementioned data, indicators of the financial stability of the banking system of Tajikistan were calculated, the results of which are shown in Table 9.

Table 9. Analysis of indicators of financial stability of the banking system of Tajikistan
Source: calculated by the authors based on data from the National Bank of Tajikistan (2021)

	List of indicators	**2016**	**2017**	**2018**	**2019**	**2020**
1	Capital adequacy	17%	22.9%	22.1%	19.9%	18.2%
2	Return on assets (ROA)	–2.8%	0.5%	1.9%	2.1%	2.5%
3	Return on equity (ROE)	–21.0%	1.7%	7.0%	7.6%	9.1%
4	Net interest income relative to gross income	63.7%	65.2%	65.3%	66.3%	73.5%
5	Non-interest expenses relative to gross income	131.4%	61.7%	56.0%	60.2%	61.9%
6	Liquidity	30.9%	30.1%	30.8%	27.7%	30.0%
7	Liquid assets in relation to current liabilities	83.9%	73.8%	72.3%	67.4%	70.5%

According to the indicators given in Table 9, it is possible to find information on the efficiency of credit institutions' activity. In accordance with Instruction No. 176 "On procedures for regulating the activities of credit organizations," all organizations operating in Tajikistan must meet the acceptable standards set out in this instruction, i.e., comply with the prudential measures of the National Bank of Tajikistan. For example, the capital adequacy ratio for credit institutions is set at a minimum of 12%. As can be seen from the figures given in Table 9, credit institutions are meeting this indicator, but in recent years there has been a downward trend. Due to the COVID-19 pandemic, organizations have not been able to operate at full capacity, causing difficulties and having a significant impact on their financial conditions.

Despite the tense situation in the world, the profitability of domestic credit institutions showed good results. In 2020, the return on assets, which is one of the main indicators in the banking sector, amounted to 2.5%. This indicator should be at least 5%, according to the recommendations of the Basel Committee, which regulates the activities of credit institutions. Although this indicator does not correspond to the norm, positive changes are observed – i.e., in dynamics, the indicator tends to increase.

According to Table 9, it can be seen that in 2016 all indicators did not meet the requirements or showed very low values. One of the main reasons for the decline in performance is the bankruptcy of the most powerful bank in the country, Agroinvestbank, which ceased operations in 2014, the impact of which manifested itself in subsequent years. The services of this bank were used by both

legal entities and individuals of the country, who suffered significant losses as a result of the termination of its activities. In this regard, people's confidence in the country's banking system has been undermined, and they are wary of banking services.

According to the analysis of the number and volume of funds used, in the period from 2016 to 2020 the number of payments increased from year to year by 109,579 units in total during this period, or 180%, which increased the total amount of payments by 813,239 million somoni. Part of these payments were ordered, and over the past 5 years their number has increased by 4,587 units, amounting to 306,114 million somoni. In 2019, there was a decrease in payments via the Internet, from 494,000 units in 2018 to 44,000 units in 2019. The main reason was the increase in the cost of Internet services. However, in 2020 electronic payments were made via the Internet and increased by 700 units in the amount of 26,438 million somoni. This increase was due to the fact that customers did not have the opportunity to visit credit institutions and did not use active remote services.

According to the analysis, the dynamics of the number of payments used is shown in Figure 4.

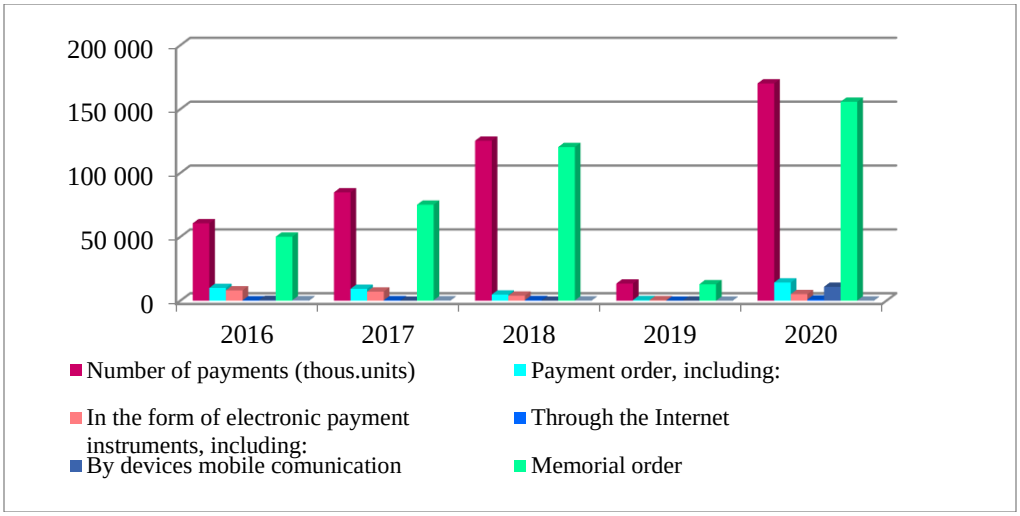


Figure 4. Diagram of the number of payment instruments used

Source: composed by the authors based on data from the National Bank of Tajikistan (2021)

Due to the fact that in the territory of Tajikistan a certain limit was set for the population to receive SIM cards in the amount of no more than 2 units per citizen. In 2017, the number of payments made by phone decreased. Despite this, in 2020, telephone payments increased by 10,260 units and amounted to 1,569 million somoni. Credit institutions actively use the Internet and mobile banking in their activities, through which they can use remote banking services. The main increase occurred in 2020, when a number of leading banks, such as OJSK Bank Alif, OJSC Bank Eskhata, and CJS MDO Imon International provided their services to customers remotely, which was actively supported by customers, during the COVID-19 pandemic. This was convenient for both credit institutions and their customers. This indicates that the population is increasingly switching to electronic forms of payment, and credit organizations of Tajikistan, like in leading countries, are making efforts to introduce modern financial technologies.

Thus, in conclusion, we can say that the banking system, like any economic system, is constantly evolving. Its structural elements should work together and be more efficient. Currently, the banking system is undergoing changes under the influence of new financial technologies. New branches

and venture funds will be created, which will be actively introduced into the activities of modern banks.

In this study, the authors also identified an assessment of the use of new financial technologies in the activities of credit institutions.

Currently, the financial sector of all countries is undergoing transformational changes that occur for a number of interrelated and interdependent reasons. Among them are: the introduction of digital technologies and their increasing role for consumers, financial intermediaries, and financial regulators themselves; increased competitive pressure on banks from financial technologies and large technology companies; as well as the COVID-19 pandemic, which accelerated the impact of these changes.

The digitalization of financial intermediation in Tajikistan is also proceeding at a pace that will make a significant contribution to the digital transformation of the Tajik economy and is one of the main priorities for the development of the country. Digitalization can accelerate the transition of the Tajik economy to a technological way of life, thereby increasing the potential for economic development and improving the wellbeing of citizens. At the same time, the high cost of new technologies, as well as the risks associated with the unpreparedness of many business entities for a complete digital transformation, require a comprehensive vision and a deep understanding of the digitalization process when making managerial decisions, including in the financial sector.

Effective management of the process of digital transformation of the financial sector, aimed at minimizing potential risks while maximizing profits, is based on:

- the comprehensive and integrated assessment of the level of digitalization of the financial sector;
- the identification of possible resources for identifying competitive advantages and improving the efficiency of the digital transformation process in the financial sector.

The financial sector is an important element of the economy and determines the speed and quality of change. Currently, electronic payments and e-commerce are an integral part of the financial sector. The financial sector is a leader in the implementation and use of innovative technologies and digital services for working with clients. One can be certain that the development of innovative technologies will contribute to the transformation of the financial sector in its current state and will affect its modernization in the future.

With the advent of new technologies, business models are also changing, and new entrants are emerging. FinTech companies are challenging existing banks and offering innovative solutions to streamline many financial services by making them simpler, more accessible and cheaper. Digital transformation helps financial companies attract and retain customers and generate profits.

The introduction of digital technologies into the banking platform has a significant impact on the workforce and the personnel management system, thereby reducing human resources through process automation. In this regard, there is a need to develop a new digital transformation management system in banking. Thus, the following areas should be developed:

- establishing communication with the audience;
- selecting and training of personnel;
- creating a database to store large amounts of information;
- inventing and implementing special mobile and computer applications.

The level of development of the digital economy and the rating of the country are measured on the basis of various structural indicators that combine individual sub-indices responsible for the digital transformation of individual sectors of the economy and society. The difference between different ratings in the choice of primary indicators lies in the characteristics of the level of use of the achievements of the digital economy in the country and their classification by sub-indices.

Existing methods do not allow for a comprehensive assessment of the level of development of the digital economy in the country. These methods mainly assess the technical aspect and thus determine the development of the digital economy, the level of ICT infrastructure and the readiness of people for transformations. In this regard, it is necessary to analyze the digital economy based on a number of indicators that assess the level of application of modern technologies in the economy at different levels.

The development and implementation of a comprehensive digital economy development index is an important task, the solution of which will identify problem areas for the development of the digital economy in Tajikistan.

Table 10. Indicators for calculating indices of the digital economy

Source: composed by the authors

					Absolute		Relative	
No.	**List of indicators**	**2018**	**2020**	**2021**	**2020–2018**	**2021–2020**	**2020–2018**	**2021–2020**
1	Number of working age population	5,473,900	5,664,300	5,870,304	190,400	206,004	3.48	3.64
2	Number of active agents	10	19	20	9	1	90	5.26
3	Number of payment points	5,177	6,991	6,290	1,814	−701	35	−10
4	Number of registered accounts	2,132,426	3,204,712	4,231,492	1,072,286	1,026,780	50.3	32
5	Number of transactions (thousand units)	125,331	170,202	204,612	44,871	34,410	35.8	20.2
6	Cost of transactions (million somoni)	706,415	1,225,511	1,229,767	519,096	4,256	73.5	0.35
7	Number of complaints	36,000	35,500	34,990	−500	−510	−1.4	−1.4

Based on the analysis of the indicators (Table 10) needed to calculate the indices, it becomes clear that the use of digital financial services is growing significantly in Tajikistan. In turn, credit institutions strive to introduce more accessible and convenient financial technologies and provide their customers with quality services. The analysis showed that the number of active agents provided by digital financial services is increasing year on year – from 10 to 20 in 3 years. The number of registered accounts also increased by 32% compared to 2020. The number of payment points increased to 1,814 in 2020, and decreased by 10% the following year. The main reason for this is the closure of some credit institutions. The number of transactions is also growing from year to year, including in 2021, and their number will increase by 20%.

Thus, it can be concluded that digitalization in Tajikistan is at a moderate level, while the use of digital financial technologies is increasing at a slight pace.

A comprehensive assessment of access should use both supply and demand information to measure a specific set of digital financial services, i.e.: access to digital financial services; the use of digital financial services; and the quality of digital financial services provided to users (Table 11).

According to these indicators, it becomes clear that Tajikistan has just started providing digital financial services and is at a lower level than other developed countries. Tajikistan ranks 139th in the UN e-government ranking (UN DESA, 2020). The e-growth index is 0.3366, indicating an average growth rate. This figure is much higher in Kazakhstan at 0.725, reflecting a high level of growth. High-speed Internet access is still limited and expensive compared to in other regions of

Central Asia. According to the World Bank, in Tajikistan in 2018 only 33% of people used the Internet on any device, while in Kazakhstan (Turdibekov, 2018) this indicator was 50%.

Table 11. Digital financial services indices

Source: composed by the authors

Indicators for measuring access				
No.	**Indicator**	**2018**	**2020**	**2021**
1	Internet users (%)	17	25	33.3
2	Percentage of administrative units with agent outlet			
3	Number of DFS agents per 10,000 adults	0.144	0.12	0.11
4	Number of active DFS agents per 10,000 adults	0.018	0.033	0.034
5	Number of merchant payment points per 10,000 adults	9.45	12.3	11
6	Percentage of adult population with registered DFS accounts	38.9	56.5	74.7
Indicators for measuring usage				
7	Percentage of active DFS accounts	46	50	66.6
8	DFS transactions (by volume) per registered account	35	64	81.1
9	Value of DFS transactions	8,480	12,134	6,598
Indicators for measuring quality				
10	Number of complaints per 10,000 active DFS accounts	169	111	83
11	Percentage of complaints resolved	33.3	38.4	45.6
12	Transaction failure (%)	17.1	6	4
13	Financial literacy	Low	Low	Low

Permanent Internet access in Tajikistan is maintained only in large cities, where residents pay the highest prices in the world for Internet services. The cost of the main subscription package is 16% of average monthly income. However, despite this, the number of Internet users in the country has grown to 33.3%. According to the calculation of the accessibility index for the population, it was found that the number of digital financial service providers is 0.11, i.e., 0.11 credit institutions per 10,000 people of working age. The number of credit institutions in the country is decreasing, and only the strongest and most competitive organizations are engaged in the process of digitalization, the introduction of financial technologies, and the promotion of their activities. Of the digital financial service providers, 20 were active, meaning 0.034 per 10,000 able-bodied people, which is a very low rate. The number of payment points is 11 units per 10,000 population across the country against 450 units in Kazakhstan. Only 74.7% of the working population have a registered account for digital financial services. This indicator should be increased, and the working-age population should use digital financial services more. Despite this, this indicator is growing from year to year, and in 2018 grew by 38.9%.

Based on the calculation of accessibility indicators, it was found that only 66.66% of registered digital financial services accounts are active. The average of this indicator in Kazakhstan is 92%. Approximately 81.1% of transactions are active accounts of registered digital financial services. For each registered digital financial services account, transactions amount to around 6,598 somoni per month.

Using an indicator to measure quality, we determined the quality of digital financial services, which showed an average level. Financial services to clients are provided in simple, understandable language, without any hidden conditions. They are also adapted to: the local context and language requirements; the established template/disclosure format, including design, font size, eligibility for compensation and related processes: and the visibility of the total cost of the service including fees, taxes, commissions and etc.

There are 83 complaints per 10,000 active accounts on the quality of financial services, of which only 45.6% are resolved. Failed transactions amount to 37.6% of monthly transactions, which is a high indicator, and financial institutions should try to reduce this. This indicator is associated with the financial literacy of the population, and, as noted above, the level of financial literacy of the country's population is very low. According to the International Finance Corporation (IFC), two-thirds of the population do not use the Internet, and 90% of the population do not use financial services. Only 10% of the population is financially literate, which is why unsuccessful transactions are more common. To overcome all of these shortcomings, it is necessary to increase the level of financial literacy of the population and attract more people to using financial services, which, in turn, should increase the number of active agents providing financial services. In the territory of the republic, the most active subjects are credit institutions, which should provide customers with convenient financial services through the introduction of financial technologies, which also contributes to the economic development of the country.

Due to globalization and fierce competition, major banks around the world are moving to a new business model – a digital banking model that allows customers to conduct transactions through remote channels. Each bank uses digital technologies to expand the product line to meet the specific needs of the buyer.

The National Bank of Tajikistan has identified four system-forming banks of the country: OJSC Eskhata bank, OJSC Orienbank, SSB of RT Amonatbank, and CJS MDO Imon International (see Table 12).

Table 12. List of systemically important credit institutions of Tajikistan for 2021

Source: composed by the authors

No.	Systemic credit institutions	The final rate, %
Commercial banks		
1	SSB of RT Amonatbank	30.53
2	OJSC Orienbank	21.43
3	OJSC Eskhata bank	11.98
Microfinance organization		
4	CJS MDO Imon International	6.42

At the next stage of the study, the authors determined the impact of financial technologies on the structure of the banking system.

In modern conditions, there are a number of trends in the financial market of Tajikistan that are the basis for the development of financial technologies, including:

- the decrease in the marginal income of banking operations;
- the transformation of business models of financial market participants and their desire to create an ecosystem;
- the increase in the inflow of financial services based on their digitalization;
- the loss of monopoly by banks in the provision of traditional banking services, as well as the significant strengthening of the role of non-financial organizations in the financial market;
- the willingness of banks to cooperate in various forms with technology start-ups.

The value of information technology in the financial sector is generally high. In the near future, the banking sector will be dominated by trends to improve the quality and reliability of the offered banking products and services, organize electronic access to customers and increase the speed of payment transactions.

This is due to the desire of commercial banks to gain a competitive advantage in financial markets. In modern conditions, banks are looking for development opportunities based on the use of new financial technologies, the most promising of which are: big data analysis, artificial intelligence, machine learning, robotics, biometrics, cloud technologies, blockchain and mobile technologies. Every year, more and more people in Tajikistan use smartphones and tablets to access the Internet and meet their business and personal needs with the help of digital technologies. This provides additional opportunities for the development of the mobile economy: the more mobile devices are used every day, the more companies are interested in creating mobile Internet services.

Every year, the mobile economy in Tajikistan shows an average growth of 3%. The development of mobile technologies allows entrepreneurs to focus on this task without being distracted by administrative issues. Mobile business services are actively developing and will continue to grow. Modern information technologies have a fundamental impact on the business processes of commercial banks, bringing them to a qualitatively new level. It should be noted that banking technologies are closely related to information technologies, which contributes to the complex automation of business. In modern banking practice, mobile technologies can be divided into the following main areas of development: mobile banking, Internet banking and the client-bank system. On the basis of the client-bank system, customers of commercial banks have the opportunity to remotely perform various operations, allowing them to receive information about their account status and other banking information, account management, card payments and services, as well as other current operations.

Using mobile banking, the subscriber receives banking services directly through a laptop, smartphone or tablet using wireless access technology. Based on this technology, it is possible to transfer data from websites to the mobile devices of bank customers with Internet access. Internet banking is a promising direction in the development of banking information technologies. In connection with the development of distance banking systems, systems of various forms and volumes of banking services were created: Internet client, Internet banking, telebanking, WAP service or mobile banking.

To further study the impact of promising financial technologies on the institutional structure of the banking sector in Tajikistan, it is necessary to assess the impact of the development of mobile technologies on the number of internal structural units of credit organizations in Tajikistan. First of all, it should be noted that the number of credit institutions in Tajikistan has significantly decreased in recent years. An analysis of the features of the supervisory policy pursued by the Bank of Tajikistan in recent years has revealed that in the near future no more than 30–40 credit organizations will operate in the banking system of Tajikistan.

As of January 1, 2022, there are 64 credit organizations operating in Tajikistan. In 2016, there was a decrease in the number of credit institutions, and since then their number has been steadily declining. At the same time, the decrease in the number of credit institutions was significant, as evidenced by statistical data: in 2016, the total number of credit institutions was 104, and in 2022 there are 64 – a decrease of 40 credit institutions.

The main reason for the decrease in the number of credit institutions is the revocation of banking licenses because of a lack of capital, as well as violations of banking legislation. The reduction in the number of banks, on the one hand, can be seen as a process of improving the banking system, which will generally increase confidence in the banking sector. On the other hand, a clear result is a decrease in competition in the banking services market.

Following the above objectives, indicators of the share of payment orders received by credit institutions in Tajikistan via the Internet, as well as the share of payment orders received by credit institutions through messages using mobile devices, will be considered.

A regression dependence model was built using the Excel spreadsheet editor. The initial data for building the regression are given in Table 13. To determine the indicators, the following coefficients are established:
Y – the number of operating internal structural divisions of credit institutions (branches);
X_1 – the share of payment orders received by credit institutions via the Internet, %;
X_2 – the share of payment orders received by credit institutions in the form of text messages using mobile subscriber devices, %.

Table 13. Indicators for constructing regression
Source: calculated by the authors

Date	Number of internal operating structural divisions of credit institutions (branches), divisions	Share of payment orders received by credit institutions via the Internet, %	Share of payment orders received by credit institutions via text messages using mobile subscriber devices, %
31.03.2019	244	4.7	0.04
30.06.2019	240	4.63	0.044
30.09.2019	247	5.46	0.0451
31.12.2019	247	5.188	0.05
31.03.2020	250	5.56	0.12
30.06.2020	252	5.5	0.26
30.09.2020	250	5.303	0.54
30.12.2020	252	5.32	0.71
31.03.2021	252	5.3	1
30.06.2021	196	6.1	1.4
30.09.2021	195	6.7	1.6
30.12.2021	194	11	2.028

Based on the quarterly data provided, regression statistics (correlation coefficient and coefficient of determination) were constructed.
A regression equation is given for the dependence of the number of internal structural divisions of credit institutions (branches) on the share of payment orders received by credit institutions via the Internet and the share of payment orders received by credit institutions via messages using mobile devices. The following regression equation was obtained:

$$Y = 264.5 - 1.96X_1 - 26X_2$$

The proximity of the correlation coefficient (R) is equal to 0.84, indicating a close linear relationship between the variables under consideration. The determination factor, $R^2 = 0.71$, shows that this regression equation explains 70% of the variable variances of the result, while the other factors make up only 30%. The actual value of the F-test (Fisher test) was 9.72. The value of the table was set at 4.96. Since the real value of F (9.72) > F_{Table} (4.96), the statistical significance of the equation is generally recognized, which allows it to be used in practical forecasting and analytical calculations.

Table 14. Regression equation indicators

Source: calculated by the authors

Correlation analysis					
R-package	*R*-square	*R*-square normal	Standard error	Observation	
0.841683	0.70843	0.635537	15.3	11	
Regression analysis					
Indicators	*Df*	*SS*	*MS*	*F*	*F* Significance
Regression	2	4550.181	2275.09	9.718828	0.007227
Residual	8	1872.728	234.091		
Total	10	6422.909			
Regression card					
	Coefficients	Standard error	*t*-statistics	*P*	
Y	264.5209	21.50222	12.30202	1.77	
Variable X_1	−1.96157	4.386957	−0.44714	0.66	
Variable X_2	−26.3106	10.79386	−2.43755	0.0407	

Thus, it can be said that with an increase in the share of payment orders received by credit institutions via the Internet by 1%, the number of operating internal structural units of credit institutions will decrease by approximately 2 units. With an increase by 1% in the share of payment orders received by credit institutions through messages via mobile devices, the number of internal structural units of existing credit institutions will be reduced to 26.

Thereby, with the increase in the use of the Internet and mobile technologies for various payments, the number of internal structural divisions (branches) of existing credit institutions will decrease. The more mobile and Internet technologies will be used by clients of credit institutions, the more banks will reduce their structural units, and, accordingly, the cost of maintaining them.

In this research, the authors also reveal the impact of blockchain technology on GDP.

The stage of digitization of economic processes is significantly changing the traditional direction of economic activity. Consolidation of evidence on the role of blockchain technologies in the developing world and their impact on macroeconomic indicators has led to their rapid growth in developed countries in recent years. At the same time, the use of blockchain technology makes it possible to highlight many of the biggest changes in the economic environment that have taken place as a result of "blockchainization":

- a decrease in transaction costs as a result of the transition to a digital payment system;
- a reduction of the operational and loan risk of credit institutions;
- an increase in the volume of transactions in the stock markets.

It should be noted that the financial sector of our country is already in the process of transitioning to a revolution in business processes, and blockchain technology can also have a significant impact as one of the types of modern financial technologies.

In this regard, the main task is to find solutions to problems, and ensure the transition from a general idea of the impact of this technology on the economy and its individual industries to a high degree of formal assessment. The calculations in this paper are aimed at determining the effectiveness and feasibility of the transition to the infrastructure of financial transactions and business processes.

At the same time, it should be noted that fundamental factors certainly cover a wide range and require a separate analysis of these factors in order to correct the results obtained.

Based on algorithms and approaches, a mathematical model will be built that allows integrating blockchain technology into the economic environment to determine the degree of impact on GDP. The construction of such a model will make it possible to determine the sensitivity of the country's

economic dynamics when introducing this technology into certain functional areas of the national economy.

In the field of blockchain technology, its main approaches in banking can be distinguished: reliable verification and processing of data, accounting and protection of information resources in a decentralized way with a small number of intermediaries facilitating transactions and a low level of control from regulators. These approaches indicate the prospects for their implementation in the financial sector of the economy, where a large number of different operations are carried out, which reflects the effective accounting and reliability of both the financial system itself and the economy as a whole.

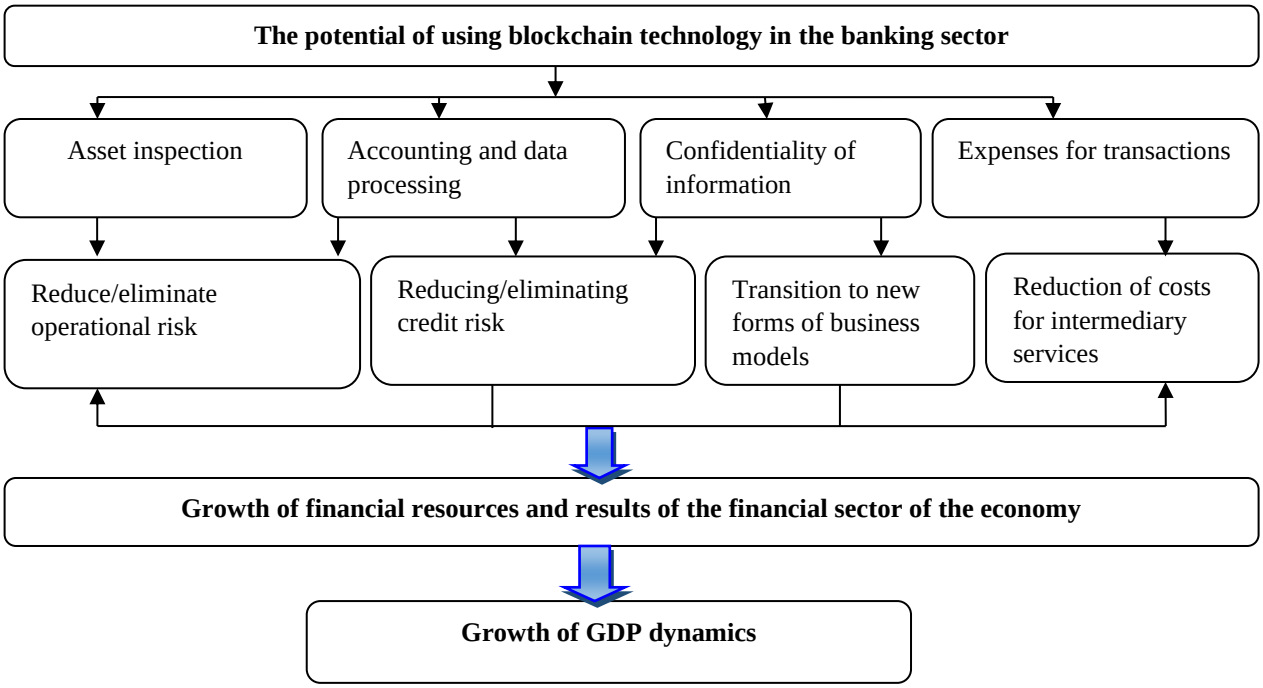


Figure 5. The use of blockchain technology in the banking sector and its impact on GDP
Source: composed by the authors

At the same time, it should be noted that the methodological analysis is based on the analysis of increasing the efficiency of the banking sector of the economy under the influence of blockchain technology through the prism of accounting, assessing priorities, and optimizing its operational processes. This aspect reflects the study of the impact of blockchain technology on the financial sector and the national economy based on four key factors. The first factor for the regression equation is the total amount of payments received by the bank, which contributes to the new commission income.

Another influencing factor is the profit of credit institutions. That is, it is a fact that with the introduction of blockchain technology, credit institutions receive more profit. The third factor is the total volume of loans issued by credit institutions, which leads to cost reduction and the optimization of operational processes, as well as the reduction of operational risks. The fourth factor is the total volume of attracted deposits, which is the main source for credit institutions.

Table 15. Description of the variables according to the model

Source: Compiled by the authors

Variables	**Indicators**
Dependent	
Gross domestic product, million somoni	GDP
Independent	
Total amount of payments, million somoni	V_{payments}
Total amount of profit/loss received, million somoni	$V_{\text{financial results}}$
The total volume of issued loans, million somoni	V_{loans}
The total volume of attracted deposits, million somoni	V_{deposits}

Now, on the basis of these indicators, we develop a mathematical-regression model, which expresses the effect of the above factors on GDP.

Table 16. Coefficients of regression equations

Source: calculated by the authors

Variables	**Parameter**
GDP	8,850.942
V_{payments}	−0.0018
$V_{\text{financial results}}$	23,487
V_{loans}	0.208
V_{deposits}	0.147
R-complex	0.75
R^2	0.6
R^2-standard	0.4
F-standard	3.5

As a result of the introduction of variables, the following regression equation was obtained:

$$Y = 8850.942 - 0.0018X_1 + 23.48738X_2 + 0.208079X_3 + 0.147063X_4$$

Now we can look at the resulting model and the impact of each of the factors affecting the volume of GDP when implementing blockchain technology. The complex correlation coefficient (*R*-complex) shows the density of the relationship between the volume of GDP and the factors influencing it. The overall correlation coefficient was 0.75, which means that there is a strong correlation between the four factors that affect GDP. The coefficient R^2 represents the change in GDP under the influence of factor indicators and evaluates the quality of the constructed model. Based on the constructed model, it was found that the coefficient R^2 is equal to 0.6, i.e., the selected factors have a significant impact on GDP.

The significance of the complex correlation coefficient is checked using the Fisher *F*-scale. To do this, we first determine the *F*-value of the observational and tabular indicators. To do this, we use the Fisher distribution table, which in the case of ($\alpha = 0.05$; 4; 11) is equal to 3.36. It was observed that the *F*-speed on the model is 3.5, which is higher than the F-factor in the table. This suggests that the regression equation is significant and reflects the validity of the resulting model.

As a result, it should be noted that the developed regression equation indicates the presence of a positive impact on GDP, which quantifies the degree and potential impact of blockchain processes on economic processes.

According to the dynamics of changes in GDP (Figure 5) before and after the introduction of blockchain technology, it can be seen that GDP is growing. In other words, the volume of factors affecting GDP will increase with the introduction of blockchain technology, which will not only

increase the macroeconomic indicators of the country, but also increase the level of stability and efficiency of its participants and ensure the competitiveness of the economy in decades to come.

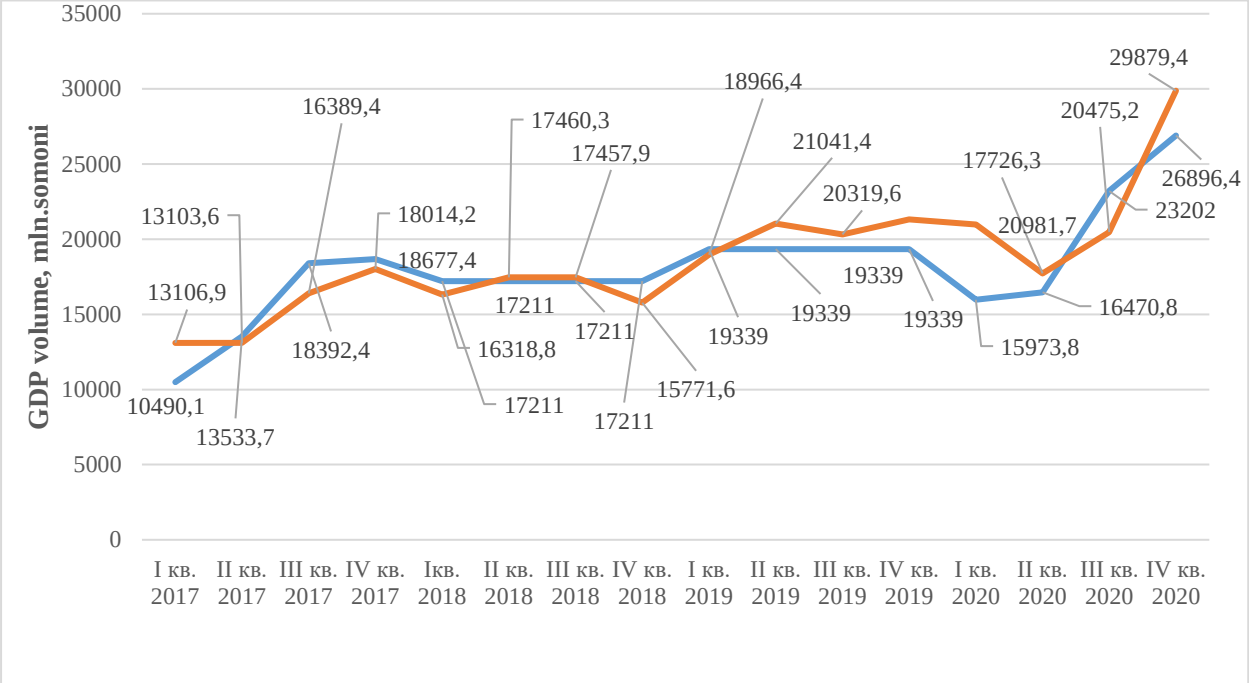


Figure 5. Dynamics of GDP change

Source: composed by the authors based on data from the National Bank of Tajikistan (2021)

Conclusions

This study allows us to conclude that the use and further development of financial technologies can ensure the creation of new organizational models of the banking market and improve the quality and availability of banking technologies in servicing, both for individuals and corporate clients in the digital economy. As a result of cooperation with FinTech startups, banks receive a more comfortable environment for implementing their own innovative direction as the main advantage, as well as the associated reduction in operating costs, the improvement of a personalized approach to the sale of products and services, and an overall improvement in the quality of customer service. During this study, we also found that the process of modernization of financial technologies is able to change the existing paradigm of the development of the financial market.

In conclusion, we can say that the technological foundation is now beginning to form in Tajikistan, which is necessary for the development of new technological industries, including FinTech directly.

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SECTION 3

INNOVATIVE MARKETING TECHNOLOGIES IN THE DIGITAL ECONOMY

DIGITAL PLATFORMS IN THE GLOBAL ECONOMY

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Abstract. *Globalization of the economy has led to a significant increase in competition in various areas. One of the key business tools that allows organizations to gain a strong competitive advantage is digital platforms. Hence, this study considers impact of digital platforms on changes in the global market and global competition. To do this, this work analyzes the trends of platformization of the economy its impact on the structure of the world market, and considers the peculiarities of value formation on platforms. An attempt was also made to classify the consequences and risks of using platforms in countries with different levels of economic development. The digital platform environment can be potentially dangerous for competition. Through network effects, platforms can gain market power and abuse their dominant position, for example by imposing exclusivity agreements on their suppliers or demanding predatory prices from their competitors. However, in various cases of competition, platforms were not considered dominant in the relevant market. The innovative capabilities of global platforms will increase. Countries with a lower level of digitization may lose the ability to develop a local innovation environment, as all resources and developer potential will be concentrated on work for other countries. This has the potential to significantly increase the gap in the level of not only economic, but also innovative and digital development.*

Keywords: *Globalization, digital platform, competition, network effect, value chain.*

Introduction

A key trend in the digital economy has been the emergence and rapid growth of several large global digital platforms characterized by data-driven and digital intelligence business models. The ranking of the world's largest companies by market capitalization has undergone significant changes: while a decade ago it was dominated by multinational companies in the oil and gas industry and engineering, today companies specializing in intelligence and digital data have become leaders. Their specialization has also changed, as now they are mainly either Internet companies (for example, Alphabet (Google), Meta) or software developers (Apple, Microsoft). (CompaniesMarketCap, n.d.)

This unprecedented and significant specialization shift reflects hyper-dynamic international competition in traditional and new markets for goods and services. It should be noted that over the past decade, companies leveraging the power of platform business models have grown significantly in size and scale. Platform ecosystems are being strengthened by the digitization of products, services and business processes, and the global market landscape is changing.

In this regard, the aim of this study is to assess the impact of digital platforms on the transformation of global markets. To achieve this goal, the factors of the dominance of digital platforms in world trade and the challenges and opportunities that arise before developing economies in the process of market transformations are considered.

The main body of the paper

Digital platforms are an important aspect of current international competition, as they create new challenges and may require the revision of competition policy guidelines (Tirole, 2017, p. 379). A comparison of the composition of the world's top 20 companies (by sector and industry) by market capitalization shows dramatic changes. For example, in 2010, the top 20 included seven companies from the oil, gas and mining sectors (35% of the total), while there were only three companies from the technology and consumer services sector, including digital platforms, and another three companies from the financial sector. In 2022, the situation has changed significantly: the number of technology and consumer services companies in the top 20 has increased to eight (40%), and financial companies to seven. Only two mining companies remain in the top 20 in 2022. Four of the top 10 companies in 2022 were not even in the top 100 in 2010 (Amazon, Alibaba, Meta, Tencent).

Even more remarkable is the change in the following aspect. In 2010, oil and gas companies accounted for 36% of the top 20 in terms of total market capitalization, financial services companies 18%, and technology and consumer services 16%. In 2021, the share of the latter increased to 56% and the share of financial services to 27%, while the share of oil and gas companies in the total market capitalization decreased considerably over the same period to just 7% (UNCTAD, 2021). The world's leading digital companies are highly concentrated geographically: of the world's 70 most valuable digital platforms, most are based in the USA, followed by Asia (particularly China).

Economic value is traditionally closely associated with the production of goods and services. The key questions to determine this value relate to the methods of production, the distribution of products and the reinvestment of the income from this production (this is the productive transformation of materials into goods and services that create wealth potentially distributable in society) (Mazzucato, 2018, p. 287). In this context, the main actors in the economy are producers, consumers and the government, and the main objective is the production of goods and services from various resources (labor and capital).

In the new business models of the digital economy, two emerging and related forces are increasingly driving value creation: platformization and monetization of the rapidly growing volume of digital data. Digital platforms are central players in the economy and digital data is a key resource that leads to the creation of value. Their interaction has a significant impact on the receipt of added value and its value in turn. While the digital economy is just beginning to emerge in most developing countries (Iqbal et al., 2021), evidence of its impact on value creation and distribution is still limited. It is important to determine the ways in which companies create value and remove obstacles to it, which will make it possible to accurately assess the potential for creating and distributing value, the modalities of its modernization and its management, and the forms of its reception.

The concept of a platform is not new and, in essence, it refers to mechanisms that bring together a set of parts for interaction. Parker et al. (2016) define a platform as "...a business based on creating opportunities for evaluative interaction between external producers and consumers. The platform provides an open infrastructure with participation of all participants in these interactions and sets the conditions for their management" (p. 11).

Digital platforms provide mechanisms for these online interactions, and can be:

- intermediaries, when they connect different groups of people, i.e., sides of multilateral markets (Baldwin & Woodard, 2009, p. 19; Gawer, 2009). Thus, Facebook connects users, advertisers, developers, companies and others; Uber – passengers and drivers;
- infrastructures that can rely on different sides of markets. For example, users can design Facebook profile pages and software developers can create apps for Apple's App Store. In fact, certain businesses can only be part of a platform business itself. In the case of Apple, its activities are mainly focused on the sale of high-end consumer goods, i.e., traditional business.

Platforms can be organized and developed according to their functionality, their scope (at the level of companies, industries or the economy as a whole), their geographical orientation and their degree of openness. An important difference concerns their underlying operations, which can be divided into two main categories (Koskinen et al., 2018):

1. Transaction platforms are two-sided/multi-sided platforms or marketplaces that provide an infrastructure, usually an online resource, that supports the exchange between different (Gawer, 2014) entities and is closely linked to transformations in the digital economy (these platforms have become the main business models of large digital companies such as Amazon, Alibaba, Meta and eBay, as well as those that provide digital assistance – Uber, Didi Chuxing, Airbnb).
2. Innovation platforms (engineering or technology platforms) are how companies, industries or sectors use "shared components and subsystems within a product family" (Krishnan & Gupta, 2001).

At the industry level, these platforms provide ways to share common projects and interact across sectors. Examples of these platforms include operating systems (e.g., Android or Linux) and technology standards (e.g., MPEG video) that provide a common approach for businesses across a sector/industry to interact. At the enterprise level, these platforms were created as part of product offerings, adding functionality for their specific models.

Digitalization profoundly affects the formation of the global market structure in the following areas:

– direct communications (refusal to mediate). Digitization directly connects supply and demand via digital platforms;

– growth in the number of small businesses in traditional sectors (digitalization has significantly lowered barriers to entry in many markets, especially in consumer goods and services; small businesses easily connect to a large consumer base at low prices, leading to a market shift from large business dominance to growing small business influence);

– growing oligopoly among global platforms: while barriers are lower in traditional sectors, they are higher in emerging industries, especially digital platforms, and only a few companies can dominate. For example, Alibaba and Tencent dominate the mobile payments industry and are branching out into other parts of the financial services supply chain (Zhang & Chen, 2019, p. 11). This structure has the advantage of economies of scale or information scale, but can also lead to price distortions in the absence of competition.

A new landscape is emerging on digital platforms, which are divided into two main groups: for-profit platforms and non-profit platforms (UNCTAD, 2018). Non-commercial platforms are likely to be small compared to for-profit platforms. Uber is classified both as an e-commerce platform (ride services are ordered online) and as gig work (this term refers to irregular and one-time work, performed, for example, via Internet applications). Similarly, Airbnb includes e-commerce (lodging booked online) and is representative of gig work. Some platforms are versatile.

Platforms allow more efficient use of physical resources or time. Often accessed through mobile apps, they combine and aggregate supply and demand in ways previously unavailable (faster, cheaper, and easier to coordinate), including in geographies and service sectors where low density once acted as an obstacle.

Among the main characteristics of digital platforms are: the provision of an intermediary infrastructure between different groups of users; reliance on network effects as more users give rise to more users, leading to monopoly tendencies; and the use of cross-subsidies (the practice in which one division of a business reduces the price of a good or service, which is offset by a price increase in another division).

Platforms also tend to outsource jobs and services. In addition, platform owners set the rules for the development of products and services, as well as interactions with the market, i.e., access

conditions and prices. The most important value of digital platforms is related to the data extracted by users, which can be further analyzed, used and sold to third parties.

A unique and fundamental feature of the platform is the network effects (more users of the platform creates even more users and therefore the cost of the platform increases), the dynamic of which has been noted by Evans and Gawer (2016, p. 5) to be a "self-sustaining cycle of growth." The competitive advantages of the most successful platforms are considered to be global connectivity to the Internet and software engineering (Evans et al., 2008). These network effects can be direct (e.g., Facebook user growth) and indirect, where growth in the number of users on one side of the platform leads to their growth on the other side (user growth of video games drives the growth of video game developers).

The fast-growing nature of digital platforms is confirmed by the explosive growth of their market capitalization over the 2015–2020 period from $4.3 trillion to $7.2 trillion, with seven superplatform companies accounting for around two thirds of that value. The market capitalization of each of the seven platforms exceeded $250 billion, and in 2021 the market capitalization of Apple, Microsoft, and Amazon exceeded $1 trillion (CompaniesMarketCap, n.d.). At the same time, the conditions for the formation of the platforms differ numerically, despite the fact that they pursue common goals of data control and market dominance. While in the USA platforms emerged from a free market, although some government support was provided to them, in China the creation of platforms was supported by aggressive government policy, which included the protection of national companies against competition from global platforms (Bieliński, 2018; Thun & Sturgeon, 2017).

The dominance of a number of global digital platforms in the market is determined by several key factors, among which the most important is the achievement of monopolization based on: a platform that will drive out competitors; and the exceptional ability of the platforms to extract, analyze and control data (the intermediary function of the platforms allows them to accumulate data on all the interactions that traditional companies do not have, and this data can be converted into digital knowledge, can reduce costs, and can improve products compared to competitors). The literature indicates that when there are no radical technological changes that can challenge the business models of global platforms, their success relies on "virtual cycles of network effects" (UNCTAD, 2021, p. 85).

One of the key factors in the growth of any digital platform has to do with so-called network effects – the benefits that platform users receive from additional users who join (Van Alstyne et al., 2016). Platforms involve two or more partners. These can be, for example: accommodation providers and tourists (Airbnb); advertisers and consumers (Meta); or merchants, buyers, payment processors and logistics providers (Alibaba). Thus, in addition to direct network effects, platforms also have indirect (cross-sectional) network effects, where the expansion of one side of the market increases the added value for the other group. The presence of network effects is an incentive for the rapid growth of successful platforms, as additional users make these platforms more attractive. Network effects can also generate blocking effects – participants are more likely to stay on the platform rather than switch to competing platforms, which can pose problems for public authorities to ensure that markets remain competitive.

A platform-centric company has a big advantage in a data-driven economy. Platform owners, acting as intermediaries and providers of certain types of infrastructure, can extract all data relating to events that have occurred between different users of the platform. Thus, the growth of digital platforms is significantly linked to their ability to collect and analyze digital data. While digital platforms can be involved in a variety of economic activities and sectors, the collection (or extraction, when done without the knowledge or consent of users) of digital data is an essential part of their business models. Digital platforms can help create the value of interaction between different parties of the platform (producers and consumers of various goods and services). However, at their core, their effective functioning depends on digital data, and

the main source of their value comes from using this data in intelligent ways. Large digital platform companies see their data pools and data processing capabilities as a key competitive advantage. Thus, how specific firms extract value from such data is key to understanding and influencing the process of creating and retaining added value in the digital economy.

For digital platforms and for digital transformation itself, data and digital intelligence play a key role. At the same time, the genesis of the digital economy lies in an unprecedented amount of comprehensive machine-readable information. These digital data are the consequences of different types of personal, social and professional activities carried out on digital platforms, which increasingly constitute the digital substrate of economic and social activities in almost all sectors.

Along with the increase in data, converting these data into useful information for better decision-making poses additional challenges. A whole new value chain is developing around companies supporting the gathering of data-driven insights, including data harvesting (to provide new data sources), data storage, data modeling, data analysis and data visualization. At the lower levels of the data value chain (DVC), the information content is limited and therefore the opportunities for value creation are also low.

The result of this DCS is digital intelligence, which can inform companies (and other organizations) in their efforts to make decisions and implement innovations. Additionally, data may be used to improve algorithms used for automated decision making in the development of products, processes or services (Mayer-Schönberger & Cukier, 2013). Digital intelligence assumes a certain centrality and/or abundance of artificial or non-human intelligence, causing transformational impacts – for example, in the form of intelligent manufacturing, capturing a wide range of technologies with impressive intellectual results, such as analytics and algorithms.

Digital intelligence can be used for various purposes. From an economic point of view, it can have direct value as a service or be used in production processes. Productivity in the digital economy is determined in many ways by the appropriate application of digital intelligence. In particular, high economic returns are associated with appropriate skills and control. Thus, digital intelligence becomes digital capital, which results from: 1) access to large amounts of relevant data; 2) controlling their use; 3) the ability to process and transform data into digital intelligence; and 4) their application in manufacturing processes. The economic value of this digital capital is formed through various forms of data monetization (Figure 1).

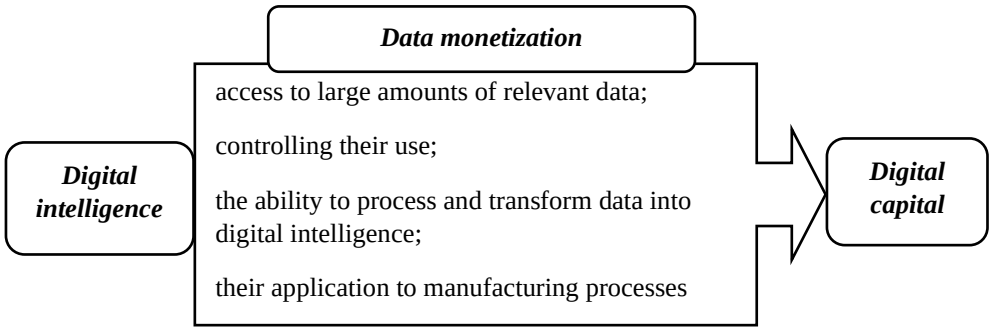


Figure 1. Data monetization – the process of transforming digital intelligence into digital capital

Some digital platforms appear to provide various products and services for free, but these transactions still create value for platform owners because users and consumers provide them with various aspects of their personal data (location, preferences, relationships and personal behavior). Value is created after data is transformed into digital intelligence and monetized through business use. The interests and behavior of digital platforms depend on how they

monetize data to generate revenue. There are four main types of trading platforms (Srnicek, 2017):

- ad platforms are companies such as Google and Meta that rely heavily on advertising revenue (advertising accounts for over 80% of Twitter and Google's revenue, and nearly 100% of Facebook and Snapchat's revenue). These platforms are strongly encouraged to extract and store personal data essential to their targeted advertising campaigns. Privacy disputes are a natural feature of this business model;
- e-commerce platforms offer online marketplaces with lower transaction costs for buyers and sellers (Amazon, Alibaba and eBay). Digital marketplaces often generate revenue by charging fees for each transaction. Each market sets its own commission, and this varies widely. Apple, for example, charge a 30% commission on each seller (Chung, 2018). These platforms can also use the data they collect from buyers and sellers to offer better services;
- product platforms aim to transform a traditional product into a rented service. For example, Mobike took the standard purchase of a bicycle and turned it into a bicycle rental service. With the growth of the Internet of Things, this type of platform will become more and more useful;
- cloud platforms such as Alibaba Cloud, Amazon Web Services (AWS), Google Cloud Platform and Microsoft Azure. They provide as a service various hardware, software and developments needed in the data-driven economy. There are also specialized platforms for the manufacturing industry (e.g., Predix from General Electric or MindSphere from Siemens) and agriculture (e.g., XeonView from Monsanto and MyJohnDeere from John Deere). Recently, AI has become an important part of these services. For businesses around the world, cloud computing promises cheaper, more secure, simpler and more flexible services than in-house information technologies. For developing countries in particular, this could reduce barriers to accessing advanced and large-scale computing needs (Greengard, 2010). As a result, cloud platforms provide the basic infrastructure of the 21st-century global economy.

It is important to note that individual data has little or no value. Value occurs when data is collected in large volumes and processed to inform and make data-driven decisions by individuals, businesses, governments, and other organizations. Thus, it is the ability of digital platforms to aggregate, process, transfer, store and analyze data that allows them to generate value. Therefore, digital data and digital platforms can be seen as two sides of much of the value creation that occurs in the digital economy.

In order to analyze the implications of global platforms on inequality, it is necessary to consider how information comes to have economic value. Weber (2017, p. 88) distinguishes, first, the raw data received by suppliers; second, information products produced by value-added companies; and third, the consumers of these information products. In particular, Facebook acts both as a provider of data and as a producer of information products based thereon, and may also return these products to users in the social interaction system and sell them to companies as advertising space. A kind of fundamentally new global data value chain (GDVC) is being formed, in which most countries are data providers, and only large platforms can receive valuable information products from them (and monetize them).

Such unequal participation of countries in the new international division of labor leads to previously unknown market distortions, since platforms in this context ensure absolute dominance. Traditional companies, in turn, will be forced to share their own data with global platforms in exchange for access to the latest applications and technologies. Despite the well-known comparatively low price of labor in developing countries, this will always be subject to automation, and the gap in the data economy between platforms and these countries will deepen, as will their addiction. We call this phenomenon information colonialism, when the place of the vast majority of developing countries in the international division of labor will remain solely as exporters of raw data and importers of finished information products.

Developing countries should use global electronic transaction platforms to support domestic production and exports, not just imports of goods, as the latter drive up consumer spending. An important issue is to ensure the access of developing countries to global platforms, which remains unequal due, for example, to the lack of solutions in these countries in the field of international payments.

The benefits of global digital platforms are also seen in terms of developing countries' use of their infrastructure, on the basis of which digital businesses and innovations can grow, stimulating the development of entrepreneurship. In this context, the role of innovative platforms that constitute the economic environment of content producers, as well as transactional platforms that simplify user interaction, is important. Gawer (2014) notes that an important system-forming function of innovation platforms lies in "generative digital innovation processes" – these platforms use differentiated, complex and innovator-centric design strategies that aim to build an innovation ecosystem.

The digital innovation process is not discrete, and the digital foundation of platforms can be used in the future without additional costs. At the stage of introducing a digital product into the infrastructure of a global platform, this product can be scaled with the global digitization process, and this mechanism is applicable to an innovation platform on which an ecosystem for improving innovations (combinatorial) has been created. Innovators and entrepreneurs in developing countries must have the skills and access to build on this foundation.

Generally speaking, there are a number of risks of an even greater lag of developing countries in the digital economy. As the innovation capacity of global platforms grows, lagging countries may lose the ability to develop local innovation ecosystems as developer resources and capabilities become increasingly focused on supporting technologies in other regions.

Competitive dynamics between global digital platforms are geographically multi-layered and impact platform expansion. Economies of scale make it difficult for startups in developing countries to compete with global platforms for product categories and markets. Therefore, startups are forced to seek out those niche markets that global platforms either do not want to or cannot serve.

Conclusions

Our research has shown that digital platforms can transform global markets and increase competition while improving consumer and societal well-being. However, they can be perceived as unfair competitors by traditional companies, since these platforms generally do not meet the same regulatory requirements. Antitrust authorities around the world oppose overregulation of the platform economy, which could reduce its potential benefits.

In the design of platforms for traditional enterprises, a key place is occupied by: technologies, which involve the formation of complex information systems, methods of machine learning and artificial intelligence; the organization of a complex digital ecosystem; and the design and development of organizational capital and management systems. A centralized approach to intra-firm control will not suffice in this case, as much of the value creation takes place outside the traditional boundaries of the firm.

The environment of digital platforms can be potentially dangerous for competition. Due to network effects, platforms can acquire market power and abuse their dominant positions, for example by imposing exclusivity agreements on their suppliers or by extorting predatory prices from their competitors. However, in various cases of competition, platforms were not considered dominant in their respective markets.

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SECTION 4

DIGITAL ENTREPRENEURSHIP

SMART TECHNOLOGIES: DIGITAL SOLUTIONS FOR AN ENERGY-SAVING PRESENT AND FUTURE

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Abstract. *Driving towards a high-tech future, digital technologies contribute to the expansion of economic opportunities, increasing the level of social well-being and environmental protection. The appliance of digital technologies as tools to improve energy efficiency for all economic sectors is aimed at solving the major objectives of sustainable development. Alternative energy production is rapidly gaining popularity around the world and is becoming the preferred source of energy supply for consumers. The effective application of digital technologies to stimulate production and supply growth in demand in developed and developing countries ensures the competitiveness of alternative energy sources. As Tajikistan is a country with rich hydropower resources, around 96% of electricity in the country is generated by hydroelectric power plants. In terms of hydropower potential per capita (87,800 kWh per year/person), Tajikistan shares the first two places in this indicator with Norway, and has the potential to serve the wider region. However, there is a lack of digital technologies, and modern techniques need to be introduced to adequately respond to the needs and consider negative trends in climate warming. Thus, these risks require a search for more effective technologies for the development of the country's energy sector. The smart home concept takes a special role in applying the capability for increasing the efficiency of energy resources' use and energy saving. The smart home concept entails the most outstanding idea for effective house space formation through digitalization. This article presents research results on an autonomous intelligent system within a residential building based on the use of digital and intelligent technologies. The trends in the development of the intelligent smart home system and the barriers that slow the development of this market are identified based on global experience. This integrated automatization project for autonomous homes is developed based on KNX digital and intellectual technologies. The solutions proposed in this article are verified by calculations of economic efficiency and can be recommended for further practical use.*

Keywords: *information technologies, smart home, digital technologies, energy-saving, KNX, efficiency.*

Introduction

Digital technologies are actively being introduced into all spheres of modern society. Pursuant to the challenges and opportunities of the digital economy, implementing the ideas of the smart home and smart city concepts can be considered as one of the directions for changing the life habits of the modern population. These concepts are technologies for integrating the Internet and digital interactive services into various electronic devices (TVs, computers, mobile phones, tablets, household appliances, etc.) for the purpose of forming a single digital space for user convenience. The main principles of the smart home concept are considered to be human-oriented, life quality improving, and ensuring economic efficiency. These principles shall be implemented through the widespread introduction of digital technologies and engineering solutions. The purpose of the smart home is not only limited to the digital transformation and automation of processes, but also a comprehensive increase in energy efficiency within housing space. The human-oriented principle is the main principle of a smart home, such as the principle of providing residents with the opportunity to be involved in energy consumption management by applying digital technologies.

The governments of many countries are developing strategies for sustainable development, the most important areas of which are to ensure energy security and increase energy efficiency. The implementation of energy efficiency and energy saving programs in the energy policy of developed countries and regions, such as the EU, is considered an additional source of energy.

In developing countries, energy conservation and energy efficiency programs tend to focus on eliminating energy poverty and improving the quality of life of the population.
Of particular concern to the global community are climate change trends and the environmental aspect of the problem of energy conservation and energy efficiency. Growth in the consumption of energy resources invariably entails increased environmental pollution.
The prospects for reducing the energy intensity of the global economy and the destructive impact of its development on the environment are associated with the development of the smart home concept. Currently, the strategic priority for the development of megacities in many countries is the creation of a smart city. The problem of implementing intelligent systems for managing the energy consumption of cities is of particular relevance in the context of the predicted growth in the urban population. According to UN estimates, by 2050, 67% of the world's population will live in cities.

The main body of the paper

The current level of intelligent technologies and the emerging trends in their development in the near future enable humanity to increase the efficiency of energy resource use based on the implementation of the concepts of smart home and smart city, and make a significant contribution to improving the environmental situation on our planet. Today, the thesis is undeniable that humanity, by changing its consumption of energy resources, can change the world (Kremlev et al., 2014).
The depletion of fossil fuel reserves, climate change, the aggravation of the environmental state, increases in prices for energy resources followed by growth in consumption, and the rise the significance of energy efficiency and saving increase these problems, and pose challenges for the global community to search for problem-solving mechanisms.
In 2018, global consumption of all energy sources increased by 2.3%. Moreover, the predominant demand was typically for electricity and gas power sources. The highest rate of energy consumption was in China (3.7%). In the USA, in 2018, compared to 2017, the increase in energy resources consumption amounted to 3.5%. According to experts, one of the reasons that led to this increase is climatic conditions such as hot summers and cold winters. At the same time, energy consumption in the EU decreased by 1% within the reviewed period. For example, energy consumption decreased by 3.5% in Germany, resulting from a warm winter period and the effective implementation of an energy-saving policy in the country.

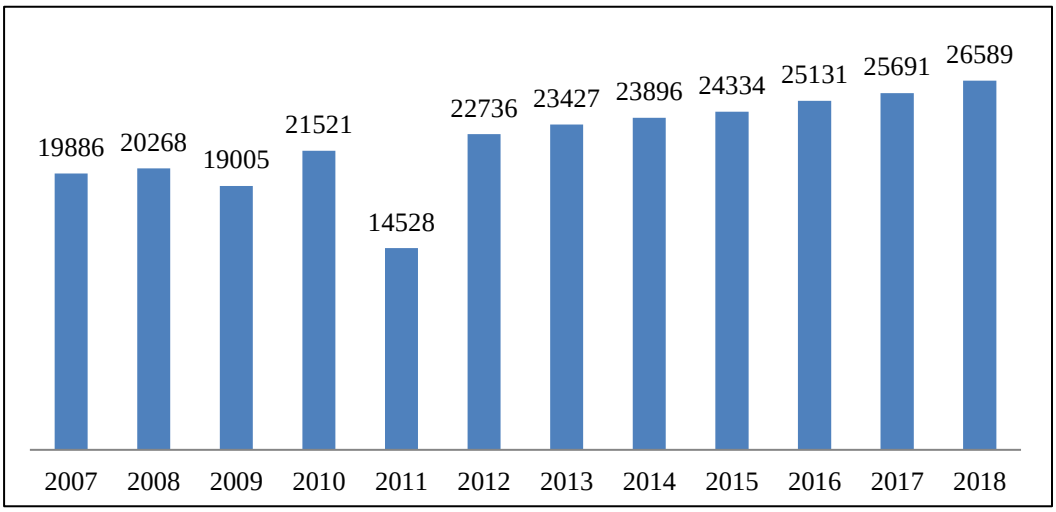


Figure 1. Global electricity consumption dynamics, TWh
Source: Enerdata (2022)

The global electricity consumption dynamics provided in Figure 1 indicate a noticeable growth rate. Global electricity consumption in 2018 increased by 3.5% compared to 2017. Global electricity consumption in 2018 is illustrated in more detail in Figure 2. At the same time, global energy consumption mainly increased due to Asia (around 80% of this increase), where China consumed 60% of the total amount of energy used (Enerdata, 2022). Economic growth and industrial demand have led to an increased demand for electricity in China (Figure 2).

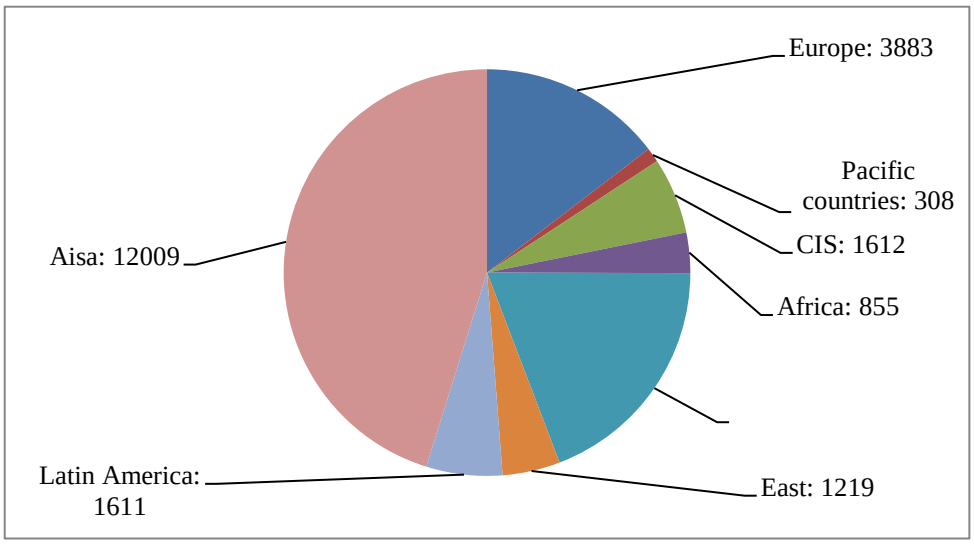


Figure 2. Electricity consumption by regions of the world in 2018, TWh
Source: Enerdata (2022)

Moreover, energy demand increased in Japan, India, Indonesia, and South Korea. Compared to 2017, US electricity consumption increased by 2.2% in 2018. The residential sector had a significant impact on the increase in electricity consumption. The increase in electricity consumption in this economic sector amounted to 6.2%, resulting from the increase in the electricity consumption of household appliances and air conditioning. In the residential sector, the electricity consumed by household appliances is around 50%, while the use of centralized or individual air conditioning systems in the US is almost 90% of electricity consumption.
Economic growth in some countries (e.g., Brazil and Russia) has contributed to the growth in electricity consumption. There is also an increase in electricity consumption in Africa (Egypt and the Middle East). The electricity consumption rate in Europe remained stable throughout 2017 and 2018 overall, as it decreased in Germany, Austria, and France, stabilized in the UK, Italy, and Spain, and increased in Poland, Bulgaria, and the Netherlands (Enerdata, 2022).
The environmental aspect of the problem of energy saving and energy efficiency is of particular interest. Growth in the consumption of energy resources invariably leads to a negative impact on the environment. Energy-related CO_2 emissions increased by 2.1% in 2017 and by 1.9% in 2018. As a result of energy sector activities, CO_2 emissions into the environment increased by 1%–1.5% in 2019, and this was determined by the increase in energy consumption. All countries except those in Europe and Latin America experienced increased energy consumption. Despite the policy of shifting from coal to gas, CO_2 emissions into the environment increased significantly in China, India, and Russia by 3.1%, 4.2%, and 3.9%, respectively. In the USA, CO_2 emissions increased by 3.1%, driven by increased weather-related energy consumption. In the EU, CO_2 emissions decreased by 2.1% due to several reasons such as reduced energy demand (in Germany, for example), an increase in the share of renewable energy sources in electricity generation, and relatively favorable climatic conditions. In Japan since 2016, carbon emission has continued to decrease due to solar and nuclear energy use.

The limited opportunities for implementing the potential for increasing energy efficiency and energy saving that are available to developing countries, including Tajikistan, can be determined by the following reasons:

- low level of motivation to use energy-efficient household electrical appliances, modern intelligent home support systems, and digital technologies in management;
- weak regulatory and legislative framework for energy-saving;
- unfavorable investment climate and, as a result, limited access to investments for the implementation of energy-saving programs.

In this regard, the benefits resulting from the implementation of energy efficiency and energy-saving programs are characterized by different scopes in each country. In developing countries, where a significant part of the population is below the poverty line, these programs are focused on providing access to energy for this part of the population, thus reducing energy poverty.

Currently, the lowest GDP energy intensity indicators in oil equivalent (0.057–0.108) are present in Colombia, the UK, Indonesia, Japan, and Europe. Most countries have high GDP energy intensity (0.112–0.326), including the USA, Brazil, India, China, Argentina, the CIS, and others.

The special significance of the energy saving and energy efficiency problem and the search for mechanisms to solve it in different countries is seen at all levels. At the state level, problems are solved considering the characteristics and different scales of such problems as those noted above. Such solutions include ensuring the energy security of the country, providing the population access to energy, and reducing energy poverty and the negative impact on the environment (X10, 2019).

The increased interest of business in energy-efficient technologies is caused by the following:

- reducing energy costs and increasing the competitiveness of their products;
- improving the company's image from an environmental perspective;
- reducing the cost of technological processes in the use of the building.

The interest of the population in energy efficiency improvement is specified by its particular importance in improving the living comfort in the house, reducing the cost of energy resources, and improving the environmental situation.

A special role in the implementation of energy-saving and energy efficiency improvement programs is given to state authorities. Effective energy-saving state management measures made France form the Energy Saving Agency, Japan the Office for Rational Use of Natural Resources, the UK the Energy Efficiency Committee, etc. The principle of mandatory state expertise on energy saving consists of determining the compliance of the entity's activities with the principles of energy saving, as well as establishing the compliance of project, planning, and other decisions with the requirements of energy saving legislation. The main purpose of this examination is to prevent the production and release of energy-inefficient equipment, technologies, devices, household appliances, etc. Economic incentives for investments to improve energy efficiency are effective measures of state support for the growth of the energy-saving equipment and services market.

The effectiveness of government incentives for energy saving differs in different countries. This can be described by the effectiveness of the implemented measures. For example, tax benefits established by the governments of Canada and the USA have not had a stimulating effect on intensifying investments in energy-saving programs in the industry. In Canada and France, accelerated depreciation based on increased depreciation rates has had a significant impact on stimulating industrial energy-saving programs. The narrowing of the energy efficiency gap between the West and East German economies was ensured by the fact that building owners in East Germany were legally able to invest part of their income tax in energy efficiency improvements.

Programs aimed at producing and promoting energy-efficient equipment, devices, materials, and systems on consumer markets had a significant contribution to the development of energy saving and energy efficiency in a number of countries. These programs provide incentives for manufacturers and dealers to produce and distribute such products. For example, a US electric utilities consortium regularly provides funding to incentivize manufacturers to produce more energy efficient models of energy-consuming equipment and devices.

Besides the American energy companies, large European energy companies such as EdF (France), ENEL (Italy), and a number of companies in the UK have a significant positive experience in the development and implementation of consumer demand management programs for energy. This experience is already being actively used in a number of developing countries.

The experience of establishing energy service companies that offer energy-efficient equipment and technologies for various sectors of the economy also deserves attention. The significant contribution made by these companies to energy efficiency and energy saving served as a prerequisite for the initiation of a project to create an international energy-saving fund for the organization of energy service companies in Eastern Europe and the CIS by the UNECE Committee on Sustainable Development (United Nations, 2015).

At the same time, it should be noted that activities in the area of improving energy saving and energy efficiency can be considered a business direction. Therefore, state policy in this area should also provide incentive measures for development and should reduce risks.

The research results in this paper show that countries' economies, including in the housing sector, have unused potential to reduce their energy intensity. The program of energy saving and energy efficiency improvement in housing and communal services based on the use of intelligent systems can be considered one of the directions of this reduction.

The global market for smart home technologies in 2020 amounted to $78.8 billion; by 2026, it is expected to grow to $207.8 billion. According to existing forecasts, the volume of the global market for smart home devices will reach $207.8 billion by 2026, despite the decrease in the forecast for the market volume in 2021 due to the consequences of the COVID-19 pandemic. The largest is the US market, but changes are predicted in favor of Europe and the rest of the world. The US is the market leader, with an annual revenue of $23.3 billion, the European market is second with $20.1 billion, and China is third with $15 billion. The smart home devices market is conditionally divided into 6 segments depending on the scenarios for using devices: 1) control and communication; 2) smart home appliances; 3) security; 4) home entertainment systems; 5) comfort and lighting; and 6) energy consumption management. The largest of these segments in terms of volume is smart home appliances, which amounted $29.1 billion in 2020. This segment along with the management and digital communication segments are the most future-oriented in terms of growth. Annual growth in these segments is expected to be around 18%–18.5% (Enerdata, 2022).

According to the analytical company IDC, in the EU the volume of the smart home systems market amounted to 88.8 million systems in 2018, and by 2023 the volume of various smart home devices in the European market will increase to 187 million systems. The average annual growth rate (CAGR) in the considered market in the period from 2018 to 2023 will be 16.1%, as shown in Figure 3.

In 2018, video entertainment formed a significant share of smart home equipment in the EU at 61.2%, music speakers 18.1%, home security systems 10.3%, lighting systems 4.8%, and thermostats 2.6% of all smart home technology supplies (Bannikova, 2016).

Products from large companies such as Amazon, Google, ADT, and Samsung have promoted the spread of the smart home system in North America. In Europe, such large companies as Centrica Connected Homes (CCH), Deutsche Telekom (Magenta), eQ-3, and Enco (Toon) dominate. In Asia, the market is represented by such companies as Xiaomi, LG, U+, iTSCOM,

and Panasonic. According to forecasts, by 2023 the smart home market will grow by an average of 10% each year to $155 billion, and the number of customers will grow to 293 million. The best-selling smart home devices are smart lighting systems, smart thermostats, and security and warning systems. Currently, the main market for smart home systems is North America, and this market forms 41% of all smart systems.

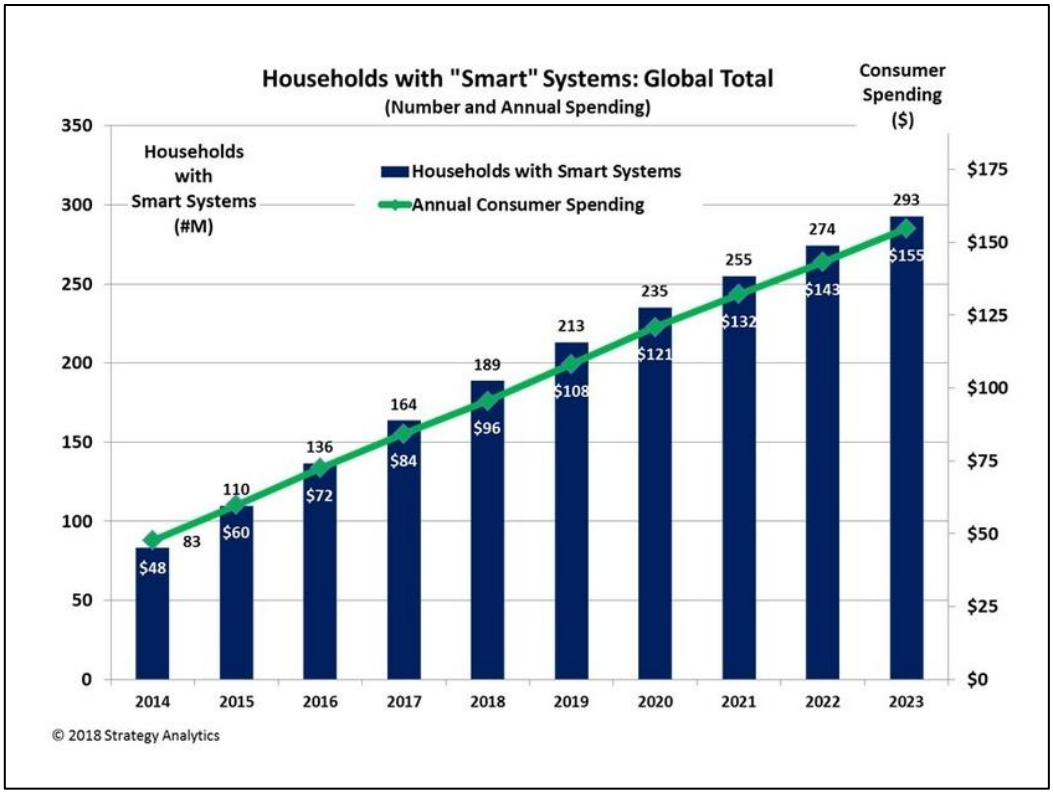


Figure 3. Growth dynamics of the global smart home market
Source: Strategy Analytics (2021)

International statistics, where the smart home concept is a long-standing reality, highlight the benefits of investments made and their rapid payback:

- reduced operating costs by 30%;
- reduced energy consumption by 30%;
- reduced CO_2 emissions into the environment by 30%;
- reduced water consumption by 41% and payment for water accordingly;
- reduced heating bills by 50%.

In addition, there are risk insurance benefits, as risks are reduced by 60% when using smart technologies. The main motivation that encourages customers to invest in a smart home system is the desire to have comfort and safety; at the same time, an important aspect of this choice is the uninterrupted operation of equipment and energy savings.

One of the main obstacles to the spread of digital systems is the problem of smart home device compatibility. The use of different data exchange communication protocols by manufacturers complicates the application of smart home devices and their integration with each other (Chew et al., 2008). The number of companies offering apartment automation services is growing, together with the growing demand for digital smart home technologies.

The amount of consumer spending per capita in the CIS – which, in Tajikistan, is $563, out of which almost 62% is food expenses – is considered a barrier to the development of the market. In Russia, this figure is almost 1.5 times lower than the world average (334,000 rubles against 483,000 rubles in the world). The lack of a necessary level of consumer confidence in smart

home technologies also negatively affects the growth in demand for smart technologies. The low level of digital literacy, observed in 39% of the adult population in Tajikistan, is an additional obstacle to the development of the market.

Considering the importance of the processes of the digitalization of the economy, it should be noted that Tajikistan, more than other countries, needs processes for the development of digital technologies. This is related to the geographical location of the republic and the lack of access to sea routes, and digital technologies are a cheaper way of communication from an economic point of view. Demand for smart home technology in Europe is much higher than in Tajikistan. One of the reasons for this is that the prices of energy products in the domestic market of Tajikistan are relatively low. Therefore, the payback period for smart home technologies based on the use of automated energy management systems in the EU is significantly lower than in Tajikistan. The low solvency of the population leads to the fact that digital solutions to the energy-saving problem are perceived by most buyers as luxury elements (United Nations, 2015).

The underdevelopment of the corresponding segment of the Internet of Things market, which includes the corresponding smart home devices, is considered as a deterrent to the development of intelligent systems in Tajikistan. Experts also point out the barriers associated with the existence of unified standards. For most construction companies, it still remains problematic to obtain practical solutions from developers and suppliers of smart home intelligent systems. When it comes to management companies, such companies, as a rule, do not have the necessary resources to operate intelligent systems, and the low cost of energy products is not an incentive for the population to make decisions on investing in energy saving. Representatives of telecommunications and smart home services also point out the problematic organization of the network model as a barrier, which is very important for guaranteeing the quality of telecom services and smart home services (Kremlev et al., 2014).

Telecommunications operators are also interested in increasing demand for smart home technologies, considering this area as a new sector of the telecommunications services market. Research shows that a number of telecommunications companies consider the automation of the management of housing and communal services a promising area of their activity. The introduction of smart home technologies in only 10% of households would create a huge market. The advantage for Internet providers consists in constant contact with the homeowner, which is difficult for service companies to achieve. As global experience shows, smart home technologies will become mass-produced only when the operator model is applied.

Energy savings from the use of digital systems in the housing sector of Tajikistan, which can be considered as a potential method of release of energy resources in the domestic market and the possibility of increasing their export, is an important advantage of smart home technologies. Today, the market for digital building management systems in Tajikistan is much lower than the Russian market, not to mention the Western market, and this market is not even at the initial stage. Consumers must realize the benefits, both in social terms and in the economic aspect. Only then will there be an increase in demand in the smart home system market, both for individual apartments and rural houses and for the construction of intelligent buildings.

Demand for research into smart technologies in the construction of buildings in Tajikistan shows that the main barriers to the growth are: the limited access to information of potential buyers of housing and office space regarding the benefits of automating systems; the insufficient level of professional capacity of designers and their limited access to standard engineering solutions in the field of designing intelligent premises; and the weak motivation of construction companies to use intelligent technologies. In addition, an important and temporary factor such as relatively low prices and tariffs for energy resources in housing and communal services should be noted. In the near future, the predicted growth in demand for smart homes

will continue to depend on access to the Internet, which shall provide automated management of life supporting systems.

Due to the low solvency of most of the country's population, the demand for intelligent systems for a separate apartment is quite limited. To date, only 1–2 Russian and Chinese companies are represented in the country's intelligent systems market. The low effective demand associated with software and setting up an automated system controlled from a computer remains problematic. The latter is characterized by significant budget costs, limiting the demand of the average homeowner for digital innovative technologies. As a rule, at the initial stage of implementation and proposal, people treat this technology with some prejudice and get used to it over a long period of time. However, given the systematic increase in utility prices, the situation may change quickly. Increasing competition will lead to the widespread and active introduction of intelligent systems at the stage of building construction (Bannikova, 2016).

The problem of implementing digital technologies in urban energy consumption management is of particular relevance in the context of the predicted growth in the urban population. The UN estimates that by 2050, 67% of the world's population will be living in cities. In most countries, the prospects for the application of digital technologies in everyday life form the basis of numerous smart city projects. The level of digital technologies achieved currently and the emerging trends in their development in the near future shall enable humanity to increase the efficient use of energy resources based on the implementation of the smart home and smart city concepts to make a significant contribution to improving the environmental state of our planet. The concept of a smart home is a logical continuation of the ideas embodied in the concept of a smart city.

Currently, due to the complexity of the smart home concept, there are various definitions in the literature. We adhere to the fact that a smart home is a complex digital building management system, including subsystems of its heating, air conditioning, power supply, water supply, ventilation, video surveillance, alarm, security, fire safety, and telecommunications. The list of managed subsystems and the functional characteristics of the integrated automated system as a whole is very diverse and is determined by the user, the level of development of the technology, and digital technologies.

The current level of development of intelligent technologies used in the integrated smart home automation system is characterized by a wide variety of data transmission methods. Electrical wiring and a coaxial cable can be used to transmit information in the automated lighting control subsystem. Twisted pairs, radio signals, or infrared rays can be used in the climate control subsystem and in the control of digital devices. The switching of various methods of data transmission (protocols) is provided for by the conversion of incoming signals using routers or special devices like bridges (data bridges) (Chew et al., 2008).

The number of companies offering services for automating energy consumption management in apartments is systematically increasing in European countries. The market of intelligent systems for smart homes is developing intensively. With the development of mobile technologies and the increasing availability of the Internet, the population highly appreciates the benefits of intelligent automation systems for managing the energy consumption of an apartment (or house). Now, a comprehensive remote-control system for home support systems has become widespread. For example, installing special software on personal computers allows users to control lighting, air conditioning and heating subsystems, i.e., energy consumption at home remotely. This will not only increase the level of comfort, but also reduce energy costs.

However, this market is not yet developed in Tajikistan and may be of interest to European manufacturers of home support automation systems such as BTicino (Italy) or In One by Legrand (France).

Providing an individual apartment in a new residential building with an intelligent system will significantly increase its cost, which, accordingly, limits effective demand. At the same time, it

should be noted that the intensive development of the housing construction market and the growth of competition between construction companies may be an incentive to intensify the use of intelligent systems by construction companies that reduce energy consumption in Tajikistan.

Different conceptual approaches to the use of smart home systems in the post-Soviet space, in Europe, and in the USA should be noted. The priority goal of automating life support systems in houses (apartments) in the EU and the USA consists of energy-saving and energy efficiency improvement. Smart home systems provide owners with significant savings in electricity, heat, and water, and the effective use of family budgets accordingly.

Effective demand for intelligent energy consumption management technologies and various conceptual approaches predetermine the corresponding scale of the spread of smart homes in the CIS countries and developed countries. In Western countries, at the beginning of this century, intelligent technologies were used in the construction of residential apartment buildings in the residential areas of cities, and in the construction of new housing estates with individual houses in the suburbs.

Unfortunately, the widespread use of digital energy consumption management systems and the use of other intelligent systems in the practice of building residential buildings in Tajikistan is limited by insufficient knowledge and information access. Investment and construction companies do not have the opportunity to receive qualified consultations regarding engineering solutions, lack qualified local experts, and suffer an ineffective regulatory framework. They also experience the priority desire of apartment buyers to save financial resources when purchasing real estate by not taking into account the costs associated with its operation and maintenance of engineering systems.

Review of modern smart home technologies.

The smart home system allows people to centrally control and intelligently manage residential, office, and public spaces. Depending on the complexity and desire of the client, the smart home system may consist of several control automation subsystems, which are shown in Figure 4.

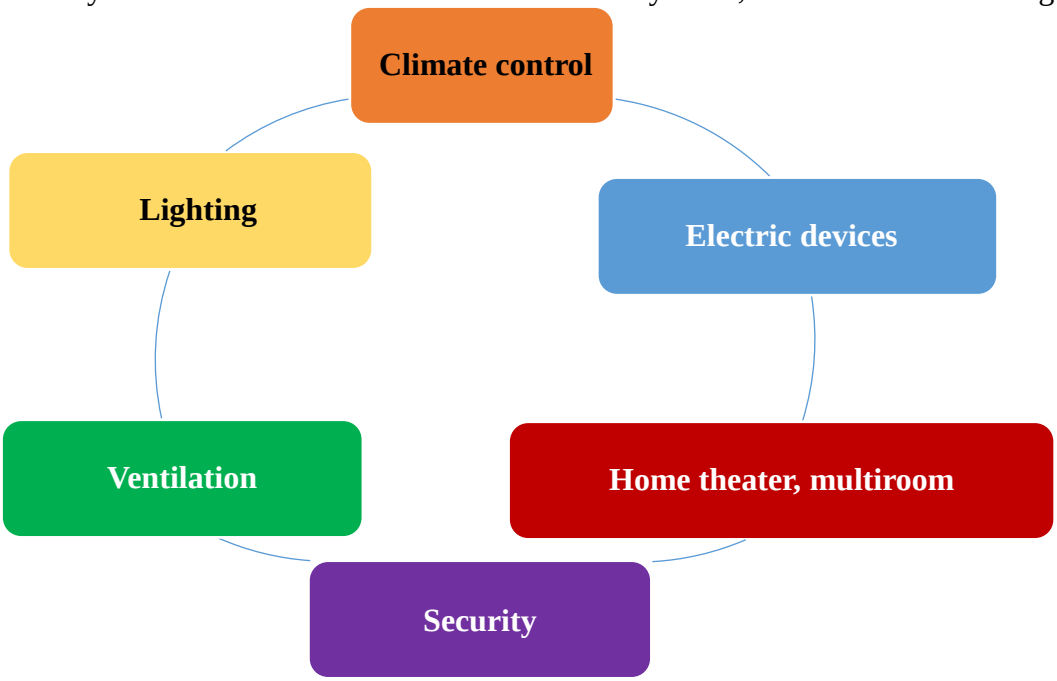


Figure 4. Residential intelligent support systems
Source: KNX (n.d.)

When installing such a system, each user can remotely control a separate subsystem using digital technologies by setting the required air temperature, illumination of individual rooms, sound, resolution of video surveillance cameras and other parameters.
In addition, a smart home may have a multi-tasking operating system and programming tools, and sometimes a web server.
Sensors are placed at certain points in the building, and all sensors are connected by a single network, either directly or through intermediate devices.
The control interfaces control the smart home system. Controlled devices are lamps, air conditioners, home theater components, etc.
Currently, there is a fairly large variety of intelligent technologies for implementing the smart home concept in global practice. Large and small companies are striving for the mass introduction of intelligent technologies in the everyday lives of people. Table 1 shows popular smart home projects from various companies.

Table 1. Smart home projects
Source: KNX (n.d.)

Company	Producing country	Cost	Abilities
Samsung Smart Things	South Korea	$89.99–$249.99 depending on capacity and equipment	Depending on the price, it can connect simple compatible smart devices, or be a more advanced smart home router of different power levels depending on the task and area of the room.
Xiaomi Smart Home Kit	China	$66	It has a remote control, window and door security sensors, can be controlled with smartphones, and can be integrated with other smart devices.
Tron Project	Russia	Starting from $1,740 depending on the complexity of the project	Offers wireless control of the smart home at the same time from several devices that may provide control of light, curtains, security, heat, ventilation, etc.
Little Bits	USA	$249	The client can independently connect devices to the network using password codes. The set includes a CP3 player and 14 modules.
Insteon	USA	$79.99	Connected to the Apple system, control is offered from any Apple device over light control, smooth shutdown, temperature control, video surveillance of the Insteon system, wireless Internet access, and push notifications when sensors are triggered.

Designing stages for a smart home system. Creating an automated digital home control system involves several steps:

- the first stage is the development of proposals, agreement with the owner of the housing, and approval of the smart home project with a detailed list of equipment;
- the second stage commences as soon as the preliminary design is approved, wherein a detailed design is developed and approved with the participation of an architect and a designer;
- the third stage involves the installation of equipment;
- the fourth stage entails the connection of programming and the debugging of equipment.

This stage includes the work of programmers who set up equipment, components and assemblies, and debug. After that, the system is put into operation.
The experience of using digital technologies in the management of house support systems indicates that these technologies provide a reduction in operating costs by 30%, payments for electricity and heating bills by 20% and 25%, respectively, and payments for water by 40%. Modern digital technologies make it possible to create fully automated houses and transfer many house managing functions to automated devices, and in some cases to fully automate

processes when human intervention is not required at all. These systems are considered in more detail below.

Climate control digital system. This allows users to adjust the temperature regime and air quality in the room depending on the temperature inside and outside, and to adjust the parameters of the thermal energy used in the apartment. Underfloor heating control ensures the maintenance of optimal temperature and humidity parameters in each individual room. The climate control system controls temperature, ozonation, humidity, fresh air intake intensity, and the cleaning system, taking into account the area of the apartment and its separate premises (north, south) and the individual requirements of the people living in it.

Digital control system for a complex of multimedia equipment. This involves sound and video control through throughout the apartment remotely. At the same time, automation can provide editing, setting automatic start times, and related settings for viewing – for example, turning on the air conditioner in the room where the home theater is installed, closing the blinds, reducing the intensity of lighting, etc.

Digital lighting control system. This system provides lighting control remotely. The advantage of an automated lighting control system is the ability to set the intensity of lighting and to turn on and off depending on the time of day and the presence of a person in the room by using information from sensor and timer data. This system also provides the possibility of simulating the presence of the apartment owners.

Intelligent autonomous power supply system. This system ensures comfort, safety, and economic efficiency. The avoidance of power supply interruptions when a centralized power supply is turned off is ensured by the automatic activation of backup energy sources such as solar panels, batteries, chargers, and liquid fuel generators installed in the system and integrated through the software.

Digital security system. This system is an integral part of the smart home. This system provides a security and fire alarm and video surveillance, ensuring protection against short circuits in electrical wiring, water and gas leaks. Security is ensured by triggering a smoke detector and turning on fire extinguishing systems, autonomous power supply, alarms, and automatic calls to the relevant services. Intelligent video surveillance based on the use of the Internet and satellite television networks is also an advantage of modern smart home systems.

At the same time, it should be noted that most household appliances included in the smart home system do not need an automation system, since they have the corresponding functions installed by manufacturers. This includes such household appliances as:

- refrigerators, which are fully automated electrical appliances that operate under a set program;
- air conditioners operating under the set parameters of temperature and humidity;
- washing machines with appropriate programs for managing operating modes and switching on and off functions;
- electric stoves, with automated switching on and turning off mode;
- electric water heaters, with programs that allow them to switch on and off;
- lighting systems, with on or off modes controlled by relays with photodiodes that react to the level of illumination.

This list of household equipment can be continued, considering the wide variety of household electrical appliances already in use and the desire of manufacturers to increase demand for such products. However, it should be noted that most people use the most common functions without applying the full functionality of the TV, air conditioner, or water boiler programs, for example.

Based on the foregoing, the following conclusions can be provided regarding the main advantages of using digital technologies for managing home support systems:

- a comfortable microclimate is constantly maintained in each room of the apartment and for each resident. Air temperature, humidity and other parameters are constantly maintained or

adjusted in each room at a certain time;

- the ability to control each system remotely is provided;
- in case of any malfunction, the system will not allow the devices to be turned on, and will send relevant information to the owner which will help to avoid significant damage in case of emergencies.

The global market for system solutions and automation equipment for building support systems is currently quite developed. The market is formed by a large number of companies, including Crestron, AMX, ABB, GIRA, SIEMENS, Schneider-Electric, MARMITEK, etc. (X10, 2019).

The development of algorithms for controlling home support systems by an intelligent room. Smart room control is performed according to a number of scenarios. In this article, we have considered user scenarios that are developed to increase the level of comfort and energy saving. When developing such a scenario, economically advantageous parameters will also be fundamentally considered.

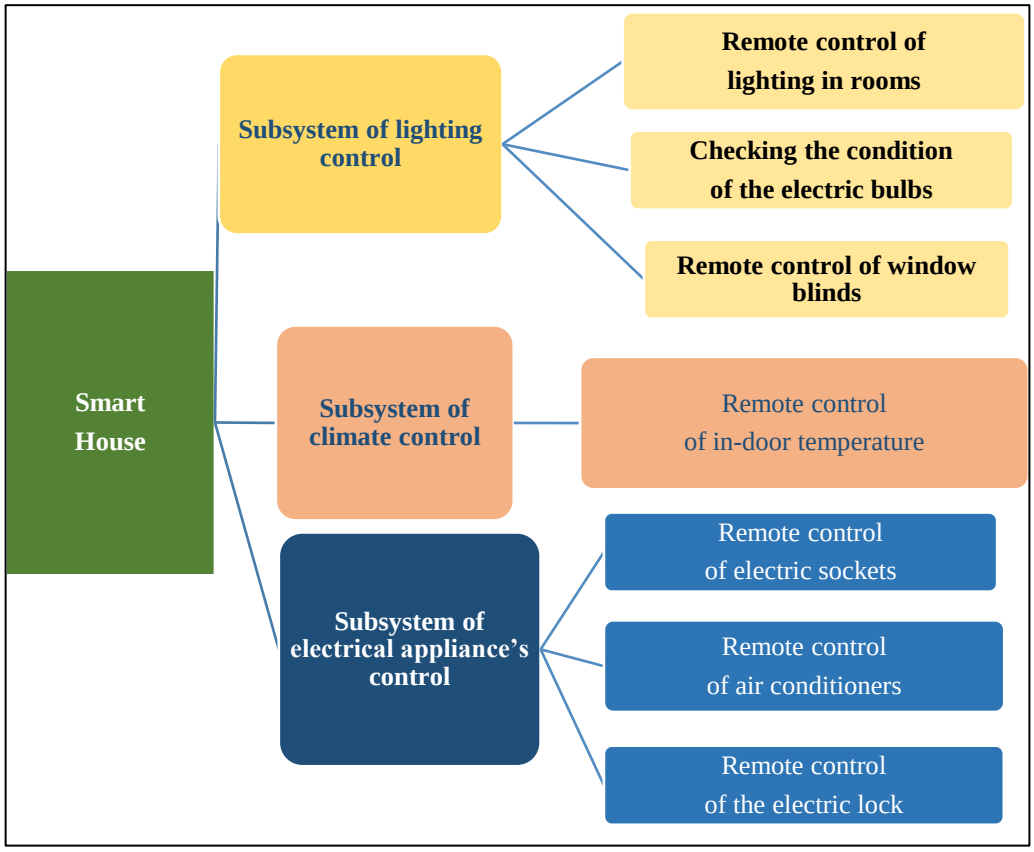


Figure 5. Functional configurations of the smart house system
Source: KNX (n.d.)

The proposed smart room system (Figure 5) monitors three subsystems that perform the relevant functions. The functions of various engineering systems of an object are weakly connected without an automation system, and in an intelligent room they often depend on each other and provide the effective work of initially unrelated tasks. Thus, the components of a digital automation system must be synchronized to work together and, at a certain time interval, provide information exchange between the system components, the dispatching console, and the central controller (if any).

Information exchange is carried out by combining system components through a single data bus or a central controller, which receives digital or analog signals from converters and

modulators that allow receiving information from systems that cannot be included in a single information network for various reasons.

For the most economical and efficient use of system resources, the following automation algorithms should be performed in an intelligent room:

1) algorithm for synchronizing the blinds and lighting system;

2) algorithm of the climate control system;

3) *control subsystem for individual electrical appliances*.

The calculation of economic efficiency for the use of digital technologies in home support systems management. A significant share in maintaining housing cost is occupied by utility bills, including payments for electricity, gas, water, heating, and other components. These costs are determined by tariffs, which are established by legislation. The amount of expenses is calculated if a meter is installed according to the actual consumption of the resource, otherwise as per the established standards. A systematic increase in tariffs predetermines the need to find solutions to reduce costs without reducing the level of comfort of life. As noted above, an effective solution to this problem is the introduction of digital technologies in house support management systems, i.e., intelligent rooms.

It should be noted that people, as a rule, point out the problem of increasing energy tariffs and overlook the types and conditions of the electrical appliances used and the modes of such appliances. The use of energy-efficient electrical appliances is an important energy-saving aspect in a residential area. Calculations point out that, in an apartment, the maximum annual electric power saving when replacing incandescent lamps with LED ones when used for 5 hours a day will be 1,080 kWh. Since artificial lighting is usually used during peak demand, the annual savings in monetary terms in Tajikistan will be from 380 to 550 somoni/year.

Table 2. Unproductive consumption of electrical energy by electrical appliances on standby mode

Source: 1Home (n.d.)

Name of electrical appliances	Unproductive electrical energy consumption, watt-hour	
	Obsolete model	New generation models
Electric stove	6.0	2–4
TV	10	0.1–0.3
Audio System	6–8	3–5
Computer	85	2.1–3.6
Laptop	3	1.5
Cell phone charger	7	0.5–15
Desk phone base	5	0.3–1.1

The ambiguous electricity consumption of old and new generation household appliances in standby mode (not disconnected from the network) should be also noted. Firstly, as can be seen from Table 2, the unproductive consumption of electrical energy by appliances in standby mode is insignificant even for obsolete models. However, when such models are removed from use, significant energy savings can be achieved even in a separate apartment, and even more if residents become in the habit of turning them off from the network.

Table 3 shows the estimated cost of automation equipment for the home support systems of selected residential premises.

Table 3. Estimated cost of automation of home support systems in a residential building

Source: 1Home (n.d.)

#	Item's name	Quantity	Price per unit in TJS	Total amount in TJS
1	Socket S55	16	35	560
2	Switch S55	5	60	300
3	Driver UIO82M	1	970	970

4	Blind actuator Zennio SHUC1C	2	310	620
5	Air conditioning driver Zennio KLIC-TS	3	900	2,700
6	Heating driver ZIO-RQUAD8	1	1,150	1,150
7	Thermometer NTC68	1	150	150
8	Electronic lock Gira Fingerprint	1	1,500	1,500
9	Lighting interface DimInBox	1	2,790	2,790
10	Power supply TDK-Lambda DSP 30-24	1	410	410
		TOTAL	**31**	**10,740**

The available expert assessments on the use of KNX system technology indicate that the annual saving of electrical energy in IR compared to the traditional model is 30%, and the saving of thermal energy is up to 40%. The annual consumption of electrical energy in the considered apartment after automation is set up will decrease by 1,158.6 kWh (Konnex Association, 2004). The use of KNX technology in the digital climate control system allows heat energy consumption savings of up to 40% (Konnex Association, 2004). The decrease in the volume of consumption of electrical and thermal energy is characterized by an increase in the comfort of living conditions, improved health, and a reduction in CO_2 emissions from energy generating sources, i.e., social and environmental performance, which is difficult to quantify. Additionally, with an energy consumption decrease, the energy losses during transmission and distribution are reduced. The payback period for capital investments of the proposed engineering solution is 3.5 years, with a profitability of 28.6%, which indicates the economic efficiency of the proposed integrated solution to the problem.

Conclusion

1. The economies of many countries have an untapped capacity to reduce electrical intensity. However, the measures taken are not enough and most countries still cannot ensure the reduction of inefficient energy costs, although the significance of energy-saving issues is recognized and there is a desire to solve them.
2. The programs aimed at improvements in energy saving and energy efficiency in housing and communal services are considered to be one of the directions for achieving the energy goals of sustainable development (SDG–2030). Untapped energy saving capacity in this area is around 30%, as specified by the energy efficiency barriers outlined in this article.
3. The active development of digital technologies contributes to the intensive development of the smart home concept. Currently, in the global practice, there is a large variety of intelligent technologies for implementing the smart home concept. When a smart home system is installed and used, savings shall amount to up to 25% due to climate control systems and up to 35% due to lighting automation.
4. A comparative analysis of the experience of implementing the smart home concept showed different purposes for its use. However, due to the obvious upward trend in prices for energy resources, the development of mobile technologies, and the increase in Internet access, the interest of the population of most countries in digital intelligent energy management systems for an apartment (or house) is increasing.
5. The advantages of the KNX system, which is applied in this intelligent room creation project, are justified based on a comparative analysis of the advantages and disadvantages of protocols and standards for the main smart home engineering systems.
6. An analysis of actual electrical and thermal energy consumption was performed and the actual invoices for its payment were processed, with the purpose of assessing the economic efficiency of the proposed solutions to the objectives set. The profitability of capital investments in the energy management digitalization system amounted to 28.7%.

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PREREQUISITES FOR THE DEVELOPMENT AND IMPLEMENTATION OF DIGITAL INNOVATIONS IN TAJIKISTAN

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Abstract *In the modern world, global processes of strengthening the information component in socioeconomic relations are taking place. The relevance of a systematic study of digitalization and the development of digital innovations is a priority at the global and regional levels. The purpose of this study is to analyze the prerequisites for the development and implementation of digital innovations in Tajikistan. To achieve this goal, the following research tasks were identified: to assess the current level of development of the digital economy in Tajikistan; to study the problems of the development of domestic digitalization; to conduct a statistical assessment of the level of digitalization of the economy and innovative development of Tajikistan as a whole; and to study the prerequisites for the development and implementation of digital innovations in Tajikistan. The methodology of the research conducted by the authors is based on general scientific methods of cognition: analysis and synthesis; historical and comparative methods; as well as on mathematical and statistical methods of study. The research conducted by the authors on the state and development of the digital economy made it possible to identify and determine the prerequisites for the development and implementation of digital innovations in Tajikistan. It is very important for countries like Tajikistan to create conditions for increasing the innovativeness of the economy, to form mechanisms and institutions that will make it possible to take advantage of the benefits of digitalization in the best possible way, and to ensure sustainable innovative development. In order to eliminate the technological gap in Tajikistan and accelerate the introduction of digital innovations in the country's economy, it is necessary to create conditions: for the accelerated renewal of production capacities in industry; the effective operation of special institutions that contribute to the creation of knowledge and its dissemination; the introduction of innovations; and the adaptation of digital technologies to particular production needs.*

Keywords: *digital innovations, digital economy, innovative development, digital technologies, innovative susceptibility, information and communication technologies*

Introduction

The expansion of globalization processes, the formation of the information space, and the increased intensity of information flows have contributed to the development of the digital economy in different countries of the world, which is being structured under the influence of accelerating waves of innovation.

The development of digital technologies is one of the most important factors in innovative development, which becomes possible due to the automation of existing processes and the introduction of fundamentally new, breakthrough business models and technologies, such as digital platforms, digital ecosystems, in-depth analytics of large data sets, Industry 4.0 technologies, robotization, and the Internet of Things.

Digital technologies serve as a mechanism for social uplift, contributing to an increase in the availability, quality and convenience of receiving services in such areas as medicine, education, state and municipal services, and culture. Digital transformations make it possible to create comfortable and safe conditions for city life based on smart technologies, and digital platforms

create new employment opportunities for people, help develop additional skills, and improve qualifications, especially for people who previously did not have such opportunities due to social or geographical restrictions. They also contribute to the emergence of new digitalization-related professions and high-paying jobs.

The digital economy and the innovative development of Tajikistan

Tajikistan currently ranks 111th in digital readiness, lagging behind Central Asian countries such as Kazakhstan and Kyrgyzstan and entering the group of low-income countries (Table 1). In terms of the economic and innovative results of the use of information and communication technologies, Tajikistan ranks 123rd, with an index of 30.7 (Figure 1).

Table 1. The Network Readiness Index 2021. Top 3 countries by income group

Source: Dutta & Lanvin (2021, p. 30).

High-income	Upper middle-income	Lower middle-income	Low-income
1. Netherlands (1)	1. China (29)	1. Ukraine (53)	1. Rwanda (101)
2. Sweden (2)	2. Malaysia (38)	2. Vietnam (63)	2. Tajikistan (111)
3. Denmark (3)	3. Russian Federation (43)	3. India (67)	3. Gambia (113)

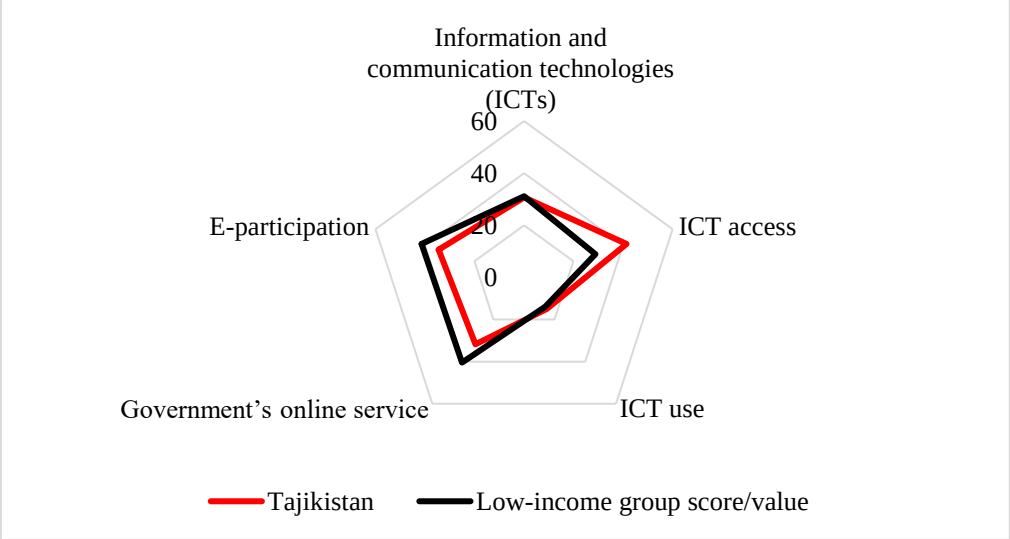


Figure 1. Innovative results of using information and communication technologies in Tajikistan and low-income countries

Source: WIPO (2021)

An analysis of the overall level of digitalization indicates that Tajikistan in 2020 managed to achieve certain successes in the development of the digital economy, namely the expansion of information and communication technology (ICT) infrastructure and the introduction of digital technologies in government structures, but still lags far behind the average values around the world (Figure 2).

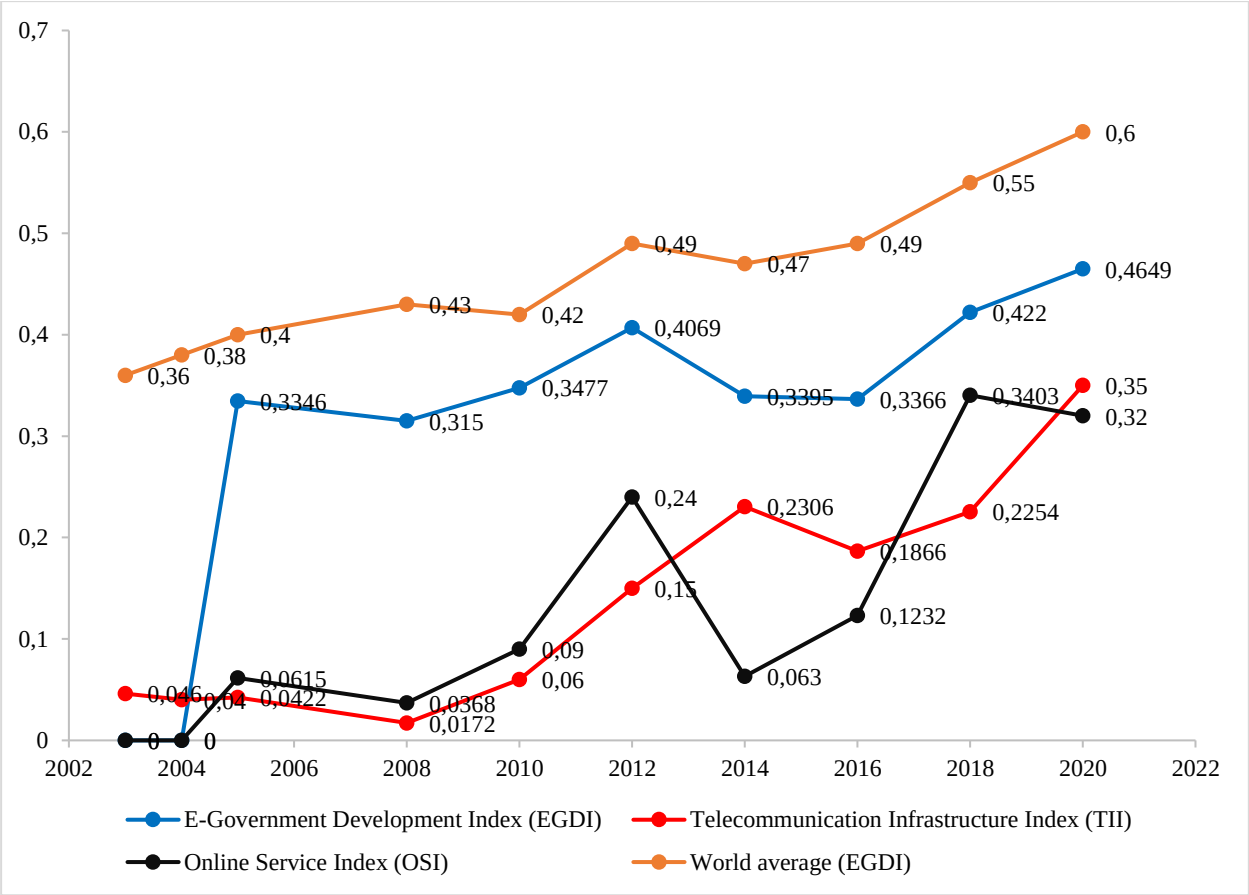


Figure 2. Dynamics of indices characterizing the development of the digital economy of Tajikistan for 2003–2020

Source: https://knoema.ru/

The World Economic Forum estimates that digitalization holds enormous potential for business and society over the next decade, and could bring in an additional $30 trillion of income for the global economy by 2025.

The digital economy is a driver that determines the speed and direction of socioeconomic progress, and a determinant of the growth of the national innovative economy. Penetrating deeper and deeper into the production and non-production spheres of information and communication technologies, the digital economy is becoming the main tool in overcoming the technological backwardness of production processes, increasing the level of reliability of the Tajik financial and economic system, and reducing the raw material orientation of the national economy. The development of the digital economy is one of the main strategic tasks for the development of Tajikistan, and is carried out in accordance with the Concept of the Digital Economy in the Republic of Tajikistan approved by the Decree of the Government of the Republic of Tajikistan No. 642 dated December 30, 2019.

The innovation environment, which stimulates the creation of innovations and ensures the transformation of ideas and developments into marketable products, needs to be transformed in accordance with the needs of the digital economy.

The formation and development of digitalization processes can also be observed by: the degree of dissemination of mobile technologies among the general population (112 mobile subscribers per 100 people); the number of people using the Internet (21.96% of people have access to the Internet); fixed broadband Internet access per 100 people (0.0675655 subscribers per 100 people); the number of servers using encryption technologies when transmitting data over the Internet (663 units or 71 units/1 million inhabitants); and business development in social networks (e-commerce, mobile banking, online education, etc.) (Table 2). Currently, the pace

of market capitalization of companies operating in the field of information technology is higher than that of companies in the commodity sector.

Prerequisites for the development and implementation of digital innovations in the country.

History is full of examples of when new knowledge radically turned the mode of production upside down and made it possible to raise the economy to a fundamentally different level. However, only since the end of the 18th century has the application of scientific knowledge and innovative developments become a systemic and mass phenomenon. The integration of production, science and invention became the basis of the industrial economy that arose as a result of the industrial revolution of the early 19th century. Such integration has made it possible to significantly accelerate the pace of economic growth and raise the level of social welfare. Today we are on the way to the post-industrial stage of evolution, in which information, knowledge and science become the main drivers of innovative development within a high-performance knowledge industry. This will also entail a high share of digital and innovative services in GDP, with competition in all types of economic and other activities, focusing on digital communication technologies.

Table 2. The main indicators of the digital transformation of the countries of Central Asia and Russia for 2019

Source: The World Bank (n.d.)

Indicators	Tajikistan	Uzbekistan	Kyrgyzstan	Kazakhstan	Turkmenistan	Russia
Number of mobile cellular subscribers per 100 people	112	101.2	134.4	138.6	162.9	164.4
Access of the population to the Internet, in % of the population	21.96	52.31	38.0	81.88	21.25	82.64
Fixed broadband Internet access, number of subscribers per 100 people	0.06757	13.94	4.194	13.21	0.087	22.64
Number of secure Internet servers per 1 million people	71.13	452.52	287.91	2,358.98	20.03	9,339.0

It is very important for countries such as Tajikistan to create conditions for increasing the innovativeness of the economy in order to form mechanisms and institutions that will make it possible to take advantage of the benefits of digitalization in the best possible way to ensure sustainable innovative development.

The costs for the introduction and use of ICT in the overall structure of costs for research and development of research institutes and universities of Tajikistan increased from 1.2% to 15% in the 2005–2018 period, but there has been a general decrease since 2011 (from 21.2% to 15%) (Figure 3).

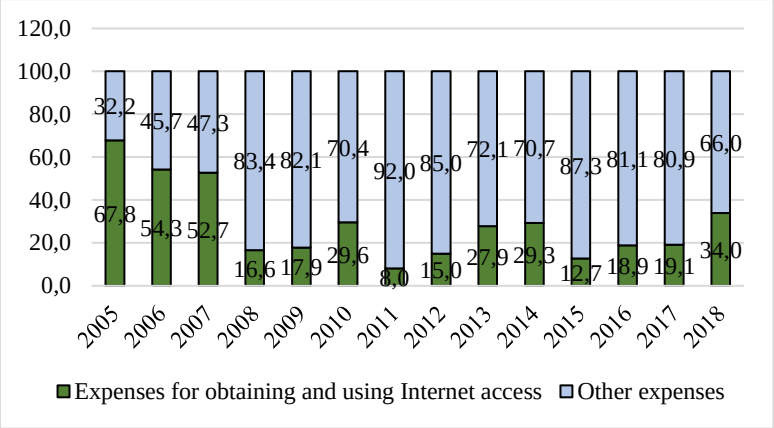


Figure 3. The cost structure for the introduction and use of ICT by research institutes and universities in Tajikistan

Source: Ismoilzoda (2020, pp. 66–70)

Thus, there are four main prerequisites for the development and implementation of digital innovations in the country.

The first is the *availability and accessibility of knowledge and technologies* that can improve production efficiency. Thanks to the rapid development of science and modern information technologies, at present, socially useful knowledge is being produced on a colossal scale that is incomparable with the past. What modern science can do in a year used to take centuries or millennia. Accordingly, there are fundamentally new opportunities for innovative development. From an economic point of view, human activity in the creation of knowledge is of interest. The creation of new knowledge is essentially a process of intellectual labor, which is the basis of innovative growth and development. Depending on the degree of favorable conditions, labor can contribute both to self-enrichment and the accumulation of a person's creative potential, and to its degradation. The main condition for the self-growth of human potential is labor free from coercion. It is clear that work under external or internal coercion, which does not bring pleasure and satisfaction, does not serve the development of personal potential, but, on the contrary, may limit its capabilities. In this case, potential is not accumulated, but only consumed (Marx & Engels, 1956, p. 563). In the process of free labor, when a person acts not as a "definitely trained force of nature," but as a "manager of his own productive forces" (Marx & Engels, 1969, p. 110), there is self-growth and development of their potential.

The first prerequisite is a necessary but not sufficient condition for the transformation of knowledge into a decisive force in the development of digital innovations. There are three more closely related prerequisites, the presence of which explains why not all countries are able to take advantage of the opportunities of the information revolution.

The second prerequisite is *innovation receptivity*. In order for knowledge and digital technologies to be introduced into the economy, it is necessary that the subjects of economic relations are able to find the necessary information, understand and perceive new knowledge, adapt it to their needs and put it into practice.

The low level of innovative susceptibility of society to the achievements of the digital economy and digital technologies inherent in Tajikistan contributes to the further deepening and growth of the technological gap between Tajikistan and other countries of the world. The World Economic Forum's (2021) Global Risks Report lists the concentration of critical digital assets and the digital divide among the most likely risks over the next ten years. Digital transformation, on the contrary, is experienced by countries that have a high innovative potential, but do not have effective innovation systems, yet are capable of searching for disruptive innovations and their implementation, completely changing the companies' infrastructure, introducing digital business thinking, etc. (Dzhurabaev & Mukimova, 2021, pp. 29–33). In this regard, it should be noted that building a methodology for researching the digital

economy should involve two components: industrial policy (since most of the innovations within the current technological order are generated in the field of material production) and the external economic component (due to the fact that external sources of competitiveness can be additionally used by countries due to the lack of internal competitive advantages in the development of the research system) (Smirnov, 2013a, p. 211; 2013b, pp. 97–102).

In order to eliminate the technological gap in Tajikistan and accelerate the introduction of digital innovations in the country's economy, it is necessary to create conditions for: the accelerated renewal of production capacities in industry; the effective operation of special institutions that contribute to the creation of knowledge and its dissemination; the introduction of innovations; and the adaptation of digital technologies to the needs of a particular type of production.

The third prerequisite is *the ability to generate innovation*. The innovation process is not limited to the simple application of existing knowledge. The innovative development model assumes that all production activities are saturated with innovation – that all employees of the enterprise have incentives and skills to generate and implement many micro-innovations. The fact is that innovation covers all aspects of modern production without exception. Accordingly, innovative susceptibility should be complemented by constant innovation and the daily improvement of production and organizational digital technologies. Here, a lot depends on the level of education and the peculiarities of thinking of entrepreneurs, managers and employees of enterprises, their inclination to invent and develop new micro-innovations, and their ability to think creatively.

All global experience shows that, at present, the information and communication technologies sector – which includes the production of computer and telecommunication technologies, the development of software and the provision of a wide range of interactive services based on them – is becoming increasingly important in the global economy.

It should not be forgotten that the development of ICT directly affects the level of a country's competitiveness, allows collecting and summarizing huge amounts of information, and opens up wide opportunities for management at the strategic level.

Digital transformation brings a significant increase in productivity, cost reduction, and an increase in sales and market share through the implementation of digital technologies. Despite this, the digitalization of the economy does not affect new technologies to a greater extent, but the transformation of thinking and organizational culture.

The fourth prerequisite is *innovative demand*. Susceptibility to innovations and the propensity to generate them do not make sense without the demand for innovations – that is, the solvent need on the part of economic entities to apply certain useful knowledge and technologies.

The economic essence of the demand for scientific knowledge is explained by the operation of the law of supply and demand, where the determining role belongs to demand. In the words of V. L. Makarov: "demand and only demand decides whether knowledge lives or not lives on. It may be sad, but there is not the slightest doubt that a huge number of ideas, discoveries, inventions and other knowledge produced by people disappeared, so to speak, without really being born. The same can be said about the potential geniuses of mankind" (Milner, 2009, p. 15). Moreover, in each given period of time, the demand in the knowledge market will express only the relative consumer ability of society to use a scientific product. The absolute consumer ability of society in relation to the results of science in its essence has no boundaries – it is unlimited (Aleinik, 1991, p. 15). The historical and modern experience of the development of mankind indicates that the need for scientific discoveries and their usefulness for society is constantly increasing.

In crisis periods of economic development, the supply of intellectual products, as a rule, significantly exceeds demand. However, not only can the lack of financial resources of consumers be the reason for the insufficient demand for intellectual products, but the specific features of the knowledge market can also create certain difficulties in terms of their

consumption and commercialization. First, the manufacturer of an intellectual product cannot estimate in advance the market demand for new knowledge embodied in the product. Secondly, a potential buyer, before presenting a demand for a particular intellectual product, must initially have the necessary level of contextual knowledge about it. Thirdly, in the knowledge market, there is a high probability of unfair and illegal appropriation by some subjects of the transaction of benefits received as a result of the efforts of others, which may generally make the activity of creating new knowledge commercially unviable. Therefore, to ensure the market circulation of knowledge, the regulatory role of the state and the development of the institution of intellectual property are very significant. The demand for innovation acts as a factor stimulating scientific activity; on the other hand, the results of scientific work become determinants of aggregate demand, due to the continuous process of improving the economic and organizational conditions of production in an innovative economy (Tumanyan, 2008).

The relationship between inventive, innovative and economic cycles is disclosed in the works of N. D. Kondratiev, J. Schumpeter, G. Mensch, A. Klaiknecht, and Yu. V. Yakovets. Thus, Kondratiev (2002) noted that "the direction and intensity of scientific and technical discoveries and inventions are a function of the demands of practical reality and previous periods in the development of science and technology. However, it is not enough for scientific and technical inventions to take place. Scientific and technical inventions may be, but may remain ineffective until the necessary economic conditions for their application appear" (p. 382). Such conditions are economic and technological crises at the end of the medium-term, long-term (Kondratiev's one) and civilizational cycles. Before the beginning of the upward wave of each large cycle, there are profound changes in the technology of production and exchange, which in turn are preceded by significant technical inventions and discoveries.

Practice shows that market competition creates incentives to generate and implement innovations, which forces the manufacturer to fight to reduce costs and improve product quality. Accordingly, those entrepreneurs who are able to respond flexibly to market impulses and actively implement new digital technologies and organization methods survive in the market. Another important condition for innovative demand favorable for investment and innovation is the business climate. The lower the costs of market access and government interactions for entrepreneurs, the more opportunities they have to introduce new technologies and improve efficiency.

Conclusion

Ensuring a high level of innovation in the economy does not guarantee a technological breakthrough in the shortest possible time. Knowledge is accumulated gradually; innovative potential must be built up to a certain critical level in order for the spread of digital technologies to take on an explosive character. Given the low quality of human capital, it is impossible to meet the demand for qualified specialists and improve the efficiency of state regulation, the level of industrialization and the export orientation of small businesses.

Based on the experience of other countries, Tajikistan has the opportunity to purposefully create institutions and mechanisms that make it possible to use the potential of the information revolution for its development.

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THE DIGITAL TRANSFORMATION OF BUSINESS UNDERTAKINGS

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Abstract. *The objective of this work is the investigation of the peculiarities of the digital transformation of business undertakings under the conditions of contemporary economic development. In the process of research, the differences between the notions of digitalization, numeralization and digital transformation were determined. Both positive and negative aspects of digital transformation were depicted. Contemporary business models which emerged during the process of digital transformation were characterized. The principal competences and basic directions of personnel training were prescribed. It was recommended to carry out digital transformation according to the following steps: preparation; planning; bringing personnel into transformation; digitalizing data and documents; and checking and implementing the new operational model and renewing the company's business model.*

Keywords: *business undertakings, digital economy, digital transformation, business models, personnel competences*

Introduction

At present, every subject of economic activity strives for the improvement of its competitive strength, because contemporary market tendencies require essential qualitative and quantitative transformations for the participants of any market. Therefore, with due regard to global and domestic tendencies existing in the social and economic sphere the sector, engagement in business undertakings has taken steps towards certain transformations. First, such transformations lie in the digitalization of business undertakings. Prerequisite to this is the active implementation of digital technologies into all business processes of an enterprise's functioning. A question that may then arise is to what degree native proprietors are ready for digital transformation.

The objective of this work is to investigate the current state of the process of digital transformation in business undertakings under the conditions of contemporary economic development. The following methods of investigation were used in the process of writing this work: analysis and synthesis, generalization, induction and deduction, comparison, and the systematic approach.

Many international and domestic scholars – D. Schallmo, A. Christopher, L. Boardman, H. M. Dergacheva, Y. O. Koleshnya, N. M. Kraus, K. M. Kraus, N. O. Androusyak, O. V. Shtepa, O.

M. Shulga, and others – deal with investigating aspects of the digital transformation of business undertakings.

The main body of the paper

The implementation of any digital technology cannot fail to be connected with digital transformation. Thus, processes such as digitalization and numeralization act as prerequisites for digital transformation. The characteristics of these notions are summarized in Table 1, providing an opportunity to reveal their essence.

Table 1. Systematization of the notions of digitalization, numeralization and digital transformation
Source: Dergacheva & Koleshnya (2020, pp. 282–283)

The notion	Author	Definition
Digitalization	Gartner, Inc	The process of transition from analogous to digital form.
	V. V. Ermolemnko.	The transformation of the data, information and expertise that is stored in documents into digital form, so that operation with the content using digital appliances should be possible.
	R. C. Härting, C. Reichstein, P. Jozinovic	The transformation of signals and media objects (for instance, documents, images or sounds) into digital form, which is processed, stored and transmitted via digital appliances and networks, caused by the application of digital technologies and the application of systems built on them.
Numeralization	The concept of development of digital economy and the society of Ukraine for the years of 2018–2020	The saturation of the physical world with electronically digitalized appliances, units and systems, and establishing communicational exchange between them that actually increases the integral communication between the virtual and the physical, thus creating cyber-physical space.
	M. V. Roudenko	The process of evolution of economic, social, industrial, technical, technological, organizational, managerial and other relations within the society, and the alternation of their subjective-objective orientation caused by the development of intercommunication (digital) technologies.
	O. I. Pizhuk	A change in the paradigm of how we think how we act and communicate with the environment and with each other. Technology, here, is but a tool, not an objective.
	A. A. Hrytsenko	The application of technologies that are based upon a discrete code system of data processing and transmitting in the process of manufacturing, distribution, circulation and consumption of the benefits.
	J. Scott Brennen, D. Kreiss	A method in which many domains of social life are rebuilt around the infrastructure of digital communications and media.
	Gartner, Inc.	The application of digital technologies for the substitution of a business model and giving new opportunities for obtaining income and value.
Digital transformation	J. Bloomberg	This wide term deals with strategic transformation of business, managed by consumers that require organizational changes and the implementation of digital technologies.
	R. M. Lisova	Deep and disruptive changes caused by the application of break-through technologies which, in their turn, change the methods of crating and receiving value.
	P. Vile, S. Warner	The essence of digital transformation is not in technologies, but in changes. The main task is to differentiate, proposing something new and more attractive for clients, having formulated the target which the clients will want to reach.

Thus, having analyzed the notions presented in Table 1 we may assert that numeralization is a way of optimizing work, while digitalization is a tool for the automation of processes. In many literary sources, digitalization and digital transformation are often equated. However, according to our point of view, digitalization acts as the first stage of digital transformation. So, digitalization presumes the automation of business processes, while digital transformation leads to changes in the types of activity, changes in the organizational structure, and application of some new business models.

Thus, the content of digital transformation may be represented by the following stages:

1. Numeralization: all data are in a digital format (digital data).
2. Implementation of digital technologies: the formation of a pool of digital technologies (digital infrastructure).
3. Digitalization: setting up and restructuring communication channels of digital technologies (digital models).
4. Digital transformation: restructuring the business concept and format (digital economy).

According to the abovementioned, it may be asserted that the digital transformation of business undertakings is a continuous process based upon the implementation of recent technologies and innovations, resulting in the formation of new business models, oriented towards clients' needs. Digital transformation possesses both advantages and faults:

1. Advantages of the digital transformation of business undertakings:
- due to automation of the processes at the enterprise, efficiency is increased and time required for repeated tasks is reduced;
- it allows businesses to maximally raise the efficiency of communications with workers, clients, or partners;
- new possibilities are opened for clients' servicing;
- the level of competitive ability of the enterprise can be greatly improved.

2. Disadvantages of digital transformation of business undertakings:
- it is necessary to study clients thoroughly and create a personalized approach to each client;
- it is also necessary to change the culture within the enterprise, showing workers the necessity of implementing new technologies and digital business models.

The fields of digital transformation include (I-Scoop, n.d.): functions such as marketing, operations, human resources, administration, services paid to consumers etc.; business processes including one or several connected operations, types and sets of activities for achieving a particular business goal; and business models such as the model of business functioning, from the approach to the market and proposed value to the ways of earning money, and the transformation of a business' principal activity by applying new approaches and sources of income, sometimes even giving up their main traditional business. Many companies now act against the rules, changing the principles of business functioning completely. For example, taxi companies that now operate as platforms (e.g., Uklon, Uber) do not have their own fleet of taxis and eliminate the work of dispatchers – i.e., everything typical of the traditional notion of a taxi service is removed. Business ecosystems, networks of partners and interested parties, as well as contextual factors which have an influence on business, like regulation or economic priorities and evolution, affect business assets. The main attention here is paid both to traditional assets and less material assets, such as information and clients. In terms of organizational culture, there must exist a well-understood specified goal, oriented towards a consumer, which can be reached by mastering basic competences in all spheres, including digital maturity, leadership, knowledge bases for workers, etc. Partnerships or ecosystems involve the growth of cooperative, joint, creative and entirely new business-ecosystem approaches. This environment includes clients, workers, and partners, but is rooted in the orientation towards the consumer,

the experience of users, the better capabilities of workers, new models of workplaces, changes in the dynamics of channel partners, etc.

Now, the technologies of Industry 4.0 are frequently discussed, and have an active influence on the digital transformation of business undertakings.

Among these technologies, we may outline: augmented reality and virtual reality (Nazarova, 2020); digital twins (IT-Enterprise, n.d.); big data (Habr, 2020); blockchain (FutureNow, 2020) and other technologies of Industry 4.0 (Habr, 2020).

These technologies are discussed below.

Internet of Things. This technology presumes the application of the Internet for the exchange of information not only between humans, but also between different things – i.e., between machines, various appliances, sensors and the like.

Big data. Large volumes of information accumulated because of the numeralization of the physical world can only be efficiently processed by computers (by quantum computers in the future) with the application of cloud computations and artificial intelligence technology.

Cyber-physical systems. These are hybrids between technologies and physical processes – for instance, intelligent manufacturing. The main idea of cyber-physical systems is maximal automation and the partial or complete separation of humans from manufacturing or business processes.

Digital twin. This is a software analogue of a physical appliance, simulating the inner processes, technical characteristics and behavior of a real object under the conditions of the influence of obstacles and the environment.

Augmented reality (hereinafter AR). These are technologies that add to the actual world, supplementing it with sensor data. Despite the title, these technologies are capable of both bringing some artificial data into the real world and eliminating objects from it. The capabilities of AR are limited only by the capabilities of hardware and software. AR adds elements of the digital world into reality. It is capable of blocking the real world, plunging the user into the digital universe.

Blockchain. This is a decentralized, divided book, in which the origin of digital assets is registered. It saves a history of any digital asset that is unchanged and transparent, due to the application of decentralization and cryptographic hashing.

In the process of outlining the influence of the digital economy on the development of business undertakings, it is necessary to determine the main changes which have happened in business circles under the influence of numeralization (Shulga, 2021, pp. 17–18). These changes manifest in the strategy of relationships with clients. The application of digital technologies, including artificial intelligence, gives birth to such tendencies as the deepening of relationships with buyers, communication with buyers within the digital medium, and reactions to changes in queries. The changes brought about by the digital economy also include:

1. New conditions in work with clients. The results of breakthroughs in science and the economy provide the intense application of artificial intelligence, from software for discovering new preparations to algorithms which determine cultural interests and presume behavior.
2. Changes in competition. The transition to the digital economy changes under the conditions of competition. For example, competitors may become partners by uniting by means of digital platforms and mutual application. This may involve the sudden appearance of competitive advantages which a newcomer may discover, for example, through a startup or via access to global digital platforms for investigation, marketing, quick sales and distribution. Such companies may often be ahead of old, renowned companies in speed, value, and quality of delivery of goods or service rendering.
3. New sources of profit and factors of competitive strength. In the digital economy, products that improve data exchange may become new sources of profit. Enterprises may exert

significant influence upon the quality, value and maintenance of products by using digital improvements.

4. New types of business. Joint innovations can be a new type of business communication in the digital economy. Their origin is connected with the rapid appearance of innovations and their destructive influence. Let us imagine that one company is short of capital, knowledge regarding the details of the business, and clients. An experienced company may possess all of those, but may lack the digital skills to operate with clients and react to changes in their requests. Eventually, these enterprises may combine their resources, jointly realizing innovative projects. The integration of possibilities promotes the creation of new values.

5. Changes of business medium in the digital community. A new organizational structure of business undertakings is developed in the digital economy – a blockchain system. Its strength is decentralization, due to which payments move immediately and transparently in the global space. This is why there is no need to set up many offices and create roles with subsequent administrative expenses.

Thus, the changes that occur in the digital economy lead to the appearance of new business models, characterizing the contemporary organization of business undertakings. Among such business models, the following may be mentioned: B2B (business-to-business), B2C (business-to-consumer), C2B (consumer-to-business), C2C (consumer-to-consumer), M-commerce (mobile commerce) and F-commerce (Facebook commerce) (Figure 1).

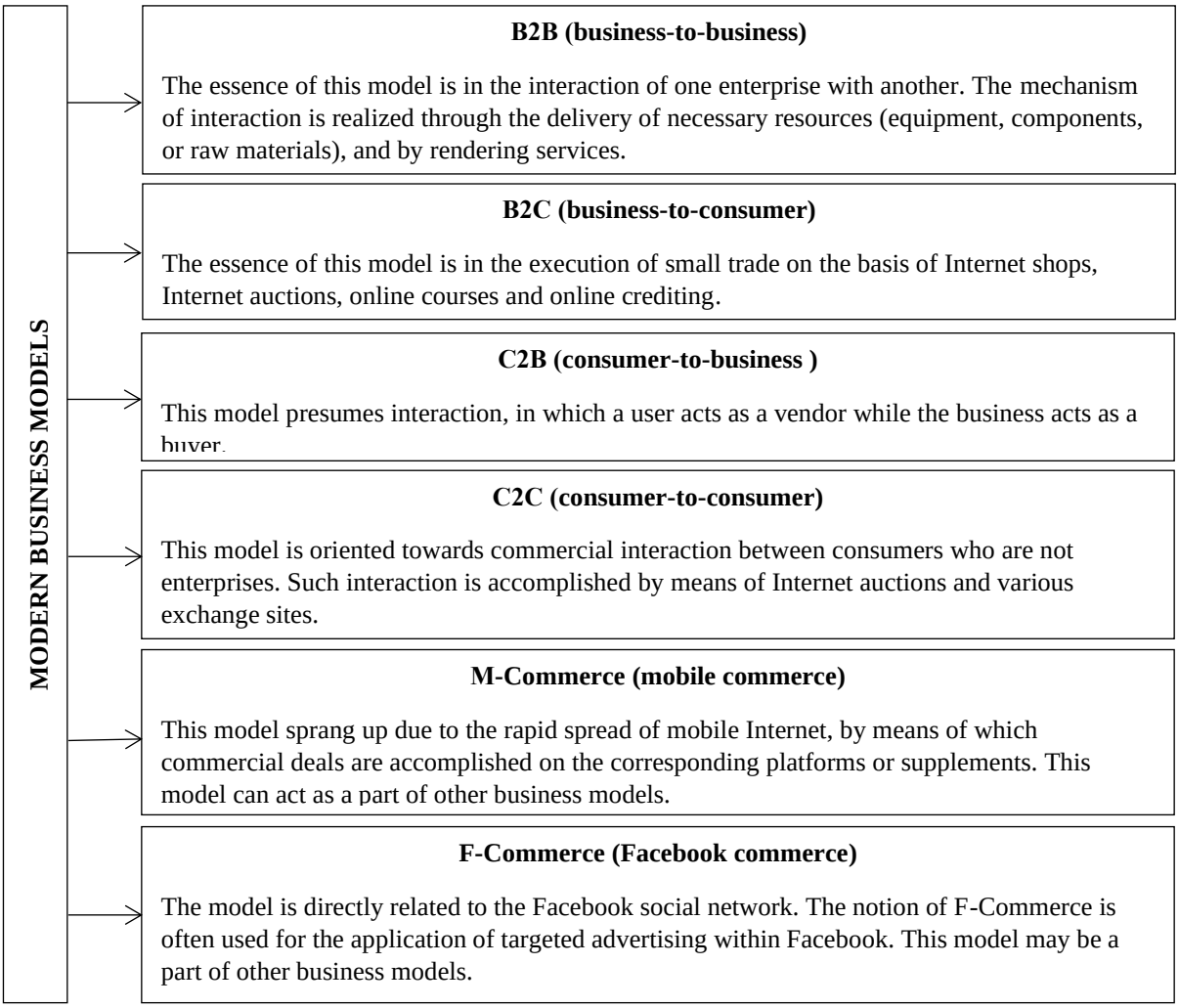


Figure 1. Business models in the digital economy
Source: compiled by the authors on the basis of Shulga (2021)

In Ukraine, the subjects of digital business undertakings use different business models, the most widely used of which are summarized in Table 2.

Table 2. Widespread business models of digital business undertakings in Ukraine
Source: Shulga (2021)

Type of business model	Essence	Model of income	Companies
B2C; B2B	Sale of manufactured goods through own site.	Manufacturer	www.magazinperchatok.com.ua
B2C; B2B; C2C	Website on which private persons or companies publish their advertisements for goods or services.	Mediator or advertisement	OLX (hybrid); Bezplatka; Kidstaff; Klubok; Klumba Ria.com; Shafa.ua
B2C; B2B	Sales through the Internet of goods purchased from different manufacturers under their own name, at their own price and mostly from their own stock.	Trade, advertising	Allo; Foxtrot; Comfy; Metro Ukraine (www.metro.ua); Rozetka.ua (Hybrid): Modnakasta; Leboutique; Eldorado; LaModa
B2C; B2B	Internet platform for contracting and realizing transactions between sellers and buyers with the establishment of the rules of realization of transactions and the application of separate elements of transaction.	Mediator (commission paid for transactions) payment for application of the platform	Prom.ua; Bigl.ua; Goodini.ua Rozetka.ua (hybrid); privatmarket.ua; Kabanchik.ua (hybrid); Skidka.ua; SvitStyle, Shafa.ua (hybrid); Prosto.ua ; Crafta.ua (handmade in Ukraine)
B2C; B2B; C2C	Platform for contacting sellers and buyers of mostly temporary services, with or without the passing of some property for some time.	Payment for usage of the platform, subscriptions, mediator	Uber.ua; Uklon; Dobovo.com; Kabanchik.ua; Doba.ua

Many scholars investigate the problems of digital transformation in the context of business models. Thus, in 2017, Schallmo et al. (2018) proposed the following sequence of stages (phases) of the digital transformation of business processes:

1. Digital Reality: the existing model of the business is defined together with the analysis of added value and the interests of the parties concerned, and the clients' necessities are expressed. This ensures an understanding of the digital reality for this company in different spheres.
2. Digital Ambition: based on digital reality, the main objectives of digital transformation within the context of time, finance, space and quality are defined. Digital ambition specifies what particular goals should be taken into account for a particular business model and its elements and the how priorities of goals and dimensions of the business model should be arranged.
3. Digital Potential: the best practices and development activators are established for digital transformation. This serves as a starting point for the design of the future business model. All elements of the business model must be logically connected with each other.
4. Digital Fit: an analysis of the variants of design of a digital business model. These variants are evaluated and compared with the existing business model, and possible combinations of the elements of design are considered.
5. Digital Implementation (numerical realization): the implementation of the developed digital business model takes place. As the development of digital experience with clients and the digital

network of value creation continues, so integration with partners goes on. At this stage, resources and opportunities are also defined.

Despite the implementation of digital technologies into the business processes of many enterprises in Ukraine, the rates of such transformation are far from satisfactory. Nevertheless, in the leading countries of the world the digitalization of business undertakings suffers from low rates. An investigation by Riverbed Technology revealed that in the USA, Brazil, Germany, France, China, Singapore, India, the UK and Australia the bulk of enterprises failed to implement digital technologies into their own business processes. The main obstacles here are financial inability, the obsolete structure of the numerical network, and poor staff qualification. Now, the professional and personal skills of personnel also require transformations that must be oriented towards developments of the digital economy. Thus, new digital competences must be formed.

The list of key digital competences is outlined below.

1. Information literacy and literacy when operating with data;
1.1. The ability to seek and filter data, information and digital content;
1.2. The ability to evaluate data, information and digital content;
1.3. The ability to use and operate data, information and digital content.
2. Communication and interaction:
2.1. The ability to communicate with the application of digital technologies;
2.2. The ability to share information due to the application of digital technologies;
2.3. The ability to get in touch with society, the ability to use state and private services due to application of digital services;
2.4. The ability to interact due to the application of digital services;
2.5. Knowledge of etiquette, i.e., mastering the rules of behavior and etiquette in digital media;
2.6. Control over digital identity, i.e., the ability to create and control accounts.
3. Digital content:
3.1. The ability to create digital content;
3.2. The ability to alter, improve and use digital content with the aim of creating new content;
3.3. Knowledge of the copyright rules and license policy concerning data, information and digital content;
3.4. Programming, i.e., the ability to write a program code.
4. Safety:
4.1. The ability to protect hardware and content, knowledge of safety measures, and understanding of risks and menaces;
4.2. The ability to protect personal data and privacy;
4.3. Health protection, i.e., knowledge and skills for the preservation of one's own and others' health from the point of view of both the ecology of the application of digital technologies and the risks and menaces to public safety;
4.4. The protection of the environment, i.e., understanding the influence of digital technologies upon ecology and the environment from the point of view of their utilization and application, because they may cause harm to objects of critical infrastructure, etc.
5. Problem-solving:
5.1. The ability to solve technical problems which may arise for computer equipment, hardware, software, networks, etc.;
5.2. The ability to define the needs and find appropriate technical solutions or customize digital technologies to one's own necessities;
5.3. Creative usage, or the ability to create, due to digital technologies, knowledge, processes and products, individually or in groups, with the objective of solving everyday life or professional problems;

5.4. The ability to personally define the need for obtaining new additional digital skills (MAUBZP, 2018).

Therefore, due to the appearance of the necessity of the formation of digital competences for personnel, there arises the need for the transformation of the process of teaching at educational institutions so that they are able to train specialists who possess these competences.

Thus, in order to have highly qualified specialists in digital business undertakings in the labor market, who will have digital intelligence and the aforementioned digital competences and skills, educational institutions should now implement innovative techniques, up-to-date technologies, and methods of teaching digital business undertakings under the conditions of artificial reality. The most vital of these are outlined in Table 3.

Table 3. Innovative techniques, technologies, and types of digital business learning under the conditions of artificial reality

Source: Kraus, Kraus & Andrusyak (2021)

Technologies, techniques and types	General descriptions
Researchers teaching digital business undertakings	This involves the organization of classes of digital business that presume the creation of problematic business situations under the teacher's supervision and that, with the active independent work of learners, concern their solution. This results in the creative and innovative mastering of professional economic knowledge of business undertakings, as well as digital skills, abilities and competences.
Cognitive research or exploring the research-based teaching of digital business undertakings.	This is a type of activity which represents the most efficient area of the transition from tuition to research because it contains nearly all of the components of the scientific and creative search and leads to the creation of new products in digital business undertakings. The main forms of search and investigation for learners of digital business undertakings are participation in the functioning of innovative research laboratories, societies, enterprises, clubs of digital businesspersons, innovative factories, business incubators, and individual and group work at scientific research start up projects in digital business undertakings. It may also involve research and practical conferences, seminars, hackathons, startups, rallies, gatherings, contests, exhibitions of research and scientific works, excursions, and participation in virtual and real contests – both during study and practical hours and on holidays. During systematic research work, learners of digital business undertakings can gain some research skills including: intellectual synthesis, analysis, comparison, generalization, systematization, abstraction, establishing cause-and effect links in successful business affairs, the ability to set up a problem in the course of digital business undertakings, the formulation of a hypothesis, the search and application of analogy, deductive conclusion, and creating proofs of promising investment projects. Practical skills may include: the usage of textbooks, reference books and additional literature on the realization digital business undertakings, both successful and unsuccessful; the selection of material for experiments; the registration of the results of investigation; self-organization and self-control in the planning of research work; the rational usage of time; means and instruments of digital business undertakings under the conditions of artificial reality; the checking of obtained results; and self-estimation.
Mixed teaching of digital business undertakings	This is a hybrid method where the online, independent and traditional teaching of digital business undertakings is united. It is expected that not only are both modern interactive digital educational technologies used together with traditional methods, but this will also create a qualitatively new approach to teaching which will transform the classroom. The six key components of the implementation of the mixed teaching of digital business undertakings are: - leadership in the knowledge of digital business undertakings, as a necessary condition for the implementation of mixed teaching; - the professional economic development of digital business undertakings is a key component for ensuring the realization of tasks envisaged in a road map of

	the implementation of programs and courses of digital business undertakings. A coordinated, detailed and systematic plan of professional economic development, on the basis of the tasks set, must be provided to all participants of the process of the implementation of teaching digital business undertakings; - the realization of teaching activity. Mixed teaching requires the application of digital interactive systems, which are means of carrying the economic tuition content of digital business undertakings, while digital interactive systems include the system of control over teaching (LMS), the system of control over content (CMS), the means of informing seekers of economic education (CMS), and the means of informing learners of economic education in the field of digital business undertakings; - reorganizing the teaching process in the direction of complete numeralization and obtaining the digital competences of business undertakings under the conditions of artificial reality; - electronic educational resources for teaching. Digital business undertakings require a solution as to whether to purchase and/or develop one's own digital content. This is very important for the implementation of online and mixed teaching technologies; - the technological infrastructure of providing teaching of digital business undertakings (a reliable telecommunication network and the requisite software and hardware for teaching under the conditions of artificial reality).
The traditional teaching of digital business undertakings, or the explanatory illustrative method	This is learning in which a teacher of digital business undertakings supplies learners with economic knowledge and explains the essence of various phenomena, business processes, economic laws, and formal and informal rules of digital business undertakings with the application of illustrative material. Learners have to master the proposed volume of knowledge in the domain of digital business undertakings and reproduce this knowledge at the level of deep understanding in practice.
Reversed teaching of digital business undertakings	This is a type of active teaching of digital business undertakings which allows the usual process of teaching to be reversed, so that learners of digital business undertakings should have video fragments to view showing successful and unsuccessful businesses as their home assignments. This way, learners study the theoretical material of the next class independently, while in the lecture room time is devoted to carrying out practical business cases. The value of the reversed method of teaching business undertakings is in the possibility to use teaching time for group classes, where students can discuss the content of the business case, test their knowledge, and interact with each other during actual business activities. During classes, the teacher's role is to be a coach or an advisor, inclining the learners towards independent research and joint work.
Problem-based learning, or the problem-oriented teaching of digital business undertakings.	This is teaching that is focused on the problem and the process of solving it, during which real, complicated problems of accomplishing digital business undertakings are used as educational instruments. Education which is based on solving business tasks stimulates the application of the skills of critical thinking and problem-solving within a limited time. This provides real experience, promoting the active process of learning and helping to systematize knowledge and naturally integrate teaching digital business undertakings into real life. Such learning is oriented towards enhancing the abilities of students to gain knowledge regarding the subject through the experience of solving the open problem of accomplishing digital business undertakings found in the prompt material. The process of PBL is not focused on solving these problems with a given solution, but on developing other desired skills.
The application of ecological systems of innovative educational hubs in the process of teaching digital business undertakings	Such structures represent the totality of organizational, structural and functional components (institutions) with their own relations that enable the process of the formation and application of scientific knowledge and the technologies of digital business undertakings. They determine the economic, legal, organizational and social conditions of the innovative process and ensure the development of enterprise's innovative digital activities. The key task of the ecosystem of an innovative educational hub for teaching digital business undertakings is in creating a creative, innovative medium for

	the development of science-intensive business by commercializing the results of scientific research and developments for the numeralization of business undertakings.
The application of story-telling as an efficient tool for creating digital stories for training sessions during the creation and realization of digital business undertakings	This is one of the most interesting and productive contemporary methods of teaching digital business undertakings. It involves the art of telling stories of initiating and developing digital business undertakings with the objective of being able to teach on the basis of such knowledge, as well as to guide by providing content with the application of special methods. Among the most popular methods are word clouds, video clips, texts, comics, films, animated cartoons, and photographs. This methods presumes the application of elements of drama, exaggeration and improvisation.
Project-based learning of digitalized business undertakings	The principal objective here is to achieve a final digital product for the facilitation of business undertakings under the conditions of artificial reality. By studying in accordance with project-based learning, the recipients of knowledge in digital undertakings provide research and react to actual, complicated and interesting problems to achieve the required knowledge and skills in undertaking digital business.

Thus, the key changes to be implemented during the course of digital business undertakings may include:
– higher education institutions, albeit not exclusively, should not be restricted to the provision of tuition courses. Instead, they must become fields for creating innovations and digital products/services. This can be achieved by combining science and practice;
– resources for the realization of joint projects should be amalgamated, and the creation of educational and research online platforms devoted to courses in digital business undertakings should be created;
– new opportunities should be provided for rebuilding the personalized educational trajectories of the development of digital business undertakings;
– the outlined system of thematic modules for teaching courses of digital business undertakings should be developed;
– equally with traditional education, society must ensure the wide application of non-traditional education, as it may help to promote the qualitative growth of competences in some parts of the functioning of digital business undertakings (Kraus, Kraus, & Shtepa, 2021).

Conclusions

Ongoing changes both in Ukraine and around the world have already led to the active restructuring of the traditional economy into the digital economy, resulting in the active process of the digital transformation of business undertakings. Under the influence of the implementation of this process, new business models have emerged, requiring transformations in all directions of the functioning of enterprises. Taking into account the fact that many enterprises have not yet started on the path towards steady digital transformation, we propose the following steps.
- Preparation. It is necessary to perform an analysis of the necessity of and readiness for digital transformations at the enterprise.
- Planning. It is necessary to outline the business processes which have to undergo digital transformation.
- Bringing personnel into the process of transformation.
- Digitalizing data and documents.
- Checking and implementing the new operation model.
- Forming or upgrading the business model of the enterprise.

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AN ASSESSMENT OF THE NETWORK CONSISTENCY OF THE ENTREPRENEURIAL STRUCTURE IN THE CONDITIONS OF THE DIGITALIZATION OF THE ECONOMY

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Abstract. *This article is dedicated to the study of network viability, the abilities of the entrepreneurial structure, and an analysis of interfirm interactions in the context of the digitalization of the economy. The key goal is to develop a network solvency model as a methodological basis for the most complete assessment of the capabilities of the entrepreneurial structure for effective interaction in an entrepreneurial network in the context of the digitalization of the economy. The theoretical basis of the model was the work of representatives of institutional economic theory, the resource approach, economic sociology, etc.*

The object of the study was the set of intercompany relations in the business network in the context of the digitalization of economic activity.

The subject of the study is the economic relations between business structures regarding the formation and development of inter-firm relations in a network association.

The logical and system methods of analysis were used alongside the methods of statistical analysis and expert assessments.

The specifics of the problem of determining the factors that affect the ability of economic entities to build effective long-term intercompany interactions in the context of the development of the digital economy determined the structure of the study.

It was necessary to analyze approaches to assessing intercompany interactions in a business network in order to identify a number of features and systematize the factors that affect the effectiveness of such interactions. The research algorithm included the following stages: the study of scientific research reflected in the periodical press on the trends in the development of the digital economy; the identification of factors affecting inter-company interactions in the business network in the digital economy; the formation of the authors' vision of the network viability of economic entities in the digital economy; and the identification and evaluation of the parameters of the network viability of economic entities in the digital economy.

The developed model of network consistency is based on the analysis of the space of factors from the standpoint of the relationships between three structural elements that have an indicative, connecting and affirming effect on the development of inter-company interactions in the context of digitalization of economic activity. The pointing element is formed by the resource characteristics of the participants in intercompany interactions, the connecting element is aimed at the competent management of emerging relationships, and the resulting element reflects the synergistic effects that appear as a result of strengthening the interactions of economic entities in the business network.

Keywords: *entrepreneurial networks, entrepreneurial structures, economic entities, intercompany relations, network solvency, digital economy.*

Introduction

A variety of organizational and legal forms of business in the modern economy contribute to the formation of a huge number of industrial, commercial, information and entrepreneurial structures. In the process of the production and economic activity of entrepreneurial structures, groups of partner enterprises are formed – entrepreneurial networks, the participants of which have a certain dependence and interconnection. The network interaction of business entities is based on: the need to reduce costs and increase competitiveness; reducing risks and threats to the external environment; obtaining the possibility of mutually beneficial use of joint resources, technology, and information; and the opportunity to create organizational and financial stability for further business development.

The developing digital economy is characterized by: the expansion and strengthening of the relationship between the state, science, education and business, implying the presence of purposefulness and systematicity in activities; planning; information transparency; contact of subjects; mobility; trust; and social activity. This implies that economic entities have: common goals; clear structures; and a high level of organization, motivation, humanization, effectiveness and coordination of actions, which is the basis for the development of entrepreneurial networks. Thus, the active processes of the digital transformation of all basic sectors of the economy contribute to the development of business networks and dictate new trends in the process of interaction between business structures. Despite the great interest of modern researchers in the topic of network business structures, the issues of managing network structures in the context of digital transformations, determining the network potential of an entrepreneurial structure, and relationship management in business networks remain understudied. The purpose of this work is the study of the networking ability of entrepreneurial structures, as well as the analysis of inter-firm interactions in the entrepreneurial network in the context of the digitalization of the economy.

Research results

The phenomenon of entrepreneurial networks is not new to the economy. Since the late 1980s, entrepreneurial networks have been actively developing, fueled by rapid advances in technology and increased market competition. The development of globalization processes has marked the transition to new business models based on strategic partnerships between business sub-subjects and the creation of value. Modern high-tech companies generate products, vicarious resources and the competencies of hundreds of partners scattered around the world. Efficient cooperation adopts the development of information technologies that allow the online mode to obtain accurate information, coordinating the efforts of all participants in the process of value creation. Enterprises are becoming the most important organizational and administrative structures in the current business climate. As a result of the effective interplay of the participants in the network, the competitive advantage for the final purchaser is the lower price, which builds the capacity of all network subjects.

The features of modern economic processes, due to the development of the digital economy, involve the formation of:

- the global ecosystem of the digital economy and the global digital space;
- a qualitatively new structure of economic assets that meet the economic priorities of the digital economy;
- approaches to the organization of manufacturing industries, the trade sector, and the service sector, taking into account the achievements of the digital economy that are effective in the context of the formation and development of the global digital space;

- principles of effective management and the improvement of the management of existing economic resources;
- conditions for the active participation of the business community and the population in the formation of the digital economy space by creating attractive organizational and regulatory conditions and a space of trust in the digital environment;
- systems for ensuring the security and sovereignty of the national space of the digital economy.

These trends have led to the formation of new forms of organizing intersubjective interactions based on the advantages of flexible structures, contracts and other types of agreements, combining external components into various types of network forms of organization and adapting to rapidly changing market realities.

The study of various definitions of network, network organization, etc., shows that within the entrepreneurial network, most researchers understand the presence of a permanent, stable circle of autonomous independent firms (usually quite highly specialized) that perform various tasks necessary either for the functioning of the parent company in the market or the implementation of some unifying idea that they cannot implement separately. A network organization combines advanced technologies, traditions, resources, goals, experience and production capabilities of agents of an entrepreneurial network.

An entrepreneurial network is a set of legal entities and individuals (entrepreneurs, enterprises and organizations) which, on the basis of social mechanisms, establish contacts, agree on forms and conditions of interaction to implement their ideas, intentions and goals, achieve competitive advantage, and reduce transaction costs and economic benefits in terms of risk and uncertainty of the external environment.

The network is an association of business structures regulated by market laws. The network elements, which are independent business entities, are aimed at cooperation with each other, the exchange of information, and the provision of products and services on favorable terms for other network participants in order to maintain their own place in the value chain.

Today, entrepreneurial networks, along with syndicates, concerns, holdings, consortiums, business associations, franchisees, cartels, pools, virtual companies, trusts, strategic alliances, unions, complexes, industrial hubs, financial and industrial groups, contract groups, multinational companies, etc., are one of the more complex forms of metacorporation – an association of a certain number of business entities that does not have the status of a legal entity.

Voluntary participation implies the development of creativity in the activities of the network elements. Network elements are constantly adapting to market requirements, take into account the development trends of science, engineering and technology, and are flexible in relation to environmental factors. This contributes to the constant renewal and development of network organizations.

It is in network organizations that the synergistic effect is clearly manifested. The ability to improve the final results of enterprises' activities through joint work and the attraction of new partners due to the reliability, sustainability, flexibility and adaptability of the structure is ensured. The use of network structures can provide small businesses with the opportunity to compete in the market with large organizations due to their flexibility and efficiency.

Today, a new trend has emerged in the global community – the creation and development of entrepreneurial networks. This is a new approach of firms to solving various problems with the rapid development of the global economy, markets, technologies, and the emergence of new high-tech products, while improving integrated solutions in the modern economy, with a high level of risk on the market.

Companies create entrepreneurial networks in the form of strategic partnerships with suppliers, consumers, governments and other organizations, various institutions, research centers, laboratories, and even with competing firms in order to increase the efficiency of the enterprise,

reach a new level of quality of products, services, development and introduce innovations to the global market which is impossible to achieve in the conditions of direct competition. Based on the foregoing, we can conclude that relationships between companies provide the formation of an entrepreneurial network in which the success of each unit depends on the success of the entire network as a whole.

Thus, business networks are based on social mechanisms and links between entrepreneurs and organizations in different sectors of society that are determined by the intentions and interests of decision-makers, as well as the potential of their enterprises and organizations (capital, knowledge, technology and other resources). Firms have variable forms of interaction due to changes in their internal environment, which involve reformatting relationships and agreements, reconfiguring the network structure, the transition from mono- to poly-centric entities and back, and establishing mechanisms of hierarchical control and partnership.

The development of network forms of intercompany interactions in the digital economy requires, in order to assess the effectiveness of organizations, taking into account not only their individual characteristics, the specificity of the resources used and the ability to manage them, but also the long-term relationships that arise within the framework of the joint use of these resources to ensure the formation of new technologies, processes and knowledge.

Within the framework of the merging approach, mutual trade between companies is not seen as a bilateral repetition of trade, but as a system which has a mutually autonomous group of agents. The purpose of directing studies in these groups is to establish, develop and successfully promote a different kind of exchange between the parties, many of whom are not seeking a purely market-facing transaction. In this way, the results of the activity of an affiliated organization are determined by the distribution of resources and mutual relations with other affiliated organizations.

The decision to create a network is not always simple and obvious. Despite their successful development, inter-firm partnerships, in fact, remain controversial. They simultaneously manifest the features of both the firm and the market. On the one hand, entrepreneurial networks behave like a single firm, and partners jointly coordinate strategic actions and collective decisions. On the other hand, the competitive mechanism of the market continues to operate within the network. The success of the result depends on many factors: the choice of the level of association, the compatibility of strategic interests, the maturity of the industry, and even the commonality of cultural characteristics.

Most of the work on network topics in economics focuses on the problems of network structures in general as a new form of organization. At the same time, the issues of the optimal choice of partners to improve the efficiency of intercompany interactions within the framework of the network structure and the development of the digital economy remain understudied.

One of the key characteristics of economic entities in modern conditions is the presence of network solvency, which will provide entities with the ability to combine in their activities two processes of interaction with other market entities: competition and cooperation. Under the network solvency of an entrepreneurial structure, one should understand the totality of means and opportunities for cooperation of economic agents in order to increase the efficiency of network organizations. The network solvency of an entrepreneurial structure is also defined as a set of means and opportunities to improve the effectiveness of its network activities.

However, this approach does not take into account the features of the developing digital economy, such as:

- a change in the economic structure, expressed in a change in traditional markets and social relations, associated with the penetration of digital technologies into them;
- a change in the economic management model;
- the transition of the function of the leading mechanism for the development of the economy to institutions based on digital models and processes;

- the expansion of control and the development of value chains for additional business models based on platforms;
- new opportunities in the economy of accommodation.

Therefore, this approach needs to be adjusted taking into account the importance of the participation of economic entities in the processes of formation of the global ecosystem of the digital economy and the global digital space. This is because the digital economy is an economy based on digital computer technology and information and communication technologies, but, unlike informatization, digital transformation is not limited to the introduction of information technology. Instead, it radically transforms areas and business processes based on the Internet and new digital technologies (Pishchulina, 2020, p. 12).

The digital economy is impossible without the use of electronic technologies, electronic infrastructure and services, and technologies for analyzing large volumes of data and forecasting in order to optimize production, distribution, exchange, and consumption and increase the level of socioeconomic development. The rapid development of digitalization is becoming a reality not without new opportunities, but with serious threats and problems. In the context of digitalization, economic actors have unequal access to digital technologies and new opportunities, which leads to the emergence of digital divides. Therefore, it is important for economic entities to form and develop network capabilities and potential, i.e., a set of means and opportunities that ensure the satisfaction of the interests of both one's own business and the business network as a whole in the context of the development of the digital economy through a system of intercompany interactions.

The formation and development of network viability contributes to the creation of conditions for the active formation of the digital economy by maintaining a digital space of trust, which will allow networks:

- to create conditions under which justice and respect for obligations arising from formal and informal agreements will be observed;
- to prevent economic conflicts between different economic entities;
- to initiate the processes of creating sustainable and effective interactions to maintain and strengthen the economic security of the subjects;
- to promote social progress and the improvement of living conditions;
- to develop cooperation in the field of digital space and, in particular, in the field of the digital economy.

In general, network viability allows assessing the opportunities available to an economic entity and identifying those opportunities that it lacks for expanding intercompany interactions.

For the formation of network viability, an economic entity must take into account the relevant requirements of the external environment. First of all, an economic entity needs to realize the value of long-term, respectful relationships with other representatives of the business community and the client as the main consumer of the created goods and services, as well as to respect the role of state institutions in the formation of effective inter-company interactions.

In the context of the development of the digital economy, the success of any economic entity is largely determined by its ability to create effective inter-firm interactions. Of particular relevance is the issue of developing networking ability and viability, the main ideas of which are that long-term intercompany interactions are one of the key resources that bring both economic and non-economic effects in the long term.

Network viability combines the following levels of connections and relationships at the same time:

- basis, i.e., a set of properties and parameters accumulated by an economic entity to realize the ability for effective functioning and further development;
- the current situation, i.e., a characteristic of the use of available abilities under the current economic conditions.

Here it is also necessary to consider the fact of the presence of unrealized opportunities that reduce the effectiveness of inter-firm interactions in the business network.

Network viability is an opportunity for future development, i.e., the presence of prospects for the acquisition of new forces and abilities. This once again proves the important role of network potential as the ability of an organization to build effective inter-company interactions in the context of the development of the digital economy ecosystem.

Thus, economic entities can achieve sustainable development by choosing the optimal model of network viability as a factor that ensures the satisfaction of the interests of both business and society in the context of the development of the digital economy through a system of intercompany interactions.

Therefore, thanks to the assessment and timely formation of effective networking ability, participants in interfirm interactions have the opportunity to form a base of strategies that allow them to satisfy their own goals and all market requirements.

However, it should be noted that the key factors influencing the formation of network viability are the features of modern economic processes due to the development of the digital economy, described above. Thus, when forming effective intercompany interactions, economic entities should take into account the main directions of digital transformation: ensuring universally accessible connection to high-performance broadband Internet networks; digital platforms; infrastructure for information storage; big data processing technologies; and the formation of the digital space.

The network viability formed at the same time will be able to ensure the effectiveness of inter-company interactions by: attracting stakeholders to interact in solving a wide range of issues related to the development of the digital ecosystem of the business network; globalization of resources to create the possibility of managing risks arising from the complexity of the tasks of the functioning of the business network; coordination of actions between interested counterparties of the business network; and the formation of the possibility of rapid generation of knowledge.

It should be noted that the specific type of network consistency is determined by the forms and methods of implementing inter-firm interactions in the business network. At the same time, the following should be taken into account: due to differences in the levels of availability and use of opportunities, economic entities differ in scope, goals and ways to achieve these goals. Consequently, these aspects should somehow be traced in the strategies of economic entities seeking to realize their networking ability.

To date, the system of intercompany interactions is not developed, which is due to the lack of information about the needs and requirements of each economic entity, as well as the insufficient development of forms and methods for conducting a dialogue between participants in intercompany interactions. In particular: there is no well-developed system for analyzing the needs of participants in intercompany interactions; the actions of participants in intercompany interactions are still characterized by isolation and inconsistency; and economic entities are guided to a greater extent by their internal needs.

Any economic entity that is a member of the business network, as an open and complex system, is constantly exposed to internal and external influences, resulting in both qualitative and quantitative changes. This is reflected in the dynamics of a large number of evaluation indicators, each of which can only give a points-based characterization of one or another aspect of activity. Therefore, in relation to the assessment of network solvency, it is legitimate to apply the method of identifying the most significant indicators for all participants in intercompany interactions, followed by their integration.

Since an entrepreneurial structure is an open organization consisting of interrelated business processes, its network consistency can be represented as an integral system, divided into blocks that describe various aspects of activity that affect the final efficiency of intercompany

interactions in an entrepreneurial network. It follows from this that economic entities should not so much dictate their terms to other market participants as interact with them in determining the needs of economic development in the context of digitalization.

Thus, it is important to determine ways to improve the system of intercompany interactions in order to achieve the goals of developing the digital economy. An analysis of approaches to evaluating the effectiveness of intercompany interactions showed the presence of a number of common features and factors that affect the effectiveness of such interactions. These are: resources and infrastructure (Williamson, 1996); management of network relations; and network structure (Asaul et al., 2004; Echols & Tsai, 2005). It follows that the main criteria that determine the effectiveness of intercompany interactions are specific resources, as well as the management of their distribution and use in intercompany interactions. Thus, it was advisable to include these parameters in the first place in the indicators assessing the level of network viability, and then bring out the most significant parameters according to the participants of intercompany interactions. Each of the components of network viability in this case, although it should have a certain set of indicators is, in fact, not strictly distinguished – they are interconnected and influence each other in different ways.

To assess the network viability of an entrepreneurial structure, it is proposed to consider the model of network viability through the interconnection of elements that have an indicative, connecting and affirming effect on the effectiveness of network organizations.

The pointing element is the presence of basic conditions, without which economic entities do not form sufficiently significant motives for creating long-term sustainable inter-company interactions in the business network. This element reflects the presence of certain resource characteristics that allow economic entities to interest other counterparties in interactions. In the conditions dictated by the developing digital economy, first of all, the multiplicity and complementarity of information and communication resources are required, since computerization is a central and indispensable condition for the development of information interactions. It is the presence of a modern technical base that allows economic entities to accelerate the processes of accumulation, processing and transmission of information, and the analysis of big data.

In addition to the presence of the resource component, the effectiveness of managing the distribution of these resources in the process of inter-company interactions in the business network plays an important role. This determines the structure of the connecting element of the network potential model. To strengthen inter-company interactions, an economic entity needs certain funds to realize its own opportunities and those received from other participants in the entrepreneurial network. This implies the existence of a system of adaptive, coordinating and protective mechanisms focused on the trends of the digital economy. Effective coordination of intercompany interactions is ensured, first of all, by the ability of an economic entity to maintain electronic communication and data exchange with other participants of interactions. In the presence of such abilities, the possibility of implementing effective electronic transactions in real time is realized, thereby significantly accelerating the processes of intercompany interactions.

Since one of the problems of intercompany interactions is the problem of a lack of trust between the participants in the relationship, it becomes necessary to have a high level of information openness to ensure the guarantee of the conscientious performance of contracts. The adaptive parameter of management is determined by the readiness of economic entities to develop technological flexibility in response to the changing requirements of the factors of the digital economy. This implies the availability of special software to achieve the efficiency of decision-making by officials based on algorithms that have been tested and recognized as optimal.

The resulting element reflects the synergistic effect resulting from intercompany interactions, which ensures the dominance of the effect of joint interactions over the sum of the effects of

autonomous activities. The higher the synergistic effect, the more stable the intercompany interactions (Table 1).

Table 1. The elements for assessing the network viability of economic entities participating in an entrepreneurial network in the digital economy

No.	Element of network consistency	Network solvency indicators
1	Pointing	Provision of employees with personal computers Availability of technical means for mobile access to the Internet (smartphones, tablet computers, modems) Availability of servers, local area networks Availability of corporate email/social network Use of cloud services
2	Binding	Share of departments using electronic data interchange in their activities Possibility of placing/receiving orders for the sale of goods/services using global information networks Possibility of using electronic payments Providing information using global information networks Participation in interactive communities Share of departments using in their activities special software for: scientific research, design, management of automated production and/or individual processes, CRM-, ERP-, SCM-systems, solving organizational, managerial and economic problems, managing purchases and sales of goods/services Using business integration platforms
3	Resulting	Share of revenue received from the sale of goods/services using global information networks Ability of joint platforms and technologies to ensure end-to-end automation and integration of production and management processes into a single information system Development of cooperation in the form of outsourcing, etc. Implementation of personalization of goods through the use of additive technologies Presence of joint or cross ownership, causing connections and personal contacts Increase in the number of ongoing interactions over a period of time Increase in the number of new interactions over a period of time

For the specified estimated indicators of the network solvency of economic entities participating in the entrepreneurial network, it is possible to apply the following criteria: either the target value or the availability criterion (Yes/No [1; 0]).

Thus, the objective function of this assessment, taking into account the significance of each of the indicators, is formed according to the formula:

$$\left[1 - \sum k \frac{(1 - \Delta I)}{1}\right]$$

where k is the share of the i-th assessed indicator;

ΔI is the change in the value of the i-th indicator (either the deviation of actual indicators from the targets is used, or the "yes/no" criterion, where "yes" is equal to 1 as a target value and "no" is equal to 0).

If the obtained value of network solvency is equal to 0, then the economic entity is absolutely incapable of creating and strengthening sustainable inter-firm interactions in the business network. If the maximum value of the objective function is equal to 1, this means that all elements of network solvency that are important for the development of intercompany interactions are present in the economic entity (or have reached the target values).

To make a decision about the sufficiency of the level of network solvency, the mathematical method of dividing the segment in half can be used as a decision rule. Then, according to the

obtained value of the objective function, it is possible to single out the categories of network consistency presented in Table 2.

Table 2. Criteria for assessing the level of network viability of economic entities participating in an entrepreneurial network

Indicator value	Network solvency level	Characteristic
≥0.75	High level of network solvency	The economic entity effectively uses its capabilities to implement effective interfirm interactions in the business network in the digital economy
$0.5 \leq X \leq 0.75$	Average level of network solvency	The economic entity has unrealized opportunities that reduce the effectiveness of interfirm interactions in the business network in the digital economy
≤0.5	Low level of network solvency	The economic entity is not capable of creating effective intercompany interactions in the business network in the digital economy

The advantages of this technique are:

- the possibility of applying the assessment for any economic entity, regardless of its size, form of ownership or territorial location;
- the possibility of obtaining an assessment of the network solvency not only of individual economic entities, but also of business networks as a whole;
- the possibility of comparing the network solvency of entrepreneurial structures;
- the possibility of isolating weak points in network viability for further strengthening and improvement.

Conclusions

This study showed that the development of network forms of intercompany interactions in the digital economy requires taking into account the main priorities in their creation: solving the problems arising before participants on the basis of their full interaction; increasing the efficiency of activities of economic entities included in the network; and obtaining a synergistic effect.

The main problems hindering the creation of effective inter-firm interactions are the lack of information about the economic, investment and production capabilities of economic entities and the degree of their participation in cooperation, the lack of a mechanism for internal incentives for the participation of enterprises in the processes of inter-firm interactions, as well as the underdevelopment of the market for applied services (information, advisory, engineering, design, etc.) for enterprises.

Thus, in order to create and strengthen inter-company interactions in the business network in the context of the digitalization of economic activity, subjects need to develop network viability through a system of information and communication resources that allow economic entities to accelerate the processes of accumulation, processing and transmission of information, to analyze big data, and to solve the problem of isolation and inconsistency. The proposed model of network consistency allows tools to be developed for analyzing the effectiveness of intercompany interactions, and enables the management of the development of entrepreneurial networks in the context of the digitalization of economic activity.

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DIGITALIZATION AS THE BASIS FOR INCREASING THE COMPETITIVENESS OF INDUSTRIAL ENTERPRISES IN THE CONDITIONS OF INDUSTRY 4.0

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Abstract: *This article considers conceptual and practical aspects of the digital economy and industrial digitalization in new conditions. It explores the main trends of digitalization in the context of Industry 4.0, based on which recommendations for implementing digital technologies in the industry of Tajikistan are elaborated. In the course of the study, it was determined that the introduction of digital technologies can reduce transaction costs, accelerate production and management processes, and boost labor productivity, thereby improving the competitiveness of industrial enterprises. This article also identifies the main problems hindering the process of digitalization of the economy of Tajikistan in general, and industry in particular. Based on the results of the study, ways to resolve existing problems are proposed. In particular, the study substantiates the need to solve the problems of developing IT infrastructure and the industrial Internet, improving institutional support and the state regulation system, reducing dependence on foreign technologies and software products, solving problems of human resources for digitalization, and developing automated process control systems. The study also substantiates: the prospects for the development of a new industrial policy; the creation of a state system for supporting and stimulating private information systems; the creation of an ecosystem for the development of digital technologies, in particular through the extension of cooperation between market participants; and the intensification and encouragement the use of Internet technologies to manage production processes, supplies and sales, marketing and communications. It is also important to address issues related to: creating conditions for the development of technologies for collecting, analyzing and using big data; creating a system for generating modern software that allows collecting, analyzing, and building algorithms and using large amounts of data; developing the practice of automation and robotization of industrial production; and optimizing the use of cutting-edge technologies and the development of predictive analytics.*
The study indicates that it is necessary to resolve issues related to technological competencies, the business environment, investment policy, the quality of the business environment and the level of its development, as well as issues of a structural and component nature. To increase the competitiveness of industrial enterprises in the context of Industry 4.0, it is also necessary to: create an effective business foresight system; identify customer needs, including personalized products and services; create the necessary ecosystem with conditions for effective interaction between participants; and use artificial intelligence to predict the scale of the business and a combination of its various types.

Keywords: *industry, digitalization, innovation, competitiveness, competitive advantages, efficiency, sustainable development.*

Introduction

In the context of Industry 4.0, competitiveness functions as a fundamental factor in the development of national industry in Tajikistan. The practice of industrially advanced countries shows that due to such qualities as speed, flexibility and the use of new technologies, digitalization allows competitive advantages to be created and industry to be elevated to a whole new level of development. However, in order to enjoy the benefits of digital technologies and deepen industrial reform for the purpose of switching to digital platforms, it is necessary to create an ecosystem and develop necessary institutional documents. In this context, using the advantages of digital technologies to gain a competitive advantage in industry requires studying the influential factors and conditions necessary for the formation of a digital ecosystem in the production industry.

Under the conditions of the modern economy, one of the main directions for improving the competitiveness of industry in Tajikistan is the introduction of digital technologies and the use of the advantages of digitalization. Digitalization makes it possible to create conditions for improving sustainable competitiveness and to bring technological processes, as well as the entire system of organization and management of industrial production, to a completely new level. The implementation of innovative digital technologies for the manufacturing of high-technology products is crucial for creating competitive advantages and the technological development of national industry. Due to the development of information and communication technologies based on the Internet, mobile communications, the use of modern digital platforms, network technologies, new software, as well as various forms of digital devices and equipment have become available.

Currently, industrially advanced countries implement various digital technologies, such as robotic devices, smart technologies, automated and robotic technological platforms, non-waste and unmanned technologies, as well as production technologies equipped with various detectors and digital sensors. The industrial digitalization process is developing at a rapid pace, and at this stage the digitalization of industry not only improves the competitiveness of the industry, but also creates the basis for improving the competitiveness of regions and the country as a whole, while creating the foundation for the development of the digital economy in Tajikistan. Against this background, the creation of a necessary digital platform in industry is the primary objective of modern society.

The purpose of this study is to determine the properties of digital technologies used in industrial production, as well as the ecosystem and technological platforms, the use of which ensures competitive growth of industry.

Data and methods. The study was based on systematic and integrated scientific approaches using the methods and techniques of statistics and comparative economic analysis.

The concept of economic digitalization and its advantages in industry. Despite the fact that the issues of implementing digital technologies in the economy and industry were raised in the middle of the 20th century, *Being Digital* by Nicholas Negroponte is considered to be the principal work in this area. In this book, which was published in 1995, the author first formulated the concept of an electronic economy, where he substantiated the possibility of the transition from handling atoms to handling bits. The digital economy is capable of bringing about significant economic shifts and influencing whole areas of business, the labor market and people's lifestyles (Brynjolfsson & Kahin, 2000; Bahl, 2016). Digitalization also plays a key role in reducing inequality (Beerepoot & Lambregts, 2015), boosting innovation through the emergence of digital start-ups, and has a positive impact on reducing corruption and improving the efficiency of market institutions (Quinones et al., 2015; Lehdonvirta, 2016).

A review of various concepts shows that the digital economy allows developing countries to achieve significant success in increasing the productivity of capital and labor, reducing transaction costs, as well as the internationalization of business (Dahlman et al., 2016). This study shows that the concepts of digital economy were formed under the influence of concepts such as information economy, electronic economy and information society. In this context, Don Tapscott (1996) pointed out that the digital economy includes information and communication activities that comprise the basic tasks of collecting and processing information, including those based on Internet technologies. It should be noted that these activities have been mentioned in the US Department of Commerce report "The Emerging Digital Economy" (Margherio et al., 1999), and in their 2000 collection *Understanding the Digital Economy* (Brynjolfsson & Kahin, 2000).

Thus, it should be noted that the digital economy includes digital products and services and the IT industry segment, with the help of which economic transactions are carried out. These technologies reduce costs, increase the productivity of labor and equipment, and increase the

competitiveness of goods and services. However, it should be noted that digitalization creates a number of threats that are mainly related to the security of systems and platforms used, as well as the risks that accompany the implementation and use of digital technologies, including in industry.

The advantages of digitalization in industry are associated with the active introduction of new generation technologies, in particular artificial intelligence, cloud computing, big data analytics and machine learning, robotics, augmented reality, Internet technologies, 3D printing, and others which have become available for business and industrial enterprises in recent years. The introduction of digital technologies in industry allows artificial intelligence to be used to monitor the supply system, production processes, sales, and the efficient use of production facilities, and to bring interactions with suppliers and consumers to a new level.

Practice shows that the digitalization of industry can develop in the directions of the digitalization of business models and the digitalization of production processes, which involve the use of digital platforms to organize and manage production operations at industrial enterprises. In this regard, the main trend in the development of modern industry is digital transformation, which serves as the basis for improving the productivity of capital and labor.

Our research has shown that the introduction of digital technologies in industrial production makes it possible to improve the efficiency and quality of decisions and optimize business processes using technology platforms. In this case, we are referring to big data analytics, which allows us to quickly collect information and transfer it to digital platforms for further processing through the entire organizational and production chain. With the help of digital technologies, industrial enterprises will be able to increase production, reduce costs and improve the efficiency of production capacity.

Digitalization in the global industry: Current state and trends

To date, countries such as China, Japan, South Korea, the UK, Germany, France, the USA and Canada are the world leaders in industrial digitalization. According to the Boston Consulting Group, the current level of digital maturity of various industries varies. For example, in the mining and metallurgical sector, it lags behind by 30%–40%. However, the leading companies in this area achieve significant results with digital help – for example, an increase in production by 10%–20% or an increase in drilling efficiency by 20%–30% (BCG, 2021).

According to Markets and Markets (2021) forecasts, the size of the Industry 4.0 market will be $64.9 billion in 2021, and by 2026 it will grow to $165.5 billion at an average annual growth rate of 20.6%. Key factors driving its development include the rapid introduction of artificial intelligence and the Internet of Things, which leads to an increase in demand for industrial robots in the pharmaceutical and medical device manufacturing sector, an increase in public investment in 3D printing and additive manufacturing, and the introduction of blockchain technology in the processing industry (Figure 1).

According to IDC forecasts, by 2022, 65% of global GDP will be digitized. From 2020 to 2023, direct investments in digital transformation will amount to $6.8 trillion (Business Wire, 2020). Global trends in industrial digitalization clearly demonstrate that digitization in industry is characterized by such basic elements as cooperation, intelligence and innovation. In this context, the cooperation of countries for the purpose of industrial digitalization seems to be important, since its fragmentation around the world will not deliver the desired results. Moreover, the digitalization process itself implies the sharing of technology platforms, IT infrastructure, software products, and artificial intelligence. These forms of interaction create open innovation, which serves as the basis for the formation of a digital ecosystem and corporate forms of innovation.

Industrially advanced countries such as Germany, Singapore, China, the UK and South Korea have interesting experiences in this sphere. For example, Germany continues to forge ahead with Industry 4.0, and the UK aims to become a digital power. South Korea has already begun

construction of smart factories in the processing industry. Today, some digital start-ups have moved beyond the boundaries of industry and are moving into larger ecosystems, such as the creation of smart cities. One survey showed that there are currently more than 1,000 smart cities already in existence or under construction around the world. China alone is implementing around 500 smart city development projects. According to existing data, in 2020, global expenditures on the implementation of smart city plans amounted to $124 billion, which was 18.9% more than in 2019. China spent $25.9 billion, which is 12.7% more compared to the same period in the previous year.



Figure 1. Attractive opportunities in Industry 4.0
Source: Markets and Markets (2021)

As of today, there is a global trend in the transition of enterprises to a new generation of digital technologies. Modern industrial enterprises are active users of cloud computing, big data, mobility and social networking technology. The use of digital technologies contributes to the development of major innovations, artificial intelligence, the Internet of Things and blockchain. In this context, the IDC has identified nine aspects where enterprises need to build the right capabilities for Digital Transformation 2.0. These aspects are relevant to the future of digital infrastructure, trust, intelligence, customers and consumers, work, operations, interconnectedness, digital innovation and branches of industry (Figure 2).

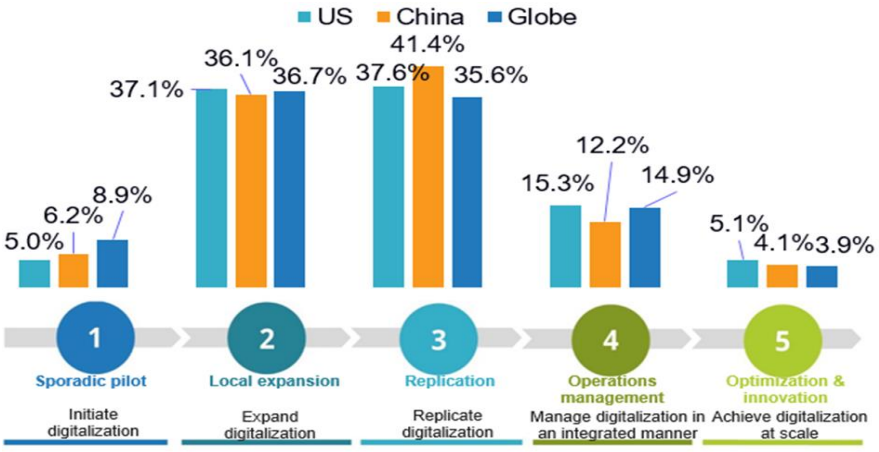


Figure 2. Aspects of digital transformation in enterprises, 2020
Source: IDC (2021)

The European Union uses the Digital Economy and Society Index (DESI) to measure the level of development of the digital economy. This index summarizes the indicators of digitalization and digital competitiveness of the EU Member States. The index includes indicators such as communications, human capital, use of Internet services, integration of digital technologies, as well as digital public services. Figure 3 shows the results of this index in 2020.

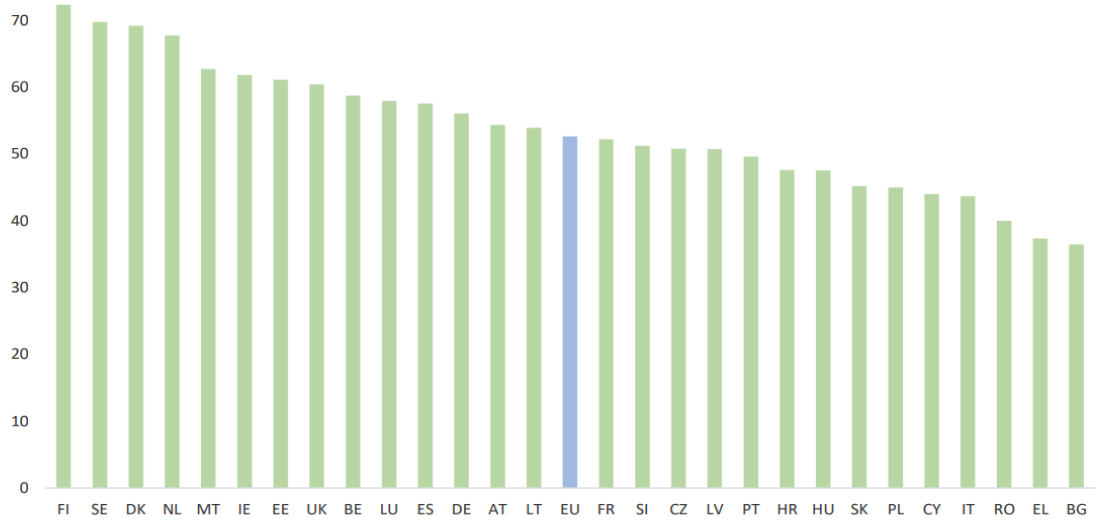


Figure 3. DESI 2020
Source: *European Court of Auditors based on the DESI Index.*

Impact of digitalization on industry competitiveness.
Studies have shown that digitalization in industry makes it possible to reduce the organizational and management cycle, thereby creating an effective planning system based on the analysis of big data, which will lead to the improvement of the competitiveness of an industrial enterprise. Digitalization in industry implies a completely new concept, i.e., a holistic change in the organization and management of industrial production. Digitalization allows real-time information support for decision-making, thereby accelerating the cycle of development of current and strategic initiatives.
In the context of Tajikistan, an important area for the implementation of digital technologies is the processing industry, which can become the main driver of national industry and the primary area in promoting exports. As the experience of industrially advanced countries shows, digitalization lies at the heart of the system of factors ensuring the competitiveness of the processing industry. New trends in the development of the processing industry require a new approach to the organization and management of production, in particular based on the expansion of interactions between manufacturers and consumers through various communication and marketing technologies, which are based on the use of state-of-the-art digital platforms.
The role of digitalization in maintaining and improving the local and global competitiveness of industry is also important. New trends in ensuring the competitiveness of industry, which are dependent on the use of digital technologies, imply a global modernization of the industrial sector. In this regard, in the author's opinion, digitalization in the processing industry of Tajikistan can become the basis for improving its competitiveness, since it makes it possible to:
- create an effective business foresight system, since digital technologies that allow processing big data offer real-time control of business processes and the elaboration of various scenarios of development;
- accurately identify customer needs, including personalized products and services, since modern technological platforms make this possible;

- create the necessary ecosystem with conditions promoting effective interaction between participants, in particular for the manufacture of new and even extremely complex products;
- use artificial intelligence, or a combination of different types of artificial intelligence, to forecast the scale of business.

Industrial digitalization in Tajikistan: Problems and solutions

Tajikistan has adopted the Concept of the Digital Economy in the Republic of Tajikistan (hereinafter – the Concept), which, in particular, provides for the digitalization of key areas of economic activity, as well as key industrial sectors such as energy and mining. In this context, a fair question arises as to why exactly the extractive industry, and not the processing one, was chosen as the target of this legislation. Global practice shows that the processing industry is the leader in the implementation of digital platforms. Hence, it follows that the main institutional document, which in essence should determine the promising directions for the introduction of digital technologies in industry, de facto excludes their use in the processing industry.

In conditions when the global economy is achieving rapid progress and time is the most valuable form of capital, the implementation of this Concept is extended until 2040, i.e., divided into three stages: the first stage until 2025, the second stage until 2030, and the third stage until 2040. This once again indicates that the development and determination of the time frame for the implementation of this Concept is not scientifically substantiated and does not fit into the general trends of development of the global economy. It is also worth noting that only two paragraphs are devoted to industrial digitalization as a key area of the national economy. They mainly refer to the digitalization of the extraction industry with the prospect of using autonomous machinery and the introduction of a decision-making system mainly based on the analysis of big data.

According to this Concept, it is also planned to introduce sensor technologies, detectors and advanced analytical tools that allow visualizing data, conducting scenario modeling and making management decisions based on them. In addition, it is planned to launch pilot projects on the creation of model digital factories in the processing and extraction industries, where Industry 4.0 technologies will be implemented.

The analysis of the text of the Concept shows that it does not cover the full range of promising areas of industrial digitalization and active use of digital platforms to improve the competitiveness of industrial enterprises. Based on this, in the author's opinion, the following problems exist today on the path towards ensuring industrial digitalization, creating the necessary ecosystem and increasing in the role of digital technologies in ensuring the competitiveness of the industry of Tajikistan:

- the underdevelopment of IT infrastructure and the industrial Internet, as well as the lack of systems for analyzing big data;
- the imperfection of institutional support and the system of state regulation and support for the introduction and implementation of digital technologies in industry and other sectors of the economy, especially in terms of linking technologies and innovations to industrial production;
- the dependence on foreign technologies in Tajikistan, since the country does not produce technological equipment and software (dependence is mainly on Chinese technologies and software for industry, and all major codes and developments are foreign);
- the fact that small and medium-sized businesses do not have enough financial resources and state support in the acquisition and use of new technological platforms, as well as strategic corporate innovations, which, among other things, create a digital ecosystem;
- the existing personnel training system for digitalization of the economy and development of the digital ecosystem does not meet the requirements, and reforms in this field are fragmentary and fall short of expectations in solving the problems of staffing for the transition to a digital economy;

- the problems that exist regarding financial support and the high cost of digital start-ups, which are associated with a lack of financial resources and budget funding;
- at the level of industrial enterprises, the low digital maturity of current processes, the low level of automation, the lack of competencies and the low level of IT literacy among employees;
- the low level of development of automated process control systems, as well as information security risks, a decrease in the number of jobs and a temporary deterioration in production manageability.

Along with the above problems, one can add issues related to technological competencies, the business environment, investment policy, the quality of the business environment and the level of its development, as well as issues of a structural and component nature. This requires a balanced approach to identifying and solving problems that hinder the development of digitalization processes in the industry and the entire economy of Tajikistan based on the application of the project approach in particular.

To solve the problems that hinder the introduction of digital technologies in industry, it is necessary to develop sectoral digitalization programs and create conditions for the formation of a completely new digital economy ecosystem. In this context, attention should be paid to the following points:

- the development of an industrial policy, which will determine the directions and prospects for the introduction of digital platforms in industrial production;
- the creation of a state system for supporting and encouraging private information systems, including on the basis of determining the conditions, standards and trends for industrial digitalization;
- the creation of an ecosystem for the development of digital technologies, in particular through the expansion of cooperation between market participants, strengthening the relationship between science and production, developers and manufacturing enterprises, as well as the formation of a new system for commercialization of research and development and intellectual deliverables;
- the promotion and encouragement the use of Internet technologies for the management of production processes, supply and distribution activities, marketing and communication, as well as management decision-making;
- the creation of conditions for the development of technologies for collecting, analyzing and using big data, which can solve numerous problems, in particular in the sphere of organization and management of industrial production;
- the preparation of recommendations for the creation of systems generating modern software, which allows collecting, analyzing, building algorithms and using very large volumes of data;
- the cultivation of the practice of automation and robotization of industrial production, i.e., combining measures and mechanisms for industrial digitalization, which, through interaction, allow creating an effective system of autonomous functioning;
- the optimization of using cutting-edge technologies, which allows determining the priorities and directions for high-priority digitalization in the industrial production system;
- the development of predictive analytics, which is aimed at monitoring the efficiency and smooth functioning of technological platforms;
- the training of personnel in the sphere of the digital economy possessing relevant competencies in the field of software development, artificial intelligence and technology platforms, as well as the implementation of special industrial software already existing on the global market.

Conclusion

Therefore, the implementation of digital technologies in industry contributes to the improvement of the competitiveness of industrial enterprises both at the product and industry levels. Moreover, the use of digital technologies has a positive impact on all production processes, including such important indicators as labor productivity and transaction costs. The introduction of digital platforms also allows an enterprise to enter the international market and integrate into global digital platforms to promote its products and improve technological processes. It is clear that digital technologies will create a sustainable competitive advantage for industrial enterprises and products.

Tajikistan still has to overcome numerous institutional, investment and technological challenges in order to achieve a full transition to digital platforms. However, there are prerequisites and conditions for this. Developed countries have elaborated certain algorithms and templates for the transition to the digital economy, which allow certain problems to be solved faster and more efficiently.

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SECTION 5

ANALYTICAL SUPPORT OF DIGITAL TRANSFORMATIONS

AN ANALYTICAL SUPPORT METHODOLOGY FOR TRANSFORMATIONAL PROCESSES

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Abstract. *This article is devoted to the problems of the analytical support for digitalization of the modern economy and their impact on economic growth and social welfare. It is shown that businesses in the field of computer and information technologies, as well as the sharing businesses, are developing rapidly based on the widespread use of Internet services and cloud technologies. It is noted that for businesses that rely on Internet services, the analytical support system is simplified, which is reduced to managing the creation, processing and redistribution of information, rather than creating new products and industries, which also inhibits economic growth. The results of the study of the compliance of the methodology of analytical support of digital transformation processes with the modern conditions of the digital economy allow the author to state that the development of the methodology of the accounting and analytical process involves: first, the study of cause-and-effect relationships in the economy and the management and institutional sphere of regulation of this process; second, the establishment of an organic link between the state of the economic and institutional environment with the content of the accounting and analytical process; and third, the formation and establishment of such a link allows economic entities to develop in accordance with corporate interests, which are defined in the economic strategy.*
However, it has been proven that the practice of accounting and financial reporting has accumulated negative properties that make it difficult to update the concept of information support for setting and implementing management goals, the need for which is long overdue.
We believe that in order to improve the effectiveness of control measures, the accounting and analytical array should be supplemented with information from big data databases, which are formed from management, tax, and statistical reports, information summary reports of financial regulators, and sources of non-financial information. Suggestions for improving the methodology of analytical support for digital transformation processes and specific practical recommendations will contribute to the acceleration of digital transformation accounting and analytical processes, and this will allow timely identification of risks of loss of stability and efficiency of economic entities, helping them to take into account measures to eliminate or mitigate negative consequences in formulating development strategies. Proper methodological support for any transformation processes of an economic entity reflects the level of its economic development, priorities, strategic guidelines, and opportunities to achieve them. In addition, it must be adequate to the industry specifics of those regulatory objects under the management of which the necessary regulations are created, otherwise these regulations will be useless.

Keywords: *digitalization of the modern economy, transformational processes, analytical support, IT platform, information technologies*

Introduction

The relevance of the topic of analytical support for digital transformations is due to the rapid and active penetration of digital information technologies into all spheres of the functioning and life of modern society. The governments and business structures of all countries of the world are aware of the vital need to accelerate the processes of digital transformation and digitalization of the economy in order to gain competitive positions in the changing digital space of the new world economy, which, of course, requires the necessary analytical and scientific-methodological study of the implementation of appropriate changes. The opening of an IT platform, the existence of cloud technologies, the introduction of a single international format for providing financial statements in XBRL electronic format, and many other innovations in the field of electronic information technologies significantly increase the requirements for the efficiency of accounting, review and analysis processes. At the same time, in modern conditions, the management of enterprises constantly solves complex adaptive tasks

to reformat the systems of existing methodological support for accounting, control, and analytical processes and to prepare external and internal reports.

In today's conditions, all existing functional elements of the financial and economic management system of business structures proceed with state participation, namely: organization and motivation, planning and budgeting, accounting and reporting, analysis and regulation, and control and coordination. These elements are under pressure from quite serious disagreements – sometimes even direct contradictions of state and corporate interests. The problem of creating transparent financial statements has also not yet been solved.

Thus, the above-mentioned issues determine the relevance of the research topic and require further development of the methodology for the analytical support of digital transformations regarding the unity of their levels and types. At the same time, the significance of this study increases significantly in the current conditions of digitalization of the economy, which undoubtedly requires a clear interpretation of the main content provisions and the unambiguity of calculation algorithms.

The main accounting principles that determine the state of all accounting activities, as well as possible prospects for improving the accounting methodology in the context of the evolutionary development of economic life, are described in the works of a number of well-known scientists: J. Akerlof, H. Anderson, R. D. Barro, R. Boyer, H. G. Gadamer, R. Griffin, J. M. Keynes, D. Locke, J. S. Mill, B. Needles, A. Smith, J. Stiglitz, M. Friedman, Hayek von F. A., J. Schumpeter, and L. R. Emerson.

In the works of Iziri Yuji, L. I. Gomberg, and V. V. Leontiev, studies of the matrix form of providing accounting records and developing new reporting forms are presented. It should be noted that these studies are becoming particularly relevant and important in the context of digital transformations of the economy for the development of multi-level accounting records, which are objects of on-farm control.

The developments of scientists and practitioners from different periods of history confirm the relevance and complexity of the research topic. Scientific discussions on the institutionalization of analytical support for the entire management system of corporate structures make it necessary to develop a scientifically based concept of accounting and analytical processes that will meet the financial interests of all involved participants in expanded reproduction.

Therefore, the relevance of the formulated problems and the need to identify options for their elimination determined the choice of the research topic and its purpose and objectives.

The purpose of this study is to improve the methodology of modernization of accounting support for digital transformations in the context of institutional changes, aimed at supporting the implementation of economic strategies for the development of various corporate structures.

To ensure this goal, the following tasks were formed: 1) to justify the need for analytical support of digital transformations taking into account institutional changes in the system of regulation of the economic environment; 2) to analyze modern concepts of digitalization of accounting processes and prove the allocation of the concept that is most adapted to the conditions of the corporate environment in order to further improve it in relation to its practical application in economic activities; 3) to justify methods for choosing the priority objects and methods of accounting procedures in specific conditions; and 4) to propose a model of analytical support for digital transformations to achieve corporate development goals.

The object of this research is a set of corporate structures, and the subject of the research is a set of accounting and analytical measures of support for digital transformations.

To achieve this goal and solve problems, such general scientific methods as induction, deduction, classification, comparison, logical and statistical analysis, proofs, and generalization were used. Particular methods of cognition were also used, namely: observation, expert assessment, modeling, methods of cognitive analysis, economic, mathematical and

statistical methods of data processing, as well as tools of organization theory and systems theory.
The theoretical basis of the research was formed by the scientific works of scientists of different times, which reveal the essence of accounting and analytical support of economic processes and mechanisms of their application.

The main body of the paper

The evolutionary path of development that is characteristic of many national systems of analytical support of economic processes has one common feature, the essence of which is to follow changes in the socioeconomic environment and institutions of its regulation, leading to constant changes in the methodological and legal bases of analytical support of economic processes in accordance with the needs of economic agents at all levels of economic life. The concept of evolutionary economy is interpreted by the author as the process of increasing the variety of factors of production, complicating the forms of their management (accounting, control and other information support) which occur due to changes in technologies, goods, organizations, institutions, which are periodically repeated (Kuter et al., 2011).
The methodological foundations of the evolutionary theory of T. Veblen (1899, 1904, 1914), D. North (1997), and many other foreign scientists are adopted as a basis by economists to ensure the continuity of the positive historical heritage of existing concepts of analytical support for economic development. This can be seen in the example of the new doctrine of the digital economy constantly being developed by scientists from different countries and institutional structures.
Thus, V. S. Sopin (2009) draws attention to the concept of further development of this relatively young direction of economic thought – the theory of evolutionary economics, the basis of which was formed thanks to the works of the following scientists: T. Veblen's *The Theory of the Leisure Class* (1899), *The Theory of Business Enterprise* (1904), and *The Instinct of Workmanship and the State of the Industrial Arts* (1914); *The Theory of Economic Development* by Joseph Alois Schumpeter (1928/2008); and *An Evolutionary Theory of Economic Change* (Nelson & Winter, 1982).
In the research of Professor N. L. Pyatov, this direction is referred to as the "evolving economy," in which the main paradigms of accounting continue to develop, and therefore the concept of analytical support (Pyatov, 2016).
The formation of a knowledge society in the period of the late 20th and early 21st centuries led to the emergence of technoscience, the transformation into a market product of scientific knowledge, and the large-scale transition to IT technologies of the entire accounting and analytical and reporting processes of economic entities.
The particularly important opinion of V. S. Stepin should also be noted: in the context of global crises, we need an updated concept of national economic policy – that is, a policy that does not suppress corporate management initiatives regarding the choice of management models, including accounting, control, analysis, and information support for the goals of economic strategizing. The latter, is "a prerequisite for the transition from one stage of System Integrity (homeostasis) to another stage, more complex integrity (a new type of homeostasis)" (Stepin, 2006, p. 14; 2012).
D. Bell's (2004) book also clearly states that there is a "decline in the role of material production and the development of the service and information sector" (pp. 241–242). Thus, it becomes clear that the fundamental changes that are taking place in socioeconomic relations in the new society require the development of new concepts for the implementation of the financial, technological, and social interests of its representatives. In this regard, a completely different model of analytical support for such interests is required. The basic foundations of

development, namely the production and distribution of goods and, accordingly, built-in structures, including institutions with broad regulatory functions, are being rebuilt to meet the new interests of society. It should be noted that absolutely all systems of analytical support for regulatory institutions that need to manage society both vertically and horizontally in economic relations are being sharply rebuilt.

As Professor Pyatov (2014) appropriately noted, the need to study the causes and consequences of transformational changes in accounting and analytical processes is due to "looking at the development of accounting as part of the evolution of culture."

Consistent development of economic process management systems and their analytical support using the latest technical solutions determine the creation of an evolutionary development of accounting and analytical processes. It is these studies that we have taken as a basis in the search for and identification of possible options for updating the provisions of the methodology of analytical support for digital transformations in modern economic conditions, except for the concept of information management. Thus, the term *information management* originates from the term *information resource management*, which means the company's purposeful use of information as a special resource. In addition to this interpretation, M. Attinger introduced the term *integrated information management*, a characteristic feature of which is the creation of an information infrastructure that provides the necessary level of coincidence and compliance of all components in the management system (Blatov, 1928, p. 273).

S. V. Kroshilin and E. I. Medvedev (2008, p. 485) define *information management* as information management for improving the effectiveness of management decisions. This includes planning, organizing, coordinating and controlling information activities and processes, as well as communications within the company aimed at improving the quality and efficiency of its activities. Thus, taking into account the opinions of the above-mentioned scientists, information management has been formed today as a special sphere of specific knowledge and a scientific and practical discipline, which embodies theoretical and practical foundations taken from various related fields and disciplines such as computer science, management, and systems methodology.

However, we understand information or analytical management as a set of models for managing analytical information. Due to its technological essence, this includes more practical foundations than theoretical. Thus, for the modern information society, it is quite important to develop the methodology of accounting and analytical processes, which allows us to meet the information needs of managers of various levels who already use modern high-tech tools, models, and methods of digitizing information and transmitting it through electronic communication channels.

In digital economic transformations, the temporality of analytical information takes on a new impetus – it becomes relevant. This means that information modified by various methods – such as sampling, correlation, and regression analysis, separation, application of coefficients, grouping – at the requests of managers becomes relevant, and the preparation of such a volume of analytical data for a specific time period makes this information temporal. We believe that relevance and temporality are very significant characteristics of the quality of analytical information, which is necessary for management structures of economic entities of horizontal-vertical chains (Gafarov, 2008).

Simultaneously with the constant increase in requests for relevant accounting and analytical information from various users, a completely new stakeholder segment of management theory and information theory has been formed (International framework for integrated reporting, 2017). This assumes that particularly important business stakeholders, such as investors, counterparties, and financial and credit institutions, receive accounting and analytical information on their first request (Skvortsov, n.d.).

At the International Congress of Accountants in 2018, emphasis was placed on the fact that "new information and digital complexes are able to quickly solve accounting, analytical and control and regulatory issues" (Pyatov, 2012, 2016). In this regard, there is a growing need for the rapid acceleration of the modernization of information support processes for managing the economic development of all large enterprises (Melnik, 2016). This also applies to companies with a state share, whose economy plays a decisive role in today's conditions of macroeconomic support for dynamics in general. For example, the corporate management system of Centrenergo can be described as a mirror of the Ukrainian economy, since it constitutes 20% of the country's thermal generation, and its state significantly determines the dynamics of the development of many other areas that form tariffs for services.

The analytical material available to managers, formed in accordance with internal corporate methods, is also necessary for evaluating the interaction of the directorate of an economic entity with various users. All other things being equal, when digitalizing communications of company managers with economic entities of the external environment – such as counterparties and regulators – the efficiency of using analytical data when checking the actual indicators of operational reports for the required reporting period and identifying deviations from indicators structured in the strategy for the same period significantly increases due to the technological support of accounting and analytical processes. In addition, it is necessary to apply a set of methodological materials for analyzing the results of control procedures and implementing related actions, such as modeling improvements in economic tactics and implementing necessary strategy adjustments, the typical content of which is presented in Figure 1.

Experts call such procedures "IT control." According to Professor Bogopolsky (2011), in any large company, IT control is so important that at least one employee of the internal control system (ICS) must be a certified IT specialist. Failures in the operation of large IT systems, especially with self-written modules and improvements, can create significant risks of distortions in the process of forming an enterprise's financial statements. Therefore, the IT specialist of the ICS should be competent in conducting intensive testing of the controls of various IT systems used by the company. Such testing consists of running fictitious operations, various business scenarios, or fictitious clients through the tested IT system and then comparing the results obtained for such simulated transactions with expectations (Bogopolsky, 2011)

It is advisable to present the general majority of the above information in the form of graphic illustrations of the company's document flow. It should be noted that in practice, such graphs are drawn up as illustrations, that is: diagrams, maps, or a list of works on creating, checking and processing documents, which are performed by authorized persons of the company within a pre-set time limit.

According to the information received from interviewed specialists, "no illustrative form can be called predominant; it is best to have both illustrations of the document flow schedule and its text version, which indicates the list of works and responsible persons." It is important that before approval by management, the document flow schedule must be coordinated with the heads of economic services of the company, which determines its compliance with job descriptions, the provisions of the current accounting policy and other elements of the company's strategy management.

To implement practical analytical support for the digitalization of transformation processes, it is significant to meet conditions such as the presence in companies of various high-tech complexes of systems for collecting accounting and reporting information, followed by its processing into a relevant form which can be used by managers to manage tactics and development strategy.

For this purpose, companies should employ professional specialists who not only provide such complexes, but also freely navigate the current modern evaluation models based on complex mathematical calculations.

The ESG disclosure index provides that each company must put a hyperlink to the ESG disclosure index in its traditional annual financial report. This is due to ensure convenience for users of financial statements – investors who are dissatisfied with the fact that it is very difficult to find integrated information in company reports, and that this takes a lot of time.

Using this indicator will allow companies to attract much more unambiguity and consistency in their reporting practice. Keep in mind that the above-mentioned index can be compiled using the tools of the Global Reporting Initiative (GRI).

Digitalization and digital transformation are quite firmly established in the programs of the largest panel discussions at various economic forums and specialized conferences. It should be noted that students of higher educational institutions believe that information courses are necessary for studying since digitalization processes are accelerating in modern society (Ostenda et al., 2018).

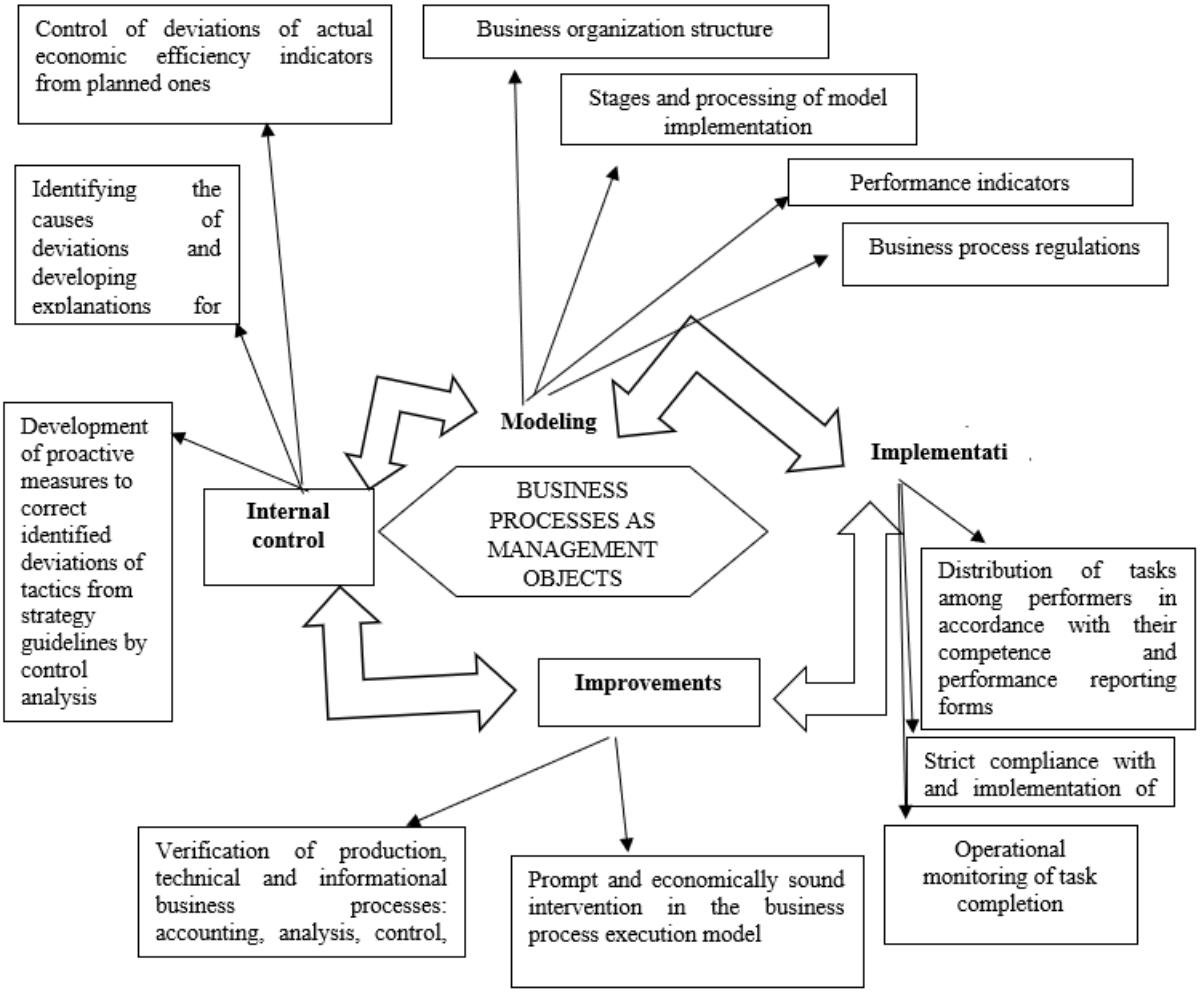


Figure 1. Model for maintaining consistency of economic tactics with the company's development strategy targets

Source: compiled by the author

The potential of this market is huge. According to Forbes magazine, more than 60% of the world's largest corporations will choose digital transformation as their strategy. Almost everywhere in IT technologies, open API (Application Programming Interface), SDK (Software development Kit), and other various integration tools are used. Companies do not need to program anything from scratch, because there are more than enough solutions on the market. All that is required is an understanding of the company's business and the developed digital transformation strategy (Ryzhkov, 2016).

In the conditions of the modern economic system, which is characterized by rapid changes, scientists and practitioners are constantly looking for ways to identify synergistic effects caused by the digitalization of corporate management systems processes. Thus, we can cite the opinion of L. Popovich et al. (2010) that "in the context of the global digital economy, it is necessary to create new mechanisms for the formation of synergistic effects in complex socioeconomic systems."

For a comprehensive solution to the tasks set, A. Koptelov (2007) suggests using the ARIS Audit Manager web product, which allows users to automate testing procedures and create reports on its results. This works working on the basis of ARIS – a market-leading business process management solution which provides the enterprise with all the necessary documentation to cover the life cycle of the on-farm control system, from documentation to monitoring (pp. 5–6).

In the author's opinion, the adaptive regression model proposed by Y. Novoselov (2011), which quantitatively describes the dependence of corporate activity indicators on the impact of a whole range of various factors on its results, is of research interest. This technique can be used to identify the results of any dynamic process. The initial point of this construction is the formation of groups of analog objects, and for each individual company, an individual taxon is determined for the entire complex of factors (Novoselov, 2011). The developer of this methodology is convinced that it provides an objective comparative assessment of the activities of the structures that are part of the group, and, taking into account their territorial isolation and reproductive potential, consists in compiling all the resources that provide not only growth, that is, quantitative potential, but also qualitative potential, that is, progressive dynamics of development. Starting work on this methodology involves conducting a comparative assessment of the activities of the holding structures based on the construction of adaptive regression models that allow us to more objectively characterize the whole set of factors that determine the final results of the activities of separate structures and the holding company in general. It is recommended to determine the information set of data for evaluation by constructing a matrix of paired correlation coefficients and taking into account the professional judgment of experts and subsequent analysis of the information obtained. However, here it is doubtful whether experts should be involved in interpreting the content of the assessment matrix, since usually they have different profiles and levels of professional training. In order to receive the necessary response, in practice, the head of the group of supervisors should indicate this in advance.

In the context of large-scale digitization of accounting and analytical information, according to D. A. Piperkov, T. Nestorenko, and T. Pokusa (2021), computer assessment systems become the subject of the intellectual efforts of specialists in various fields of activity, and special emphasis is placed on the banking system.

Since 2017, business entities have somewhat intensified the systematization of existing reporting and management forms and their transfer entirely to digital platforms. In this regard, in order to facilitate control over the clarity and coherence of personnel work on the formation of information both in accounting and in other information systems, it is necessary to develop a standard regulation on structural divisions with document management rules and other analytical support measures.

The conducted research revealed the problem of non-compliance with the deadlines for transmitting information from production sites and workshops to the central accounting departments of all studied economic entities. After all, the consequence of violating deadlines is the need to adjust accounting and analytical data and clarify tax returns, and this leads to additional complexity of accounting work, time, and financial resources of the company to eliminate shortcomings in the work. The lack of information about internal reporting channels and ways to save it in the document flow regulations is a drawback. Therefore, for example,

the provision by accounting departments of companies of reports on the cost of work to the financial and economic departments does not correspond to the procedure for collecting and deadlines for transferring documents from production sites.

In today's conditions, departments and services of complex economic entities are experiencing a significant shortage of information. On the one hand, there is a constantly growing need for detailing new ways to aggregate accounting information, maintain it digitally and control it more quickly. On the other hand, it is necessary to detail accounting and control information in an analytical context and expand the types of reporting. The managers of grassroots production structures of complex economic entities do not use complex digital platforms due to the lack of awareness of the rules of their application. As before, the main array of information is processed in the MS Excel program, and the order of movement of information flows is shown in Figure 2.

Scaling documents on digital platforms implies the growing need for managers to expand the capabilities of existing software products. The management of many complex economic entities have not developed a clear policy of information and software digitalization of document flow in all reporting formats, which is one of the reasons for using disparate programs for collecting and processing information, and this leads to unjustified dispersion of tasks solved for various software products. In this regard, control over the solution of tasks in such economic entities will not be productive.

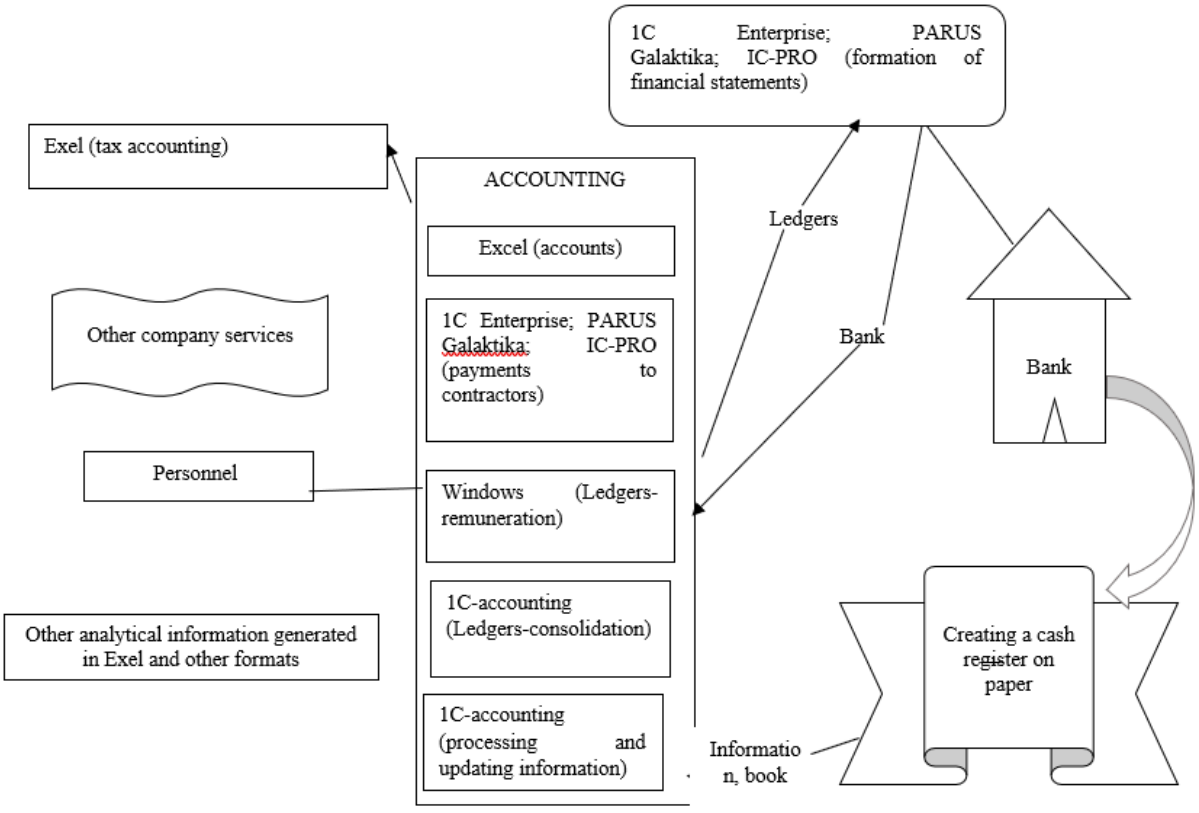


Figure 2. Information flows of accounting and analytical support for transformation processes
Source: compiled by the author

It should be noted that the information systems currently used are rather poorly integrated with each other, which leads to the problems of double input of information, irrational document flow and unjustified additional costs of labor and financial resources. The management of business entities do not make proper efforts to identify opportunities for integrating software

products to create a corporate-wide system for collecting and processing accounting information on a digital basis, as required by the best system for implementing corporate law. The accounting policies of many companies do not cover issues for which national accounting standards and the IFRS do not specify accounting methods. Furthermore, accounting methods that eliminate controversial tax issues and which, for example, are not regulated in the tax code of Ukraine, Russia, Belarus and many other countries are not reflected. This applies, for example, to: the procedure for accounting for special clothing; the procedure for reflecting and distributing transport and procurement costs, evaluating materials in analytical accounting and their storage locations (applying accounting prices); the procedure for accounting for income tax in accordance with the requirements of Accounting regulations 17; the procedure for reflecting certain specific income and expenses, and other nuances. As an undeniably negative factor that prevents the improvement of the accounting and analytical process in the company's financial and economic activity management system, we have identified a lack of analytics such as dictionaries and interpretations of important accounts. These lacking elements are summarized in full in Table 1.

To interpret the content and meaning of analytical data transmitted over digital communications, it is necessary to analyze the composition, size and dynamics of all data; the reasons that led to their composition, size and dynamics; and the consequences of the formed data array for current development and for strategizing.

Table 1. The incompleteness of analytical data in accounting registers

Source: compiled by the author

Account	**Analytical data**			
Account 10 "Fixed assets"	Analytical data on all types of fixed assets (production, non-production)	Analytical data by groups of fixed assets	Analytical data on the places of their operation, fixing	Analytical data on a materially responsible person
Account 15 "Capital investments"	Analytical data on types of capital investments (construction, acquisition)	Analytical data on types of construction (ground-based, other)	Analytical data on objects	-
Account 20 "Production stocks"	Analytical data for acquisition purposes	Analytical data on objects	-	-
Account 23 "Production"	Analytical data on production facilities	-	-	-
Account 31 "Bank accounts"	Analytical data on payment types (areas of activity)	Analytical data on accounts (on grounds)	-	-
Account 14 "Long-term financial investments"	Analytical data on types of financial investments	-	-	-
Account 63 "Calculations with suppliers and contractors"	Analytical data on settlements secured by the bill of exchange	Analytical data on contracts	Analytical data by type of acquisition	Analytical data on objects
Account 36	Analytical data on settlements secured	Analytical data on contracts	Analytical data on objects	Analytical data by type of work

"Calculations with buyers and customers"	by the bill of exchange			
Account 50 "Long-term loans" Account 60 "Short-term loans"	Analytical data on types of borrowing (credits/loan settlements, interest settlements)	-	-	-
Account 372 "Calculations with accountable persons"	Analytical data on types of business trips expenses			
Account 66 "Calculations of employee benefits"	Analytical data on calculations with employees (full name)			
Account 37 "Calculations with various debtors" Account 68 "Calculations on other transactions"	Analytical data on objects			
Account 39 "Deferred expenses"	Analytical data on types of expenses	Date of occurrence, write-off period, distribution base		

With proper addition – that is, an add-on of accounting information proposed above by analytics – it is necessary to completely redo the existing reference books in order to update them and bring them towards a single information structure.

Conclusions

The results of the study of the compliance of the methodology of analytical support of digital transformation processes with the modern conditions of the digital economy allow us to state that the development of the methodology of the accounting and analytical process involves: first, the study of cause-and-effect relationships in the economy, management and the institutional sphere of regulation of this process; second, the establishment of an organic link between the state of the economic and institutional environment with the content of the accounting and analytical process; and third, the formation and establishment of such a link allows economic entities to develop in accordance with corporate interests, which are defined in the economic strategy.

Digital transformations are being achieved via the usual models of industry markets and their management, thereby increasing the competitiveness of their participants. Thus, digitalization determines the development prospects of companies, industries, and national economies in general. In today's conditions, the management of economic entities has at its disposal a powerful arsenal of advanced IT technologies and IT software systems and platforms, the download and application of which requires appropriate information support. This mission is always performed by accounting and analytical and regulatory processes. However, it has been proven that the practice of accounting and financial reporting has accumulated negative properties that make it difficult to update the concept of information support for setting and implementing management goals, the need for which is long overdue.

We believe that in order to improve the effectiveness of control measures, the accounting and analytical array should be supplemented with information from the big data databases, which are formed from management, tax, and statistical reports, information summary reports of financial regulators, and sources of non-financial information.

Suggestions for improving the methodology of analytical support for digital transformation processes and specific practical recommendations will contribute to the acceleration of the digital transformation of accounting and analytical processes, and this will allow the timely identification of risks of loss of stability and efficiency of economic entities and take into account measures to eliminate or mitigate negative consequences in formulating development strategies. Proper methodological support for any transformation processes of an economic entity reflects the level of its economic development, priorities, strategic guidelines, and opportunities to achieve them. In addition, it must be adequate to the industry specifics of those regulatory objects under the management of which the necessary regulations are created, otherwise these regulations will be useless.

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THE THEORETICAL FUNDAMENTALS OF THE TRANSFORMATION OF THE DEVELOPMENT OF THE DIGITAL ECONOMY

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Abstract. *This study reveals the essence and importance of the digital economy as a major factor in socioeconomic development. The benefits of digitalization for society and the economy in general have been proven, as users of digital services and products have the ability to gain high-speed Internet access and improve their information and knowledge base, making life more comfortable and convenient. It is proved that Ukraine ranks first regarding freelancers among European countries, and therefore improving the legal and regulatory framework for this type of activity will improve the socioeconomic standard of living.*
The aim of this work is to reveal the theoretical and practical foundations of the importance of the digital economy as a factor in the socioeconomic development of the state.
The paper notes that the modern global labor market is a complex, multi-component and dynamic system that is permanently affected by information technology, which, in turn, entails changes in the content of the labor process, its organization, employment structure, social and labor relations, and also requires the formation of fundamentally new competencies of the employee. Digital technologies have created a very specific process of labor and have changed all of its elements: the subject, means, technology, organization and results of labor.
The impact of new technologies on human resources is unpredictable. This process is complex because it is not so much about innovative technologies as about how people are going to use them.
This paper contains an economic analysis of the main trends, problems and prospects of the digital economy in Ukraine in terms of key sectors, namely: telecommunications, IT technology and information services. It is established that these industries are developing quite rapidly and show relatively strong economic results. This contributes to increasing the investment attractiveness of enterprises, in particular for external investors. Prerequisites for the development of the digital technology sector in Ukraine are the growing market of information services, the availability of human capital, and minimal government intervention in the functioning of the industry.
These scientific research results are focused on developing a set of modern economic instruments and identifying promising areas of digital transformation of economic systems, including conceptual approaches to the transformation of the digital economy, which, unlike existing approaches, take into account the components of stimulation, motivation, and indicators of digital economy development.

Keywords: *digital economy, digitalization, development, digital labor market*

Introduction

The development of relationships in the social environment depends on the level of economic development. This applies at any level: global, national, regional, territorial, etc. Digitization of the economy is a certain form of economic technology with its own characteristics, trends and patterns. Many countries around the world use this technology to increase the efficiency of economic development, increase competitiveness, and more.
The information revolution, characterized by the massive spread of information technology among the population and businesses and their constant improvement and adaptation, has a significant impact on the development of national and regional economies.

Features of the development of modern economic systems, including the digital economy, formed the basis of research by many international scholars, including: J. Galbraith, D. Tapscott, N. Negroponte, and T. Messenburg. Ukrainian scientist M. Voynarenko dealt with the issues of capitalization of information and intellectual potential. The works of L. Kit, A. Shemet, I. Malik and others were devoted to the development of the network and information economy. Studies of transformational processes of the economy in the conditions of decentralization were outlined in the works of K. Bystryakov, S. Voit, B. Egorov, A. Klyuchnik, V. Lagodienko, L. Malik, V. Nemchenko, O. Pavlov, T. Stroyko, Y. Khvesyk, and others.
The results of previous research have created a strong theoretical and methodological basis for the processes of economic transformation, but there remains insufficient use of digital technology in socioeconomic development. It is important to identify promising areas of digital technology in the development of economic systems.

The main body of the paper

The essence and significance of the main components of the digital economy. The sequence of evolution in the technological world forms new production tools and a certain basis for various economic agents. New economic systems are being created as a result of industrial revolutions. The following two main approaches to understanding the role and place of digitalization in global industrial production are identified. The first treats the current stage of introduction of information and technological achievements as evolutionary – the next as revolutionary. According to the latter, the digital economy is studied as the basis of the fourth industrial revolution, because there is a clear change in basic technology and there are signs of changing technical and economic conceptuality.
Today, the formation of the industrial revolution is associated with the development of communicative Internet technologies, which have radically changed the technology of business processes and are called digitalization. Thus, the first step of the fourth industrial revolution and the third wave of globalization was the digital economy.
The hallmark of the digital economy is its connection to the demand economy, which is not based on selling goods and services, but gaining access to them when needed.
Digital diffusion occurs when digital technologies accelerate the transfer of knowledge, business innovation and productivity within the company through the supply chain of industries to achieve sustainable economic development.
The digital economy has significantly changed traditional business processes. Due to the most complex levels of digitalization, the economy sees the global transformation of industrial relations of participants, the result of which is the integration of production and services into a single digital system, in which (Mesenbourg, 2021):
- all elements of the economic system exist simultaneously in the form of physical objects, products and processes, as well as their digital copies;
- all physical objects, products and processes become part of an integrated IT system due to the availability of digital copy and the element of connectivity;
- due to the presence of digital copies and becoming part of a single system, all elements of the economic system continuously interact with each other in a mode close to real time, simulate real processes and predicted states, and provide constant optimization of the entire system.
The main segments of the digital economy are (Mesenbourg, 2021):
- the information and communication technologies sector and infrastructure related to e-business;
- digital production and e-business, including industry, and business organization processes using computer networks;
- e-commerce, i.e., retail and the Internet sales of goods.

The information and communication technology sector is one of the main components of the modern world, representing a new technological paradigm which belongs to the type of general-purpose technologies that are widely used and adapted to different sectors of the economy.
The world's largest IT companies are presented in Table 1.

Table 1. The largest IT companies and their market capitalization
Source: compiled by the author on the basis of Mesenbourg (2021)

Company	Sphere of activity	Market capitalization, billion $
Microsoft	Software	905
Apple Inc.	Electronics, information technology	896
Amazon Inc.	Retail company, sales and purchases over the Internet	875
Alphabet Inc. (Google)	Internet services, video hosting, applications	817
Facebook	Internet, social network	476
Samsung Electronics	Technologies	234

Artificial intelligence is becoming the core and foundation of a crucial technology for humanity (Nekrasov, 2019). Artificial intelligence has been characterized as a breakthrough class of technology over the past 10 years, which has occurred as a result of advances in computing power, volume, diversity and speed of data growth (Allam, 2016).
The volume of investments in the field of artificial intelligence in the world is growing rapidly. In 2018, this amounted to $27 billion (of which 55% was US investment). The share of digital services in Ukraine and the EU is presented in Table 2 (Nekrasov, 2021).

Table 2. Share of digital services in Ukraine and the EU, %
Source: compiled by the author on the basis of Nekrasov (2021).

Digital service	Ukraine	EU
E-commerce in retail	4	7
Organizations that use CRM systems	10	33
People who buy online	23	55
People who receive services online	29	48

According to the results of one study, artificial intelligence will increase, and in 2030 global GDP will rise by 14%, or $15.7 trillion due to the active use of artificial intelligence (Klingler-Vidra, 2019).
Researchers believe that artificial intelligence will be part of the digital transformation strategy and a priority for almost one third of companies. As for the industries that predict the maximum effect from investments in artificial intelligence technologies, they include: IT, technology and telecommunications (59%), commercial and professional services (43%), as well as consumer services and the financial services sector (32%) (Klingler-Vidra, 2019).
Broadband Internet access is a turning point that can transform and create jobs, drive productivity, and be the foundation of economic competitiveness in the long run.
The turbulent development of the world has helped broadband become a critical infrastructure that determines the competitiveness of countries in the global digital economy.
Broadband not only makes it possible to provide new services and create new industries, but also transforms existing industries and traditional regulatory principles with great speed (Alekseev & Bogatyrev, 2020). As a result of broadband:
- newspapers have become online content providers;
- voice over Internet protocol revolutionized the telephone market;
- in the music industry there is work on creating new income schemes;
- the copyright industry is facing new challenges in the protection of intellectual property online.

Thus, the ability to receive broadband Internet will directly affect employment. The ability of the Internet to reduce transaction costs provides opportunities for people who have difficulty finding work or access to productive resources, as well as improving the integration of people with disabilities and people living in remote areas.

According to research by the World Bank Group (2020) on employment, the 30% penetration of fixed broadband access on average in the Eurasian Economic Union may lead to the creation of 2–4 million new jobs by 2025, 1 million of which can be created in the field of information computer technology. It is possible to achieve an increase in productivity by up to 1.73% by 2025.

The essence of this fifth generation (5G) connection technology means accelerating data transfer by almost 40 times or more. The rapid development of such technologies will lead to a revolution in industry, agriculture and transport. There is a possibility of uninterrupted and high-speed data transmission, where devices can exchange data directly and provide access to the remote control of agricultural machinery, industrial works or unmanned vehicles.

The industrial sector of information and communication technologies is of great importance in the global economy. In industrial production, productivity has not increased over the last ten years, and demand has been largely fragmented, leading to a need for innovation.

In general, the share of material production in the world is declining, and thus the tertiary sector of the economy is beginning to occupy a leading position in the world.

Given that a third of the total economic value of the Internet of Things is concentrated in industrial production, the center of gravity of the new revolution falls on industrial enterprises (Aharon et al., 2015).

The next driving force of the digital economy is the spread of digital platforms. Recently, many digital platforms have emerged around the world that use data-driven business models to reshape existing industries. Digital platforms act as mechanisms that prevent different parties from interacting online.

Some non-global digital platforms have taken major market positions in certain segments. For example, around 90% of the Internet search engine market is owned by Google. Facebook accounts for two thirds of the global social networking market, and its platform is among the most popular social networks in more than 90% of countries. More than 40% of the world's online retail sales are through Amazon's network, and its subsidiary Amazon Web Service accounts for about the same share of the global cloud infrastructure market (UNCTAD, 2019).

One of the vectors of e-business which is actively developing is e-commerce. E-commerce is the field of computer networks and business processes that are associated with such transactions. E-commerce includes: e-information exchange, e-capital movement, e-commerce, e-money, e-marketing, e-banking and e-insurance services (World Bank Group, 2020).

Currently, Amazon, Google and Facebook are considered powerful companies in global e-commerce. Each of these giants has played a role in shaping the e-commerce industry. While before they each worked in their own niche, now there is an increasingly fierce struggle between them that poses a threat to other brands and retailers in the market.

Summing up, we note that the main current trends in e-commerce include (PaySpace Magazine, 2020) trade without barriers, the growth of subscription purchases, one-button purchase, and direct sales from manufacturers.

Current state and level of digitalization of Ukraine's economy. Current trends in the development of digitalization of various spheres of society on a global scale are obvious and inevitable. These trends are the basis for the latest stage of technological arms races, the consequences of which will be geopolitical and geoeconomic leadership. At the same time, there is the chance that, both for developed and developing countries, improvement of the domestic and socioeconomic situation is realized. Today, the digital agenda and the formation

of a hypercompetitive digital economy are the top priorities for many countries around the world.

Indicators of a country's readiness for digitalization include the four most important factors that describe the level of digitalization of the state: (1) the general level of digitalization of the economy; (2) the extent to which households are covered by the digital sphere; 3) the level of digital gaps; and 4) the state of intensity of state participation in digitalization.

It should be noted that the concept of digitalization of the economy in Ukraine is significantly different from what is currently understood worldwide. Currently, in Ukraine, talking about the concept of digitalization is specific, and attaches importance to concentrating exclusively on the formation of new types of services based on the collection and analysis of data from various physical objects. This does not address radical changes in the production system or in approaches to the design, production, marketing and operation of the physical objects which were laid down in the concept of Industry 4.0.

According to the report of the World Economic Forum (WEF) for 2019, which relates to the level of technological development and innovation in Ukraine, it should be noted that among the 100 countries in the world Ukraine occupied 60th place. In two indicators, the structure of production and driving forces of production, Ukraine took 70th and 59th place, respectively (Aharon et al., 2015). Thus, Ukraine is one of the countries lagging behind in this regard.

Losses in the leading industries have undermined the development of related enterprises in machine tools, toolmaking, metallurgy, materials science, industrial chemistry and others. Thus, as a result, for the 1992–2019 period the share of manufacturing in the structure of Ukraine's GDP decreased significantly from 44.6% to 11.5%, and became almost half the level of middle-income countries (19.6%). It was almost equal to the share of agriculture (10.1%), the export earnings of which today determine the dynamics of the hryvnia exchange rate, as well as inflation and the overall solvency of the state.

According to reports from the State Statistics Bodies, the deindustrialization of Ukraine's economy is accelerating. The rapid decline in production affects all areas of industrial production without exception (UNCTAD, 2019).

Overall industry represents 23%–24% of GDP, 12% of which refers to the processing industry. In 2019, this industry was rapidly declining compared to others. It should be noted that the component of the private sector in the processing industry is very high, at 95.3%. Thus, it can be argued that the negative state of industry is not related to the form of ownership. The starting point for the decline of industry was 2014, after it failed to recover from the fall of 2014–2015. In 2018, industrial production was at 82% of the level of 2013, so a decline in industrial production was evident. Considering the state of industry in 2019, we note that it exhibited positive dynamics for only three months, from March to May, and since the summer the decline has intensified (United Nations Conference on Trade and Development, 2019).

We recognize that the decline in industrial production is observed not only in our country. However, taking into account the results of 2019, the industrial production of the euro area decreased by 4.1% in December, while during the same period in Ukraine, industrial production decreased by 7.5% (PaySpace Magazine, 2020).

The level of digitalization that is occurring in the economy of Ukraine differs significantly depending on the specific industry. The sphere that concerns the financial services, communication services, and logistics of Ukrainian companies uses the achievements of information technologies as widely as international competitors.

Despite such trends, there are still a number of industries where the intensity of the use of digital technologies is extremely low. Thus, this state is the basis for a significant lag in productivity that characterizes these industries.

Some scholars believe that, in Ukraine, the level of enterprise spending on the development and implementation of new technologies and products and the state of investment in the innovation

component is absolutely dissatisfactory. Compared to global leaders, this is catastrophic in terms of the prospects for the development of the country (Kormakova et al., 2019).

The results of 2018 on innovation in industry provided by the State Statistics Bodies show that only 16.4% of enterprises used such technologies (Nekrasov, 2019). As for developed countries, there the share of innovative enterprises was 4–5 times higher, accounting 5%–60% of the total number of enterprises (UNCTAD, 2019).

In Ukraine, only 3.9% of enterprises spent on research and development (internal and external), and the component of innovative products, which is important in the total volume of sold products, has long been at the level of 6%–7%. Regarding the science-intensiveness of GDP in Ukraine, there was a reduction in the 1990–2019 period by almost three times, and the current value is less than 1%.

The IT sphere in Ukraine and high-tech export. The weakest point in the digitalization of Ukraine's economy is the complete absence of large Ukrainian IT companies. All powerful Ukrainian companies in this industry operate in the domestic market.

Considering the investment component in the IT industry, its share of industry in Ukraine is increasing, not taking into account the limited investment resources in the country (during 2013–2016, IT companies invested around $264 million in fixed assets and intangible assets) (Yahoo, 2020). However, overall, this share is less than 0.5% of total capital investment in the economy. The dynamics of growth of the IT market in Ukraine are shown in Figure 1.

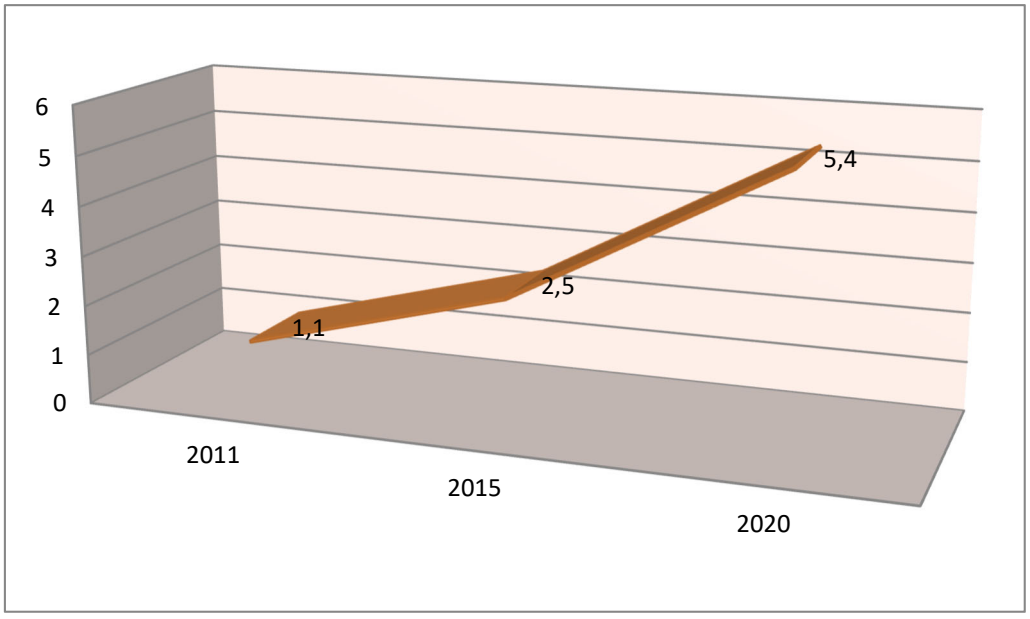


Figure 1. Dynamics of growth of the IT market of Ukraine
Source: compiled by the author on the basis of Demianchuk et al. (2021)

Almost 10 years ago the level of proposals for the provision of IT services was negative, due to the complexity of developing effective information systems. However, it is worth noting that there is a need for businesses in IT, and this is growing every year. It should be noted that companies lack the competencies to provide the required level of IT services for business, and they are also constrained by the limitations of low IT budgets.

According to forecasts, by 2025 the IT industry is likely to grow to $8.4 billion, and the number of jobs will increase by 2.5 times to more than 240,000. According to experts, the IT services industry in Ukraine tends to grow under any circumstances, but systemic problems (including weak investor protection, unclear tax rules and the lack of effective copyright laws) are slowing

down and hampering work – not only for outsourcers, but also for other companies (Klingler-Vidra, 2019).

With regard to the export of IT sectors, we note the level of digitalization of the economy and the importance of high-tech exports. Exports of IT services (% of exports of services, according to the balance of payments) in Ukraine are growing every year. Such services, namely in the field of information technology, bypassed pipeline transport to become the second largest branch of all exported services (Aharon et al., 2015).

According to the estimates of the IT Ukraine Association, it is noted that more than 80% of IT services in Ukraine are formed for foreign markets, which make this industry export-oriented (Ministry of Education and Science of Ukraine, 2019).

According to the estimates of the IT Ukraine Association, the IT industry in 2016 was in third place in the overall list of Ukrainian exports (Filipishyna, 2021). Based on this forecast, by 2025 the industry has every chance to grow to $8.4 billion and provide more than 40,000 jobs. Data from the World Bank show that Ukraine ranks 33rd in terms of exports of IT services (World Bank Group, 2020). Leading positions are occupied by the USA and China. Their volume of the global market of IT services in 2017 exceeded $3.5 trillion. India's IT market can be estimated at $145 billion, which is almost 40 times more than that of Ukraine. It should also be noted that the Indian information technology market has active support at the state level, which cannot be said of Ukraine. To date, the number of IT professionals in India has exceeded 4 million, which is 40 times more than in Ukraine (Klingler-Vidra, 2019).

The current state of affairs is partly explained by the fact that the digitalization movement in the Ukrainian economy took place much later than in European countries, and such a gap is still observed.

As for private companies, they mostly buy equipment and developments abroad. In 2016, procurement amounted to only $190 million – in 2020, it has grown to $300 million. The extremely low consumption of information technology, equipment, services and software has a significant direct impact on the state of Ukraine's economy.

Orders from abroad justify a certain dependence in the domestic market, which is unable to provide the IT industry with dynamic development and high wages. Working for a foreign customer does not allow IT companies to earn money constantly and on a large scale on their own products.

Features and characteristics of the digital labor market. In the digital economy, there are changes both in the nature of work and in the system of labor relations. Thanks to digital technologies, an appropriate work process is formed, which brings significant changes in its elements, such as: subject, means, technologies, organization and results of work. Under modern conditions, the information economy turns information into an object of labor.

The specificity of the digital labor market is global. The effect of the digital labor market is the interaction of the employer with the employee, which takes place on the digital platform through the remote work mode. Thus, a job seeker can be employed remotely without having territorial or national borders.

To consider such work a specific segment of the labor market helps segmentation of the global market that occurs on the basis of the mandatory use of modern IT devices or other gadgets and their technologies at all stages of work, namely: job search, job or order, its implementation, sending the result of work and receiving payment for work. A comparative description of the traditional and digital labor market is given in Table 3.

Table 3. Comparative characteristics of the traditional and digital labor market.
Source: compiled by the author on the basis of Filipishina et al. (2020)

Traditional labor market	Parameters	Digital labor market
Used with or without ICT, depending on the specifics. Coordination is carried out by the immediate supervisor, and they are transferred to the work performed.	Technology of work performance, its coordination and transfer to the buyer	Execution, coordination and transfer of the finished product is carried out with the help of ICT to the employer. The product sold in the digital labor market is a labor service created with the help of ICT.
The monthly salary, corresponding to the chosen form and system of remuneration, provides additional material incentives in the form of bonuses, profit sharing, dividends.	Pay	One-time or divided into certain parts for the volume of work performed using electronic payment systems and electronic money. The main level for determining the remuneration is the level of complexity of the work and the uniqueness of the labor service provided.
Real workers looking for work in enterprises and organizations that produce goods or provide services.	Interaction of the employer with the employee	The mandatory use of ICT at all stages of employment: job search, receiving an order, its implementation, transfer of work results and remuneration.
Existence of permanent staff, lack of regulations.	Labor market mobility	Flexibility of the digital labor market is associated with a virtually unlimited level of digital mobility, which greatly reduces the cost of maintaining it by the employer. The main feature of the mobility of this segment of the labor market is its virtual nature, the movement of labor occurs without its physical movement. A sufficient condition for labor mobility is the demand for a certain type of service, the ability of a virtual employee to produce services of the required quality, as well as their willingness to find and fulfill new orders.
Low level of dynamism: - the labor market is not moving forward to a new, more efficient employment structure, and if it is moving, it is extremely slow; - stagnant labor market, in which there is virtually no movement of workers through available jobs, or the transfer of jobs from inefficient production to efficient.	The level of dynamism of the labor market	High level of dynamism: - high labor turnover, labor market demonstrates the ability to quickly update the structure of jobs; - the labor market is able to move directly, without deviations and slippage, to a new structure of employment, which is dictated by a shift in demand, changed by technological and institutional conditions.
All age groups.	Age structure of employment	The demographic and digital market belongs to the young generation of workers who are able to produce innovations, quickly navigate information flows and learn.

The following digital devices act as tools: laptops, computers, various gadgets, tablets, cellular devices, cameras and more. The input information required for employment is digitally recorded. Information is the object of a specialist who, thanks to their skills, experience and ability to select and highlight innovations, makes changes to it. Therefore, the digital labor market is a unique segment of the global labor market, which remotely generates supply and demand for digital labor services and has the interaction of its actors, which is carried out exclusively through information technology.

Digital employment is an extremely important and appropriate activity of the active population, which has economic orientations, with the help of digital technologies, where the result acts as an information product and direct interaction is a reference point for meeting public and

personal needs and economic benefits for workers and interested employers. Labor supply and demand takes place on special online platforms which form the terms of employment, payment issues and performance appraisal.

The main specificity of the digital market is the interaction of digital labor market actors, which takes place through the online platform. This is a place of conflict of interest for employees and employers and a place of agreement to pay for services provided. The labor service is formed with the help of computer systems in the formation of goods sold in the digital labor market.

Note that a characteristic feature of the digital labor market is a high level of flexibility, which indicates a high level of labor mobility. The main characteristic of the mobility of this segment of the labor market is its virtual nature. Thus, the movement of labor is carried out without its direct, physical movement, from any country to another. Note that experts highlight the creation of a new, modern type of mobility, i.e., digital, which occurs without the physical movement of labor, which greatly reduces the cost of maintenance for the employer (UNCTAD, 2019).

With regard to globalization and informatization, it should be noted that technology raises the level of competition and strengthens the competitive advantage of people with relevant, quality education, the highest level of professionalism, talent, honesty and the ability to solve non-standard problems. The most popular in the digital labor market is intellectual work, which is characterized by the specifics of the services offered.

Researchers note that the digital labor market is shaping innovative employment. The main carriers of innovative human capital are people who are constantly improving their knowledge, professional skills, self-education, and use the experience gained for the productivity of innovations using different areas of choice via computer systems.

Economically active youth are the main agents of the digital space that master and use it. According to a report by the US Bureau of Labor Statistics on the demographic structure of employment in the digital segment, the largest share of employment is in the age group from 16 to 35 years, as they account for 50% of the total number employed in this segment (PaySpace Magazine, 2020).

Among the main stakeholders in labor services in the so-called virtual labor market are innovative companies covering the global market and companies that are young and fast-growing.

One of the hallmarks of the digital labor market is that it has a high level of dynamism. There are the following four models of labor market dynamics, which depend on the composition of factors such as the intensity of reproduction of labor (high, low) and the intensity of reproduction of jobs (high, low) (Allam, 2016):

- a model with a high turnover of labor (observed during the labor market, demonstrates the ability to quickly update the structure of jobs);
- the arrow model (assumes that the labor market is able to move directly, without deviations, to a new employment structure, which is formed under the influence of changes in demand, which have changed under the influence of technological and institutional conditions);
- a model in which the labor market, even under the influence of certain transformations, does not move towards a newer, more efficient structure of employment, and if this happens, it is extremely slow;
- a model of a stagnant labor market, under the conditions of which there is practically no movement of people due to the availability of jobs or the transfer of jobs from inefficient to efficient productions.

Due to its nature and level of dynamism, the digital labor market corresponds to the first two models.

Attention should also be paid to the emergence and development of the virtual (electronic) labor market, which can significantly expand the potential of labor, become a basis for alternative

spheres of professional and individual self-realization, and involve people with low social protection in the professional development process.

The next segment of the global labor market today is the traditional market, which is a set of interactions between stakeholders in labor services, creating demand and supply that are realized outside the digital sphere.

Considering digital employment, we emphasize that it is reflected in two main forms: e-freelance and e-outsourcing (World Bank Group, 2020).

An electronic freelancer performs work activities that are performed remotely using computer systems. This is used in a wide range of economic activities, namely: programming, content creation and translation, marketing research, sales, consulting, and financial accounting and administration.

Outsourcing, in other words, the use of external resources, is based on the principles of selling goods through contracts based on the transfer of non-core production and commercial operations to an independent external partner who has production cooperation, and to reduce costs. The current specificity of outsourcing agreements in the product market is based on the fact that processing is carried out, which consists in supplying the products of the main production to the customer under their brand. This is the main difference between modern outsourcing contracts and contracts that exist in a regular contract. Within the contact group, the contractor essentially provides the customer with a service that consists in the execution of the order, which is based on the production, delivery to the market and sales of the subject of the contract. Therefore, the elements of service provision are also added to the component costing of production operations.

Note that, according to experts who draw attention to the fact that the outsourcing market is formed and growing unevenly, there are sharp reactions to the variability of external factors. Thus, it is believed that such uneven development depends on the following factors:

- The involvement of specialists for design or one-time work. This is very common in the global structure of outsourcing, which provides such services. While 43% of manufacturing companies use external specialists sometimes, they do not do so constantly.
- The increasing need for outsourcing in times of crisis. The use of outsourcing services leads to a significant reduction in labor costs and other resources, as such actions allow the company to stay afloat.
- The presence of a large number of small outsourcing companies and freelancers. This is characterized by fragmentation of the market of external services and the number of small organizations and individual outsourcing specialists and services that provide them, and can range between wide limits.
- The involvement of specialists from other countries and the impact of emigration. Thanks to digital technologies, the participation of specialists in remote work from countries with lower wages is gaining popularity. IT outsourcing, remote call centers, marketing research, and sales are considered key services of this model.

Analysts of modern economic development predict that in the near future – under the influence of the fact that the main drivers of market development are the development of digital technologies – cloud technology, artificial intelligence, and robotics will be dominant.

Thus, e-outsourcing is the transfer of part of the business processes that take place by third-party organizations that use computer software and the Internet.

Globally, the following processes have had the greatest impact on the development of outsourcing:

- technology (complexity, location and nature of services that can be used for outsourcing). These criteria have become large-scale and are constantly evolving, expanding their benefits for use in business;

- internationalization (increased political and regulatory stability, improved education of labor market representatives, reduced resistance to mobility, implementation of cloud and mobile solutions);
- economic and political factors (the need to maintain a certain budget within the public sector of the economy, strengthening the requirements for risk assessment of financial services, such as the adoption of Directive 2004/39/EC of the European Parliament and of the Council regulating financial instruments markets). These factors also concern the protection of information aimed at combating corruption (World Economic Forum, 2019).

The following types of outsourcing exist, and their use depends on the location of the customer and the contractor and the subordination between them:
- offshoring (the customer and the contractor are in different countries, and the contractor is a division of the customer);
- outsourcing (the customer and the contractor are in the same country, and the contractor is an independent company);
- offshore outsourcing (the customer and the contractor are located in different countries, but the contractor is an independent company).

There are also types of outsourcing depending on the tasks that are delegated to performers:
- production outsourcing is the transfer of production functions to the contractor;
- outsourcing of business processes is the transfer to the executor of processes that are not the main activity of the customer;
- IT outsourcing is the transfer to the maintenance of customer information systems (e.g., development or maintenance of software, website creation, maintenance of related equipment).

Based on the above, we note that one of the undeniable advantages of outsourcing is the transfer of non-core and specialized areas of customer service.

The main advantages when deciding to outsource companies are as follows (Nekrasov, 2019):
- increasing demand by attracting additional labor resources;
- reducing costs by reducing payments, as well as the lack of an additional social benefits package which the employer provides to full-time employees, and potentially the replacement of existing employees;
- flexibility in cost allocation via scheduling, mobility and the reduction of permanent staff and subsequent use of temporary labor, if necessary;
- accessing the best modern professional skills by replacing workers, access to the local labor reserve;
- predictable, standardized (international) processes via the management and quality of contract work, the impact on margins and net profit of suppliers;
- concentrating capital and rebalancing regulatory or business uncertainties via the concentration of professional skills, technologies and internal interaction that allows set tasks to be solved (in particular in the sector of services related to finance).

Significant trends characterize the development of the global market for international outsourcing services:
- high growth rates of sales in the market of science-intensive goods and services. The range of processed products in this group consists of: serial electronic devices that are mainly consumer-based, and their components, and the components and parts of modern devices related to data processing and transmission (computers, memory units, microprocessors, printers, etc.). The range of science-intensive services provided by outsourcing contracts includes applied research, research on new products, engineering services, information technology services, communication services and more;
- improving the qualification level of labor-intensive services. It is worth noting that business models for most labor-intensive services have changed from a low-cost approach, in which the main element is to reduce costs and to attract cheap labor, to a transition to a professional model

that involves highly qualified personnel capable of performing new, more powerful, modern, and efficient business operations.

Thus, the turbulent development of the global labor market is a rather complex, multicomponent and volatile system, which is permanently affected by information technology. This in turn entails changes in the essence of the labor process, its organization, structure of employment, and social labor relations, and also requires the creation of fundamentally new competencies of the employee (Mikhno et al., 2022). Digital technologies have formed a specific process of labor and have made a significant contribution to changes in all its elements, namely: the subject, means, technology, organization and results of labor (Yankovyi et al., 2019).

It is impossible to disagree with the fact that current changes in the field of new technologies and their impact on human resources is predictable (Filipishyna, 2021). This process is quite complex, because the main goal is not so much about deep innovative technologies, but about how society perceives their use.

Conclusions

The modern world has already taken the first step towards a fundamentally new technological, economic and social reality. However, the challenges facing modern industrial society are difficult to overestimate. We are talking about a change in the global socio-technological structure, which results in the complete reformatting of our usual systems and the formation of new social and economic strategies. At the same time, the technological paradigm is changing, management models and social norms are changing, and large-scale demographic changes are taking place.

The essence and significance of the digital economy as the main factor of socioeconomic development are revealed in this work. The benefits of digitalization for society and the economy in general have been proven, as users of digital services and products are the population that has the ability to gain access to high-speed Internet, information, and a broad knowledge base, making life more comfortable and convenient. It is proved that Ukraine ranks first for freelancers among European countries, and therefore improving the legal regulation of this activity will improve the socioeconomic standard of living.

The model of transformation of the digital economy and society is considered. The main factors and indicators of the development of Ukraine's digital economy are identified: the development of digital finance, social networks, digital identification and infrastructure; the protection of intellectual property and e-commerce; and the business and data revolution. The formation of a model of transformation of the digital economy has been studied, which will take into account the incentives and motivations of digitalization participants. This will lead to the development of digital infrastructure and business, the renewal of projects, and the competitiveness of industries and sectors of the national economy. It is proved that the digital economy is an open, complex, nonlinear, poorly structured non-equilibrium.

The necessity of the investment component in promoting the development of the digital economy and society is substantiated, as no transformation is possible without significant investment. Analysis of investment processes in the digital economy shows that significant innovative changes in telecommunications occurred due to the transition of companies to 3G and 4G in 2015 and 2018, respectively, and the volume of investment increased during these periods by 14,799.9 million UAH and 11,489.7 million UAH. It is proved that the creation of engineering clusters, intersectoral alliances, centers, laboratories, incubators, accelerators, venture funds, and innovation teams that integrate IT companies, local authorities, educational institutions and service structures in the field of information is promising for the development of the digital economy in Ukraine. These strategic dominants of the digital transformation of

the economy will allow investors to focus on promising long-term investment projects that will ensure the sustainable development of public welfare.

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ANALYSIS OF DIGITAL TRANSFORMATION IN UKRAINE

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***Abstract**. This article analyzes the main indicators of the digital transformation of the management of the national economy of Ukraine in order to identify the strengths and weaknesses of the country's network readiness and assess the demand and supply in IT, the level of involvement of economic stakeholders in digital technologies, and the prospects for the digital economy and its impact on the achievement of sustainable development goals. The principles of the relationship between electronic business and the population are developed.*
The paper considers the main tasks of digital transformation. Its advantages and risks are revealed both for the country as a whole and at the level of individual companies and industries. A brief overview of the digital transformation in Ukraine is given, involving: the banking and financial sector, the service and industry sectors, and the social sphere. The share of services and social sectors is predicted to grow by more than 20%.
For the effectiveness of decision-making, an analysis of the problems of digitalization of the economy of Ukraine at the micro and macro levels was carried out. A grouping of indicators for evaluating the effectiveness of digital transformation was conducted, which makes it possible to comprehensively assess the scale of economic transformation in order to develop proposals for digital support of key national socioeconomic processes. Due to its implementation, the main factors and indicators of the development of the digital economy of Ukraine were identified. To analyze the indicators of the digital transformation of the national economy of Ukraine, the following were chosen as the information base: global connectivity, IT maturity, indicators of investment and innovation activity, and the relationship between GDP and digital transformation. Among the indicators of connectivity for end users, the level of services of telecom operators received the highest ratings. E-government scores, the number of users accessing the Internet, the cost of broadband, and cybersecurity awareness were above average. At the same time, all of these indicators, except for the cost of broadband access, had a positive trend. A set of measures are proposed to restore and develop the economy in areas of specialization.

***Keywords:** digitalization, digital economy, transformation, digitalization*.

Introduction

The spread and constant updating of digital technologies significantly changes ways of life and the behavior of economic entities, and necessitates the improvement of business processes and the emergence of new business models. Experts, scientists and politicians are widely discussing these changes. At the same time, it is expedient to be aware of actual transformations, their gradual nature, and the essential properties which make up the basis of their effective activity. The aim of the work is to analyze the main indicators of digital transformation of Ukraine and develop actions to improve the innovative state of the country.
General scientific methods are used in the research, in particular: generalizations, comparisons, methods of theoretical and empirical research, analysis and synthesis, deduction, expert evaluation, and statistical analysis.

Main part

The use of the digital economy for the country is becoming a daily norm. Today, such areas of life as medicine, security, education, transport, ecology, and tourism cannot be imagined without the use of information and communication technologies. Therefore, the question constantly arises regarding the expansion of methodological research approaches to the development of the digital economy. The speed of technological change determines the pace

of analysis of the impact of digital technologies on economic processes. There has been a significant amount of in-depth research in recent years.

The COVID-19 pandemic significantly accelerated digitization processes, creating not only new needs and opportunities, but also new dependencies and problems. In modern conditions, the urgent need is not only for a theoretical understanding of the threats or opportunities posed by digital technologies, but also to determine the speed of effective transformation of business processes, which will optimize transformation costs.

Competitive advantages and innovations in the digital world are based on accurate analysis and understanding the vast array of data that is constantly being created. In order to use big data knowledge and act on it in real time, it is important for business analysts to become the most sought-after professionals in the next decade of the 21st century – from startups to large corporations.

The system of state bodies, as a key element of the mechanism for managing the development of the national economy, consists of legislative and executive bodies. The only state legislative body in Ukraine is the Verkhovna Rada. On August 29, 2019, the Verkhovna Rada Committee on Digital Transformation was established, the main tasks of which are the drafting of law and the preparation and preliminary considerations of issues, as well as the implementation of control functions for the digitalization of society in Ukraine.

The legislative basis for the process of digitalization of the national economy currently consists of 16 laws, 15 bills, 5 international documents (conventions, declarations, directives), the resolutions of the Verkhovna Rada and the Cabinet of Ministers, and orders of Ministries.

The purpose of digital transformation is to change the logic of companies' processes and transition to risk-oriented management based on the introduction of digital technologies and big data analysis. Big data refers to very large data sets that can be mathematically analyzed to identify patterns, trends, and correlations, especially with respect to human behavior and interaction.

The tasks of the digital transformation are:

1. Ensuring the adaptability of the company to new tasks and challenges.
2. Improving the reliability of electricity supply to consumers.
3. Improving the efficiency of the enterprise.
4. Increasing the availability of electricity grid infrastructure.
5. Developing human resources and new competencies.
6. Diversifying the enterprise's business with the help of additional services.

The high speed of digitalization in all aspects of life is due primarily to its possible positive manifestations and consequences at all levels.

The benefits at the level of the whole society are:

• economic and social effects of digital technologies for business and society;
• improving the quality of life, primarily by improving the satisfaction of specific preexisting and new needs of people;
• increasing the productivity of all social labor by increasing it at the level of individual industries and enterprises;
• the emergence of new models and forms of business that can increase profitability and competitiveness;
• increasing the transparency of economic transactions and ensuring the possibility of their monitoring;
• ensuring the availability and promotion of goods and services, both public and commercial, at the global scale;
• the emergence of human-replaceable control systems, for example, for enterprises of certain classes.

Advantages at the level of individual companies and industries include:

• getting rid of intermediaries. Digitization allows manufacturers to arrange on their websites the sale of their products or services and reach out to potential customers. Consumers get the opportunity to independently choose the goods and services offered on the servers of airlines, hotels, e-shops, etc.;
• cost optimization, which involves, above all, reducing the cost of information retrieval, identification and measurement of transaction costs; the costs of promoting goods and services; and the costs of concluding and conducting negotiations, etc.;
• acceleration of all business processes, including by reducing the time of communications;
• reduction of reaction time to market changes, reduction of terms of development of products and services and their introduction on the market;
• better understanding of customers and improving the quality of products and services;
• creation of new products and services, increasing the flexibility of the offered products and their high adaptability to the new expectations or needs of the consumer.
The technological advantages due to digitalization include:
• information sharing and lack of competition in the consumption of knowledge and information, as the use of a database or knowledge base by one consumer does not prevent its simultaneous use by other consumers;
• accumulation of large amounts of data and their automatic processing and analysis;
• synchronization of information flows, the possibility of point-by-point distribution of data throughout the business and, as a consequence, the ability to track a large number of chains between suppliers and consumers, as well as conducting intellectual and point analysis;
• not just mastering new technologies at the applied level, but the transition to an awareness of the potential of new innovations, to create new innovative products focused on the development of technological intelligence (for example, data management technologies);
• transition from paper to electronic documents (sick leaves, employment records, etc.).
The tangible consumer and employee benefits are:
• reduction in the cost of payments and the emergence of new sources of income;
• the cost of Internet services is much lower than in the traditional economy (mainly due to reduced marketing costs), which makes services more accessible (both commercial and public), and goods and services become available anywhere in the world to any buyer;
• goods and services take into account the consumer preferences and needs of customers;
• the range of information, educational and entertainment services is significantly expanding, the level of provision and speed of which are also increasing (Ukrainian Institute of the Future, 2018).
However, not everything is so optimistic. The digital economy carries with it corresponding risks (OECD, 2017). For privacy, these risks are:
1. The penetration of third-party IT technologies in all aspects of life and activity significantly limits our privacy and increases its vulnerability.
2. There is a real threat to national cybersecurity: finance, transport and energy infrastructure, economic management, social engineering and modeling.
The risks to society are:
1. This significantly increases the number of people who lose their jobs due to the robotization of firms and companies.
2. Poverty and human resources. A significant proportion of people are more likely to be unable to cope with modern work due to their unpreparedness.
3. Children's access to personal computers from an early age leads to the formation of machine thinking (instantaneous, mathematical-linear, fragmentary, superficial) to the detriment of systemic thinking (multifaceted, holistic, philosophical, complex). The disappearance of the latter from our lives causes problems regarding the optimal resolution of everyday

contradictions. The development of driving innovative ideas requires non-trivial mental capabilities.
4. In the absence of economic need, the individual decreases and then disappears altogether.
5. The child loses qualities such as imagination, replaced by a false version – a man-made reality on which modern culture and art are based.
For spirituality and moral climate, these risks include:
1. The connection with the real world will soon be broken. The current computer generation is interested in almost nothing but modern gadgets. Over time, people become locked only in communication with artificial intelligence. Through this, they build communication with others.
2. The machine has no feelings, such as morality. Given that morality is a purely sensual concept, it disappears along with human emotions. The ability to empathize – the main goal and criterion of personal development – disappears completely.
There are also macroeconomic threats posed by digitalization. Slow productivity growth will threaten progress in improving global living standards, the viability of social protection systems, and the ability of economic policies to respond to future shocks (Pisarenko et al., 2019). However, according to World Bank experts, pessimism about global prospects is felt not because of the development of digital technologies, but against it. Thus, the world is experiencing a trend of declining global productivity, increasing global inequality, and the crisis of global governance.
In the field of IT, there is a decrease in the number of patents issued annually.
Despite this, digital technologies in the economy continue to develop and expand the scope of their use (Delo.ua, 2019). The digital economy has very bright prospects.
The development of Ukraine's digital economy requires new types of relationships between e-business and the population, which should be based on the basic principles of formation and development of these processes (Figure 1).

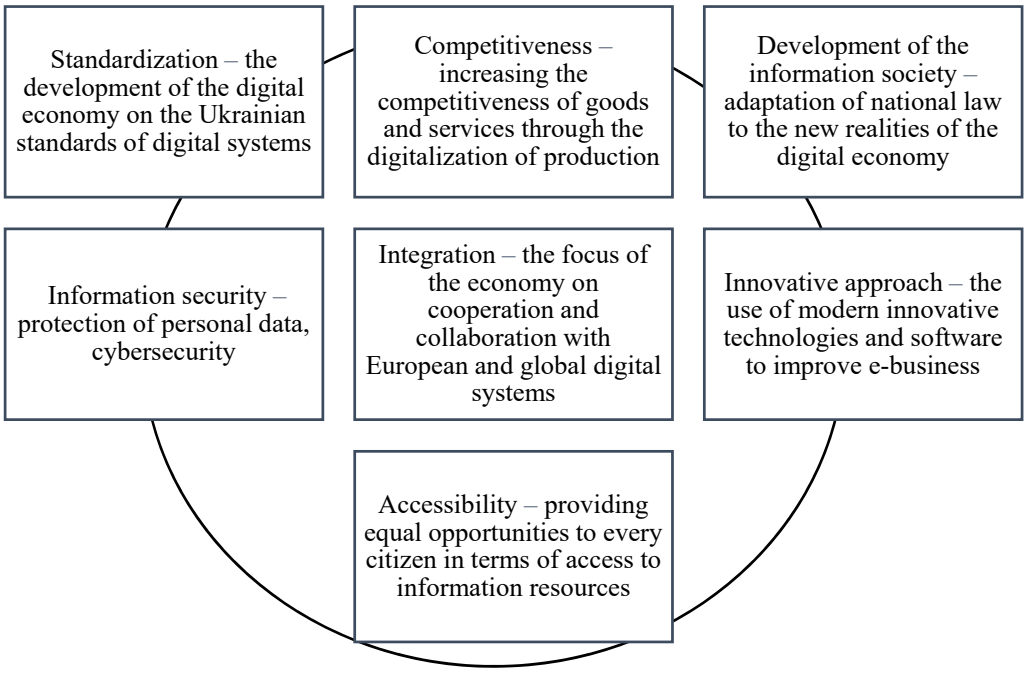


Figure 1. The principles of the digitalization of Ukraine's economy
Source: Author's own development

The growth of data and new tools for their analysis have allowed the world to move from situational to integrated digital transformation.

Global spending on digital transformation in 2020 amounted to $1.3 trillion, according to the Worldwide Digital Transformation Guide (IDC, n.d.). According to calculations in Statista (2022), in 2022 these costs will amount to $1.78 trillion – and in 2024, to $2.39 trillion. This shows that the whole world has chosen a rapid vector for the development of digital technologies, and the COVID-19 pandemic was the impetus for this. It is pertinent to consider a brief overview of the digital transformations of Ukraine.

Digitalization of banks. Over the last few years, the banking system has undergone major changes. The advantage of providing digital services and exceptional interaction with customers were caused by the restructuring of the financial market, including the development of cryptocurrency, bitcoin and blockchain. The main directions of the modern banking system in terms of digitalization are:

- Digital transformation of bank transfers. This process becomes automated – now, customers do not need bank staff to make a transaction.
- Rethinking the banking business model. A good example is the use of blockchain technology, which reduces fraud in the banking sector. This is already used in transactions such as payments, direct investment transfers, trade and production management, mortgage, credit reports, etc.

Cloud technologies in the banking sector. Thanks to the provision of network access, banks have many new opportunities, including cooperation with partners for the development of digital products and optimization of business processes.

Digitalization of the financial market. Experts from PwC, a consulting and auditing company, believe that the digitization of the financial market is caused by two factors:

- Complete adaptation of generation C to the digital environment. Consumers are constantly ready to share their personal experiences and impressions on social networks.
- The emergence of new economic benefits. Digitalization has shifted capital to social networks and websites.

Financial and accounting calculations require highly qualified IT specialists who will be able to optimize business processes. Now, more and more financial companies are investing in digital technology to increase the efficiency of their operations, as well as make extra profit.

Digitalization of the market. The IT solutions segment dominates and is expected to reach $798.44 billion in 2025 in the USA. This trend can be explained by the rapid development of new technologies.

In the coming years, we will see an increase in the share of services by 19.5%. Regarding the analytics segment, there is growing demand due to the synthesis of large amounts of data and an increase in the number of devices and applications with built-in artificial intelligence.

The sphere of social networks will be the fastest-growing, with an increase of more than 20.6%. This is due to the promotion of a social networking platform that helps companies identify their target audience and understand their behavior when purchasing goods or services. Experts expect the professional services segment to grow by 19.9% over the next 7 years. The increase in the number of digital technologies stimulates the demand for higher education programs to train the existing workforce, which is successfully adapting to new technologies. The healthcare sector will achieve the highest growth – 19.5% – due to increased demand for electronic devices with built-in artificial intelligence and the ability to monitor the general condition of the patient online.

The share of small and medium-sized businesses will increase by 20.1% by 2025. Phenomenal growth can be explained by factors such as lower device costs and increased attention to cloud and peripheral computing.

The economic effect of the digitalization of industry can be multifaceted, and can involve both the digitalization of technological processes and ways of organizing production and the

digitalization of means of labor (equipment, devices, machines) with the best quality characteristics.

Analysis shows that digitalization has almost no effect on Ukrainian industry, which is showing a tendency to rapidly reduce its pace of development. For Ukraine, the critical problem is the technological backwardness and the preservation of this backwardness. Ukraine not only failed to make a technological breakthrough in this regard in recent years, but also lost its position.

It is important to note that the concept of digitalization of the economy in Ukraine is fundamentally different from what is currently happening in the world. In Ukraine, the concept of digitalization is focused exclusively on creating new types of services based on the collection and analysis of data from various physical objects (buildings and structures, vehicles, industrial equipment, etc.), and does not cover the issue of radical change in the production system. Nor does it concern approaches to the design, production, marketing and operation of these physical objects, which is enshrined in the concept of Industry 4.0.

It should be noted that according to experts, Ukrainian industrialists understand Industry 4.0 mainly as the purchase of imported equipment that is relatively modern and, preferably, inexpensive. This is the end of their vision of modernization. It is estimated that the key problem is low business culture. The choice of contractors in Ukrainian companies is often carried out on the basis of the cost of the proposed solution, while nobody pays attention to the criterion of quality (Grigorenko & Yurchak, 2019). However, Industry 4.0 technologies involve the full digital integration of the enterprise vertically and horizontally, the creation of more smart products and services, and the transition to new business models.

Analysis of the implementation of the concept of Industry 4.0 allowed us to identify the common problems that hinder the development of digital trends in Ukraine and the transformation of the Ukrainian economy into a digital form (Table 1).

In 2019, 782 enterprises carried out innovative activities in industry. At the same time, the share of the number of industrial enterprises that implemented innovations (products and/or technological processes) in the total number of industrial enterprises was 13.8%.

Of the total number of innovative enterprises, the following areas were targeted for innovation: internal and external research – 24.4%; purchase of machinery, equipment and software – 64.7%; acquisition of external knowledge – 4.5%; other works – 20.6%. By types of economic activity, the largest shares of innovative enterprises were involved in the production of food products – 16.8% – and most innovation concerned the production of machinery and equipment. Enterprises not included in other groups accounted for 10.2% of innovation.

In 2019, companies spent 14,220.90 million UAH on innovations, including: 10,185.11 million UAH for the purchase of machinery, equipment and software; 2,918.85 million UAH for internal and external research and development; 37.49 million UAH for other external knowledge (acquisition of new technologies); and 1,079.45 million UAH for other works related to the creation and implementation of innovations (other costs). The share of expenditures on the purchase of machinery, equipment and software compared to 2018 increased from 68.1% to 71.6%. At the same time, the share of expenditures on research and development (R&D) decreased from 26.3% in 2018 to 20.5% in 2019, and on the acquisition of other external knowledge from 0.4% to 0.3%. The share of other expenses also increased, including for marketing and advertising – from 5.2% to 7.6% (State Statistics Service of Ukraine, http://www.ukrstat.gov.ua/).

The share of innovative products sold in the volume of industry in 2019 was 1.3%.

Digitalization of education. The field of education is also undergoing irreversible changes. The most important trend now is to receive additional education. Bitkom, Germany's digital association, conducted a survey in which three out of four respondents complained that they did not have enough time in the workplace to gain additional knowledge. This is due to the rapid development of information technology. Therefore, in such an era, it is important to be

constantly capable of learning, and employees need to be able to combine the individual components of information, approach problems creatively, and respond quickly to requirements.

Table 1. Problems of the digitalization of Ukraine's economy

Source: structured by the author on the basis of Ukrainian Institute of the Future (2018); Grigorenko & Yurchak (2019); World Economic Forum (2019); The World Bank (n.d.)

Direction	Essence
Macro level	
Institutional	- Low involvement of government agencies in the implementation of the Concept of Digital Economy and Society - Inconsistency of relevant legislation with global challenges and opportunities - Inconsistency of national, regional, sectoral strategies and development programs with digital opportunities
Infrastructural	- Low level of coverage of the country's territory by digital infrastructures - Lack of separate digital infrastructures - Unequal access of citizens to digital technologies and new opportunities (digital divide)
Ecosystem	- Weak state policy on incentives for the development of innovative economy - Immature investment capital market - Outdated education system and teaching methods, lack of focus on STEM education, soft skills and entrepreneurial skills, imperfect models of technology transfer and consolidation of knowledge and skills
State	- Low level of automation and digitalization of public services due to weak motivation of government agencies
Micro level	
Business culture	- Most entrepreneurs understand Industry 4.0 mainly as purchasing imported equipment. When purchasing, the fundamental factor is price - Low level of business culture. The choice of contractors in Ukrainian companies is often based on the criterion of cheapness of the proposed solution, while no one pays attention to the criterion of quality
Production potential	- Shortage of highly qualified personnel for the full development of the digital economy and digitalization in general - Outdated and underdeveloped hardware

The main vectors of educational development are:
- speed – learning keeps up with the times, because the usual accumulation of knowledge has long lost its relevance;
- enthusiasm and motivation are fundamental principles in education, where teachers become coordinators, guiding students online and offline;
- availability of materials in real time, which simplifies the process of acquiring new knowledge;
- interdisciplinary content – a direction that erases the rigid boundaries between industry, business and other areas, so it requires the combination of knowledge from different walks of life.

The digitalization of professions and processes is challenging traditional jobs. This applies to HR professionals, as the digitization of this area reduces workload when hiring and training.

Thanks to new tools, professionals can communicate with candidates through mobile applications, social networks and cloud technologies. For example, before an interview, a person fills out an electronic form. Thus, the employer promptly receives and processes information. Digitization refers to the following stages of employment and training: video presentations; passing tests instead of interviews; training through special portals. At the same time, digitalization has affected not only the field of HR. Experts predict that in 5–10 years, digitalization will affect professions such as: IT specialists; virtual reality architects; developers

of big data models; appraisers of intellectual property; virtual lawyers; the designers of smart homes, etc.

In future, it will not matter whether one is a virtual lawyer or a developer of big data models – lifelong learning will be mandatory, and a change of profession 8–12 times will be considered the norm.

Digitalization of society. Digitalization has begun to dictate new principles in all areas of our lives, from the banking system to health care. Society itself is no exception. Some scientists suggest that the role of people in the future will be insignificant, and it will be replaced by machine work. However, this is not true: in the digital economy, power is in the hands of the individual. Companies promote their products and services on the Internet and social networks, and to do this they need to understand the interests and behavior of their target audience.

Users originally showed low interest in fixed broadband Internet access and the use of cloud technologies. The percentage of households that had a computer, laptop, or tablet (except smartphones) at home corresponded to a fairly mediocre level, but the penetration rates of smartphones and mobile broadband Internet access showed a significant increase and reached the target level. Thus, the growth of demand took place, but insignificantly or in several directions.

To analyze the indicators of the digital transformation of the national economy of Ukraine as an information base, we chose the Global Connectivity Index (GCI). This also enabled us to assess indicators of investment in IT, IT maturity and indicators of digital economy of Ukraine and indicators of innovative economic development. According to the Global Innovation Scoreboard, the relationship between GDP and digital transformation was also analyzed.

Table 2. An assessment of connectivity for end users and organizations of Ukraine according to the Global Connectivity Index (GCI) during 2016–2019

Source: Author's own development

Indexes	Years				
	2016	2017	2018	2019	2020
Level of services provided by telecom operators (based on survey)	9	9	9	9	9
EGovernment Services (UN Review)	5	7	7	7	7
Number of people who have access to the Internet at least once a year via wired or mobile access, in % of the total population	5	6	6	7	7
The cost of a monthly subscription to the tariff plan for fixed broadband access (minimum 5 GB, speed 256 kbps), in % of the average monthly income per person	8	8	7	7	7
Cybersecurity awareness (according to expert estimates)	4	6	6	7	7
Price of monthly subscription for mobile broadband access, in % to average monthly gross national income per capita	6	7	6	7	7
Broadband download speed (based on relevant test data)	3	3	3	4	4
The total cost of analytical software for analyzing the IoT, per person	1	1	1	2	2
The amount of available data that can be used by the artificial intelligence platform per person	1	1	1	1	1

Among the indicators of connectivity for end users and organizations of Ukraine, the level of services of telecom operators received the highest marks (Table 2). The performance of e-government, the number of users who had access to the Internet, the cost of broadband access, and the level of awareness of cybersecurity were above average. At the same time, all these indicators, except for the cost of broadband access, had a positive trend.

The cost of a monthly subscription for mobile broadband corresponded to the average level, but was characterized by divergent dynamics. Broadband speeds, investment by cloud service providers, total cost of analytics software for analyzing the Internet of Things (IoT), and data

creation for artificial intelligence were low and unsatisfactory. Thus, the same trend is observed as for demand: high rates for mobile communications, medium rates for Internet access, and low rates for IoT and artificial intelligence.

The Network Readiness Index reflects the innovation and technological potential of the world, as well as opportunities for their development in the field of high technology and digital economy (Table 3), based on four factors.

1. Access to technology and Internet infrastructure. This level reflects the availability of digital infrastructures, their quality and focus on new technologies (IoT, artificial intelligence, etc.). Here, Ukraine ranked 62nd place out of 134.
2. Use of technologies by citizens, business and the state. The next step is the use of digital technologies by citizens to increase productivity, achieve certain social and commercial goals. Here, Ukraine ranked 65th place out of 134.
3. Regulation and management of technology. This level is responsible for assessing the state's capacity to regulate and increase confidence in digital technologies. Here, Ukraine ranked 58th place out of 134.
4. The impact of technology on the economy and quality of life. This level determines the extent to which existing digital technologies affect the daily lives of citizens, their quality of life, and doing business. Here, Ukraine ranked 79th place out of 134 (Ukrainian Institute of the Future, 2018).

Analyzing the data in Table 3, we can say that the most popular and recognizable in the modern world is the Global Innovation Index (GII), as the number of mentions when querying Google search sites on the Internet is 457 million units. The second most popular is the Digital Adoption Index (DAI) – 191 million mentions. Our countries are not represented in the Digital Evolution Index (DEI) and the Digital Economy and Society Index (DESI), so we omit them according to the methodology described above.

Table 3. The most popular indicators of digitization by the number of mentions in the Google search engine

Source: Author's own development

Index name	Popularity of the index (number of mentions when making queries on Google search sites on the Internet), thousand units	Representation of Ukraine	Period of representation of Ukraine (from what year)
Digital Economy and Society Index (DESI)	107,000	-	-
Digital Evolution Index (DEI)	173,000	-	-
Digital Adoption Index (DAI)	191,000	+	Since 2014
IT Development Index (IDI)	70,700	+	Since 2002
Global Innovation Index (GII)	457,000	+	Since 2007
Networked Readiness Index (NRI)	897	+	Since 2002
Economic Digitization Index (Boston Consulting Group – eIntensity)	7,990	+	Since 2011
IMD World Digital Competitiveness Index (WDCI)	16,600	+	Since 2014

The Global Innovation Index (GII) is a global study by the INSEAD International Business School, Cornell University (USA) and the World Intellectual Property Organization. The study analyzes the level of innovation in institutions, education, infrastructure and business (via 82 different variables) on the basis of which the corresponding rating is formed (Rudenko, 2021). In 2020, Ukraine ranked 45th in the overall ranking of the Global Innovation Index 2020 and scored 37.4 points out of 100.

Some individual components of the rating were as follows:

- education – 23rd place (+20 places);
- R&D – 44th place (+10 places);

- creation of knowledge (patents and inventions) – 23rd place (–6 places), according to the registration of utility models we are ranked number 1;
- political and operational stability – 123 place (+2 places);
- government efficiency – 93rd place (+2 places);
- rule of law – 109th place (–2 places);
- regulatory policy – 88th place (+6 places);
- ease of starting a business – 52 place (–4 places).

We also considered other elements of digital transformations:

1. Big data is important, and involves a set of methods and means of processing structured and unstructured different types of data in real time in order to analyze them and use them to make appropriate decisions in different segments. These segments include:

- Smart energy. The introduction of smart grids allows city services to analyze electricity consumption in real time. Using data analytics, they can predict consumption peaks and plan energy distribution accordingly.
- Public transport. Transport infrastructure uses big data to ensure fast and safe travel in the city. The city authorities receive data on traffic, which allows them to effectively manage the transport system. Usually the city's smart transport system consists of an intelligent transport network.
- City infrastructure management. Big data helps control and manage issues such as waste disposal, transportation and resource savings. To do this, sensors are built into the city's physical infrastructure. In order to transform the infrastructure into a smart technical base consisting of a network of sensors and connected devices that collect data, smart applications are installed that process data, translating it into notifications and actions.
- City security. Real-time crime mapping programs use data analysis to identify patterns of crime and problem areas by predicting the number of crimes. This allows the police to increase security in the necessary areas (Westmore, 2013).

Big data has both advantages and disadvantages. Effective use of large amounts of data can accelerate decision-making in many areas, resulting in improving citizens' lives and enabling companies and governments to provide the necessary services in real time. Among the positive effects are simplification and better efficiency of various services for citizens, the ability to obtain data for advanced developments, making more necessary decisions for different businesses in real time, saving money, and the emergence of new types of work. Negative consequences include distrust of the data itself (inability to verify its accuracy) and accountability, as well as concerns about maintaining the confidentiality of private data.

In contrast to this approach, the world's leading industrialized nations (USA, Germany, Italy, Japan, China) do not consider services based on the analysis of big data as an independent and self-sufficient sphere of economic activity. Under the digital economy, they understand the processes of creating and using unified production and service (or product and service, PSS) systems (OECD, n.d.). Outside of such a system, a service component without a physical product, even if it is based on the most advanced technologies such as neural networks and the IoT, will not have a significant economic effect and cannot be fully monetized.

In addition, according to PwC (Imena.ua, 2017), the IT products industry is difficult to assess due to the existence in Ukraine of mostly quasi-product companies. That is, when the company's headquarters and market are abroad, but all production is in Ukraine. As for the hardware, it remains underdeveloped and consists mainly of the production of components for the equipment of previous generations.

2. Cloud computing is the digital technology most used by companies. The latter are increasingly investing in cloud computing services, such as financial and accounting software and customer relationship management software.

3. Artificial intelligence is a combination of technologies that is already radically changing the world. AI is used in various fields and makes it possible to assess the quality of work of workers, look for the causes of defects in products, replace manual labor with automated, and generate new knowledge that helps to make quick decisions.
4. As for robotics, it is multidisciplinary. This affects many professions, from agriculture and industrial production to services and retail.
5. Another common technology is 3D printing, or additive manufacturing – the process of creating a physical object by layer-by-layer printing on a digital drawing in 3D. This is a technology that can reduce the cost of building new infrastructure (housing and offices) and can extend to large-scale infrastructure projects.
6. Blockchain (distributed registry) technology has become popular in recent years, allowing users to create and share unique digital records without the need for a centralized trusted party. Using a smart combination of cryptography and peer-to-peer networks, blockchain ensures transparent and accurate storage and dissemination of information among groups of people, ensures the security and tracking of each transaction, and protects against fraud.
7. Drones combine three technologies: IoT through built-in sensors that collect information and transmit it over the Internet for analysis; advanced battery technology (allows drones to work); and cognitive computing (allows drones to operate autonomously).
It is also necessary to note the direct link between GDP and digital transformation of the state. The amount of expenditures for the implementation of R&D (access to information resources) of Ukraine from all sources in 2020 amounted to 17,022.42 million UAH. The knowledge intensity of GDP is steadily declining – from 0.70% in 2013, to a critical value of 0.41% in 2020 (Figure 2). At such values, science ceases to perform an economic function. According to experts, with a science intensity of less than 0.9% of GDP, science performs only a cognitive function.
The share of expenditures for scientific and technical work in GDP in 2019 was 0.43%.
According to experts, the use of digitalization in Ukraine in the period up to 2030 will contribute to GDP growth of more than 8 times (up to $1 trillion), which will affect the wellbeing and quality of life of citizens below the European average (Ukrainian Institute of the Future, 2018).
Another indicator of the impact of scientific and technological progress on the economic development of countries is aggregate factor productivity (AFP). Economic growth can be promoted either by increasing the cost of labor and capital used in production, or by increasing the efficiency of resource use (the growth of AFP).
In general, over the last 20 years (except for the crises of 2009, 2014–2015, 2020), the AFP in Ukraine has grown at a high average annual rate of 10.3%. In all crisis years, the AFP fell at an average annual rate of 22.4%, because companies were trying to survive, rather than invest in improving resource efficiency.
The main factors that contributed to the reduction of the AFP in Ukraine in 2020 were, first of all, political factors and the crisis caused by the COVID-19 pandemic, namely:
- slowdown in business activity as a result of the elections of the President and the Verkhovna Rada of Ukraine in 2019, which is typical for Ukraine during all presidential elections;
- reduction of sales in the high-tech sector by industrial enterprises and the share of gross value added in the volume of output of this sector.
The following factors also had a negative impact:
- declining nature of funding for research – from 0.55% of GDP in 2015 to 0.41% of GDP in 2020. SFP, according to OECD research, directly depends on the volume of spending on science and innovation relative to GDP, especially in the business spending sector;

- a significant share of the transfer of results of scientific research and technology without registration of intellectual property rights, which significantly reduces the cost of scientific activities.

Based on the relationship between GDP and digitalization, it is proposed to measure the effectiveness of digital transformation in this direction by estimating the share of value added by the IT sector in GDP, GDP itself, high-tech and net IT exports, the share of new products for consumers, productivity growth, robotics industrial production, etc. In addition, this index also includes indicators that reflect a wide range of social consequences of digital transformation, including those that assess the level of economic inclusion (Pizhuk, 2020). In particular, the latter include indicators of employment and the percentage of IT professionals, gender gap in Internet users, income inequality, etc. (Table 4).

All indices analyzed in the paper allow us to comprehensively assess the scale of digital transformation of Ukraine's economy in order to develop proposals for the digital tracking of key national socioeconomic processes and to save on the unproductive resources of entities, institutions and governments, and to outline management process as an element of generating social value.

Table 4. Grouping of indicators of the efficiency of the digital transformation of the economy for definition

Source: Author's own development

No.	Groups of indicators	Indexes
1	Share of value added of the IT sector in GDP	The method of calculating GDP by expenditure (sum of final consumption, capital expenditures, government expenditures and net exports related to IT) was used
2	The share of e-commerce in GDP	% of total GDP
3	Development of e-commerce	1. Penetration of e-commerce (%) 2. Share of online buyers (%) 3. Growing e-commerce turnover
4	The share of the IT workforce	% of the total number of employees
5	Net IT exports	Amount of net exports of ICT-related equipment and services and net exports of cross-border e-trade
6	High-tech exports	% of total exports of industrial goods
7	Increasing labor productivity	GDP growth per capita (according to The Conference Board Total Economy Database)
8	Employment rate	Ratio (percentage) of the number of employed persons to the number of unemployed persons registered with the state employment service during a certain period
9	IT specialists	% of those employed in the economy
10	Internet access in schools	% of schools with Internet access for pedagogical purposes
11	Income inequality	Gini Index
12	The presence of a gender gap among Internet users	The difference between the female and male population in the use of the Internet

During the 30 years of Ukraine's independence, one of the priorities of its economic policy has been to attract long-term foreign investment, as well as intensifying activities to promote them. Note that Ukraine has investment-attractive factors that contribute to the expansion of its investment ties, namely: large and competitively unrestricted domestic market; geographical location at the intersection of major transport routes between Europe and Asia; cheap and at the same time skilled labor; high scientific potential, etc.

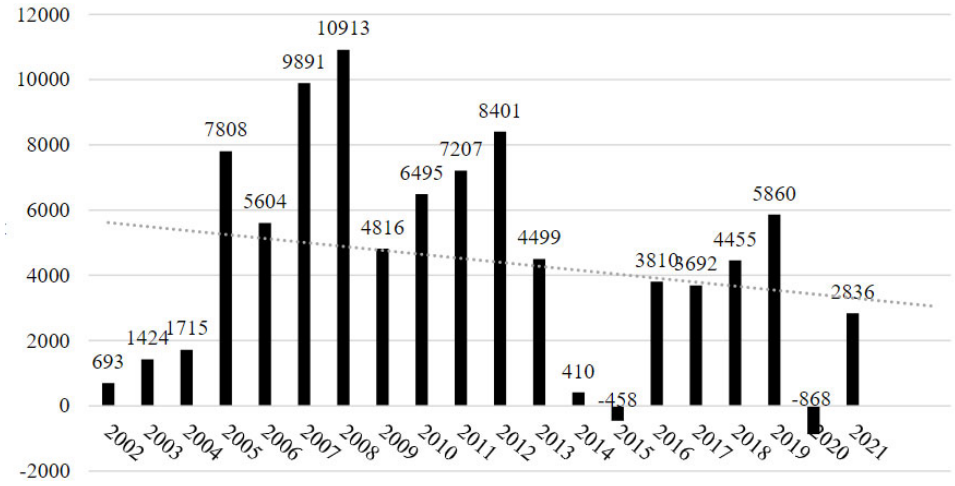


Figure 2. Receipt of foreign direct investment in the economy of Ukraine for the 2002–2021 period (first half), million $

Source: based on OECD (2021)

The degree of investment attractiveness is an important indicator of the country's investment climate and the effective socioeconomic development of the state's economy in general, so it is relevant to analyze the annual FDI inflows (Figure 2). The volume of FDI in the economy of Ukraine for the period 2002–2020 reached its maximum. Compared to 2012, in 2019 (before the pandemic) investments decreased from $8,401.0 million to $5,680.0 million due to both declining investment activity and an unfavorable investment climate in Ukraine. The structure of Ukraine's foreign direct investment by type of economic activity in 2020 is shown in Figure 2.

Given the need to ensure investment attractiveness in the international market, competitiveness, and the socioeconomic development of Ukraine, the strategic vector of its development is the digitalization of the economy, the conclusion of the Agreement on EU support for e-government and digital economy in Ukraine (Agreement of Financing, 2020), and active digitalization.

To improve the economic condition of Ukraine, a number of measures were proposed (Figure 3) (Ukrainian Institute of the Future, 2018). To improve the situation, it is necessary:

- to increase the volume of investments in scientific and innovative activities, first of all, by the state;
- to promote the transformation of public procurement into a mechanism for supporting innovation and creating demand for innovation;
- to ensure the development of high-tech competitive industries, taking into account the peculiarities of creating added value throughout the innovation chain (from basic science to commercialization, implementation in production and market entry);
- to introduce expanded incentives for the commercialization of the results of scientific and technical activities financed from the state budget and the establishment of closer ties between science and industry;
- to provide institutional and financial support for the development of innovation processes and products, innovation infrastructure, assistance in registration of rights and protection of intellectual property;
- to promote access to foreign markets of goods and services with a high share of gross value added, etc.;
- to closely monitor the impact of new mechanisms on innovation, especially technological SMEs, and gradually introduce additional tools to reach more beneficiaries.

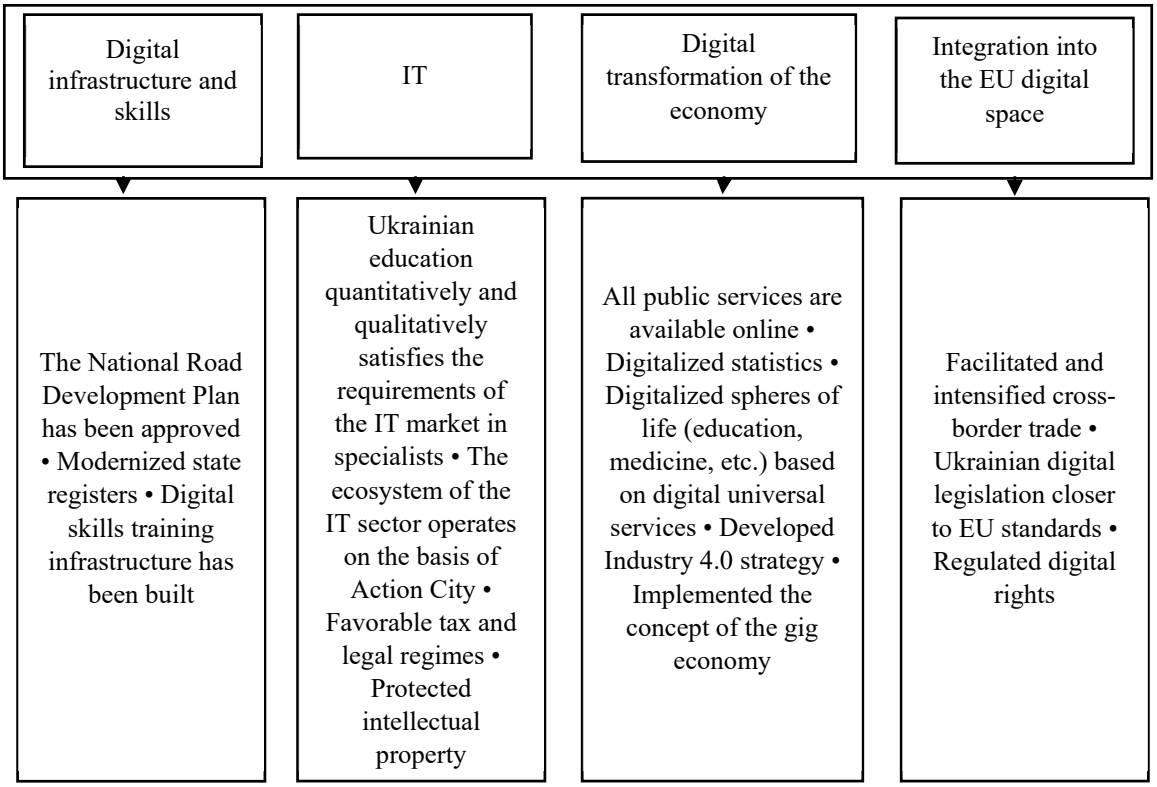


Figure 3. A set of actions for economic recovery and development in areas of specialization
Source: Author's own development

As a result of the implementation of the proposed actions, improvements in the economic sphere as a whole are expected. Here, we can include:

1. Coverage with new high-speed communication standards. The technological platform of state registers is functioning.
2. A high level of basic and professional digital skills.
3. IT departments have English-language programs and attract students from all over Europe.
4. Ukraine is a European laboratory and a platform for the development of new technologies (FinTech, AgriTech, drones, the IoT, artificial intelligence, digital currencies).
5. Universal digital services are present in key areas of life (education, medicine, etc.).
6. Industries and businesses are being modernized, technological production is being built, and high value-added products are being produced.
7. New industries and new professions create new prospects for economic growth.
8. Digital identification and trust services are harmonized with the EU.
9. Full interoperability of Ukrainian registers.
10. Ethical issues of biotechnology, personal information, and cybertechnology have been settled.

Conclusions

This study showed that in Ukraine there is a system of state structures regulating the process of digital transformation of national economic management, and the National Strategy for Digital Transformation developed legal, organizational, economic and psychological methods of regulating the digital transformation process. However, there are currently some shortcomings in this activity.

Therefore, in order to restore the economy, which should become more productive, sustainable and inclusive, it is proposed to carry out economic transformation with the use of digital technologies in the following priority areas:
1) implementation of strong principles of governance based on long-term forecasting and planning of the country's development, ensuring the strengthening of public confidence in the actions of the government;
2) modernization of infrastructure, acceleration of the transition to alternative energy, expansion of access to energy resources and IT;
3) transition to more progressive taxation, rethinking the methods of taxation of corporations, wealth, and labor resources at the national level agreed in the framework of international cooperation;
4) updating educational programs and increasing investment in mastering the skills needed to create jobs and markets of the future;
5) rethinking labor legislation and social protection, taking into account the realities of the needs of the new economy in labor resources;
6) expanding the infrastructure of health care facilities, as well as care for the elderly and children, and ensuring access to innovation for the benefit of people and the economy;
7) stimulating an increase in the allocation of financial resources for long-term investment in development to strengthen stability and international integration;
8) rethinking competition and antitrust law in accordance with the requirements of the fourth industrial revolution, ensuring access to markets at both national and international levels;
9) promoting the creation of markets of tomorrow, especially in areas that require the cooperation of public and private sectors;
10) stimulating increased investment in research, innovation and inventions that can create new markets of tomorrow;
11) encouraging companies to accept diversity, fairness and inclusiveness to increase their creative activity.

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INCREASING THE EFFECTIVENESS OF FOOD SUPPLY CHAIN LOGISTICS THROUGH DIGITAL TRANSFORMATION

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Abstract *During the COVID-19 crisis, there were many restrictions placed on transportation. Due to this, a significant disruption in the food supply chain emerged. The transportation of fresh food and maintaining its quality from farm to the table, or distributing and then collecting from warehouses and delivering to the consumer, has become crucial. Technologies, and especially the IoT, have become the primary tools to fight this. The research objective is to analyze and create new knowledge about digital technologies used to improve and make more effective food supply chain processes. An exploratory case study methodology helps to investigate a large consortium based on IoT technologies, implemented in pilot cases at the farm level and measuring their performance over a period of four years. This is an interpretative study, and the method of semi-structured interviews and document review for collecting the data was used. The results show IoT-connected sensors and systems in food and beverage supply chain logistics offer real-time visibility and data-driven analytics, allowing stakeholders to improve performance, cut operating costs, conduct predictive maintenance to avoid downtime, and even decrease energy usage or reduce negative environmental impacts.*

Keywords: *agriculture, digitalization, digital technologies, IoT, logistics, supply chain, effectiveness.*

Introduction

The European Green Deal sets out how to make Europe the first climate-neutral continent by 2050. It outlines a new, sustainable and inclusive growth strategy aimed at improving people's health and quality of life, boosting the economy, caring for nature and leaving no one behind. The strategy of Farm to Fork (European Commission, 2020a) is at the heart of the Green Deal. It addresses the challenges of sustainable food systems and seeks to ensure a sustainable livelihood for primary producers who are still lagging behind in terms of income, which is essential for the success of the climate recovery and transition.

Given the complexity and the huge number of actors involved in the food value chain, crises such as COVID-19 affect the food chain in different ways. Although there has been sufficient food supply in general, this pandemic has presented many problems, such as logistical

disruption of supply chains. In today's intensely competitive global marketplace, businesses' pressure to find new ways to create value and offer it to their customers is growing ever stronger. The growing need for the industry to compete with its goods in a global economy across cost, quality, and service dimensions has contributed significantly to the need to develop a more efficient logistics system.

Technology has been completely revolutionizing the present era, and digitalization can bring new opportunities for companies by improving the whole value chain (Kilimis et al., 2019). The agricultural sector is no exception. Digital transformation can bring new opportunities for agriculture and food (agrifood) companies and open up new growth paths for development. One of the most significant contributions to future sustainability would come from a radical transformation of the agrifood value chain (Renda et al., 2019).

Literature review

The applications of digital solutions in the agrifood sector are very diverse. They can help extend shelf life, monitor freshness, display information on quality, improve safety, and improve convenience. Rotz et al. (2019) emphasize the technical and organizational challenges of digitalization in agrifood. Lack of awareness, especially among rural farmers, low level of digitalization of agrifood companies, and low incomes of rural farmers – together with high costs of ICT infrastructure, insufficient personnel to handle ICT facilities, and the absence of local language content on the Internet – are making digital transformation a challenge (Salampasis & Theodoridis, 2013). Many problems exist throughout agriculture, such as irrigation, the use of pesticides, fertilizers, the monitoring of crops, land and livestock (López-Morales et al., 2020). Potential applications of ICT solutions in agrifood are very diverse, including, among others, software for supply chain or financial management, mobile applications for farm management, agricultural land use optimization, precision agriculture applications and others which fall into other categories of ICT-enabled services (Salampasis & Theodoridis, 2013). Motivated by digital transformation, the agricultural sector is offering its farms new services and devices (drones and satellite images, sensors, actuators, weather information) to optimize resources, increase efficiency and at the same time reduce the effect on the environment (López-Morales et al., 2020).

Digital transformation can significantly contribute to the improvement of products and/or services and the management of operations in a more efficient way. It can also trigger costs reduction or can help to gain a competitive advantage in the market. Ulas (2019) pointed out several driving factors expediting digital transformation: globalization, the advancement of technology and innovation, electronic commerce, and social media. The idea of an interconnected world has also gained attention from the industry sector, and the vision of the digital revolution is emerging, popularly known as Industry 4.0 (Kang et al., 2016).

Experts highlight four areas in which digitization technologies will have the most significant impact: productivity, revenue growth, employment, and investment (Rußmann et al., 2015). The development of Industry 4.0, artificial intelligence, the Internet of Things (IoT), blockchain, cloud computing, augmented reality, 3D printers, chatbots, big data, and nanotechnology have been speeding up the process of digitalization.

The *digital agricultural revolution* is a new term explaining the changes that the agrifood industry's traditional approach is undergoing as part of a fundamental transformation. As stated by Schwab (2016), this no doubt offers significant opportunities through the availability of highly interconnected and data-intensive computational technologies as part of Industry 4.0.

The term *logistics* could be interpreted in many different ways. Various authors emphasize different aspects of its definition. Logistics is the core of production and marketing organization (Movahedi et al., 2009). The quality of marketing depends on how the products

are delivered to the final customer. The value of logistics for the agrifood industry has become more widely recognized by organizations worldwide. Agrifood logistics is an important part of the economy and an interconnected system that controls, coordinates, and organizes different flows of logistics, ranging from production through points of storage, processing, and trade to the final consumer. The aim is to provide the final consumer with uninterrupted supplies of safe food products with minimum logistics costs and under environment-friendly conditions (Wajszczuk, 2016).

When it comes to agricultural logistics, we need to look more broadly and include the supply chain concept. Supply chain management is a core component of the performance of companies' value chains (Hult et al., 2007). Supply chain management is the management of trading off products and information in the logistics process of companies, ranging from sourcing raw materials to delivery to the customers (Felea & Albastroiu, 2013). The supply chain includes a substantial number of manufacturers, suppliers, and consumers and is undoubtedly responsive to many complexities. Subsequently, it is one of the key concerns in the supply chain management sector (Emamisaleh et al., 2018). Logistics is a supply chain activity that plans, implements, and manages the reliable, efficient transportation and storage of products, services, and information to meet consumer needs (Croom et al., 2018).

Researchers have identified five dimensions of supply chain management and integration activities: strategic supplier partnerships, relationships with clients, sharing of quality information, operational lean practices, and postponement (Mogaka et al., 2020). Considering agrifood business, supply chain management means that agrifood products reach the market in time.

The field of supply chain processes and logistics for agriculture and food produce is, to some degree, unpredictable. Over time, the supply chain mechanism for such products has grown into an increased chain of facilities, such as in-time deliveries, centralized specialized manufacturing processes, and the maintenance of low loading rates. Agrifood companies produce raw materials for agricultural processing and fresh products, which are delivered to the consumer directly or indirectly. The quality of raw materials, products and the costs generated by agrifood companies and enterprises will have a significant impact on the efficiency of the entire supply chain. Due to their direct interaction with the environment and living organisms, the types of production technologies and logistics will affect these costs and quality (Wajszczuk, 2016). Mathur et al. (2018) specified that if a company can start measuring customer satisfaction related to what a supply chain can do and also link customer satisfaction in terms of profit or revenue growth, then it can attach customer values to profit and loss, and even to the balance sheet.

Essential success elements for retailers and manufacturers are the efficiency of the logistics and the technology used. The entire process needs to be controlled effectively to ensure that the correct products are delivered, to the right location, in the proper condition, within a reasonable period of time, while maintaining cost efficiency for all parties involved. It is essential to highlight the maintenance and spare parts and tools, specifically among supply chain activities. In short, the challenges to be met are related to the quick and reliable delivery of the spare parts inventory at minimum costs (Lozano et al., 2017).

Wajszczuk (2016) summarizes the many studies conducted, identifying that the main challenges related with logistics are: the issue of receiving aligned-quality goods from various small farmers; different sources of supply of raw material batches; contamination issues; the presence of numerous and independent links in the entire supply chain; the formation of very long marketing channels, where an unequal balance of power appears in the supply chain; poor infrastructure and limited access to the required means; and difficulties in establishing horizontal farm cooperation, mainly due to the lack of trust, mostly in developing countries (the lack of proven business models, modern storage infrastructure, ICTs, etc.).

In general, the ratio between the profits and the costs arising from the supply chain helps to evaluate the efficiency of the logistics system. Elements such as the aggregate costs of logistics, the level of logistics service quality, the performance of the business system, the overall duration of the logistics processes in the system, and its quality (logistics services' level) are common KPIs, or key performance indicators, for any logistics system (Tyapuhin, 2007). The latter are widely used in the comparative evaluation of business entities and their logistics systems, and, as such, they are measurable. Moreover, these KPIs are the backbone of the planning of operations, tactics, and strategies of modern companies and the monitoring of the effectiveness of the logistics system and business entity's management accounting system.
Elements such as transportation costs, storage costs, goods-processing-affiliated costs, inventory management costs, order management costs, costs related to the exploitation of logistics information systems, stock formation costs, raw material maintenance costs, finished product costs, the costs of potential damages arising from the manifestation of the logistics risks or from the insufficiency of logistics services comprise a general classification of logistics costs by functional areas (Arshinina & Kiseleva, 2020)
To continue, the evaluation of the quality of logistics services is a necessary undertaking that is evaluated directly during its provision. It is also important to place logistics services on a high-level corresponding with the potential consumer's needs. To sum up, the extent of congruity between the consumer expectations regarding the logistics system and the actual level of this service's provision defines the logistics service's quality. The level of logistics service provision is expressed through a set of quality criteria such as the physical environment of the service, consumer behavior, the reliability of the logistics service provider, responsibility, maturity of the service, and security (Tyapuhin, 2007).
Logistics system resources are inputs, whereas the outputs reflect the results, and the quality of all logistics services depends on their structure, quantity, and composition. For this reason, it is necessary to assess the accuracy of the time and the place of delivery, range and the quantity of products supplied, quality indicators, and compliance with the prices on the market so that we can formalize the procedure on how to evaluate the efficiency of logistics.

Data and methodology

Applying technologies to any parts of the food supply chain enables stakeholders to collect and analyze data which was previously not accessible. The result becomes the foundation for further improving existing agrifood value chain logistics processes and creating new ones. IoT technology is one of the crucial elements of effective logistics in any industry (Da Xu et al., 2014). The rising usage of smart sensors, smart carry bar codes, and different tags, enabling precise, real-time tracking through the entire food supply chain, are good examples of how the IoT makes logistics more effective.
The purpose of this paper is to analyze the role and impact of digital technologies, the IoT in particular, in the logistics of the food supply chain and underline the effectiveness of the logistic system when technology is applied in real-world conditions.
The research objective is to analyze and create new knowledge about digital technologies used to improve and make more effective food supply chain processes. An exploratory case study methodology helps to investigate a large consortium based on IoT technologies, implemented in pilot cases at the farm level and measuring their performance over a period of four years. The paper seeks to better understand and provide insights into how digital technologies, the IoT in particular, are being used in logistics to bring more value to the food supply chain.
This is an interpretative study, and the method of semi-structured interviews and document review for collecting the data was used. Experts on the agrifood sector's digitalization were selected. They had no less than ten years of experience working with digital innovation

technologies and tools, creating products, implementing them into the market, and conducting analyses. At least five experts were selected who directly took part in implementing the IoF2020 project. A total of 15 interviews were conducted. The different methods of analysis of the final data were implemented to achieve the paper's objectives.

Referring to the IoT in the agrifood sectorial context means that particular layers of the system, usually three (device, network, and application), are applied (Villa-Henriksen et al., 2020). Such application enables gathering data from each step of the agrifood supply and value chain processes. IoT technologies are considered the most important digital innovations that influence the largest amount of valuable data collection in the agrifood sector (Tzounis et al., 2017). It is expected that by 2050, IoT technologies have the potential to increase agricultural productivity by 70%. This will enable, for example, achieving higher crop yields with less cost, improvng the nutritional value of food significantly, and improving care quality and herd productivity in livestock (Sarni et al., 2016).

A significant amount of food in many cases is wasted due to logistics problems. The most significant loss occurs during transportation and storage. In total, this amounts to over 20% of the world's food production. IoT solutions applied to the food supply chain can reduce this number by 10%–15% (PwC, 2013).

During the COVID-19 crisis, there were many restrictions on transportation. Due to this, a significant disruption in the food supply chain has emerged. The transportation of fresh food and maintaining quality from farm to table, or distributing and then collecting from warehouses and delivering to the consumer, has become crucial. Technologies, and especially the IoT, have become the primary tool to fight this.

Digitalization of the agrifood sector is one of the priorities moving towards the EU's twin transition. The European Commission (2020b) has approved various large-scale projects to accelerate digital innovations into the sector. During the past five years, a vast number of various use cases have been approved and successfully applied in everyday food supply and value chain processes. The usage of sensors, smart planning, smart animal health monitoring, plant disease monitoring systems, etc., are helping farmers to continue their daily operations while reducing their environmental impact and maintaining their competitiveness in the market. EU funding has laid a solid foundation for such possibilities and solutions to be commercialized and available to the market.

IoF2020, DEMETER, ATLAS, and SmartAgriHubs are four large-scale piloting initiatives that have secured a total of €80 million for research and innovation into the application of emerging technologies for the agricultural sector. IoF2020 was founded in January 2017 to promote the IoT in the food and agriculture industries. This initiative, which has received a €30 million investment, puts together two ecosystems – agribusiness and advanced ICT suppliers – that have boosted digital innovation in agriculture (European Commission, 2021). This is why the IoF2020 has been chosen as a use case to analyze.

The IoF2020 project's main objective is to set a strong foundation for implementing IoT technology in agrifood to provide safe and healthy food, help farmers stay competitive, and increase the competitiveness of the food supply and value chain in the EU. The project's main result is the EU's consolidated leading position in the global IoT industry. This has created a healthy ecosystem through the whole food value chain, involving: farmers, the food industry, technology providers, and research institutes. Led by the highest ranking educational institution in agrifood research, Wageningen UR University, IoF2020 was joined by 73 partners acting in 22 EU member states. This is by no means the biggest pilot project of its kind.

There are 19 use cases divided into five types of trials: arable, dairy, fruits, vegetables, and meat. The pilot's purpose was to demonstrate the use of innovative digital IoT solutions for a vast number of application areas.

The project has taken a multi-actor approach choosing key performance indicators (KPIs) closely related to user acceptability, stakeholder engagement, sustainable business models, new components improving the technology, and market readiness levels. These factors are significant in analyzing the effectiveness of the logistics of the food supply chain.

In general, a KPI is a value that indicates the degree to which a strategic goal has been accomplished. In selected pilot use cases, KPIs are used to determine if established goals have been met at different levels. Each use case measures the effect of the IoT solution on various industries, business priorities, and society at large. Consequently, primary success metrics show observable performance in meeting the critical market goals. In the scope of the IoT, three levels of KPIs are indicated: operational (number of sensors installed, number of farmers participating, number of ICT component used), strategic (yield increase, efficiency, improved market access, less water use, work time efficiency, etc.) and visionary (less CO_2, user satisfaction, work stress reduction, farmers' livelihood, etc.). For this analysis, strategic and, in some cases, visionary KPIs have been considered.

A well-coordinated distribution plan for use case results and project learnings, backed up by customers and consumers, guarantees a high degree of business exposure and a quicker learning curve. As a result of IoF2020, data-driven farming, autonomous operations, virtual food chains, and personalized nutrition for European citizens are now feasible.

The pilot use cases demonstrated solid results on IoT technologies; for example, on an average farm using IoT, yield rises by 3.75%, and energy costs drop by 27% to €36 per hectare, while water use for irrigation falls by 12%.

Based on the experts' suggestion, the pilot cases most suitable for analysis in agrifood supply chain logistics based on IoT technology were chosen. They were selected from three areas of trials: arable, fruit/vegetable, and beverage. According to experts, these are some of the most important areas where food supply chain logistics must be effective and sustainable.

The implemented pilot project's main objective is the traceability of food and feed logistics. The use case has developed a smart system that ensures adequate feed logistics and maximum traceability of the distribution process. It incorporates a revolutionary method that secures and authenticates the transportation of goods in the agrifood chain, ensuring that feed and food are shipped without fear of losing quality and being contaminated. For the capability to control and monitor such a process in a healthy and traceable procedure for their goods before they leave the factory, producers of animal feed and human food allocate a significant amount of time and money.

The use case involved the task of providing a system that can control the goods' transport and delivery to the customer's silo or warehouse. It provided an additional management system to ensure that these items are shipped and distributed correctly. As a result, it eliminates the possibility that products will be shipped to the incorrect storage areas or polluted and spoiled, causing harm to the consumer.

An integrated IoT-based automatic storage detection system can ensure that the proper merchandise is shipped, as well as keeping track of its transportation and registration information. The use case demonstrates that the whole procedure is entirely traceable, and the possibility of pollution is reduced.

In this case, logistics in the food supply chain addresses essential food safety issues and sustainability requirements while increasing productivity and significantly increasing user satisfaction. The target group of users was animal feed and bulk-goods buyers. Nevertheless, the use case targeted farms, consumers, supply chain managers, and warehouse/silo owners directly.

The increase in consumer trust in food delivery and the availability of sufficient knowledge to make food choices reflect consumer satisfaction. This data was structured, analyzed, and shared with customers and other stakeholders.

Consumer trust is one of the crucial factors in the food supply chain, so the IoT technologies in the use case were projected to solve that. Consumer confidence in food on the market can be strengthened, and this particular use case the application of the IoT tool has proved this.
This particular use case has an obvious supply chain process, which needs to be improved in management. The crucial roles here are played by relations with clients, strategic supplier partnerships, and, of course, the sharing of quality information.
The supply chain starts at the silos/warehouses and continues to the end-users. In between, some processes could affect the final delivery result. Controlling and monitoring such processes as trailer equipment and loading procedure, silo device, and unloading procedure is essential. The possibility to share accurate information with drivers, logistics managers, and consumers creates added value. Operating such data brings different value propositions to different stakeholders. For example, a farmer receives a transparent process, which requires less paperwork and is equipped with online monitoring and digital signature. This helps with the easy delivery of the right food to the right animal. The transport manager enjoys less paperwork and holds data on which exact quality bulk-goods are being delivered, and tracks the trailer's exact location. For the driver of the trailer, automatization means reliability in the process and less human error, and importantly in times such as the COVID-19 pandemic, this creates a contact-free process. The measurable value created for the customer is the significant reduction of the risk of wrong warehouse or silo delivery by up to 90%, which helps maintain good quality relations with the clients. Overall, the logistics controlled by such a system become leaner in management processes.
The use case significantly contributes to solving logistics' main challenges in the agrifood sector. The implemented system tends to reduce the risk of animal feed contamination by up to 20% and reduce human food contamination by up to 22%.
When food becomes polluted during handling and transportation, it increases food waste. In many cases, cleaning processes cannot be applied, nor is it possible to clean to the point that the food would regain its previous quality. Thus, the reduction of waste by contamination is also an important value proposition created by the use case. Simultaneously, increased security of bulks goods delivery is observed, which lowers the lack of trust in the whole supply chain.
Food supply chain stakeholders are provided with the possibility to trace the food and its quality up and down the supply chain. Improved traceability by up to 25% is expected using this system.
The performance and overall impact of the use case consist of all the value propositions which arise from it: reduced risk of animal and human feed contamination, reduced waste by contamination, improved traceability, and increased security of bulks goods delivery. Measuring its effectiveness, it is important to underline the reduction of recovery costs and reduced additional transport compared to the usual logistic process. Moreover, the increased user satisfaction using IoT systems on silo devices is 7.9 (on a scale from 0 (not satisfied) to 10 (extremely satisfied)) and on trailer equipment 7.65 (on a scale from 0 (not satisfied) to 10 (extremely satisfied)).
Real-time data distribution and tracking of all trailers, secure delivery procedures via traceability from the factory to customer, accurate monitoring of the discharging process, direct warning in the event of anomalies during deliveries, data collection for analysis and prevention, and enhanced food safety all contribute to new and easily measurable value in the food supply chain.
Overall, the use case demonstrates improvement in the business system's performance, rising user satisfaction, and service quality. Furthermore, it reduces the cost of recovery and transport.
The IoT-based tool enables the traceability of trays, anti-theft functionality, and temperature monitoring. The system connects different parts of fruit supply logistics: farm production, the processing industry, transport, and finally retailer and end-consumer.

Since fruits and vegetables are perishable, returnable transport items (RTI) are essential in bringing products to the market. Millions of different kinds of RTIs are used daily, both inside and outside the supply chain. These stakeholders feel an urgent need to remove inefficiencies to assure product quality and security while protecting company assets.

It was discovered that this method could go beyond simply being a monitoring and tracking system. It can also collect data, store it, and retrieve it when needed. The amount of collected data can be vast and overwhelming in detail. However, the system can quickly analyze complex value chains or commodity flows and deliver the output simply and understandably. As a result, by relieving pressure on supply chains or commodity flows, the approach positively impacts sensitive market situations. Customers can receive single, project-based implementation and end-user training to help them use innovative trays independently. Customers and the entire supply chain need to know where those assets are at any given time. It is crucial to consider the number of RTIs required during peak harvesting seasons versus the number required during the quieter winter months.

Using closed scenarios and targeted data provides a more precise and informative analysis and evaluation. Thus, IoT technology contributes to gathering and analyzing big data that was missed, and provides results that can contribute to optimizing everyday business planning processes.

The system enables players to see issues across the supply chain by providing information on bottlenecks, thereby facilitating pinpointing opportunities for expansion, developing new processes, analyzing trends, and increasing the efficiency of the supply of raw materials. Quality information and its analysis is therefore making a big difference for stakeholders.

All along the line there is tremendous potential for increasing the management effectiveness of the supply chain and finding bottlenecks or other problems at an early stage, which involves maintaining the best possible partnerships with suppliers and clients and creating new ones based on the efficient management of processes.

RTI flow lacks transparency and cannot be fully tracked by the service provider. At the same time, all value chain stakeholders cannot experience optimal customer support, which leads to a lack of trust and inefficiency.

UC.2 shows that the market needs to adjust very quickly to rising demand in the supply chain, and every stakeholder must be highly adaptable to respond to it. The analysis of big data helps not only to solve the existing challenges, but also – crucially – helps to predict the upcoming pressure on the food supply chain.

When consumer needs and expectations have been estimated, every end-user is assured of the expected supply. The process thus becomes efficient, and sustainability increases significantly. The system assesses the freshness of shipped goods such as fruits, and eventually this can be adapted for the shipment of vegetables. This means a significant reduction of spoilage and a contribution to preventing food waste.

Real-time product monitoring brings the service quality to the next level – pool efficiency increases by 25%. At the same time, the high-security level for distribution is increased by 15%.

Food quality and traceability are also some of the main achievements in this use case. The improvement of traceability infrastructure by 50% strongly contributes to preserving product quality and increasing the supply chain system's performance.

By improving the logistics and packaging, the use case achieved an increase of food safety by 5%, reducing the food waste by 5%. Moreover, the service quality was raised by the faster reaction time to real-time data, which improved by 5%.

The production costs lowered – the RTI loss rate was reduced to –5.5%, and the recovery rate increased by 80%.

This prevents variability in wine quality during transportation, wine production, and management, which is supported by smart sensors that monitor everything including temperature, humidity, and shock. Tracking and monitoring proceed from wine producer to consumer based on the IoT system.

The logistics path from manufacturer to customer is a process that can degrade beverage quality. This use case aims to eliminate such risks by equipping beverage supply chain stakeholders with extensive data analysis of the distribution process.

An automated system tracks the entire wine and beverage distribution chain to prevent harm from integrity-related issues during shipping and storage. It also develops a direct relationship between producers and retailers, and builds a vast database to schedule secure shipments, enabling new and customized IoT-based security solutions. The use case provides software as a service to monitor distribution-related variables, including temperature and humidity, to help control beverage quality.

Multi-actor data analytics in the beverage industry is still an empty field. Integrity management systems have not yet been established in the same depth in this supply chain as they have in other industries. The main reason behind this is the complexity and number of stakeholders involved in the process, making it difficult to control. The provided system disrupted the supply chain with the capabilities to control and acquire the data.

A system which monitors beverage delivery routes and keeps a data record of every transaction brings much more transparency to the stakeholders and enables them to take full advantage of the features brought by data analytics. Data provides monitoring of the locations and changes of the beverage containers, and expands the information with environmental details contained in those boxes. For consumers, it becomes possible to track their wine bottle back to the winery. This gives visibility and traceability to the beverage supply chain.

The system aims to gather a wealth of information about temperature during shipping, shocks that cause bottle ruptures, closure leakage, and the percentage of bottles with defects like cork taint, label damage, pressure loss, and oxidation.

The database can also provide information on customer satisfaction, marketing problems, and communication effectiveness.

This data collection is beneficial for the wine and beverage industry, and it is now available to many value chain actors for the first time.

Such supply chain management, by providing quality information, strengthens the relations with clients and brings significant value for strategic partnerships. Seeing all of the parts and pieces of the supply chain, a link is made with all stakeholders.

This is particularly important in closing the gap between wineries and wine shops since their connection previously was the importer’s responsibility.

When delicate products, such as food or drinks, enter the supply chain, an environment with various parameters must be strictly monitored for the proper temperature and freshness to keep the quality from the beginning point to the end-consumer. Different stakeholders, such as producers, carriers, dealers, retailers, and insurance firms, are involved in the beverage logistics industry. Stakeholders have identified the practical issues of the everyday beverage supply processes and their impact on the system to validate the integrity of logistics. With so many stakeholders taking part in the management of logistics in order to improve the service, many bottlenecks must be solved.

UC.3 brings lean practices into the beverage supply chain, controlling many processes and stakeholders, as a result of which it is usually very complex and complicated. In this case, used by operators, it is first and foremost a tool that visually presents the documented beverage journey and serves as evidence of delivery at the goods’ final destination. Finally, it offers valuable information to help retailers understand market demands and sell the product.

The beverage supply chain experiences increased sustainability. Traceability of the beverage from the first stop to the consumer brings transparency and ensures quality products.
UC.3 made a breakthrough in cost reduction and monitoring of wine and beverage quality during transport. This directly led to the improvement of the distribution conditions and an increase in the logistics' overall satisfaction. A satisfaction index (usefulness of the tool, from 1 (not useful) to 5 (very useful)) of 4 was achieved.
Improvement in transport quality and reduction of product damages enabled the beverage supply chain's efficiency to be achieved. The amount of product returned due to damage claims was measured as 5 (respondents were asked if data was useful to reduce complaints of the damage and improve product handling, from 1 (not useful) to 5 (very useful)).
Increased client satisfaction was rated 4 (asked if the tool is useful in helping to have a stronger relationship with the client, from 1 (not useful) to 5 (very useful)).
Connecting producers and retailers, a crucial factor which became possible due to supply chain visibility, was rated 4 (asked if chain visibility improved with the provided data from 1(not improved) to 5 (significantly improved)).
The system helped increase IoT user satisfaction due to improved transportation, reduced greenhouse gas emissions, and reduced shipping costs.

IoT technology results and discussion. As the analysis of the pilot use cases implemented in the food supply chain revealed, Internet of Things technology is revolutionizing logistics. The mass connectivity of parcels to the end-consumer is enabling supply chain and logistics stakeholders to conduct real-time tracking and management decisions that increase operating performance and asset monitoring, and at the same time keep the quality of products and contribute to the Green Deal goals, such as reducing food waste and greenhouse gas emissions. Table 1 presents accumulated analysis results from all three uses cases' performance indicators connected to IoT technology.

Table 1. Summary of the results collected during the research and from the IoF2020 project documentation. *Source: Created by the authors*

Dimension	Categories	Indicators	Technology impact (productivity, revenue growth, employment, investment)	Food supply chain management (strategic suppliers partnership, relations with clients, sharing quality information, operational lean practices)	Challenges solved (quality products, traceability, contamination, lack of trust, increased sustainability)	Use case
Economic	Productivity increase	Preserve product quality	Yes	Yes	Yes	UC.2, UC.3
		Reduction of loss rate	Yes	Yes	Yes	UC.2
		Recovery rate increase	Yes	Yes	Yes	UC.1, UC.2
		Increase security of bulks-goods delivery	Yes	Yes	Yes	UC.1
	Efficiency improvement	Reduced product return due to damage claim	Yes	Yes	Yes	UC.3
		Real time product monitoring	Yes	Yes	Yes	UC.2
		Increased reusability of transport	Yes	Yes	Yes	UC.2
		Improve logistics and packaging	Yes	Yes	Yes	UC.2

	Cost reduction	Production costs reduction	Yes	N/A	Yes	UC.1, UC.2, UC.3
		Reduce additional transport	Yes	Yes	Yes	UC.1
		Reduce shipping costs	Yes	Yes	N/A	UC.3
		Reduce recovery costs	Yes	Yes	N/A	UC.1
	Quality improvement	Improve distribution conditions	Yes	Yes	Yes	UC.3
		Increase transport quality	Yes	Yes	Yes	UC.3
		Reduce risk of animal food contamination	Yes	N/A	Yes	UC.1
		Reduce risk of human food contamination	Yes	N/A	Yes	UC.1
Environmental	Reduced waste	Reduce product damages	Yes	Yes	Yes	UC.3
		Reduce food waste	Yes	Yes	Yes	UC.1, UC.2, UC.3
		Reduce waste by contamination	N/A	Yes	Yes	UC.1
	Lower emissions	Reduce greenhouse gas emission	N/A	N/A	Yes	UC.1, UC,2 UC.3
	Resource use efficiency	Lower paper documentation use	Yes	Yes	Yes	UC.1, UC.2, UC.3
		Facilitation of equipment	Yes	Yes	Yes	UC.2
Social	Transparency of food chain	Increased supply chain visibility and traceability	Yes	Yes	Yes	UC.1, UC.2, UC.3
		More data available	Yes	Yes	Yes	UC.1, UC.2, UC.3
		Trust on the quality of food products	N/A	Yes	Yes	UC.1, UC.2, UC.3
	User satisfaction	Increase IoT user satisfaction	Yes	Yes	Yes	UC.1, UC.2, UC.3
		Satisfaction index	N/A	Yes	Yes	UC.3
		User satisfaction	N/A	Yes	Yes	UC.1
		Increase client satisfaction	N/A	Yes	Yes	UC.3
		Connect producers-retailers	Yes	Yes	Yes	UC.3

In notoriously complex food supply chains with a vast number of stakeholders and a myriad of different levels of processes, the visibility task turns into an unnecessarily long and drawn-out

process – a process that hardly anyone would take on the challenge of solving. Thousands of supply chain puzzle pieces would never fit together and, in many cases, would fall apart. Or so it was until digital technologies stepped in.

As shown by the goals achieved by the use cases, the IoT has simplified supply network management, streamlined operations, reduced operational expenses, increased quality of transportation, and connected all players along the chain. Data was the missing puzzle piece to set everything in order. The pilot cases reduced the number of supply chain management components. As a result, operational costs are being reduced even while food and beverage production capacity is growing. Digitalization experts stated that IoT technology is expected to significantly impact logistics in the food supply chain by reducing operational costs by at least 50% over the next 5 years and helping double shipping amounts.

IoT technology is driving the agrifood sector towards greater collaboration. The potential of food supply chains as full-scale collaborative ecosystems is vast. The digitalized distribution system transforms the food supply chain into one that is secured, based on providing outstanding and precise data in a highly scalable manner for every player and helping the emergence of innovative business models reliant on big data. The knowledge obtained from such a single network enables stakeholders to improve supply chain productivity.

As described by the experts and based on the use case findings, food traceability and the transparency of the whole food supply chain are among the most significant issues in the agrifood sector. Traceability in food supply chain logistics is related to the ability to collect data and ensure the quality of the final product. This means that data needs to be collected, analyzed, and delivered, involving correct information about the food, feed, and food manufacturing process at all stages of the food supply chain. This allows the product to be certified, for example, as organic, or checked for quality and safety control – all of which can be traced through the food supply chain.

The amount of data that systems can gather and manage is unforeseen. A logistics manager can access the dashboard at any time to receive real-time updates on the exact location of an asset, its distance, and its expected time of arrival based on actual travel conditions. These real-time warnings help players in the food supply chain to stay flexible and adapt quickly through a dynamic transportation network. Delays in the supply chain can often cause significant losses, but logistic managers acquire the knowledge they need to mobilize quickly. Due to IoT technology, an expensive disturbance is usually transformed into a temporary issue.

If any food and beverage product requires special handling or temperature control, geolocation capabilities can be coupled with the monitoring of transportation conditions for added value. The manager is also alerted if an asset falls outside a predetermined temperature range or receives unexpected vibrations or shocks.

As interconnectivity is becoming the logistics sector's practice, the industry must recognize the value of digital security. Connected systems help monitor all objects, and asset tracking logistics applications help monitor deliveries, warn the management team if anything is missing, increase the transparency of who visits the warehouses at any given time, and more.

Since anything from rising temperatures in containers to security breaches can be tracked remotely, IoT technology reduces the need for physical supply chain supervision. The Internet of Things is changing security by allowing for more open supply chain solutions. On the other hand, technology is widening the digital space and increasing the need for data protection.

With the ambitious goals being set up in the Green Deal, IoT technology is a tool to help achieve them.

As presented by the use cases, there is no doubt that the demand for environmentally sustainable logistics in the food value chain is expanding and will grow in the coming years. This means that environmental concerns should be at the core of every food supply chain stakeholder plan. Although there is no one solution to the climate problem, the Internet of

Things helps reduce the agrifood industry's environmental footprint by making logistics processes smarter.
Food chain logistics stakeholders can use data collection, analysis, and machine learning to forecast traffic flow and reduce the number of unused trailers, boxes, etc., on the road at any given time. This strategy not only reduces cost – it also lowers total carbon emissions.
The transparency provided by IoT technologies significantly aids in the reduction of food waste and goods loss and damage. This is particularly valid for perishable products such as fruits, vegetables, etc. The systems help achieve better cargo control and establishes leaner, more effective food supply chain logistics processes as a whole.
By making the processes automated, controlled, and visible, a new path is created to a leaner and greener food supply chain. The transformational potential for the IoT in the logistics food supply chain, making it sustainable, is undeniable.

Conclusions

IoT-connected sensors and systems in food and beverage supply chain logistics offer real-time visibility and data-driven analytics, allowing stakeholders to improve performance, cut operating costs, conduct predictive maintenance to avoid downtime, and even decrease energy usage or reduce negative environmental impacts.
With the responsibility of logistics in the agrifood sector to fulfill two-day, overnight, or even same-day service obligations and at the same time to trace the origin and keep the quality of the products unaltered, the Internet of Things is a crucial component in assisting players in meeting the demands of today's fast-paced, global economy.
The pilot use cases in the agrifood sector have demonstrated many ways that IoT technologies can transform food supply chain logistics from the ground up.
Through the IoT, the management of supply chain processes is better regulated, and as a result, production risks are reduced. The ability to predict performance levels accounts for improved product delivery planning.
A vast amount of data is being collected by smart sensors using IoT technologies. This information can be used to monitor all stakeholders' overall efficiency in agrifood supply chains and their employee results, equipment quality, and more.
Agrifood industry logistics cost management and significant food waste reduction are possible due to increased control over supply chains. By being able to see disruptions in traffic flow, quality, or risks of contamination of goods, stakeholders can take measures to reduce or avoid losses.
The IoT, through automation and machine learning, helps to increase efficiency down the supply chain. Using smart devices provides the opportunity to automate multiple processes and significantly reduce physical supervision.
Keeping product quality and at the same time not lowering volumes of production becomes a common process. Better control over the logistics process helps maintain higher standards for food and beverage quality, and retains production growth capacity through the whole food and beverage supply chain.
The results of applying IoT technologies to food and beverage supply chain logistics processes provide higher revenue for all stakeholders.

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SECTION 6

DIGITALIZATION AS A FACTOR OF ECONOMIC SECURITY IN THE CONTEXT OF GLOBAL CHALLENGES

DIGITALIZATION OF THE UKRAINIAN ECONOMY: GLOBAL CHALLENGES AND LOCAL DILEMMAS

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Abstract *The rapid development of information and communication technologies has caused significant changes not only in public life, but also in business processes. Innovations and progressive methods of managing economic activity have caused inevitable changes in its structure. The reality of today is that 55% of global business is digital, and 99% of workers who moved to online work due to the COVID-19 pandemic do not want to return to their workplace in the office. Digitalization is a priority direction of development for modern Ukraine. Despite the significant efforts of the legislative and executive authorities of Ukraine to form the necessary infrastructure, the process of digitalization of the economy in the state still does not meet global challenges, which makes it a relevant object for modern research in the field of management. The theoretical and methodological basis of the study is the fundamental provisions of economic theory and the work of domestic and foreign scientists on the study of the process of transition of the global economic system to the digital space. The study is based on the dialectical method of cognition and a systematic approach. The purpose of this study is to deepen the theoretical foundations of the study of the digitalization of the economy and to identify the impact of global challenges on the digitalization of the economy of Ukraine. This study reveals the essence of theoretical and methodological approaches to the study of the concept of the digitalization of the economy, and establishes its key elements. The domestic and foreign works of scientists devoted to the development trends of the processes of digitalization of the economy and public life are analyzed. It is established that despite the large number of studies of this process, its theoretical aspects and problems of practical implementation are still insufficiently studied due to the high speed of innovative transformations that occur in the global economy and unforeseen factors, the management of which presents certain difficulties even for developed countries (such as the COVID-19 pandemic). The paper analyzes the position of Ukraine in international rankings that describe the process of digitalization and the level of development of the digital economy. It is established that the most significant assessment criterion for the state is the knowledge possessed by specialists in the field of technology and innovation. However, it is emphasized that the local state problem is the outflow of such a resource abroad due to the impossibility of ensuring a high level of wages and appropriate working conditions. The global challenges of digitalization of the economy are identified and local dilemmas are presented that hinder the transformation of economic activity and public life.*

Keywords: *digitalization, digital economy, global economic system, digital space, digital infrastructure, electronic commerce.*

Introduction

The digitalization of the economy is a modern global megatrend that has appeared as a result of the rapid development of information and communication technologies and is designed to simplify business activities through the unification of fragmented approaches to its management. In the widest sense, digitalization is commonly understood as the transformation of information through its synchronization and compression in such a way that the sender and recipient of digital data can successfully communicate with each other (Explanatory Dictionary, n.d.). It has become an integral part of market relations, which are rapidly moving online in the 21st century, thereby opening up new frontiers for national business and making it easier for entrepreneurs of any size to enter the international market. The global problem of the healthcare system, which faced the COVID-19 pandemic, also had a special impact on the growth of the pace of digitalization of the economy.

Statistical data only confirm the statement of the famous American futurist John Naisbitt (2003), that "new information technologies will first be used to solve old industrial problems, and then gradually give rise to new activities, processes and products."

Despite the fact that the concept of digitalization is not innovative, it is only beginning to develop in economic theory. Changing approaches to managing human economic activity

requires a qualitative restructuring of the global economic system, innovative knowledge and time. It should be noted that the global level of economic development throughout the history of mankind was characterized by a high level of asymmetry; therefore, the processes of digitalization of the economy in different countries occur with different intensity. Most revealing in this case are the growth rates of e-commerce. In 2014 this accounted for only $1,336 billion, which represented 7.2% of the total volume of trade, while in 2020 this figure reached $4,248 billion, i.e., 24.9% of worldwide trade (WTO, 2014, 2020; Statista, 2022). Innovative approaches to management and digitalization are being actively introduced in various industries, especially in the construction industry (digital construction, virtual reality, etc.).

Digitalization is a priority direction of development for modern Ukraine. Back in 2016, the ProZorro electronic public procurement system and the e-Health electronic health care system were successfully introduced in the territory of the state. Since 2018, the government of the country has been actively developing and implementing basic provisions to enhance the development of the digital economy and other areas of activity. In 2018, the "Concept for the Development of the Digital Economy and Society of Ukraine for 2018–2020" was adopted, the Internet was launched in 4G format, and laws were adopted "On Electronic Trust Services," concerning the provision of a high level of protection of electronic signatures, and "On the Main Provisions for Ensuring Cybersecurity in Ukraine," designed to guarantee the protection of the interests of the national community in cyberspace. In 2019, the State Agency for Electronic Governance of Ukraine was replaced by the Ministry of Digital Transformation, whose activity is aimed at ensuring the implementation of the digital rights of every citizen, namely the right to access broadband Internet, increased availability of information and communication technologies, and so on. In order to transform the perception of the ongoing digitalization processes by the population, in March 2021, the Cabinet of Ministers of Ukraine adopted the Concept for the Development of Digital Competences, the main goal of which "... is identifying priority areas and main tasks for the development of digital skills and digital competencies, increasing the level of digital literacy of the population ... in the conditions of development of the digital economy and digital society." However, despite the significant efforts of the legislative and executive authorities of Ukraine to form the necessary infrastructure, the process of digitalization of the economy in the state still does not meet global challenges, which makes it a relevant object for modern research in the field of management.

A large number of works of both domestic and foreign scientists are devoted to the study of the process of digitalization of the economy and modern trends in its development. The solution of the problems of socioeconomic relations in the modern paradigm of the information economy is reflected in the works of: D. Antonenko, I. Antokhonova, D. Bell, A. Berko, N. Vasilyeva, O. Vilkhivskaya, V. Vysotskaya, L. Vinarik, L. Vinnik, L. Garmider, D. Amora, O. Melnichuk, A. Orlova, V. Pavlova, O. Pushkar, E. Ponomarenko, J. Strauss, A. Chuchkovskaya, A. Shchedrin and others. The study of global trends in the development of digitalization is reflected in the works of: A. Abeliansky, M. Alstyne, J. Burrell, S. P. Choudary, C. Freund, A. Goyal, M. Graham, M. Hilbert, I. Hjorth, V. Lehdonvirta, E. Oreglia, G. Parker, D. Tapscott, D. Weinhold, G. Karcheva, S. Kuznetsova, D. Ogorodney, V. Openenko, B. Panshin, A. Spartak, I. Sagittarius, V. Khalin, S. Chebanov, G. Chernova, I. Shkvarun, and others. The main problems of digitalization in Ukraine and trends in the development of the digital economy and digitalization of public relations are considered by such domestic scientists as S. Alpakov, O. Bilyk, S. Veretyuk, O. Hudz, O. Dannikov, O. Dzhusov, V. Zagariy, T. Kovalchuk, S. Kolyadenko, Y. Levitskaya, A. Marchenko, V. Pilinsky, I. Plykus, N. Podolchak, V. Sinilnik, K. Sichkarenko, and others. However, despite the large number of studies of this process, its theoretical aspects and problems of practical implementation are still insufficiently studied due to the high speed of innovative transformations that occur in the global economy and unforeseen

factors, the management of which presents certain difficulties even for developed countries (such as the COVID-19 pandemic). Such problems determine the relevance of the study of the digitalization of the economy of Ukraine.

The purpose of this study is to deepen the theoretical foundations of the study of the digitalization of the economy and to identify the impact of global challenges on the digitalization of the economy of Ukraine.

The object of this study is the process of the digitalization of the economy of Ukraine.

The theoretical and methodological basis of the study is the fundamental provisions of economic theory and the work of domestic and foreign scientists on the study of the process of transition of the global economic system to the digital space. The study is based on the dialectical method of cognition and a systematic approach. The main results of the study were obtained using a set of general scientific and special research methods, namely: theoretical generalization, induction and deduction to analyze the conceptual and categorical apparatus of studying the digitalization of the economy; system analysis and synthesis to establish the features of the digitalization of the economy; and abstract-logical and statistical analysis to explain the trends in the development of e-commerce in Ukraine and the positions of the state in international rankings.

The information basis of the study is the official data of international organizations (the United Nations Convention on Trade and Development (UNCTAD), the World Trade Organization (WTO), the World Bank, the World Economic Forum (WEF) and others), statistical agencies and authorities of the European Union, European Commission (EC) and Ukraine, the materials of scientific periodicals, and Internet resources.

The main body of the paper

The rapid development of information and communication technologies has caused significant changes not only in public life, but also in business processes. Innovations and progressive methods of managing economic activity have caused inevitable changes in its structure. The realities of today are such that 55% of global business is a digital space, and 99% of workers who moved to online work due to the COVID-19 pandemic do not want to return to their office workplace (Marinova, 2022). The digitalization of economic activity and public life is rapidly increasing, which poses a number of tasks for states and individual economic structures to create conditions for its successful integration into existing systems or build new ones based on the constitution of the modern information space. In order to identify the basic conditions for the successful implementation of digitalization in the economy, it is necessary to clearly identify its essence and key elements. There is currently no single approach to the interpretation of the concept of digitalization of the economy in economic theory. An analysis of theoretical developments made it possible to systematize theoretical approaches to the definition of the concept of digitalization of the economy (Table 1) and to establish that a variety of methodological approaches to its understanding are crystallized in several synonymous definitions and similar concepts: digital economy, electronic economy, Internet economy, and digitalization of the economy. Systematizing approaches to understanding the essence of the digitalization of the economy, it should be noted that within the framework of the time-spatial approach, it is considered as a stage in the development of the global economy which plays a significant role in the development of the world community. The functional approach focuses on the content and key operations that are carried out in the process of establishing an economic system via the Internet. The communication approach reveals the essence of the digitalization of the economy as a process of interaction between various business entities. The process approach focuses on the direct transformation of the economic system. Finally, the systemic

approach considers it important to consider the digitalization of the economy as an integral system of interconnected elements, which acquires certain features.

Table 1. Theoretical approaches to the definition of the concept of digitalization of the economy
Source: developed by the author

Name of approach	Essence of interpretation	Representatives
Temporal-spatial	A new way of the economy based on knowledge and digital technologies, within which new digital skills and opportunities are formed for society, business and the state.	The World Bank (2016)
	The main modern trend in the development of the economy and society, based on the transition to a digital format for presenting information, which is aimed at increasing the efficiency of the economy and improving the quality of life.	Khalin & Chernova (2018)
	The modern innovative stage of economic development, which is based on the integration of physical and digital resources in the sphere of production and consumption, in the economy and society.	Achapovskaya (2019)
	A driver of innovation, competitiveness and economic growth, which leads to lower costs and new opportunities in various sectors of the economy.	Shuiskiy (2019)
	A driver of global economic growth aimed at accelerating economic development, increasing the productivity of existing industries, creating new markets and industries, and achieving inclusive sustainable growth.	Rozanov et al. (2021)
Functional	A digital economy, but to a large extent we mean doing business in Internet-based markets.	British Computer Society (2013)
	The consumption of goods and services using digital information technologies (online trading, e-government, etc.).	Pyvovarov (2018)
Communication	A form of economic activity that emerges from a billion instances of networking between people, businesses, devices, data, and processes. The basis of the process is hyperconnectivity, i.e., the growing interconnectedness of people, organizations and machines, formed by the Internet and mobile technologies.	Deloitte (2019)
Process	The transformation of various spheres of the economy by transferring all information resources and knowledge to a computer platform.	Veretyuk & Pilinskyi (2016)
	Active introduction and practical use of digital technologies for collecting, storing, processing, converting and transmitting information in all spheres of human activity.	Babkin & Lychagin (2020)
	The process of creating a technology-driven system designed to generate new sources of income and expand the boundaries of economic opportunities for a business entity.	Tumanyan (2019)
	The process of structural changes at the microeconomic level, aimed at moving existing economic models to the digital space.	Blix (2015)
Systemic	The set of mechanisms necessary to achieve stable economic growth over time and, consequently, for the transition of developing countries to the level of developed ones, as well as for the latter to remain so.	Martínez Euklidiadas (2021)
	A process or ecosystem that transforms all areas of economic activity into a digital economy in its broadest sense.	Hanna (2020)

The study of the essence of existing interpretations of the concept of digitalization of the economy confirmed the conclusion that there are a large number of relevant definitions, each of which characterizes certain aspects of the organization of economic activity on a digital platform depending on the objectives of the study, which are determined by the level of development of the economy as a whole. Thus, the understanding of the essence of digitalization of the economy is being transformed both at the national and global levels.

The economy of the state, as a system, consists of a number of interrelated elements: the market, industry, agriculture, finance, trade, entrepreneurship, management, marketing and many

others. In modern conditions of globalization and internationalization of economic activity, each of the presented elements functions by being closely interwoven with information and communication technologies. Trade, advertising and PR, finance, entrepreneurship and a certain part of the service sector have long used the digital Internet space to manage information flows. It was these areas which formed the basis of the digital economy, the concept of the development of which appeared in the last decade of the 20th century. The basic requirements for entrepreneurs and public authorities have become the availability of qualified personnel and appropriate infrastructure, and for consumers – the presence of an Internet connection and access to computer technology. Despite the fact that in Ukraine the percentage of funds that the population spends on providing themselves with communication services is constantly growing (3.3% in the first half of 2021 compared to 2.4% in the first half of 2018), the picture of population coverage regarding information and communication technologies is very blurry (State Statistics Service of Ukraine, n.d.-a, n.d.-b). This is due, first of all, to the imperfection of statistical accounting in this area. At the moment, the official website of the State Statistics Service of Ukraine (n.d.-a) presents data only on the coverage of the population with communications, without specifying information on the number of Internet users. In addition, this information is no longer updated. The State Statistics Service of Ukraine's (n.d.-b) data on the activity of enterprises involved in the process of digitalization of the economy are relevant and very detailed, but they only allow a fragmentary assessment of the pace of transition to a digital system. Under such conditions, international ratings that assess the level of development of information and communication technologies and the degree of readiness of digital infrastructure are becoming key indicators of the process of digitalization of the economy. The digital economy of Ukraine has found its assessment in a number of such ratings (Table 2).

Table 2. Assessment of the level of digitalization of Ukraine's economy in international rankings, 2020
Source: compiled by the author on the basis of Acs et al. (2020); Dutta & Lanvin (2020); United Nations DESA (2020); IMD World Competitiveness Center (2021)

Rating / index name	Ranking of Ukraine	List of countries holding the nearest positions
Digital Platform Economy Index (DPE Index)	54th from 116 countries	Brazil – 51, Argentina – 52, Mexico – 53, Saudi Arabia – 55, Oman – 56, Montenegro – 57
United Nations E-Government Development Index EGDI	69th from 169 countries	Colombia – 67, Armenia – 68, Azerbaijan – 70, Peru – 71
Network Readiness Index (NRI)	53th from 121 countries	Bulgaria – 50, Bahrain – 51, Brazil – 52, Thailand – 54, Kuwait – 55, Costa Rica – 56
World Digital Competitiveness Ranking (WDCR)	58th from 63 countries	Peru – 55, Indonesia – 56, Philippines – 57, Argentina – 59, South Africa – 60, Colombia – 61

The Digital Platform Economy Index (DPE Index) was presented in 2020 by the Global Entrepreneurship and Development Institute to assess the level of development of the digital entrepreneurship system. This indicator includes four structural elements: Digital User Citizenship (DUC), reflecting the flow of users with digital technologies; Digital Technology Entrepreneurship (DTE), which describes the number of actors creating entrepreneurial innovations in the digital space; Digital Multi-Sided Platforms (DMP) – the number of sites where social and economic interaction between users; and Digital Technology Infrastructure (DTI), which includes all requirements for the organization and conduct of technical, social and economic activities on digital platforms (Acs et al., 2020). The Network Readiness Index is formed by four groups of indicators that reflect the network readiness of the state to digitize the economy. These groups include technology (use of ICT as a key factor in economic

development), people (ICT coverage and skills to use it productively), public administration (security of personal data in the digital space) and the impact of digitalization on society's wellbeing (Dutta & Lanvin, 2020).

The United Nations E-Government Development Index is calculated by the United Nations Department of Economic and Social Affairs. It is the only global index that assesses the state of digitalization of government activities in relation to other countries. The indicator is a relative indicator and is used for comparative analysis. It assesses the volume and quality of online services in the form of an index of online services, the status of development of telecommunications infrastructure and the index of human capital (Ministry of Electronics and Information Technology, 2021).

It is worth noting that due to the intensification of the activities of the Ukrainian authorities in providing the state with the necessary regulations governing the digitalization of the economy and the introduction of affordable software technologies for the population, the country ranks high in international rankings. Thus, in the territory of the state, the following are already available: 4G mobile communication, broadband Internet access, and the ability to receive a number of government services and electronic identification through the Action program. The number of enterprises engaged in e-commerce has increased as, accordingly, has its overall volume of trade (Figure 1). Thus, in 2018–2020, despite not insignificant changes in the quantitative structure of enterprises engaged in electronic commerce, its volumes increased by 59.8%, or 136 billion UAH, which is one of the most significant indicators of the growth of the digital economy in the country.

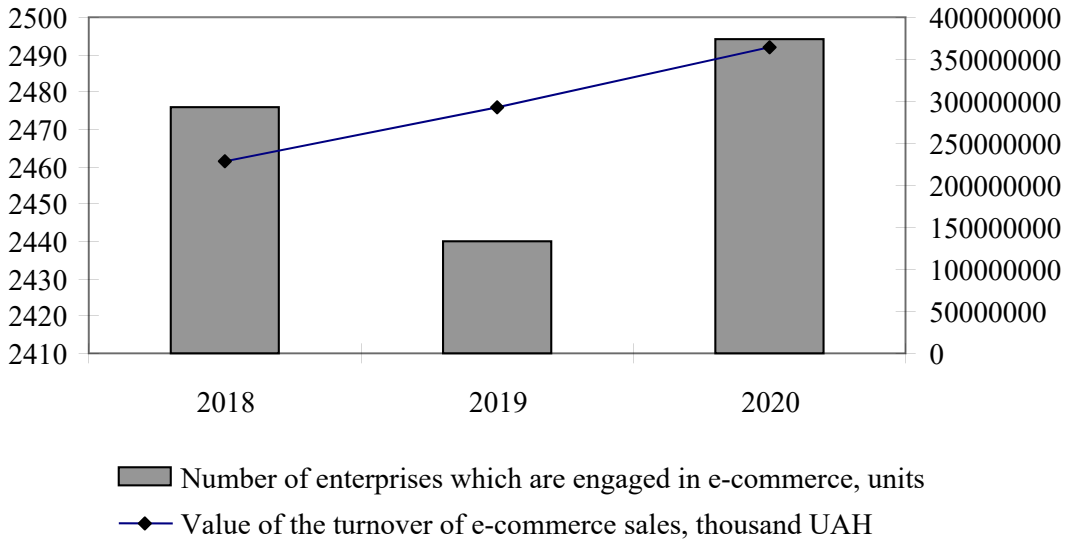


Figure 1. Dynamics of the number of enterprises using e-commerce and the volume of e-commerce in Ukraine, 2018–2020

Source: State Statistics Service of Ukraine (n.d.-b)

Ukraine's position in the World Digital Competitiveness Ranking is not high enough, which is explained by the specifics of calculating this index. However, it is the most indicative for assessing the process of digitalization of the economy, as it takes into account not only the development of enterprises in this area and the availability of specific knowledge for the employees of such enterprises, but also the strategy of digital transformation of public policy and society as a whole. It is worth noting that digital competitiveness is assessed by the International Institute for Management Development on three main criteria: knowledge, technology and readiness for the future. According to the rating, Ukraine occupies a fairly high position in terms of knowledge: in 2017 it was only 45th place, in 2020 it is already number 38.

Less significant is the increase in the country's rating in terms of digital infrastructure and the readiness of society as a whole, which occupied 60th position in 2017 and 58th in 2020.

The presented results of the analysis of the international position of the Ukrainian economy in the global digitalization process show that the country is making significant steps towards integration into the global digital space, but is not quite ready for the global challenges it poses due to a number of local problems (Figure 2). Already today, the process of digitalization is significantly changing the structure of the world economy and, accordingly, the Ukrainian economy. Not only production systems are subject to transformation, but also social relations and mechanisms of redistribution of economic and social benefits. The digitalization of the economy affects many aspects of human life and public policy. Thus, the transition to a digital economy requires a change of mindset, which involves not just digitizing existing processes, but the innovative reengineering of all processes at organizations of any level in the state, regardless of ownership.

Changing cultural traditions is also a global challenge for digitalization. While traditional cultural values are a unique form of ethnic heritage, modern innovations are common and global. This changes the attitude to economic identity and, accordingly, makes any economy more open and flexible in terms of consumer demand. As for technological transformation, it is based on the availability of scientific and technical information and informative and communicative technologies for a wide range of economic entities and the population. Demand for technological capacity is growing every day, but the level of investment in this area in the Ukrainian economy is still insufficient for a breakthrough in building a digital economy.

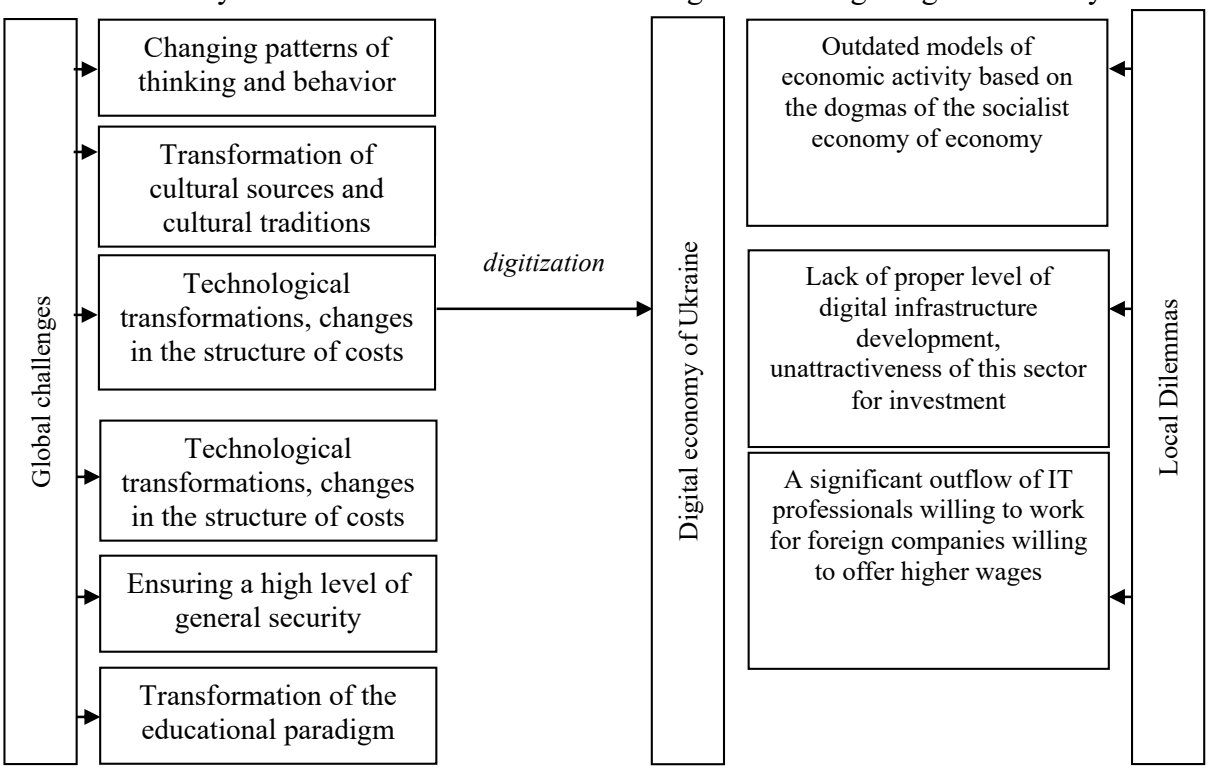


Figure 2. Global challenges and local dilemmas on the way to the digitalization of Ukraine's economy
Source: Developed by the author

With the onset of digitalization of the global economy, international financial markets have changed, which has resulted in the emergence of regulatory arbitrage, cryptocurrencies, FinTech and other elements of the innovative financial market. All of these have contributed to changes in the principles of funding and investment, and have had a significant impact on the transformation of the measurement of value.

Global requirements for successful digitization are data security and the availability of highly qualified specialists. While the first is still a matter of further development around the world, the transformation of the educational paradigm is especially relevant for the countries of the post-Soviet space, including Ukraine. Within the framework of training specialists, work with remote elements, the project approach and the case method of formation of key competencies are still underdeveloped. The new format of training requires universities to be a platform for assembling high-class professionals, rather than manufacturing them by limiting sources of knowledge and reflection.

Conclusions

Unfortunately, the Ukrainian economy is still far from being integrated into the global digital space, despite the success of the steps already taken by the state in this direction. The level of socioeconomic development of the country as a whole does not meet global requirements for the implementation of innovative programs. Of course, the European Union is currently implementing several projects aimed at stimulating the digitalization of Ukraine's economy, but these steps are still insufficient. One of the main reasons for slowing down the digitalization of the economy in the state is the lack of understanding of this process in the collective consciousness. Thus, the priority point of transformation is working with human resources as the main factor of production in this area.

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THE TRANSFORMATION OF ENTREPRENEURIAL ACTIVITY IN THE CONDITIONS OF THE DEVELOPMENT OF THE DIGITAL ECONOMY AND A METHODOLOGY OF ASSESSING ITS DIGITAL SECURITY

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***Abstract**. The innovative way that business is developed in the context of the digitalization of the Ukrainian economy dictates conditions where modernization and the development and strengthening of business positions on an international scale become more and more significant and unavoidable for every enterprise. Therefore, this is subject to detailed control and the implementation of digital security. The purpose of this study is to substantiate and develop theoretical and methodological provisions and scientific and practical recommendations for improving the system of businesses' economic security in the digital economy.*
The stages of introduction of digital technologies were considered. This made it possible to trace the chain of development of digitalization in the country: from a sales representative offering modern digital devices to an ordinary consumer using these devices and software in everyday life.
Research has shown that the digital revolution is changing business models, manufacturing and competitiveness. Over the past two years, the vast majority of enterprises have been using information and communication technologies. The analysis showed that digital business models tend to differ depending on the size of business structures and technologies. Businesses use ERP systems when they reach a critical level, allowing them to cope with the complexity and significant time, financial resources, and retraining required to implement ERP. Thus, the gap in the distribution of ERP is much larger between the structures of medium and small businesses than between the structures of large and medium businesses.
Intersectoral differences in digitization are significant. In knowledge-intensive sectors, enterprises are more intensively using all types of technology, and some aspects of digital transformation are almost complete – for example, the average share of employees with access to connected devices is around 90%, compared to 50% in all sectors.
In order to unify the process of studying the conditions in which digital innovations and entrepreneurial activity take place, a methodology is proposed for assessing the country's economy regarding digital transformation. No significant relationship was found between the level of digitalization and the overall performance of the company. This may be due to the fact that the companies under study are not clearly perceived by specialists and information technology leaders due to the lack of digitalization, and in most cases are not subject to strategic planning. Infrastructure companies are more likely to see tangible results in performance assessments such as improved accuracy and quality. The banking sector will benefit by increasing the flexibility of processes, strengthening their focus on customer needs, increasing sales and the emergence of fundamentally new products. The industrial sector indicates a low return on projects in terms of increased sales and the emergence of new customers, as well as the emergence of fundamentally new products, services and opportunities.
A significant relationship between organizational digital culture and the level of digitalization was not identified due to the low level of staff involvement in the digital development project. The digitalization of business processes will give impetus to the total complexity of all professions, on the one hand, freeing up the time of employees to solve more complex and creative tasks. On the other hand, it will significantly increase the requirements for their qualifications. Activities have been developed to support digital security risk management and enterprise resilience.

***Keywords:** digitalization, security, innovation, technologies.*

Introduction

Rapid reductions in computing costs, the emergence of the Internet as a means of communication, the rapid development of mobile Internet, the proliferation of everyday applications and the growing role of social networks and commercial platforms are significantly affecting the functioning of the economy and have a strong impact on business, community organizations and privacy. New digital technologies, such as the Internet of Things,

artificial intelligence and big data, are leading to further disruptive innovations and the creation of new opportunities and challenges.

Digitalization has brought many benefits to consumers and businesses, but it has also created new challenges. Leading scientists of different countries are engaged in research on the development of the digital economy, including Dannikov and Sichkarenko (2018), Kolyadenko (2016), Gudz (2018), Matveychuk (2018), Haanaes & Fjeldstad (2018), Carlsson (2004), Ayres and Williams (2004), and others.

The object of this research is the processes of formation and functioning of the system of economic security of entrepreneurial activity in the conditions of the development of the digital economy.

In the process of writing this study, the author used general and special methods that allowed for the systematic investigation of the problem of digital security of business in the digital economy. In particular, the following methods were used: multidimensional factor analysis; statistical analysis; modeling of structural equations; and strategic analysis.

The main body of the paper

Given its significant impact on the current state of business, production and consumption models, the issue of digitalization needs further study.

There is a need to study how the current digital revolution and information and communication technologies (ICT) affect the economy and what problems are holding back their development in Ukraine.

The *digital economy* is a term that captures the impact of digital technologies on production and consumption patterns. This includes how goods and services are bought, sold and paid for. This term has evolved since the 1990s, when the focus was on the impact of the Internet on the economy. This has been expanded to include the emergence of new types of digital-focused firms and the production of new technologies. Today, the term encompasses a dizzying set of technologies and their applications. These include artificial intelligence, the Internet of Things (IoT), augmented and virtual reality, cloud computing, blockchain, robotics and autonomous vehicles.

It is recognized that the digital economy includes all parts of the economy that take advantage of technological change that leads to the transformation of markets, business models and day-to-day operations. The digital economy covers everything from traditional technologies, media and telecommunications to new digital sectors. These include e-commerce, digital banking and even traditional sectors such as agriculture, mining or manufacturing, which are affected by the use of new technologies. Thus, the digital economy will become a normal economy as the absorption and application of digital technologies in all sectors of the world increases.

Today, Ukraine is actively implementing measures to digitize its economy. Digitalization of the economy is not an end in itself, but only serves as a tool to achieve the strategic goals of Ukraine and the vision of the Ukrainian economy in 2030 (Digital Agenda, 2016; National Economic Strategy of Ukraine 2030, 2021). Digitalization of the economy will contribute to:

- creating conditions for increasing the capitalization of Ukrainian business;
- implementing the technological development of the Ukrainian economy;
- increasing the competitiveness of the Ukrainian economy in global markets.

Table 1. Stages of implementation of digital technologies

Source: Kolyadenko (2016), Digital Agenda (2016), National Economic Strategy of Ukraine 2030 (2021)

Stage	Participants in the process	Example
1. Digital core	Physical technology providers	Semiconductors and processors
	Device suppliers	Computers and smartphones, software and algorithms

	Internet providers	Internet and telecommunication networks
2. Digital providers	Parties that use these technologies to provide digital products and services	Mobile payments, e-commerce platforms or machine learning solutions
3. Digital programs	Organizations that use digital provider products and services to change the way they do business	Virtual banks, digital media and e-government services.

To understand the trends in the digital economy, a study of the stages of implementation of digital technologies in economic activity was conducted (Table 1).

Thus, the chain of digitalization development in the country can be traced: from a sales representative who offers modern digital devices to an average consumer who uses these devices and software in everyday life.

The introduction of digital technologies will help business structures:

- to do business differently, as well as more efficiently and cost-effectively;
- to open many new opportunities;
- to offer goods and services to more consumers, especially those who previously could not be served;
- to experience new market structures which remove, among other things, transaction costs in traditional markets;
- to obtain and analyze large amounts of data.

There is a need to study the current state of Ukraine's economy regarding the introduction and development of digital technologies both at the national level and at the enterprise level. First of all, an analysis of the factors hindering the digital transformation of entrepreneurial activity was conducted. This study was conducted in Ukraine and covered the following topics:

- general information about the company/institution;
- infrastructure and services;
- sales and supplies;
- management practice;
- degree of competition;
- innovations;
- power;
- use of top management's time;
- land and permits;
- crime;
- finance;
- relations between business and government;
- labor;
- business environment;
- efficiency;
- module of green economy;
- aspects related to the environment;
- environmental impact;
- governance and the environment;
- environmental policy and regulation;
- the impact of the institution on the environment.

Enterprises of various forms of ownership and sizes took part in the study. Regional stratification was carried out in the following oblasts: Rivne; Sumy; Zaporizhia; Vinnytsia; Zhytomyr; Dnipro; Kharkiv; Poltava; Kherson, Nikolaev; Odessa; Kyiv.

The number of interviews in the institutions contacted was 8.9%. This number is the result of two factors: explicit refusal to participate in the survey, which is reflected in the rate of deviation (including the deviation of the examiner and the main survey); and the quality of the sample, as represented by the number of unavailable units.

Particular attention was paid to the correct calculation of weights. It was necessary to accurately adjust the results in each region/industry/size to take into account the presence of inappropriate units (if the company ceased operations or was out of reach; for educational or government agencies who answer after calls on different days of the week and at different times; and for cases with no sound in the phone line, where answering machines or faxes were reached, or where an incorrect address was listed and the authors failed to find new links). The information needed for the adjustment was collected at the first stage of implementation: the screening process. The survey was conducted according to a two-stage procedure. A telephone questionnaire was first used to determine eligibility and appointments. Then there was a face-to-face interview with the head/owner/director of each institution.

The results of the study are provided in Table 2. Given the fact that digitalization is global in nature, the analysis was conducted in comparison with other European countries.

Table 2. Analysis of the factors hindering the digital transformation of entrepreneurial activity

Source: Schwab (2019); National Bank of Ukraine (2020)

Safety indicator	Ukraine	The average in Europe	Divergence
Percentage of enterprises that pay for security	78.2	55.5	−22.7
Average security costs (% of annual sales)	2.3	3.5	1.2
Percentage of firms affected by the digital threat	18.8	16.2	−2.6
Average losses due to digital security (% of annual sales)	3.5	5.1	1.6
Percentage of businesses that identify digital security as a major constraint on business	30.9	17.2	−13.7
Labor potential			
Percentage of enterprises offering formal training	24.3	32.2	7.9
Years of experience as a top manager in the enterprise sector	18.1	18.0	−0.1
Proportion of skilled workers (of all production workers) (%) *	89.4	76.6	−12.8
Percentage of enterprises that define labor standards as the main constraint	19.9	10.7	−9.2
Percentage of workers with sufficient digital technology skills	37.9	20.5	−17.4
Factors hindering business development			0.0
Percentage of enterprises that chose access to finance as the biggest obstacle	13.9	14.4	0.5
Percentage of businesses that chose business licensing and permits as the biggest hurdle	0.7	2.6	1.9
Percentage of enterprises that chose corruption as the biggest obstacle	17	7.1	−9.9
Percentage of companies that chose courts as the biggest obstacle	2.2	1	−1.2
Percentage of enterprises that chose crime, theft and disorder as the biggest obstacle	1.6	2.8	1.2
Percentage of enterprises that chose customs and trade as the biggest obstacle	2.2	3.4	1.2
Percentage of enterprises that chose electricity as the biggest obstacle	1.7	9.2	7.5
Percentage of enterprises that chose an inadequately educated workforce as the biggest obstacle	3.9	8.3	4.4
Percentage of enterprises that chose labor standards as the biggest obstacle	2	3	1.0
Percentage of enterprises that chose political instability as the biggest obstacle	25.4	11.9	−13.5
Percentage of enterprises that chose informal sector practices as the biggest obstacle	9.2	12.1	2.9
Percentage of enterprises that chose the tax administration as the biggest obstacle	3.1	4.1	1.0

Percentage of companies that chose tax rates as the biggest obstacle	12.5	13.1	0.6
Percentage of enterprises that chose transport as the biggest obstacle	3.7	3.7	0.0
Capacity of production (%)	68.8	73.2	4.4
Real annual sales growth (%)	−7.7	0.7	8.4
Annual employment growth (%)	0.2	4.5	4.3
Real annual growth of labor productivity (%)	−7.7	−3.3	4.4
Percentage of enterprises that buy fixed assets	37.0	39.0	2.0

Research has shown that the digital revolution is transforming business models, manufacturing and competitiveness. The vast majority of enterprises use at least some ICT. In 2019, an average of 93% of enterprises in European countries had broadband. Virtually all large business structures (98% on average) and more than 91% of small business structures are now connected to broadband. However, the gap between the use of ICT by large and small business structures remains significant.

Business digitization will continue quickly. This will be facilitated by technological developments such as the deployment of 5G networks and increasing the connection of objects via the IoT. However, diffusion remains uneven between business structures. The share of employees who use Internet-connected devices is an indicator of how much ICT has been implemented throughout the business. The proportion of workers using computers with Internet access has grown significantly in Europe over the past decade. However, among small business structures it remains slightly lower compared to large business structures (Figure 1). In 2019, there were significant differences between countries. More than 70% of employees used computers with Internet access in the Nordic countries.

Businesses can choose from a wide range of digital technologies, and websites using broadband Internet are the most common tool (in 2019, 78% of businesses had their own website). Although it is the hallmark of the Internet age, a much smaller proportion of businesses sell through e-commerce. In Europe, only 24% of businesses with at least 10 employees received electronic orders in 2019. This share, which has remained stable since 2016, increased by only 5% compared to 2010. In 2019, e-commerce generated an average of 19% of total turnover. Up to 90% of e-commerce revenue comes from business-to-business transactions through e-commerce programs.

There is a pattern here, in that digitization allows organizations to expand business integration, in addition to managing information flows in companies, for a variety of business functions. Enterprise Resource Planning (ERP) allows business entities to take advantage of higher integration of information and processing into various business functions.

Given the fact that the digital economy primarily affects the development of enterprises whose activities are related to information technology, an analysis of the enterprise for the 2021–2018 period was conducted, the results of which are provided in Table 3.

According to the results, we see growth, but its rate is lower than the rate in developed countries.

Customer Relationship Management (CRM) tools enable business entities to collect, integrate, process and analyze information related to their customers through the intensive use of ICT. Currently, ERP and CRM are used by 36% and 30% of enterprises in Ukraine, respectively, which are 10% higher than they were in 2010 (Il'chenko, 2021). An analysis of the use of ICT tools and activities in European enterprises is provided in Figure 2.

Although most businesses are interconnected, digital technologies are still primarily seen as a means of communication – the level of acceptance tends to decrease as technology improves.

Analysis showed that digital business models tend to differ depending on the size of business structures and technologies. For example, small businesses are less likely to use corporate

resource planning (ERP) systems than large businesses. Businesses use ERP systems when they reach a critical level, which allows them to deal with the complexity and considerable time and financial resources and retraining required to implement ERP.

Thus, the gap in ERP diffusion is much larger between medium and small business structures than between large and medium business structures. The opposite applies to software for supply chain management, cloud computing or big data analysis, for which the digital divide is widening between medium and large businesses.

Digital conversion also occurs at different speeds. For example, small and medium-sized enterprises (SMEs) are catching up with larger enterprises through social media. Conversely, the implementation of software for business intelligence and supply chain management has made little progress in 2014–2020, especially among SMEs. Similarly, the share of SMEs training staff in information and communication technologies has not increased significantly – it remains relatively low.

Table 3. Growth rates of digital technologies in Ukraine

Source: Il'chenko (2021), State Statistics Service of Ukraine (2020)

Field of use	Indicator	Growth rate (changes) of the indicator by years						Average growth rate
		2013 / 2012	2014 / 2013	2015 / 2014	2016 / 2015	2017 / 2016	2018 / 2017	
Information and communication technologies	Enterprises, units	113.1	91.1	104.4	90.7	112.9	109.0	103.1
	Employed workers, persons	99.0	86.8	85.8	93.9	97.6	99.2	93.5
	Value added at production costs, thousand UAH	109.2	120.8	104.4	136.7	115.9	111.5	116.0
Production using high technologies	Enterprises, units	107.8	91.5	96.5	85.8	104.9	104.2	98.1
	Employed workers, persons	97.3	91.4	91.4	96.5	99.8	92.8	94.8
	Value added at production costs, thousand UAH	100.3	104.4	114.6	127.3	108.6	90.2	106.9
Production using mid-level technologies	Enterprises, units	112.7	88.4	102.6	95.0	109.0	105.8	101.9
	Employed workers, persons	95.9	83.5	89.4	96.3	100.7	100.5	94.2
	Value added at production costs, thousand UAH	94.0	101.4	117.1	91.7	125.4	123.1	107.9
Information sector	Enterprises, units	107.1	87.3	97.9	83.0	108.3	104.2	97.5
	Employed workers, persons	99.0	86.7	90.4	97.4	113.0	101.0	97.6
	Value added at production costs, thousand UAH	116.8	113.9	97.4	124.1	162.7	103.9	118.1
High technology services	Enterprises, units	109.3	88.8	101.4	86.0	111.8	107.1	100.2
	Employed workers, persons	97.5	88.1	87.8	94.4	99.6	98.6	94.2
	Value added at production costs, thousand UAH	110.9	105.5	108.0	137.2	116.1	114.8	115.0
Intellectually rich market services	Enterprises, units	109.4	88.8	102.7	90.1	111.3	106.6	101.1
	Employed workers, persons	97.2	89.5	91.9	97.3	97.7	97.8	95.2
	Value added at production costs, thousand UAH	89.1	93.8	108.8	195.8	119.7	105.2	114.4
Services related to the use of computer equipment	Enterprises, units	116.3	92.8	105.8	89.8	117.1	111.8	105.0
	Employed workers, persons	109.7	89.0	94.8	99.3	105.0	105.0	100.2
	Value added at production costs, thousand UAH	143.9	131.2	106.8	170.5	136.4	112.9	132.0

SMEs face several size barriers in terms of the awareness, skills and finances required to implement new digital tools and additional organizational changes. These barriers are a symptom of imperfections in the commodity, credit and labor markets.

The popularity of cloud computing has grown with the explosion of network density and speed and the constant increase in proposed computing power. One third of European businesses buy cloud computing services, an increase of more than 10% in just 5 years. In particular, cloud computing allows small and medium-sized enterprises (SMEs) to access additional processing capacity and storage capacity, as well as databases and software in quantities that meet their needs. In addition to flexibility and scalability, cloud computing reduces the cost of technology upgrades. This frees businesses from previous investments in equipment, as well as from regular maintenance, IT team and certification costs.

More advanced and specialized ICT technologies are less widely used. These include big data analytics (BDA) and radio frequency identification (RFID), where use is limited to certain types of business.

Another major indicator of the development of digital technologies is the prevalence of social media. With its rapidly growing prevalence in society, social media has become a multidimensional vector of information dissemination. Social networking is the most popular activity on the Internet in most countries, used by almost three quarters of Internet users. Companies and other organizations are also increasingly using social media to communicate with individuals (such as potential customers). More than half of the enterprises studied had a presence on social networks. Nevertheless, there is still a marked contrast between countries. Utilization ranges from almost 80% in Iceland and over 66% in Norway, Brazil, the Netherlands, Ireland and Denmark to below 30% in Japan, Poland and Mexico. Medium and large companies are more likely to use social media. Businesses mainly use social media for external interactions. This use includes developing the company's image and marketing products, as well as receiving or responding to customer opinions, reviews or questions. They are much less likely to use social media to engage customers in the development or innovation of goods or services. Social media is also used as a channel for collaboration with business partners, although there are other tools for this kind of interaction. Social media has also become an important tool for hiring employees. Within the European Union, more than half of large business entities used it for recruitment in 2017.

In enterprises, social media is seen as a potential exchange of ideas, opinions or knowledge in the workplace. This use is still relatively low among small businesses (around 12% in Europe). However, this has a significant presence in large business structures (around 30%). For large business structures, the acquisition of social networks is also closely linked to the acquisition of BDA. This illustrates how some businesses are experiencing an integrated digital transformation based on synergies between additional digital technologies.

Regarding the implementation of big data analytics, the study showed that BDA refers to the use of methods, technologies and software to analyze the vast amount of data generated by electronic activity and machine-machine communication (e.g., data obtained from social media activities, production processes). Reducing the cost of storing and processing data has contributed to the collection of large amounts of data and the adoption of BDA. Meanwhile, the expansion of cloud computing combined with the advent of easier-to-use analytical tools has made BDA more accessible to SMEs.

However, large business structures remain the largest and fastest-growing category of users today.

Over the past five years, an average of 12% of businesses in the countries for which data are available have used BDA. This share reached 22% in the Netherlands and over 20% in Belgium and Ireland. In addition, in Belgium and the Netherlands, more than half of large businesses

used BDA. Growth was significant among large business structures and to a lesser extent among SMEs.

The most intensive users of data from the geolocation of portable devices are usually in the field of transport and storage, and to a lesser extent in the construction industry. Businesses in areas such as electricity, gas, air conditioning, water supply and manufacturing are the most intensive users of data from smart devices or sensors. Social media data is mainly used in the accommodation and food and beverage industries. The real estate industry uses social media data to a lesser extent. Data from other sources are mostly used in three areas: information and communication; professional, scientific and technical activities; and real estate activities.

Analysis shows that digitalization has almost no effect on Ukrainian industry, which is showing a tendency to rapidly reduce its pace of development. For Ukraine, the critical problem is the technological backwardness and the preservation of this backwardness. In this regard, Ukraine not only failed to make a technological breakthrough, but also lost its position.

All of this indicates that Ukraine is not ready for the introduction of Industry 4.0 technologies. Moreover, the process of implementing Industry 3.0 has not yet been completed in Ukraine. Even the level of automation in Ukrainian industry is still below average. For example, in metallurgy it is around 50%. Accordingly, the problem of the digital leap, when businesses urgently need to pass level 3.0 and move to 4.0, is very acute in the country.

Cross-sectoral differences in digitization are significant. In knowledge-intensive sectors, businesses use all types of technology more intensively, and some aspects of digital transformation are almost complete. For example, the average share of employees with access to connected devices is around 90% compared to 50% in all sectors. The rate of diffusion in other sectors is much lower.

The introduction and use of ICT in business can be supported in a variety of ways. In developed countries, policies to promote the use of digital technologies by businesses are being intensively implemented. Most often, policy is aimed at business structures, whose goals are to increase profitability. This includes increasing sales, increasing competitiveness, reducing operating costs, reducing compliance costs, and increasing productivity. Policy objectives are also formulated at a more macro level in terms of stimulating growth and employment.

Using digital tools and technologies is an effective means to achieve these goals. Thus, in order to achieve the goal specified in the national program of digitalization of the economy, it is necessary to develop a program for the development of entrepreneurial activity in the context of digitalization. The main measures should be aimed at providing businesses with access to the knowledge and skills needed to choose and use the tools that will benefit them most. Second, they must help businesses implement digital tools, which may include the need to finance investment costs.

It is also necessary to use information campaigns on issues such as digital security and confidentiality, which many countries identify as key areas of economic security of business in the context of the digitalization of the economy. Technology-specific policies tend to be more narrowly targeted at specific companies or sectors, as well as network operators and relevant researchers.

A number of countries support the development and implementation of innovative products, especially digital services, to increase competitiveness and thus stimulate growth. The development and implementation of specific border technologies is a popular policy area. Artificial intelligence is most often mentioned, as well as 5G, IoT, blockchain, robotics, quantum technology and others. Data generation, collection and analysis are also highlighted as important supporting factors. At the same time, several countries emphasize the need to promote efficient technology and data markets.

Reducing digital disparities is also a stated policy goal in some cases and can often be linked to high-level welfare goals. Meanwhile, a number of countries have highlighted policies to

strengthen government implementation of digital technologies to increase efficiency, including the modernization and automation of tax systems. Several countries have targeted action in the social sectors where the government is usually active, such as promoting e-health.

Given the ongoing debate and the lack of consensus among digital development theorists and practitioners on ways and methodologies to measure the scale of the digital economy and the impact of digital transformation, an analysis of the state economy's capacity for digital transformation was conducted.

Thus, the results of the analysis prove that there should be: the implementation of developed strategies and efforts to accelerate the pace of transformation of the private and public sectors; the raising of public awareness of the use of digital technologies, strengthening the interaction of the scientific and educational community with the private and public sectors; and the creation of a business environment conducive to innovation, R&D and entrepreneurship. All of the above are key elements of the digital economy culture and tax environment, and stimulating investment in innovation and entrepreneurship development should be a priority of public policy.

It is recommended to use a number of policy tools to promote the use of ICT in business. The most widely used measures are direct financial support, followed by non-financial support. Indirect financial support, along with regulation and legislative guidance, is less often a tool of choice (Table 4).

Direct financial support includes grants to help target companies cover the cost of access to digital technologies and tools. For example, South Korea has offered grants for cloud services. For its part, Portugal offered direct financial support for the development and maintenance of websites, e-commerce, Internet marketing and big data.

In countries such as Denmark, Slovenia and Germany, direct financial support can also help businesses develop digitization strategies or increase digital capabilities and skills. Although they do not directly promote the use of digital technologies by businesses, many countries note the availability of grants or vouchers to support research and development (R&D) and other innovation activities. This support can contribute to technological progress and the development of innovative products for commercialization.

Indirect financial support includes tax credits or other benefits for ICT investments (as observed, for example, in Brazil and Japan). It also includes broader tax support schemes for research and development, including for digital technologies. Many European countries have such general support for research and development, including some who have stated that they do not have policies to promote the use of digital technologies in business. Competence centers offer measures to increase knowledge and awareness of digital technologies and related opportunities and risks.

For example, Australia, Lithuania, Sweden and Singapore provide special business advice and consulting services. Turkey provides special advice on regulations on new business models, with responses agreed between governments, while Latvia and Norway offer training. Countries such as Portugal and Slovenia give companies the opportunity to share experiences by demonstrating digital champions, group seminars, mentoring schemes and similar initiatives.

Digitization makes it easy to store and change information and knowledge. Digital technologies are creating a system of mass media and communication that increasingly connects all parts of social and economic life. In order to unify the process of studying the conditions in which digital innovations and entrepreneurial activity take place, a method of assessing the country's economy to digital transformation is proposed (Figure 1).

Table 4. Policy tools to facilitate the digital takeover of businesses by type of tool
Source: Schwab (2019); State Statistics Service of Ukraine (2020)

Countries	Financial support		Non-financial support	Regulations and legislative instructions	Together
	Direct	Indirect			
Australia	2	2	2	1	7
Austria	1	1	1	1	4
Chile	..	..	1	1	2
Colombia	1	1	1	1	4
Czech Republic	..	..	1	2	3
Denmark	2	..	3	2	7
Estonia	2	..	2	..	4
Finland	1	..	..	..	1
Germany	2	..	3	3	8
Israel	1	1	..	..	2
Japan	1	2	..	..	3
Korea	3	..	..	..	3
Latvia	2	1	1	3	7
Lithuania	1	1	1	1	4
Netherlands	..	1	..	..	1
Norway	1	..	1	1	3
Portugal	1	1	1	..	3
Slovenia	1	..	1	..	2
Spain	1	..	..	..	1
Sweden	2	0	2	1	5
Turkey	1	..	..	..	1
Brazil	..	2	..	..	2
Costa Rica	..	..	1	..	1
Ukraine	3	1	1	1	6
Singapore	..	..	1	1	2
In total	**29**	**14**	**24**	**20**	**87**

This methodology is based on econometric analysis to assess the impact of cultural, geographical, regulatory and commercial barriers on digital transformation.

Normative acts and legislative instructions are used to create legal bases in a wide range of areas. Coordination of efforts to strengthen cybersecurity is needed, including regulatory changes to codify the role of the National Agency for Cyber and Information Security. One such principle is to promote the integration of new business models in a technology-neutral way to ensure user-friendly digitization.

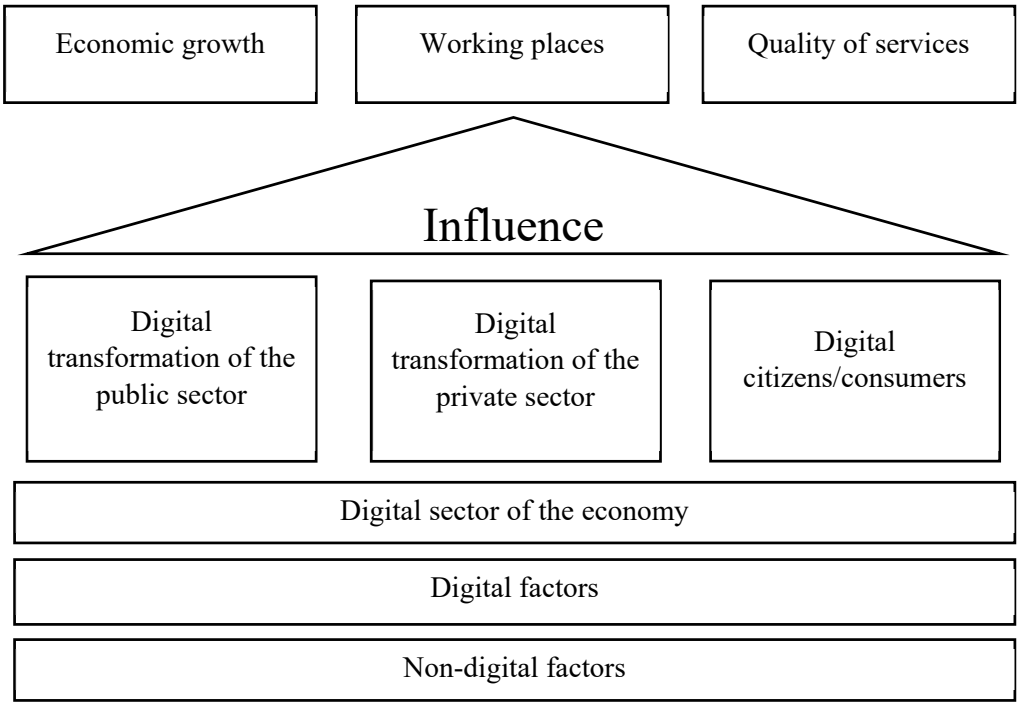


Figure 1. Methods for assessing the country's transformation towards a digital economy
Source: developed by the authors

Methodology for assessing the digital security of business

Digital security incidents harm businesses, governments and individuals by undermining the availability, integrity and confidentiality of their data, information systems and networks. Entrepreneurial structures suffer material and intangible losses, including monetary losses, loss of competitiveness, damage to reputation, interruption of operations and breach of confidentiality. With the advent of the consumer and industrial Internet of Things, which connects to the Internet, the damage can spread to the physical environment and affect security. There is a need to study trends in digital security risks and digital security policies. The focus is on policies that encourage digital security innovation, improve digital product security, and improve vulnerability management. This also opens up new opportunities for artificial intelligence regarding digital security.

The risk of digital security arises from incidents caused by threats to vulnerable sites. Sources of threats include governments, groups, and individuals with malicious or criminal intent. Their motivation varies, but usually includes the geopolitical goals of governments. Incidents can also be caused by unintentional threats, such as human error or power outages.

Analysis of the types of security related to digital technologies in the world reveals the most common:

1. Distributed Denial of Service (DDoS) attacks are a common type of incident that disrupts an Internet service by flooding it with illegitimate requests. Data on DDoS attacks usually come from companies that offer DDoS mitigation services. They do not have a comprehensive picture of the landscape, but can provide useful information on key trends. For example, according to Netscout, the scale of the largest DDoS attacks has increased over time. In 2005, the largest attacks reached 11 Gbps, 50 Gbps in 2009, 100 Gbps in 2010, 500 Gbps in 2015, and 800 Gbps in 2016. In 2018, one reached 1.7 Tbit/s (Netscout, 2019).

In 2018, the frequency of large-scale DDoS attacks decreased year-on-year, while attackers increased the size of smaller attacks in the range from 100 Gbps to 200 Gbps. This is still high for most online services. DDoS attacks do not need to use such high bandwidth to block online

services. In 2018, 96% of DDoS attacks consumed less than 10 Gbps. Meanwhile, 91% of businesses that suffered DDoS attacks said that at least one attack completely saturated their Internet bandwidth (Netscout, 2019). Although the longest attack in the third quarter of 2019 lasted more than 20 hours, 85% of attacks lasted less than 90 minutes; only 0.78% lasted more than 20 hours (NexusGuard, 2019).

2. Phishing remains common and is more difficult for humans to avoid. In phishing, one of the main vectors involves attackers disguising themselves as a reliable person in Internet communication. In this way, they receive confidential information, such as usernames and passwords, or deliver malicious code. There are different types of phishing attacks. Phishing reports often contain links to malicious websites that are becoming increasingly difficult for end users to detect without the use of automated protection. Extensive non-targeted campaigns aim to collect data by directing users to fake e-commerce or financial websites. More sophisticated emails are aimed at specific people so that they embed malicious software in their organization's information system (speech phishing).

In the countries of the European Union, phishing and farming (which redirect to fake websites that acquire personal information) differ greatly from country to country. Various factors may help explain these differences. These include lack of awareness/understanding of phishing attempts and/or inability to identify them, national languages, security measures offered by e-mail and Internet Service Providers (ISPs), etc. According to Symantec (2019), underwater phishing remained the most popular target of targeted attacks in 2018. This was used by 65% of all known cybercrime and government groups. According to Verizon, 32% of data breaches in 2018 were related to phishing activities. Phishing was present in 78% of cases of digital security espionage, including the installation and use of backdoors (Abid & Jemili, 2020).

3. Measuring software is a type of malicious software that uses cryptography to restrict or disable data availability and requires ransom to recover. Extortion programs are a form of digital extortion (Ebers & Steinrötter, 2021). Despite the fact that the required programs have existed for many years, this came into broader public focus in 2017.

These high-profile attacks have helped raise awareness of digital security and encouraged many businesses and organizations to step up their core security measures, including backup and recovery plans.

The extortionist can paralyze physical operations in factories and production environments. If an attacker gains access to an information technology (IT) system, they can successfully target an operational technology (OT) infrastructure that manages physical installations.

4. Cryptocurrencies have, over the past five years, been the target of various tools seeking to take advantage of the growing interest in them. Most cryptocurrencies are stolen from cryptocurrency exchanges. In the period from 2012 to 2019, at least 42 successful attacks were listed on the stock exchange. For example, in 2019, 12 attacks led to the theft of cryptocurrencies worth $292 million. In 2018, eight attacks led to the theft of $844 million. Some of these attacks have led the affected companies to bankruptcy (e.g., Mt. Gox, Cryptopia, Youbit). In some cases, partial amounts were collected or reimbursed to customers. Other attackers take control of a blockchain that supports cryptocurrency. In 2018, Bitcoin Gold (BTG) was excluded from the Bittrex cryptocurrency exchange after an initial attack of 51%. The attackers took over most of the network's computing power to reorganize the blockchain, which involved a cost of $18 million (Canellis, 2018). In January 2020, another 51% attack doubled BTG by $72,000. In 2018, Ethereum Classic suffered a similar attack of 51% of the total amount of Ethereum Classic (ETC) coins, for $1.1 million (Beedham, 2019).

Over the last three years, more inconspicuous techniques such as cryptocurrency and cryptojacking have been developed. Cryptojacking occurs when criminals install malicious software that usurps a user's processing power to extract cryptocurrency. Cryptojacking is cryptocurrency using scripts embedded in web content running in a user's browser.

5. Malicious software is becoming more sophisticated. File-free malware is less visible because the code runs only in system memory or uses commonly allowed tools installed on the system. Malicious software has evolved from encrypted to oligomorphic to polymorphic and metamorphic. Encrypted malware is the first step to avoid signature-based detection. With each infection, the malware is encrypted with a different key, making each file unique. However, security features can still detect a decoder that is part of the code that decrypts it and remains the same among infections.

Oligomorphic malware can change its decryptor with each generation of malicious code – that is, each time the code is distributed elsewhere. However, this technique can only create a few hundred different generations, which is not enough to avoid security.

Polymorphic malware can create countless decoders through the mutation mechanism, and cannot be detected by simple signatures.

Metamorphic malware can completely rewrite your code. Thus, each new version distributed elsewhere no longer corresponds to the previous iteration without the use of encryption.

Thus, there is a need to develop measures to manage digital risks in business.

Given the complexity of digital security risk management, it is difficult to quantify the extent to which companies implement best practices in this area. However, certain statistics provide useful information. They measure specific aspects that can be used as proxies to form a relatively strong picture of Ukraine's situation. They concern business entities that assess digital security risks, inform their employees about digital security commitments, conduct security tests or regular backups, and insure against digital security incidents.

Digital security risk assessment – a periodic assessment of the likelihood and consequences of digital security incidents – is the basis for digital security risk management. In general, the share of enterprises conducting risk assessment ranges from 14% in Ukraine to 60% in Finland. As for other indicators of digital security, this share increases on average with the size of firms. This is less than one third among small firms, but almost three quarters among large firms.

Digital safety risk assessment is extremely important to help decide what to do with risk. Risk can be reduced or transferred – it can also be accepted or eliminated, although elimination eliminates both risk and benefit. To reduce risk to an acceptable level, firms must choose security measures that are proportionate to the risk and context. Too much security hinders economic and social activities protected by security measures. Too little security will not reduce risk enough. Security measures may include security tests, backup procedures, cryptographic techniques, two-factor authentication, network access control, and the use of VPNs.

The analysis showed that the practice of risk assessment significantly correlates with security tests or backup procedures.

As observed for other ICT security indicators in this section, large businesses are on average much more likely to implement security than small ones. In addition, the variability in different countries is relatively similar between large and small structures for safety testing. This suggests that backup in large enterprises is part of core digital security practices, while in SMEs it is more sensitive to risk assessment practices.

One way to reduce risk is to decide on the transfer of risk by purchasing insurance. The propensity of businesses to purchase insurance policies varies widely, from 4% in Lithuania to over 56% in Denmark. In all but two EU countries, the propensity increases with the size of enterprises. In Denmark, it is significantly higher among small enterprises (57%) compared to medium (5%) and large (40%). This is also the case in Slovenia, although to a much lesser extent (Figure 1). In general, the propensity to buy insurance can be seen as an indication of how seriously firms take digital security. However, it also depends on the availability of insurance policies in the country that cover the risk of digital security. The digital security

insurance market is complex, and includes traditional insurance policies or stand-alone policies.

Another indicator of commitment to digital security is the share of enterprises that inform working people about their commitments on ICT security issues. This ranges from one third in Greece to more than three quarters in Ireland, where there is also a high concentration of business in the ICT sector, often a multinational bridgehead for Europe. This share also increases with the size of enterprises: less than 60% among small enterprises, but more than 90% among large enterprises.

More generally, all of the above indicators, based on Eurostat data, clearly show that firms' propensity to implement digital security measures increases with their size. In addition, this propensity is also systematically higher for firms in certain fields, such as the ICT sector, or professional, scientific and technical activities. In addition, the risk assessment is also higher, on average, in real estate.

It has been proven that there are obstacles to the widespread adoption of a digital security system. Many politicians are still unaware of the need to remove such barriers and encourage responsible behavior by all stakeholders.

This analysis allows recommendations for digital security to be developed. They aim to focus on what is critical to the economy and society, without imposing unnecessary burdens on others. The main areas are:

- adaptation of their comprehensive policy;
- ensuring that operators effectively reduce the risk of digital security to critical functions to a level acceptable to society;
- promoting and building partnerships based on trust;
- improving cooperation at the international level.

These recommendations also clarify how this area relates to broader national risk management policies.

This process should be based on a national risk assessment covering all economic and social activities.

The Government, working with relevant public and private entities, determines:

1. Critical activities related to digital security.
2. Operators of these important activities at enterprises.
3. That cyclical risk management is carried out to identify functions without which they would not be able to perform effectively.
4. That a map of the digital ecosystem, i.e., the digital environment that supports their functions along the value chain, is compiled.
5. The digital security risks of critical functions are cyclically assessed, taking into account their digital ecosystem, and the level of digital security risk to be reduced, transferred, avoided and accepted is determined on this basis. This involves risks and digital security management measures, as well as those that protect activities, detect and respond to incidents and establish resilience.

The first three stages of this process are part of a broader national risk management system and critical infrastructure protection policy, and focus on digital security. It is important to mention them in order to ensure the coordination of stages four and five with the national risk assessment and not to create an unnecessary burden for operators.

Considering the activities in accordance with the provided recommendations, this will create additional restrictions for operators and may affect their competitiveness in the global market. Therefore, governments often work with these operators and other stakeholders in the first and second stages, and more generally in the policy-making process, to best balance progress in digital security with economic and social indicators.

Step four introduces the concept of the digital ecosystem, which is broader than information systems and networks and includes digital assets such as hardware, software, networks and data, operational technologies that detect or cause changes in physical processes, and internal and external entities, individuals and processes that design, maintain and operate them, and the relationships between them. Step four is a prerequisite for step five, where operators manage digital security risk, i.e., as part of their broader enterprise risk management system and overall economic and social decision-making processes.

Given the role of digitization in stimulating the development of new sources of sustainable growth, innovation, employment, prosperity and inclusiveness, in order to maximize the economic and social benefits of the digital economy, enhanced mechanisms are needed to involve all stakeholders in policy development processes, including governments, international organizations, business, civil society, organized labor, the technical Internet community and academia.

It has been proven that the strength and dynamism of the digital economy depend on the efficient access of users and innovators to communication infrastructure and services through high-speed networks, more efficient use of digital technologies by businesses, governments, individuals and society, openness and trust.

This is further recognition that policy-making related to digital transformation requires an integrated public approach and cooperation with all relevant stakeholders.

Digital dependence on critical activities has increased and is now accelerating through the digital transformation and generalization of technologies such as big data, artificial intelligence and the Internet of Things. At the same time, digital security threats are growing in number and quality. Many governments expect that in the coming years, digital security incidents affecting critical action could lead to major catastrophes.

According to the results of the study, measures are proposed to address the issues of digital security of business. Their implementation provides a solid basis for strengthening the digital security of economic and social activities without reducing the opportunities provided by digital transformation.

The introduction of these measures in practice will help strengthen the digital security of individual enterprises without imposing unnecessary burdens on other entities.

As already proven:

– Digital transformation affects all economic and social activities, stimulating innovation and bringing significant benefits, but also exposes these activities to the growing risk of digital security;

– Digital security risks arise from intentional or unintentional threats that are transboundary, exploit vulnerabilities, and cause incidents that affect the availability, integrity, and confidentiality of the data, hardware, software, and networks on which they operate;

– The multiplicity and complexity of digital relationships between sectors, as well as along value chains, creates a common digital security risk that no one participant in the production process can significantly reduce for all;

– Partnerships in and between the public and private sectors are essential for a coherent and holistic approach to digital security risk;

– Measures taken by different operators in different sectors and countries depend on the same digital technologies and can therefore be simultaneously affected by threats that share a common vulnerability;

– Digital security incidents can spread extremely rapidly between operators, sectors and borders;

– Disruptions to critical actions caused by digital security incidents in one place may spread to other operators, sectors and countries, potentially affecting regions and international stability;

– The consequences of digital security incidents may go beyond the interests of these operators, affect society as a whole and others abroad, and as a consequence any residual risk taken by these operators could affect all those dependent on such activities, as well as society as a whole;
– Improving the digital security of activities is a priority of national policy;
– Differences in public policy in different countries increase the complexity of managing digital security of interdependent critical activities abroad, and international cooperation is crucial to reducing such differences and maximizing the global effectiveness of domestic policies;
– Digital security risk management must respect the confidentiality and protection of personal data.

Thus, the digital ecosystem means a digital environment that supports enterprises in the value chain of critical activities. It includes digital assets such as hardware, software, networks and data, operational technologies that detect or cause changes in physical processes, and internal and external entities, individuals and processes that design, maintain and operate them, and interact with them.

Developing a strategic approach to digital security risk management should be done by:

1. Adopting at the highest level a national digital security strategy, which sets clear goals for strengthening digital security and resilience to activities, as well as ensuring coherence with national risk assessment and other risk and sector strategies.
2. Establishing an internal governance mechanism that distributes authority and responsibility among specific structures for the development and implementation, together with relevant stakeholders, of policies to enhance digital security within and between sectors.
3. Ensuring internal coordination in order to:
- establish cooperation, taking into account the importance of dialogue between digital security and industry experts;
- ensure the consistency of measures;
- provide the efficient allocation of resources.

Businesses are encouraged to increase their capacity to support digital security risk management and resilience by:

1. Developing new or enhanced incident response capabilities, for example through one or more computer emergency response teams (CERTs), computer security emergency response teams (CSIRTs) and/or security centers (SOCs) responsible for monitoring, preventing, and recovering, as well as mechanisms to promote closer cooperation and communication among those involved in responding to incidents.
2. Promoting cooperation between CERT/CSIRT/SOC and operators, including incident reporting and analysis, to facilitate rapid and effective operational cooperation.
3. Application of best practices in digital security risk management related to the provision of important digital measures by the government.
4. Promotion of international digital security standards, methodologies, basic security manuals, best practices and tools.
5. Providing support to operators by exchanging information on threats, vulnerabilities and risk management practices.
6. Promoting the development of a global market for a variety of reliable security services and products, including managed services, audit and response services, including, where appropriate, a range of mechanisms for reliable signaling of the nature and level of security.
7. Supporting the development of a skilled workforce that can manage cross-sectoral and sectoral digital security risks.

8. Adopting and encouraging the adoption of responsible and coordinated processes for the detection and management of vulnerabilities, as well as the encouragement and protection of security researchers.
9. Sharing, in accordance with operators and other entities, properly compiled statistics on incident reporting.
To effectively reduce the risk of digital security to a level acceptable to society, consistent with the national risk assessment, a mechanism for reducing the risk of digital security, which includes measures to manage, protect, detect and respond, was created (Figure 2).

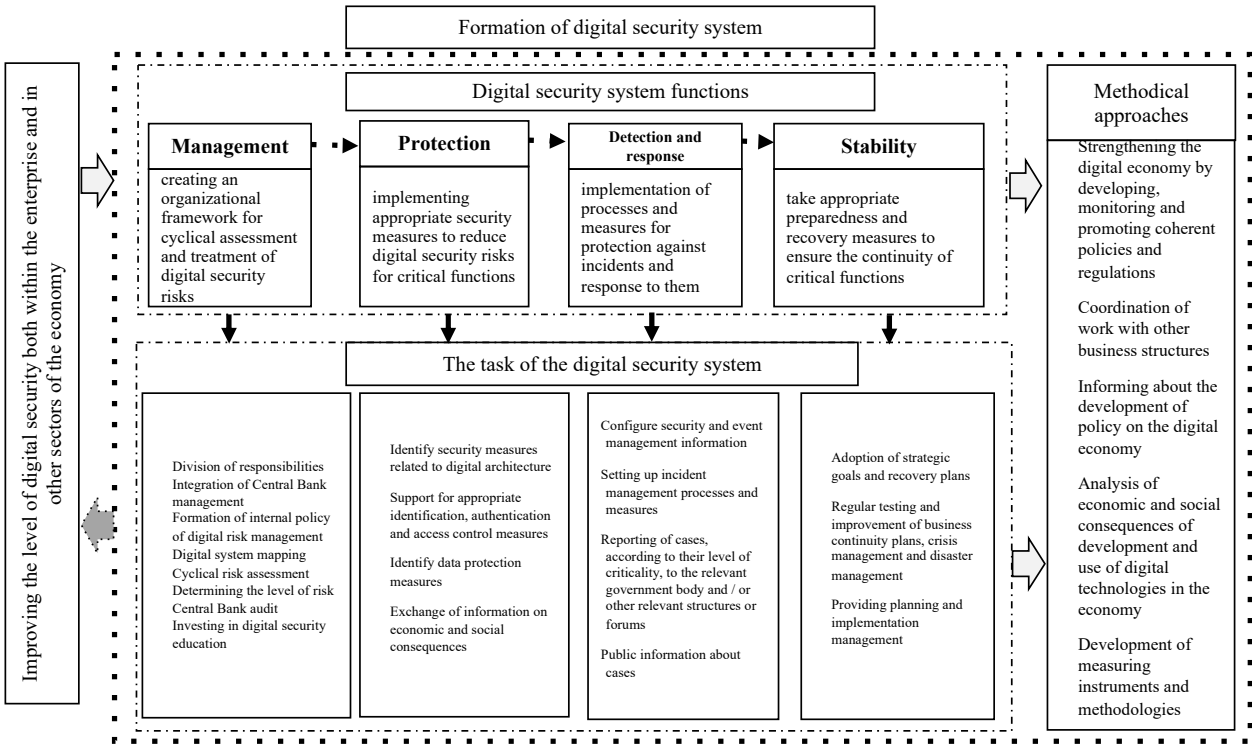


Figure 2. Digital security mechanism
Source: developed by the authors

During the implementation of the mechanism of digital security, the following methods of work are offered:
1) Strengthening the fundamentals of the digital economy by developing, monitoring and promoting a coherent policy and regulatory framework, including:
a) stimulating competition and investment in high-speed broadband and promoting convergence and universal access to broadband networks, services, programs and devices;
b) promoting investment in digital technologies and knowledge-based capital and improving the availability and use of data;
c) reducing barriers to access and use of digital technologies;
d) promoting research, innovation and new business opportunities, including those arising from new technologies and applications, while considering their economic and social implications and assessing the appropriateness of policy and regulatory frameworks and global standards;
e) strengthening confidence in the digital economy, including through the promotion of digital security risk management for economic and social activities and the protection of confidentiality, as well as the development of data transfer strategies and international arrangements that promote interoperability between systems.
2) Coordinating work with other business structures in order to:

a) develop analyses, policies and best practices that use the potential of digital transformation for growth and prosperity by strengthening entrepreneurship, ICT skills and employment and improving health, well-being and aging;
b) further develop and implement medium and long-term roadmaps for digital transformation.
3) Informing on the development of policies on the digital economy, in particular by:
a) reviewing and analyzing new technologies;
b) analyzing the economic and social consequences of the development and use of digital technologies in the economy and the impact of digital security and privacy on the economy and society;
c) developing measurement tools and methodologies, including the use of the Internet as a source of statistics, to strengthen the database for the digital economy and assess its contribution to the economy as a whole;
d) participating at the national level in cooperation with other relevant commissions in order to use innovative experience and best practices in individual countries, to provide volunteer countries with an assessment of the degree of digital maturity. This would help policymakers ensure a coordinated and cohesive approach by the government to better respond to digital transformation and make it work for growth and prosperity.
To build trust in sustainable partnerships, it is necessary to develop partnerships for policy development and implementation by:
1. Having open dialogue at the national level between operators and relevant public authorities to identify and implement measures to be taken by operators, taking into account the specifics of each sector, as well as the constraints on business, resources, regulation and the operator market, including small and medium-sized enterprises.
2. Supporting public-private cooperation and structured dialogue between operators within and between sectors, as well as with other relevant private actors (e.g., suppliers) to facilitate the exchange of digital security experiences, threat management and risk management.
3. Continuing ongoing dialogue on digital security with industry experts to improve mutual understanding of their specifics and limitations.
4. Ensuring bilateral and multilateral cooperation in order to exchange knowledge and experience on internal policies, practices and models of coordination with operators and to promote collective action.
5. Supporting cross-border cooperation and exchange of information on public-private research and development on digital security of critical activities, including methodologies for assessing the impact of digital security incidents.
6. Supporting cutting-edge research, fostering innovation, and working together to develop digital security risk management skills and knowledge that will help build a skilled workforce for the future.
Most economic and social activities are digital. Among these activities, some are critical, as their interruptions or disruptions can have a serious impact on: the health, safety and security of citizens; the effective functioning of services important to the economy and society; or economic and social prosperity in a broader sense.
The implementation of the proposed mechanism will help raise awareness of the need to develop policies to better protect information systems and networks that support business. However, such policies should not undermine the benefits of digital transformation in critical sectors through constraints that hinder innovation or unnecessarily restrict the use, dynamism and openness of digital technologies.
The modernized digital security framework will serve as a forum for (a) exchanging information on digital security activities to identify best practices in coordination with other international fora and (b) developing analytical work to support implementation.

Assessment of the impact of the human capital management system on digitalization and the overall level of economic security. Today, the use of digital technologies is perceived by the management of many Ukrainian enterprises as a purely technological task. However, the meaning of digitization is such that it is not so much technology that changes, but the system of human capital management and organization of the enterprise. Improving the level of digitization is the task not only of specially appointed IT professionals, but also of all employees of the company, from the CEO to regular contractors and employees. Without an understanding of the systemic changes taking place in the digital economy, it will be very difficult for domestic enterprises to withstand competition in current and future markets.

There is a need to study how the implementation of a human capital management strategy affects digitalization and the overall level of economic security of a business. Empirical analysis is performed by the method of structural equations. It is obvious that structural and social components need to be integrated when planning an effective human capital management strategy in the context of business process digitalization, but the issue of empirical evaluation is still relevant. Digital technologies have a significant contribution to the overall economic security of enterprises in the digital economy.

Digitization is a factor in the competitiveness of enterprises which reduces costs by up to 25%. Therefore, in international competition, companies need to actively implement digital technologies and, as a result, new approaches to human capital management from the standpoint of the development of organizational digital culture and digital knowledge. Thus, the first hypothesis for further empirical analysis is that the level of digitalization of the enterprise has a significant relationship with the overall organizational digital culture, which is expressed in increased sales, reduced resource intensity and complexity, and the emergence of new consumers, new products, services and opportunities, and thus is one of the fundamental factors of economic security.

Organizational digital culture includes values such as novelty and digital innovation, as well as digital technologies aimed at improving economic efficiency. Each of its elements has a strategic basis, while the very concept of organizational culture is the subject of a separate study. This study is important for its predictions on the human capital management strategy. Kharchyshyna (2008), Grishnova (2014), Bogashko and others studied the elements of organizational culture in human capital management, highlighting such elements as learning, motivation and internal communication. In order to formulate a special element of the general organizational culture related to the principles of human capital management, we use the term *digital culture*, which understands the intrinsic values and expectations shared by employees and aims to develop and implement digitization to systematically achieve the overall performance of the enterprise. In general, digital culture is shaped by the internal goals of human capital management and is based on the principles of governance at all levels. The specifics of business processes and organizational culture in enterprises with a low level of digitalization is manifested in outdated processes and regulations, overly strict requirements for infrastructure, and the use of outdated management methods and information transmission systems. The task of senior management is to transform organizational culture to provide increased flexibility, transparency of goals and digitization, and measures aimed at the development and practical implementation of digitization to systematically achieve the overall performance of the enterprise.

Digital organizational culture includes:

1. Interaction with the help of digital technologies by interacting with a variety of digital technologies and identifying appropriate means of digital communication in context.
2. Exchange through digital technologies, involving sharing data, information and digital content with others using relevant digital technologies that act as intermediaries in the exchange.

3. Public participation through digital technologies, where the organization can participate in society through the use of public and private digital services.
4. Cooperation with the use of digital technologies, via the use of digital tools and technologies to work together and share resources and knowledge.
5. Internet etiquette, which involves knowledge of the rules and norms of behavior in the process of using digital technologies and communication in digital environments, the adaptation of communication strategy to a specific audience, and understanding and taking into account cultural diversity in the digital environment.
6. Digital identity management, which concerns the ability to protect the organization's reputation.

Therefore, the following hypotheses were formulated for testing:
- There is a significant correlation between digital culture and production efficiency.
- There is a significant correlation between digital culture and overall organizational performance. The practice of human resources management includes the full range of applied technologies of planning, organization, control and motivation of employees for the effective operation of the enterprise, implemented on a systemic basis.

Problems of mastering the digitalization of the enterprise note the lack of staff readiness: their technological incompetence and lack of participation and interest.

It has been proven that in the early stages of digital development, most of these problems are less common. This is due to the fact that companies that are at the initial stage of their digital development and are implementing projects at this stage, which can be relatively simple. The main problems of newcomers are related to their lack of experience in project implementation (57%) and lack of qualified managers (49%). Empirical work involves varying degrees of influence of human capital management practices on the level of digitalization of the industry. Foreign scientists such as J. Storey and Kianto et al. (2017), in the example of medium and small business, do not find a significant relationship between the strategy of human resource management and digital strategy, nor the level of digitization. However, these authors emphasize the creation of a new business team culture of thinking and a new organizational culture. Thus, the following hypotheses were formulated:
- There is a significant correlation between the practice of human capital management and the level of digitization of production.
- There is a significant correlation between digital human capital management practices and overall organizational performance.

Digital human capital management tools that integrate social components such as the concept of digital culture and human capital management practices, as well as structural components, are presented as organizational and managerial approaches to new digital knowledge management and known boundaries and have some contribution to enterprise efficiency.

Some scientists (Grishnova, 2014; Petrov, 2019) note that strategic approaches to integrated human resource management are needed to address knowledge and competence issues related to new digital technologies and industrial processes in manufacturing companies, but research is conducted only in the context of a strategic approach to staff development. It is argued that leadership, training and exceptional ability are key factors in stimulating the digital involvement of staff. According to the authors, companies that intensively support the training of employees and students as future professionals practice a consistent policy in the field of digital research. Analyzing the gap between digitization needs and existing technologies, it is possible to identify key areas for digital literacy. As noted in previous sections, the effectiveness of digital technologies is determined by the knowledge and skills necessary for the safe and efficient use of digital technologies and Internet resources. Digital literacy is based on digital competence – the ability to solve a variety of tasks using information and communication technologies (ICT) and to use and create content using digital technologies,

including the search and exchange of information, answering questions, interacting with other people and computer programming.

There will also be a shift in emphasis towards the development of complex, integrated skills for collaboration and communication in the digital environment as opposed to narrowly understood computer literacy. It is important to consider digital skills which cover ICT technical knowledge in close connection with soft skills and general knowledge.

For example, this approach is illustrated in the "Target Competence Model 2025", prepared by the BCG based on the consensus of experts and an analysis of approaches. In addition to the formation of purely technical skills in working with digital devices, this model includes cognitive and socio-behavioral competencies aimed at ensuring a comfortable existence, effective communication and human development in the digital environment. Based on these competencies, we can identify the main areas of development: 1) digital skills and knowledge – for example, basic digital literacy, data analytics, machine learning, artificial intelligence, programming, IT systems architecture, cybersecurity; 2) skills and knowledge that help to cope with instability and uncertainty around the future – for example, adaptability, critical and systematic thinking, the ability to cope with stress, change management, business planning, the ability to self-study in accordance with the concept of lifelong learning; 3) skills and knowledge that help to cope with the large flow of information, including basic skills in programming, retrieval, processing and analysis of information, information hygiene, media literacy, and attention management; 4) skills and knowledge that determine high communication skills for effective interpersonal interaction – for example, the ability to work in a team, cooperation, self-presentation skills, business negotiation skills; and 5) skills and knowledge that the machine cannot master – for example, empathy and emotional intelligence, creativity and non-standard thinking, control of robotic processes.

The work of domestic scientists indicates the need for mass retraining of the laid-off labor force (Yarova, 2015; Fedotova, 2017). This primarily concerns developing digital skills that allow employees to adapt to changing work processes and the requirements of employers. On the basis of the conducted research, we formulate the following hypothesis:

- There is a significant correlation between digital knowledge and the level of digitalization of business processes.

According to the results of the analysis conducted above, it is proved that Industry 4.0 technologies are among the priority factors for competitiveness.

In order to assess the understanding of the impact of Industry 4.0 technologies among staff and to find the factors hindering the introduction of digital technologies in Ukrainian enterprises, a study was conducted.

Respondents showed a fairly high level of awareness of Industry 4.0 and were aware of the factors of competitiveness, almost as much as elsewhere in the world.

The only exception was the factor of "rapid entry into the market of new products." Very few respondents recognized it as an important factor in competitiveness.

At the same time, almost half of the respondents stated that the main barrier in the implementation of modern ICT systems is that they are not the main priority.

This confirms the weak integration of approaches. Against the background of insufficient investment in development, this means that these gaps will widen.

The awareness of all employees of the need for development contributes to the introduction of an effective system of economic security at the enterprise. A study was conducted to assess the effectiveness of the introduction of entrepreneurial culture in enterprises.

Recognizing the importance of development and investment in R&D and human resources, this ultimately concerns short-term survival priorities, profiting by key stakeholders, and ongoing projects. Accordingly, a culture of cooperation based on trust and medium-term development and innovation priorities cannot be high in such an environment. This situation

can cause decline, because without investment in the future and in infrastructure, industries are dying.

For the purpose of carrying out the empirical analysis on the test of the formulated hypotheses, the method of modeling structural equations (MSR) was applied, which is an effective method of quantitative research on implicit theoretical constructions in modern social research in verifying the conformity of theoretical models of existing practice in general. The method of modeling structural equations is a synthesis of such methods as analysis of the confirmation factor and regression, which allows research to be conducted in another direction. In modern management research, MCP methods are used to test hypotheses, as well as to assess the reliability of the presented theoretical design.

The popularity of the MCR method in foreign research in the field of management is due to its ability to take into account erroneous reports or hidden variables. The analysis is based on a system of equations consisting of several parts, and the observed or explicit variables are represented by a certain numerical expression, measured directly.

The structural component reflects the relationship between implicit variables in a simultaneous system of equations. Therefore, the measurement component in the form of an equation estimates the contribution of each explicit variable to the implicit variable.

The MCP method consists of a number of steps, the first of which uses confirmation factor analysis. This analysis confirms whether the theoretical representations are consistent with empirical data.

This study uses the traditional principal component method to determine the factor load levels of each observed variable. Discussing the scientific method, we note that an important task of the IAS method in management research is to reflect the degree of compliance of internal ideas and expectations of respondents to the theoretical a priori design, which is the variable of the internal and external management environment of the enterprise. Based on the subjective assessments of respondents, this method allows us to assess the degree of such compliance and suitability for further analysis of theoretical ideas. In part, this method from this point of view is similar to the method of expert assessments, except that in recognizing the validity of the structure the most important expert is used, and here all opinions are used.

Variables for simulation included issues of organizational culture, digital culture and learning practices that were adapted from the research of scientists (Kuybida et al., 2019). Data collection was conducted via a survey of 75 enterprises. Several methods of information collection were used: online surveys, telephone and personal interviews. The online survey was conducted on a semi-formalized questionnaire. To determine the size of a representative sample, the following parameters were accepted with a probability of 95% confidence interval, or an error of −5%: the total population was 3,183 respondents. For the estimated sample size, 1,500 people were used, and 20 questionnaires were formed and distributed to 75 enterprises. At the initial stage of the statistical survey, 330 questionnaires were incomplete and thus invalid. After this, the validity was 78%, which is a good result.

At the first stage, the structure of interrelation of variables in modeling was investigated, and the factor analysis for the definition of the size of factorial loadings of each variable was carried out.

Factor loads presented in the matrix of components are interpreted in absolute terms – the higher the load, the more the variable correlates with the factor, and the greater the variable due to this factor. The method of basic components allowed us to determine in advance how many factors to take, because their number was unknown. In factor analysis, an important concept is generality – this is the part of the variance of variables which is explained by the main components, i.e., factors, and is calculated by the sum of squares of loads on the line. To do this, we use rotation in factor analysis, where a given rotation is needed to determine the maximum value of a variable for one factor and the smallest for another factor, because it is

important that one variable does not load other factors – it should load only one factor. Thus, the inverted matrix allowed us to determine which variables load each factor, so the load was considered normal from 0.4. The obtained results allowed us to interpret the following: the first factor is loaded with all variables except PERF_10 and DIGITAL_CULT_18.

The Kaiser–Meier–Olkina (KMO) and Cronbach's Alpha test adequacy indicators indicate the adequacy of the results of the factor analysis. This allowed us to understand the most serious factors that prevent businesses from increasing their digitalization. In the field of digital knowledge, the level of awareness of the prospects for the development of various digital technologies is significant. The main initiators of the implementation of the Digital Solutions Project and the existence of a documented strategy of human capital management in the transition to new digital technologies are important in the practice of human capital management.

To determine the impact of factors on the results of the enterprise, a management chart was constructed, with the calculation of standardized coefficients, regression coefficients of the pair between variables, and factors and models of quality indicators.

Obviously, all coefficients were standardized and therefore suitable for comparison. The values of quality indicators or agreement with this model indicate that the significance of the results is acceptable.

Thus, we can discuss a number of results of testing the hypotheses put forward in this study.

Despite expectations, a significant relationship between the level of digitalization and the overall performance of the company was not found. This may be due to the fact that the studied companies are not clearly perceived by specialists and managers of information technology due to the lack of digitalization, and in most cases are not the subject of strategic planning.

Infrastructure companies are more likely to notice a tangible or significant result in such an assessment of efficiency as improving accuracy and quality. The banking sector is more likely to show a significant result in increasing the flexibility of processes, strengthening their focus on customer needs, increasing sales and the emergence of fundamentally new products. The industrial sector of the economy points to the low impact of projects in terms of increasing sales and the emergence of new consumers, as well as the emergence of fundamentally new products, services and opportunities. Enterprises that are at a mature stage of development more clearly indicate the impact of such parameters as reducing resource opportunities, the emergence of fundamentally new products, services and opportunities, the ability to comply with mandatory standards and consumer requirements.

There was no significant link between organizational digital culture and the level of digitization due to the low level of staff involvement in the digital development project. Digitization of business processes will give impetus to the general complexity of all professions, on the one hand, freeing up time for employees to solve more complex and creative tasks. On the other hand, this presents a significant increase in the requirements for their skills. This will lead to a new approach to the division of responsibilities, in contrast to the long-term principle of one person one task: one employee, or a small team. Thus, part of the principles of organizational culture is the ability to work in a team, where employees need to be responsible for a complex process/product or several processes of different profiles. As a result of the increasing penetration of algorithms and computers, digital organizational culture affects the overall efficiency of the enterprise, and a special role is given to awareness of enterprise experts about digital proposals available on the market, the experience of digital projects of other enterprises, the effects they have received, and initiating senior management to implement digital projects.

Existing human capital management practices mainly affect the level of digitization, and employee qualifications are important variables. In companies with a low level of digitalization, in 33% of cases the low qualification of staff is a barrier. Almost twice as often as other companies, companies in the early stages of development face the problem of high-

cost operating systems (82% vs. 41%–45% in other companies). It turns out that if they are different and can be invested in the project, the cost of continuous maintenance of the system for them can be a serious obstacle. Newcomers are limited in the ability to expand digital projects and due to the low level of infrastructure development (71% vs. 38%–45% of other enterprises) (OECD, n.d.).

A significant, stable relationship between the impact of human capital management practices on the overall efficiency of the enterprise was observed, as this indicator is mainly due to other factors, such as the impact of the market and general economic, political, as well as production, financial and investment management factors. However, this is also due to the fact that only 12% of companies have a separate document as a strategy for human capital management in the transition to new digital technologies for the next 5 years. If we add to this the number of enterprises that do not have such a strategy as a separate document, but at least highlighted it in a separate section, we receive a value of 17% (12% + 5%) of enterprises that, in one form or another, have a view towards new digital technologies. Exactly the same number (17%) do not plan to use digital technologies at all for the next 5 years. More than a quarter of enterprises (27%) include the use of digital technologies only in operational planning during the year. Approximately the same (26%) number do not produce digitization in a separate direction or separate section, but take into account the possibility of using digital technologies (either as stand-alone projects – 12% – or long-term investment projects – 14%).

There is a significant lasting impact of digital knowledge on the level of digitalization of the enterprise. Slightly more than one third of respondents (37%) believed that their company's specialists have all the necessary information about the development of digital technologies and are well aware of the degree of their possible impact on the company's business. A quarter of respondents (25%) were less confident in the knowledge of their specialists and their ability to assess the possible impact of digital technologies on the activities of enterprises. Thus, at least 2/3 of respondents (62% in total) provided a sufficiently high level of awareness and competence of their employees to assess the impact of digital technologies on the activities of enterprises.

Conclusions

The digitalization of Ukraine's economy is different from what is happening elsewhere in the world. In Ukraine, digitalization is perceived as the creation of new types of services based on the collection and analysis of data from various physical objects. The directions of radical change of the situation in the production system and approaches to the design, production, sale and operation of these physical objects, which are enshrined in the concept of Industry 4.0, are almost not considered.

The economic effect of the digitalization of industry can be multifaceted, involving: digitalization of technological processes; ways of organizing production; and digitalization of means of labor (equipment, devices, machines), with the best quality characteristics.

In recent years, the digitalization of business has continued rapidly. In all sectors of the economy, businesses of all sizes are increasingly equipping their staff with digital tools, although SMEs are doing so more slowly.

Digitization is multifaceted, as it involves the use of different technologies that serve different purposes and requires the recombination of different strategic assets.

Not all SMEs have the capacity to make this transformation. The smaller firms are, the less likely they are to apply new digital practices, and the more likely they are to limit their consumption of basic services. In general, the digitization of SMEs is closely linked to the way that value is created in the firm and the sector in which it operates.

Business surveys on the use of ICT show that the digital divide is smaller between SMEs and large firms in their online interactions with government, in electronic invoicing, and in the use of social media or the Internet. However, gaps in the use of SMEs widen as technologies become more sophisticated (e.g., data analytics) or massive implementation issues (e.g., enterprise resource planning for process integration) emerge. Firms also have striking differences in the use of cloud technology.

Almost all sectors of the economy are responding to policies to promote the use of digital technologies by businesses. In addition, many highlight policies that support technological progress and the development of innovative products, as well as their adoption. ICT supports the development of the digital economy and makes an increasingly important contribution to the country's economic growth. Digitization makes it easy to store and change information and knowledge. Digital technologies are creating a system of mass media and communication that increasingly connects all parts of social and economic life. This interactivity not only promotes entrepreneurship through digital innovation, but also increases the level of digital security.

The impact of individual components of human capital on the digital and general performance of industrial enterprises was also assessed on the basis of methods of factor analysis and modeling of structural equations. This research was based on the experience of 75 Ukrainian companies.

The study focused on theoretical structures such as digital culture, human capital management practices and digital knowledge of employees. The analysis of human capital management practices showed that only 12% of enterprises have a strategy of human capital management in the transition to new digital technologies for the next 5 years as a separate document. Companies that actively increase the competence of employees in the field of digitization and broadcast and implement the principles of international standards receive business benefits in such areas as reducing resource opportunities, the emergence of fundamentally new products and services, and opportunities to meet the required standards and customer requirements.

Contrary to expectations, there was no significant link between the organizational digital culture and the level of digitization due to the low level of staff involvement in the digital development project, but the digital organizational culture affects the overall efficiency of the enterprise. This involves the experience of the implementation of digital projects by other enterprises regarding these received effects, and also the initiation of top management for the realization of digital projects.

Thus, the issue of the digital security of enterprises and employees is one of the means of minimizing risk. Economic security, which is primarily related to the detection and prevention of fraud, is directly related to cybersecurity and confidentiality (the protection of systems from theft). Today, the use of digital technology is becoming a matter not only for specially appointed IT professionals, but also for all employees of the company, from the CEO to ordinary contractors and workers. Without an understanding of the systemic changes taking place, it will be very difficult for Ukrainian companies to withstand competition in current and future markets.

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SECTION 7

DIGITALIZATION AND SOCIETY

FACTORS AND CONDITIONS OF DIGITAL TRANSFORMATION OF THE ECONOMY AT THE STATE AND REGIONAL LEVELS

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Abstract. *Trends in the digital transformation of Ukraine's economy in modern conditions are studied in this scientific publication. The purpose of the research is to study current trends in the digital transformation of Ukraine's economy and determine areas for its support in ensuring the socioeconomic development of the regions of the state. The structure of digital business transformation is determined, which includes digital data, digital infrastructure, digital models, and the digital economy. At the same time, an important task of the digital economy is to help improve the living standards of the population through the availability and quality of goods and services produced using modern digital technologies.*

The principles of digitalization are defined, the observance of which serves as a basis for the creation and realization of advantages in the process of using digital technologies. Such principles include ensuring equal access to digital technologies for all citizens, promoting the development of the information society and the media, building a mechanism for economic growth by increasing efficiency and competitiveness via the use of digital technologies, personal data protection and information security, and others.

Factors in the development of the digital economy – which must be considered in two groups: external and internal – are investigated in the article. Factors of the development of the digital economy have both positive and negative roles in ensuring the development of information and communication technologies, intellectual production, digitalization of the economy, etc. Such factors are complementary and interdependent. The level of regulatory and legal framework for digitalization is an important factor in supporting the development of the digital economy at both the state and regional levels. However, the regulatory and legal framework for regulating the process of building the digital economy in Ukraine is underdeveloped – in particular, the legislative coverage of issues related to the digital economy is extremely superficial. An important prerequisite for the development of Ukraine's digital economy and the integration of the digital market into the single digital space of the European Union is the introduction of e-government. The creation of the Action online public services portal has become one of the most popular activities of the government in the field of digital environment.

The proliferation of digital platforms is another important factor in the digital economy. Digital platforms act as mechanisms that allow different participants in economic relations to interact online. In the business environment, the digital age means that many dynamic digital platforms are actively developing and are a strategic resource for maintaining competitive advantage during constant change.

The level of development of the digital economy also depends on the differentiation of incomes between individual regions. Ukraine's economy is characterized by inequality in the level of average wages and unemployment in the regions of the country. The development of the digital economy in Ukraine also depends on the possibility of broadband Internet access. This is a problematic issue today, as there is a digital divide where the availability of broadband access differs markedly in large cities and small villages. An important condition for the development of the digital economy is the formation of a modern labor market when increasing demands on education and skills, changing the rules of hiring, and increasing the flexibility and mobility of staff.

Thus, accelerating the processes of the digital transformation of the economy in Ukraine requires the formation of appropriate measures. Such support measures should include: improving the regulatory framework to intensify the process of digitalization of the economy, promoting digital technologies among businesses, creating government programs to support public sector and business cooperation in digital technologies, building digital infrastructure and expanding digital platforms in all regions to address digital inequality among Ukrainian citizens, and others.

Keywords: *digital technologies, economy, development, state, region.*

Introduction

In the modern conditions of globalization processes, the scientific and technical development of many countries, and the informatization of all processes of society, there are significant

changes in the field of economic activity. Traditional economic activity is being restructured in the direction of using information and communication and digital technologies, which determines its transition from an economy that consumes resources to one that creates them. The accelerated development of digital technologies has intensified the deepened interest in the formation of the foundations of the digital economy and the study of its impact on economic growth. The issues of digital transformation were decisive in the decisions of the G20 summit in 2015, when the place of the Internet economy as the basis of global growth was identified among the strategic priorities. It is through the use of the latest information technologies that the digital economy becomes the main condition for solving many problems of the socioeconomic development of the country as a whole and its individual regions.

Many scientific works are devoted to the study of the problems of digital transformation of the economy. The results of the study of the preconditions and the need to implement the concept of digital transformation (digitization) of the regions of Ukraine are reflected in the works of L. Fedulova. Also, among Ukrainian scientists who study the problems of formation and development of information and communication technologies in all spheres of public life, scientists such as A. Vasylyk, O. Guseva, A. Danylytska, I. Irtyshcheva, L. Ligonenko, G. Lopushnyak, O. Mykhaylenko, K. Pugachevska, B. Teteryatnyk, S. Tsymbalyuk and others should be noted.

In particular, aspects of the formation of digitalization strategy in business organizations were studied by L. Ligonenko, A. Khripko, A. Domansky. Issues of the peculiarities of formation and development of Internet trading were studied in the works of S. Naumenkova, S. Mishchenko, D. Gladun, O. Semchuk. Agreeing with the significant theoretical achievements of this issue, it is appropriate to investigate the practical manifestations of the problem in the light of recent changes in the economic situation in the regions of Ukraine. The urgency of these issues has led to the choice of topic and purpose of research.

The aim of the research is to study current trends in the digital transformation of Ukraine's economy and determine areas for its support in ensuring the socioeconomic development of the regions of the state.

To achieve the stated goal and solve the related tasks, the tools of scientific research methods were used: the dialectical method of cognition and the systematic approach; generalization and systematization – to determine the functional purpose of the digital economy and to reveal the features of public policy in this area; economic-statistical and computational-analytical – to study the dynamics of current trends in the digital economy; graphical and tabular – for the visual display of statistical data and the presentation in schematic form of the results of scientific work; and the methods of induction and deduction – to draw conclusions about the state and prospects of digital transformation of the economy of the regions of Ukraine.

The main body of the paper

Today, new digital technologies and innovative business models penetrate into all economic spheres of society, influencing the very essence of the economy and forming qualitative structural changes in it. As a result, the digital economy is being formed as a subsystem of the economy, characterized by the active use of digital technologies and the turnover of specific electronic goods in the process of its operation. The level of development of the digital economy significantly affects the level of competitiveness of the country, which requires special attention of the state and the business environment to the prospects of its development. Therefore, it should be assumed that the e-economy is already beyond purely economic processes. Digitalization is being implemented in social processes which increasingly depend on the success of both citizens and the work of government organizations and structures, which involves the large-scale introduction of information and communication technologies

(Pugachevska, 2018). Thus, the digital economy can cover everything that can be formalized or transformed into logical schemes, starting from the system of production and distribution at all levels of government and business, and ending with the exchange and consumption of goods and services. Therefore, the spread of digitalization in the economic sphere has many advantages in ensuring the socioeconomic development of the country and its regions, public demand for goods and services, etc. (Figure 1).

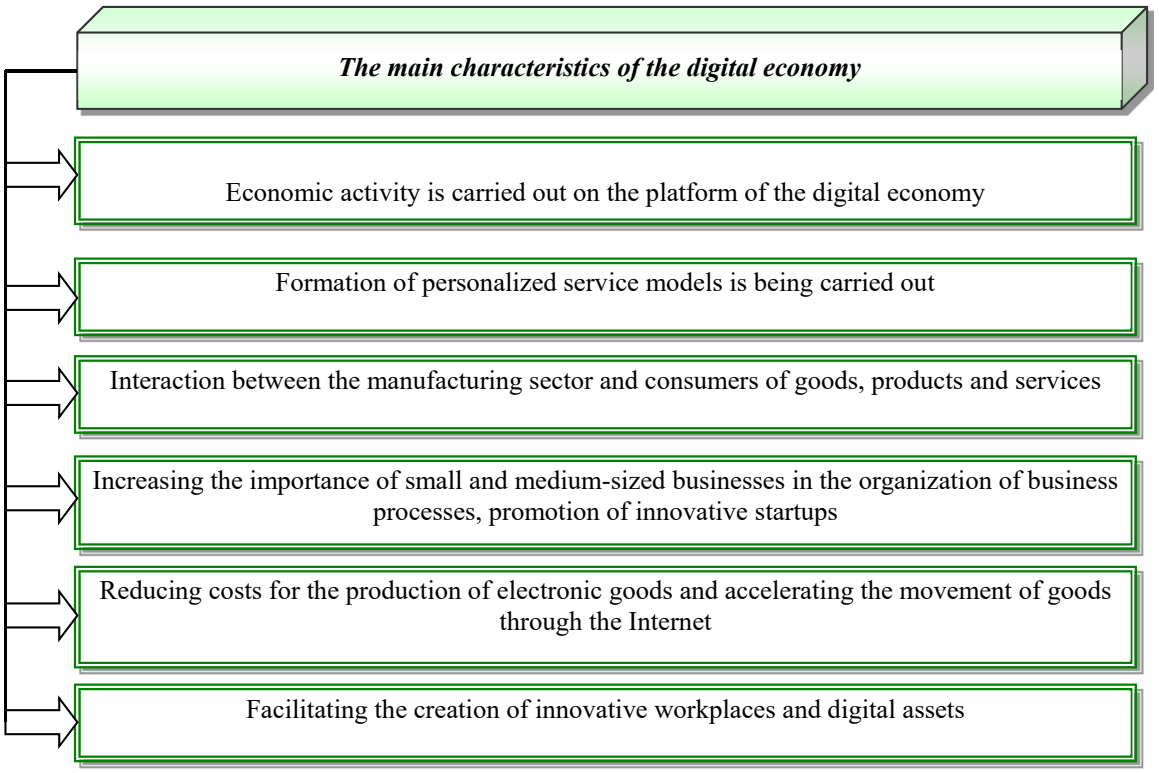


Figure 1. The main characteristics of the digital economy
Source: author own development based on Lopushnyak & Mylyanyk (2019); Hryshyna, Filipishyna et al. (2021)

According to the experience of many countries, the levels of productivity achieved in the country, the use of new technologies, and investment in high-tech production are determining factors in the competitiveness of economically developed countries (Deloitte, 2016). However, factors such as favorable geographical location, provision of natural resources, and low labor costs are secondary in providing competitive advantages. Thus, among the key factors influencing the competitiveness of industry in successful countries are: highly qualified human resources (Germany – 97.4%; USA – 89.5%, Japan – 88.7%), innovation policy and infrastructure (USA – 98.7%, Germany – 93.9%), and reliable logistics infrastructure (Germany – 100%; USA – 90.8%, Japan – 89.9%). According to a study by the World Economic Forum, the Global Competitiveness Report (Schwab, 2019) provides an assessment of the effectiveness of the global economy based on the Global Competitiveness Index 4.0 (GCI 4.0). The following G20 countries are in the top ten: USA (2), Japan (6), Germany (7) and the UK (9).

It should be noted that the opportunities for digital transformation are widely used, which provides the fullest possible potential of digital technologies in all components of business (processes, products and services, approaches to decision-making). At the same time, the presence of technology as such will never be enough for digital transformation (Sosnin, 2021). Therefore, in order for the process of digital transformation to be complete, a well-established system of defined business tasks and data for their digitization is needed. Thus, the digital

transformation reflects the relationship of all three dimensions (defined business task, data availability and information technology).

Given that integration into the European Union is one of the opportunities to overcome technological backwardness for Ukraine, attracting foreign investment and the latest technologies in the modernization of the manufacturing sector is crucial. In this, concepts are determined by the directions of harmonization with digital initiatives, a digital order for Europe (Digital Agenda for Europe), and the Digital Single Market. The following are also important: interoperability and electronic services (e-Services), which provides for Ukraine's accession to the EU Program Interoperability Solutions for European Public Administrations, e-CODEX projects, e-Invoicing, as well as Single Digital Gateway initiatives; and electronic identification (eID), which is the main prerequisite for the introduction of electronic services, e-commerce and electronic interaction of participants in economic relations.

The use of modern digital technologies is an important prerequisite for the successful operation of enterprises and organizations in the field of production and other sectors of the economy, which are rapidly replacing traditional processes with digital interaction. Organizations that welcome change and are ready for it, as well as being able to adapt to more flexible work models, have great potential for success (Pugachevska, 2018). Because digital transformation covers all aspects of business and offers effective ways to improve it along with the development of digital technologies, companies that are ready for innovative change and able to adapt to more flexible work models have every opportunity to improve business results and increase their competitive position (Figure 2).

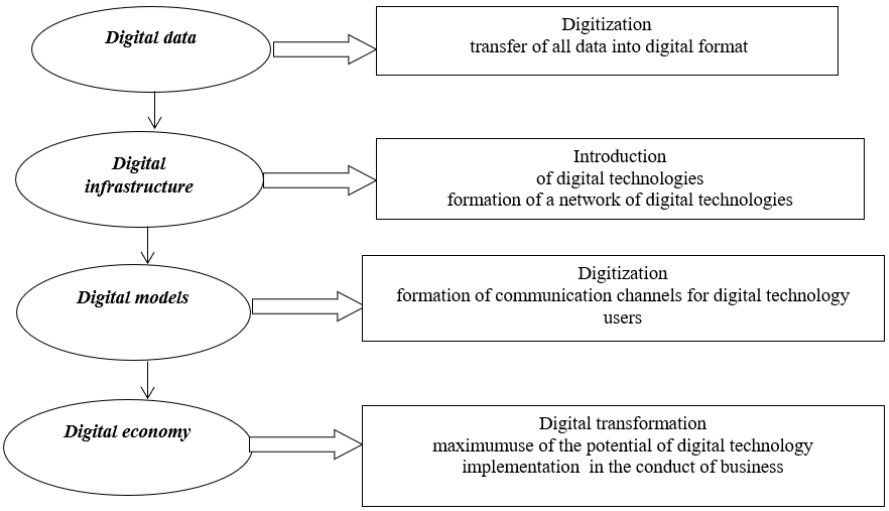


Figure 2. The structure of the digital transformation of business

Source: author own development based on Hryshyna, Filipishyna et al. (2021); Lupak et al. (2020)

The rapid development of information technology is forcing business entities to actively expand their businesses and devote special attention to the development of production networks. The types of digital technologies include: robotics and cybersystems, artificial intelligence, big data, paperless technologies, additive technologies (3D-printing), cloud and fog computing, unmanned and mobile technologies, blockchain, etc. The development of information and communication technologies and digitalization are at the center of this global production network, and provide companies with such competitive advantages as:

- additional value of goods due to quality service;
- high level of relationships with customers and consumers;
- raising the company's image through fast communication with customers;
- price reduction due to automation and implementation of business process digitization;
- transparency of internal and external processes of the enterprise;
- increased loyalty of suppliers, customers, and consumers.

The formation of a model of digital economy development, as one of the effective factors of the penetration of innovations and technologies into competitive branches of the economy, requires the development of the corresponding concept, which should contain methodological and constructive provisions and define its basic purposes, priority directions, functions and implementation mechanisms. Thus, among the main principles of the formation of such a model should be the following: the principle of ensuring the demand for information services and strengthening the information society; the principle of achieving digital transformation of industries by increasing their competitiveness; the principle of strengthening information security and the protection of personal data; the principle of ensuring Ukraine's integration into European and global systems; the principle of stimulating the development of digital infrastructures. It should be noted that the formation and implementation of strategic directions of the development of the digital economy should be based on the implementation of four generalized stages, which will provide information to identify trends in information and communication technologies, assess indicators of the digital economy, develop and justify its strategic directions, etc. (Hryshyna, Pohorielova et al., 2021).

Thus, the digital transformation of enterprises and organizations in various fields of management is a response to the rapid spread of new digital information technologies at both global and regional levels. The main goal of the digital economy is to help improve the living standards of the population through the availability and quality of goods and services produced using modern digital technologies. The rapid growth of social networks, the increasing number of smartphones, the facilitation of broadband Internet access, and the spread of machine learning technologies and artificial intelligence are providing real opportunities for the development of the modern world (Sosnin, 2021). Therefore, it is important to define the principles of digitalization, compliance with which is the basis for the creation and implementation of benefits in the use of digital technologies (Figure 3).

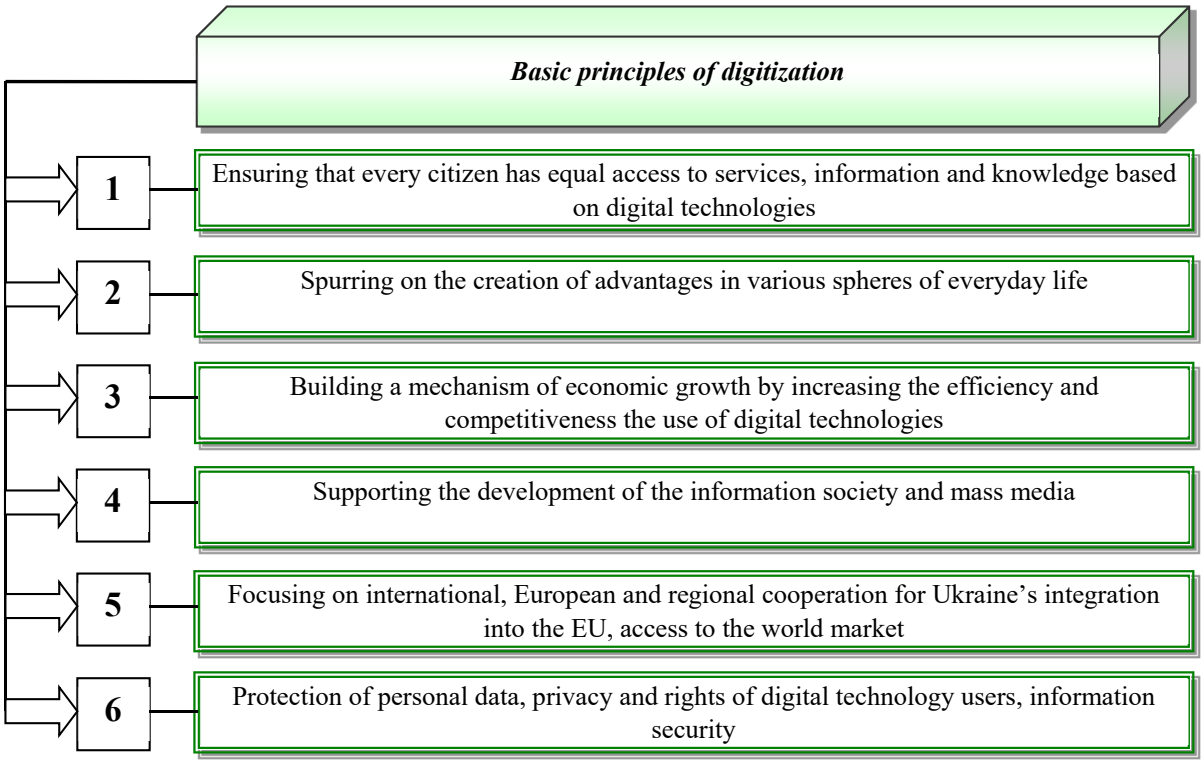


Figure 3. Basic principles of digitalization

Source: author's own development based on Lopushnyak & Mylyanyk (2019); Hryshyna, Pohorielova et al. (2021); Sosnin (2021)

Today, digital transformations are one of the main factors in the growth of the global economy, and in the next 5–10 years even greater rates are expected. At the same time, we can observe a direct increase in the productivity of companies due to their use of digital technologies, and there are a number of indirect benefits of digitalization, including new demand for innovative goods and services, new quality and value, time savings and more. With this in mind, consider the main features of the process of economic transformation, including:

- the knowledge economy, which, in addition to traditional economic factors such as labor, capital and land, includes knowledge. This is beginning to take a leading position among other economic variables in the process of creating competitive advantages of the company and the formation of the value of the product and/or service;
- the rapid development of information technology has led to the rapid transformation of knowledge into the public good, maintaining a competitive advantage for a short period. In the knowledge economy, competitive advantage is formed not through knowledge, but through the ability to quickly create this unique knowledge;
- the importance of knowledge in general is characterized by its availability, expanding opportunities for use and creation based on the use of innovations and information technologies;
- network relations create new conditions for cooperation between companies, which leads to increased attractiveness of the network to meet consumer needs, as well as creating competition within the network between its representatives.

It should be noted that the factors of digital economic development should be considered in two groups: external and internal (Figure 4). The presented factors of the digital economy play both a positive and negative role in ensuring the development of information and communication technologies, intellectual production, the digitalization of the economy, etc. Such factors are complementary and interdependent.

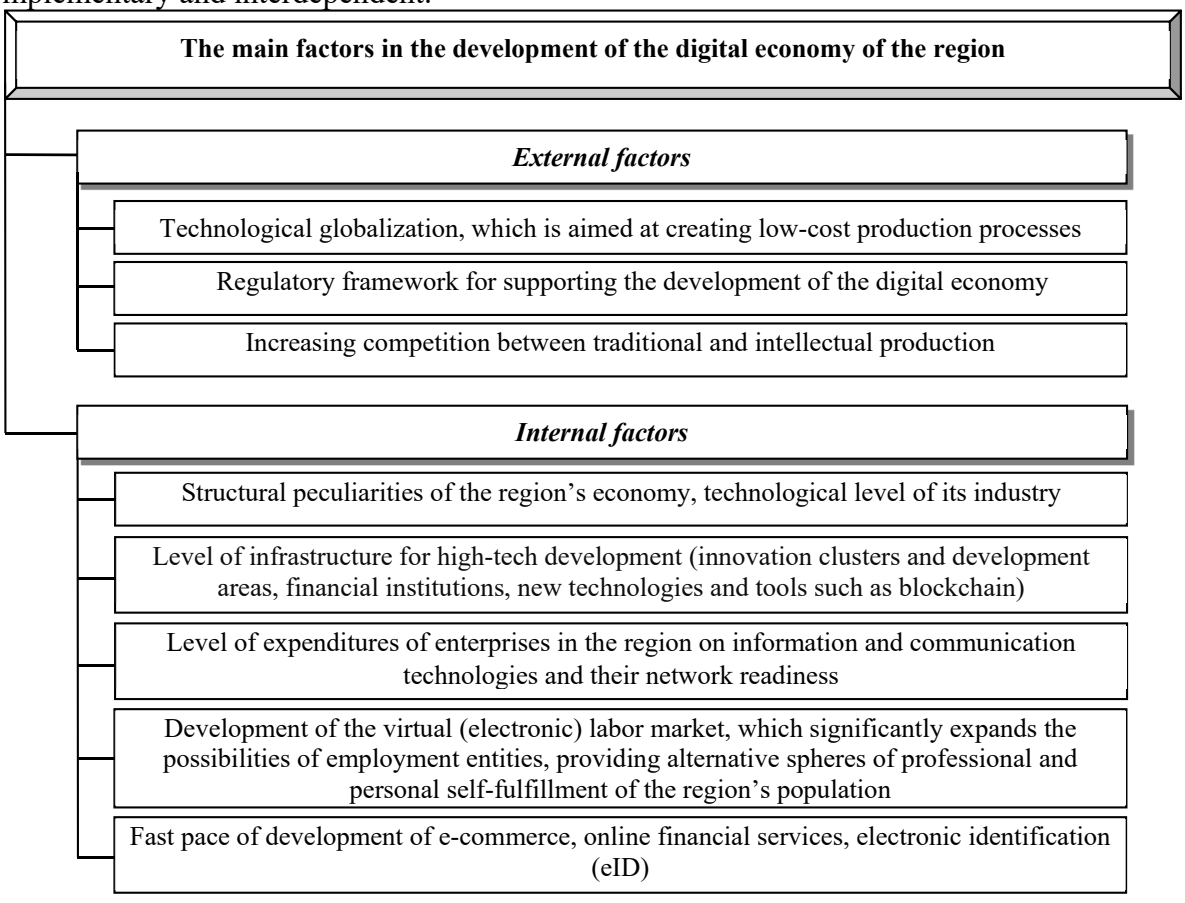


Figure 4. The main factors of digital economy development in the region

Source: author own development based on Lopushnyak & Mylyanyk (2019), Pugachevska (2018)

Creating the foundations of the digital economy in Ukraine has acquired the status of a national task of the development of the country and its regions, as evidenced by a number of legislative acts in support of digital transformation, so the level of regulatory framework for digitalization is an important factor.

To develop the digital economy in Ukraine, a number of legislative acts have already been approved, including the Law of Ukraine "On Electronic Commerce" (2017); "On Telecommunications" (2003); "On Electronic Digital Signature" (2017); "On Payment Systems and Funds Transfer in Ukraine"; "On Financial Services and state regulation of financial services markets" approved the Strategy for the Development of the Information Society in Ukraine; and "The Concept of Development of the Digital Economy and Society of Ukraine for 2018–2020" (2018). One of the most important documents on the development of the digital economy is the "Concept of development of the digital economy and society of Ukraine for 2018–2020," in which digitalization is the saturation of the physical world with electronic-digital devices, tools, systems and electronic communication between them, which actually enables the integrated interaction of the virtual and the physical, i.e., creates a cyberphysical space (Order of the Cabinet of Ministers of Ukraine, 2018). The concept notes that digital technologies are defined as "a huge market and industry, as well as a platform for efficiency and competitiveness of all other markets and industries." In addition, consider other legislation related to the digital economy:

1. The state strategy of regional development for the period up to 2020 (Resolution of the Cabinet of Ministers of Ukraine No.385 of August 6, 2014) aims to promote the level of competitiveness of regions, and ensuring the development of urban infrastructure includes:
- the expansion of transport, information and communication links of cities as centers of economic growth with less developed adjacent territories;
- support for the integrative role of cities as centers of comprehensive development by providing access via the Internet to services of museums, theaters, libraries, medical centers, universities, etc.;
- providing consumers of telecommunications services with guaranteed quality in accordance with standards, increasing the list of services based on modern information and communication technologies and scientific developments, etc. (Order of the Cabinet of Ministers of Ukraine, 2013).

2. The "Ukraine 2020" strategy of sustainable development (Decree of the President of Ukraine No. 5 of January 12, 2015), which provides for the implementation of 62 reforms and development programs of the state in four vectors, among which are:
- the vector of development – telecommunication infrastructure reform;
- the vector of security – e-government program;
- the vector of pride – the development of information society and media.

3. The Memorandum on the Establishment of the Ukrainian National Digital Coalition "Digital Transformation Coalition" (concluded on September 5, 2019), aimed at a transparent partnership between digital transformation actors, promotes the development of digital skills in Member States working together to implement digital transformation, the development of the digital economy and the improvement of digital skills at the national, regional or local levels. Such digital coalitions have been formed in 23 European countries. The Ukrainian National Digital Coalition includes 46 public and private institutions and organizations. The activities of the Digital Transformation Coalition will be aimed at consolidating and coordinating the initiatives and efforts of all partners in the field of digital development and the integration of Ukraine into the European digital space.

It should be noted that some relations concerning the use of information and communication technologies are regulated by other acts of legislation, among which the main ones are:

- The Economic Code of Ukraine, the articles of which enshrine the provisions on mandatory disclosure of state and municipal enterprises, companies controlled by the state or local government, and information about their activities by posting it on its own website or on the official website of the subject of management of state/municipal property, which performs the functions of enterprise management.
- The Civil Code of Ukraine, the provisions of which allow the display of information in electronic form; conducting a transaction in electronic form, which is one of the modifications of the written form; the display of work in publicly available electronic information systems; and the possibility of the electronic form of calculations.
- The Tax Code, which provides for the use of electronic resources in the field of taxation; the provision of electronic digital signature services; the organization of the introduction of electronic services for business entities as one of the functions of controlling bodies; control over the observance by business entities of the obligatory requirements established by the legislation on ensuring the possibility of settlements for goods (services) with the use of electronic means of payment, etc.
- The Law of Ukraine "On e-commerce" (2015), which defines the organizational and legal framework for e-commerce in Ukraine, establishes the procedure for electronic transactions using information and telecommunications systems, and defines the rights and responsibilities of participants in e-commerce. The essence of the concept of e-commerce is defined as "a relationship aimed at making a profit arising from transactions for the acquisition, change or termination of civil rights and obligations, carried out remotely using information and telecommunications systems, resulting in participants in such relations have rights and responsibilities of a property nature."
- The Law of Ukraine "On electronic documents and electronic documents circulation" (2003), which regulates relations arising in the process of creating, sending, transmitting, receiving, storing, processing, using and destroying electronic documents.
- The Law of Ukraine "On electronic digital signature" (2017), which determines the legal status of electronic digital signatures and regulates the relations that arise when using an electronic digital signature.
- The Law of Ukraine "On electronic trust services" (2017), which defines: the legal and organizational principles of providing electronic trust services, including cross-border; the rights and obligations of subjects of legal relations in the field of electronic trust services; and the procedure for state supervision (control) over compliance with the requirements of legislation in the field of electronic trust services.

In Ukraine, in order to optimize the system of central executive bodies, the Cabinet of Ministers established the Ministry of Digital Transformation of Ukraine, reorganizing the State Agency for e-Government. According to the Regulation "On the Ministry of Digital Transformation of Ukraine," the Ministry is the central certification body in the field of electronic trust services, ensuring the formation and implementation of state policy in the field of digitalization, digital development, digital economy, digital innovation, e-government and e-democracy, and the development of the IT industry. This agency will address the development of national electronic information resources, the development of broadband Internet access and telecommunications infrastructure, and e-commerce and business. Another area of the agency's work will be the provision of electronic and administrative services, as well as electronic trust services and electronic identification. In addition, the Ministry of Education covers the development of the IT industry, develops regulatory and technical documentation on digital transformation, and coordinates the activities of executive bodies related to cooperation with the EU's Digital Single Market. In February 2020, the "Action" public digital application appeared in the public domain, which provides the opportunity to receive public services online, along with a list of the top 50 services for which most applications are expected to be digitized during 2020 (FOP

registration, E-baby, services for carriers and builders, services for car owners, etc.; see public services website Diia, https://diia.gov.ua).

Thus, we can conclude that the development of digital technologies is represented in government programs, especially those related to public services, small and medium enterprises, the consumer market, health care, the creation of information and analytical systems, and more. However, the regulatory framework for regulating the process of building the digital economy in Ukraine is underdeveloped – in particular, the legislative coverage of issues related to the digital economy is extremely superficial. The nature of the interaction of the participants in this process has not been determined, which hinders the formation of legislation in other areas, including strategic planning documents.

An important role is played by the activities of the Ministry of Digital Transformation of Ukraine, among the achievements of which are:

- the creation of a portal of public services and the "Action" mobile application;
- the launch of the "Action Digital Education" educational online platform and the release of educational series on the development of digital skills;
- the promotion of the Action City initiative;
- activities in the release and distribution of radio frequencies in the range of 800–900 MHz to increase the coverage of the country with access to the Internet using 4G and 5G technologies;
- the introduction of SmartID technology and the introduction of the "eBaby" service;
- conducting multi-stakeholder consultations for decision-making involving the public and business;
- promoting the development of the cryptocurrency market, blockchain technologies and artificial intelligence;
- the development of a draft Strategy for Ukraine's integration into the EU Digital Single Market;
- the improvement of some provisions of the Association Agreement between Ukraine and the EU on the integration of Ukraine into the internal market of telecommunications services of the European Union.

An important external factor of influence is the signing of the Memorandum on the development of mutually beneficial cooperation in the field of digital transformation between the Ministry of Economy of Ukraine and FIIAPP (the EU4DigitalUA project). The EU4DigitalUA project is the EU's largest bilateral eGovernment and digital technology program in any partner country. This project consists of several sections, including: Government Interaction and Digital Infrastructure, Institutional Capacity Building, Communication and Public Information, Electronic Services Development, Cybersecurity, and Data Protection. Such cooperation will contribute to the provision of automated information exchange, the training of highly qualified specialists in the digital field, and the development of communications and support for digital change in Ukraine as a whole.

The introduction of e-government is an important precondition for the development of the digital economy in Ukraine in the integration of the digital market into the single digital space of the European Union. The creation of the Diia online public services portal has become one of the government's most popular measures in the field of digital environment development in Ukraine. One of the main goals of the Ministry of Digital Transformation in the context of using the portal is to digitize 100% of the services provided by the state by 2024. The portal already provides a significant number of public services online and the online registration of various types of certificates, licenses, permits, assistance, as well as other online registration services, etc. To receive a service on the Action portal (https://plan2.diia.gov.ua), users must have an electronic signature, and can also log in using the id.gov.ua service. The state IT company Diia is digitizing services on the Action portal, and is engaged in support of services.

Among the factors of activation of the digital economy should be noted the implementation of a pilot project for the introduction of e-TTN (electronic consignment note) in Ukraine. This project aims to optimize the design of transportation by taking advantage of the electronic consignment note through the API (application programming interface, through which one computer program can interact with another). The necessary regulatory framework has already been adopted for the project implementation. The project will serve as a step in harmonizing Ukrainian legislation with European standards and will promote the creation of digital transport corridors with EU countries (Association Agreement, 2014).

Another important factor in the digital economy is the proliferation of platforms. Over the last decade, many digital platforms have emerged around the world that use data-driven business models to transform emerging sectors of the economy. Digital platforms act as mechanisms that allow different participants to interact online. Some global digital platforms have gained strong market positions in certain segments. For example, around 90% of the Internet search engine market is owned by Google. Facebook accounts for two-thirds of the global social media market, and its platform is the most popular among social networks in more than 90% of countries. Almost 40% of the world's retail online sales are through Amazon's network, and its subsidiary Amazon Web Service accounts for about the same share of the global cloud infrastructure market (Pishchulina, 2020).

It is important to note the comprehensiveness of digital platforms, which ensures their ability to transcend borders and spread their influence to any country and territory. Through the Internet, they can operate anywhere in the world, regardless of the location of servers. An example of such use of digital technologies is the activity of Uber, which at one time became the most influential participant in the market of taxi services in many countries around the world; in the field of trade – eBay, Alibaba; in the travel industry – Booking.com, Anyway Anywayanyday.com, and others.

In Ukraine, much attention is paid to the development of digital platforms by the Ministry of Digital Transformation (https://thedigital.gov.ua/). In particular, among the large-scale initiatives should be noted the development of entrepreneurship, which has an online and offline component. Regarding the latter, in different regions of Ukraine consulting zones will open for entrepreneurs, where they can receive professional advice on business development. An online platform – "360 Tech Ecosystem Overview" – has been created for business information regarding IT companies, people, investors and the entire technological ecosystem of Ukraine in general. The information collected here contains data on the current development of IT companies, founders, officials and managers, classification of companies by industry, investment and financing, mergers and acquisitions, latest news and industry trends. Collecting and structuring information about the entire IT ecosystem, including universities, startup accelerators, technohubs and all technology industries, will open new opportunities for the market and allow all participants in the ecosystem to cooperate and develop more effectively (Pishchulina, 2020).

In the business environment, the digital age means that many dynamic digital platforms are actively developing and are a strategic resource for maintaining competitive advantage in its constant change. Interacting with suppliers, consumers and other participants, economic entities create their own digital platforms that promote the implementation of selected business models and are a prerequisite for the formation and maintenance of competitive advantage, control and coordination of internal development (Pugachevska, 2018). Thus, the digital platform is a software product that provides access to and rapid exchange of information for all actors in economic relations.

Thus, the introduction of digital technologies in all spheres of economic activity, as part of the fourth industrial revolution, is manifested in a set of changes that result in the formation of new economic phenomena:

- the digital consumer, who uses social, mobile, analytical and cloud technologies;
- the digital enterprise that uses information and communication technologies to optimize the cost of corporate functions to establish cooperation in the enterprise to increase productivity and business efficiency;
- a new wave of digital operations, where companies are restructuring their businesses using artificial intelligence, robotics, industrial Internet of Things, etc.

The key indicators of the country's readiness for digitalization include the four most important factors: the level of digitalization of the economy; digital coverage of households; digital gaps; and the intensity of state participation in digitalization (Pishchulina, 2020). According to the reporting data of the National Commission for State Regulation of Communications and Informatization (NCCIR), in the first half of 2021 compared to the same period last year, the telecommunications services market developed rapidly (Table 1). Thus, the volume of services provided increased by 17.2% and reached a peak value of UAH 49,570.7 million. The highest growth rates were observed in the segment of fixed access to the Internet, which increased by 2,113.9 million UAH – around 33.5%.

Table 1. Structure of revenues from telecom services, UAH mln.
Source: State Statistics Service of Ukraine (www.ukrstat.gov.ua)

Services	Period		
	February 1, 2020	**February 1, 2021**	**Change**
Mobile phone communication	22,175.2	25,755.6	+3,580.4 (16.1%)
Phone call activated	2,228.5	2,123.0	−105.5 (−4.73%)
FIXED access to the Internet	6,305.1	8,419.0	+2,113.9 (33.5%)
Other services	3,914.0	4,273.1	+359.1 (9.2%)
Total	*34,623.8*	*40,570.7*	*+5,946.9 (17.2%)*

According to the report of the World Economic Forum (for 2019), Ukraine ranked 60th among 100 countries of the world according to the level of development of technology and innovations, which led to the inclusion of Ukraine in the group of inferior countries (Department of Foreign Economic Policy, 2019). At the same time, the neighboring countries (Russia, Belarus, Poland, Romania, Ukraine) have significantly higher ratings and are far ahead. Unfortunately, after the collapse of the Soviet Union, Ukraine was not able to multiply its industrial base as the basis for the development of digital technologies, the Internet, and the fourth industrial revolution. The loss of the leading industrial sectors caused disproportions in the industrial sector of the national economy. For example, in 1992–2020 the share of manufacturing in Ukraine's GDP dropped from 44.6% to 11.20%, which is half as much as in the countries with average incomes (19.6%).

Under the conditions of the third industrial revolution and the beginning of its fourth era, the competitiveness of the country is determined not only by the size of gross domestic product or export volume, but by the amount of surplus value created in the industrial sector, as well as the position of the country in the global markets of surplus value. According to the methodology of the State Statistics Service of Ukraine, Gross Value Added (GVA) is calculated as the difference between output and consumption. This includes primary revenues generated by production participants. Wholesale and retail trade have the largest share in the structure of the GDP, which accounts for approximately one part, and the share of this industry was 14.5% in 2010, 13.7% in 2017, and 13.2% in 2018. The processing industry occupies the same share of GDP (16.2% in 2010, 7% in 2017, 11.6% in 2018). The share of agriculture in the structure of GDP significantly changed: from 7.4% in 2010 to 10.1% in 2018 (Table 2). Unfortunately, activities in the field of information and telecommunications in the structure of the Airborne Forces have some of the lowest values: in 2010 – 3.0%, in 2017 – 3.7%, in 2018 – 3.9%.

Table 2. Characteristics of the main types of economic activities in Ukraine
Source: State Statistics Service of Ukraine (http://www.ukrstat.gov.ua/)

Type of economic activity	Structure of gross added value, %		Number of legal entities, units		Use of information and communication technologies in enterprises, %			
	2018	2019	2018	2019	had access to the Internet, %		bought cloud computing services, %	
					2018	2019	2018	2019
Processing industry	13.6	12.6	63,309	67,078	90.0	89.5	9.3	10.0
Agriculture, forestry and fisheries	12.0	10.4	65,185	67,906	86.3	84.4	8.6	8.9
Supply of electricity, gas, steam and air conditioning	3.7	3.7	4,015	5,318	93.2	92.3	9.7	11.6
Wholesale and retail trade; repair motor vehicles and motorcycles	15.6	15.4	210,534	242,334	88.1	86.1	11.3	11.5
Transport, warehousing, postal and courier services	7.5	7.7	26,604	29,099	87.8	87.9	7.5	8.1
Information and telecommunications	4.6	5.3	25,468	28,185	90.0	89.2	15.4	17.5
Professional, scientific and technical services	3.8	4.1	57,875	62,833	88.4	87.2	13.1	13.6

It should be noted that the level of digitization of the Ukrainian economy varies greatly between different sectors. In particular, in such spheres as financial services, telecommunication services and logistics, domestic enterprises widely use the achievements of information technologies. However, in most types of industrial production the intensity of the use of digital technologies, automation, and robotization is very low, which, in turn, actualizes the task of the innovative development of Ukrainian industrial enterprises. The acceleration of innovation development is based on the implementation of the following digital technologies that contribute to the formation of new business models (Sosnin, 2021; Pishchulina, 2020):

- digital banking, which involves using mobile add-ons with special digital coding;
- Internet solutions, which will allow the computerization of various systems and their full automation through the use of the Internet;
- the digitalization of business and production processes on the basis of using innovative developments in the field of informatization;
- blockchain, which is based on innovative ways of accelerating information transfer and locking it into certain types of internal protocols of information systems, and others.

One of the criteria for assessing digital nervousness is broadband access to the Internet (WLAN), a basic service that allows the use of other digital capabilities (Ukrinform, 2020). In Ukraine, the problem in practice is the presence of the digital divide, i.e., a situation where the availability of broadband access varies considerably in large cities and small villages (Figure 5). Thus, in urban areas the number of points of digital access to the Internet is 6.12 million units, which is 76.8% of the total value of this indicator, while rural areas account for only 23.2%. At the same time, it should be noted that in small towns and villages willingness to enter the market of information services is much less, as it is not profitable for the operator to work with a small number of potential subscribers and small revenues. Thus, investing money in the formation of IT infrastructure in rural areas in most cases is not economically viable.

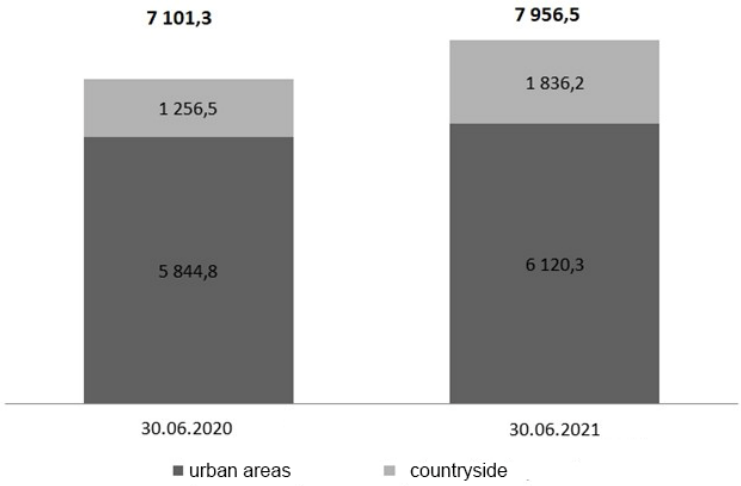


Figure 5. The number of points of physical access to the Internet in the distribution of areas, thousand units

Source: State Statistics Service of Ukraine (http://www.ukrstat.gov.ua/)

According to data from the NCCIM, the regions with the most mobile connections as of June 30, 2021 are Kyiv, Kyiv region, Chernihiv, Odessa, Mykolaiv, and Kherson, where this indicator ranges from 82 to 65 units (Table 3). At the same time, only 11% of the population lives in the capital region, a significant part of which falls on large cities. The most remote in this segment are the Transcarpathian region (35 cases) and the Chernivtsi region (33 cases). Thus, the gap in access to the Internet by regions of Ukraine is more than 3-fold, indicating the different possibilities for the population of the country to use information technology and leading to social inequality and economic disproportionality.

In Ukraine, the number of Internet users tends to stabilize (Official site of the Main Department of Statistics of Ukraine 2021). Beginning in 2015, the number of users is fluctuating within the range of 21–22 million. At the same time, taking into account the decrease in the total population of Ukraine, Internet penetration for this period has increased substantially and as of June 2021, is at an average of 68.6% (the number of Internet users per 100 inhabitants). The total number of Internet users in villages and towns with populations under 100,000 increased by 6.7%, and the number of Internet users in towns with populations over 100,000 is 75% (Table 3).

Table 3. Number of Internet subscribers by region as of June 1, 2020, thousand people

Source: State Statistics Service of Ukraine (http://www.ukrstat.gov.ua/)

	Number of Internet subscribers	Among them – private users
Ukraine	**28,787.6**	**25,683.8**
Cherkasy Oblast	74.5	65.1
Chernihiv Oblast	75.5	67.3
Chernivtsi Oblast	68.4	64.5
Dnipropetrovsk Oblast	264.5	248.5
Donetsk Oblast	171.2	161.9
Ivano-Frankivsk Oblast	404.6	360.2
Kharkiv Oblast	178.7	157.4
Kherson Oblast	91.8	81.9

Khmelnitskyi Oblast	80.7	71.2
Kirovohrad Oblast	65.1	59.6
Kyiv Oblast	154.3	146.9
Luhansk Oblast	41.6	37.4
Lviv Oblast	241.5	208.7
Mykolaiv Oblast	161.6	155.4
Odessa Oblast	1,103.5	1,016.2
Poltava Oblast	156.9	143.6
Rivne Oblast	62.6	56.1
Sumy Oblast	79.9	72.4
Ternopil Oblast	108.0	100.5
Vinnitsya Oblast	106.5	95.7
Volyn Oblast	62.7	56.6
Zakarpattia Oblast	69.2	62.9
Zaporizhzhia Oblast	153.3	140.6
Zhytomyr Oblast	99.6	92.7
Kyiv	1,842.5	1,717.1

The level of development of the digital economy is influenced by interregional disparities in the income of the population of individual regions. According to statistical data, the Ukrainian economy is characterized by nervousness in the level of average wages and unemployment in the regions (Table 4). This income differentiation indicates that the place of residence of an employee is a key factor in the individual labor supply and, accordingly, a factor that determines the level of their wages. Despite this, the main changes in the labor market caused by digitalization are similar for all regions. Companies with a higher level of human capital have more opportunities to be included in the digital economy. Regions where this is especially true include Kyiv (179,302 UAH per person), Dnipropetrovsk Oblast (92,083), Zaporizhzhia Oblast (81,949), Odessa Oblast (80,164), Kyiv Oblast (79,263) and Poltava Oblast (77,547).

Table 4. Income and expenditures of the population by regions in the 20th century

Source: State Statistics Service of Ukraine (http://www.ukrstat.gov.ua/)

	Revenues, million UAH	**Actual income**			**Costs, million UAH**
		million UAH	**per person, UAH**	**real, % to 2019**	
Ukraine	**3,972,428**	**3,062,229**	**73,355**	**102.6**	**3,989,445**
Cherkasy Oblast	96,063	76,154	64,254	103.6	105,475
Chernihiv Oblast	79,700	63,894	64,933	103.5	82,711
Chernivtsi Oblast	60,893	48,439	53,875	106.0	70,975
Dnipropetrovsk Oblast	368,017	290,917	92,083	100.1	355,885
Donetsk Oblast	218,593	171,479	41,662	100.1	162,263
Ivano-Frankivsk Oblast	103,547	82,252	60,276	102.8	104,782
Kharkiv Oblast	263,887	193,742	73,218	105.8	304,360
Kherson Oblast	79,508	64,480	63,073	104.8	85,103
Khmelnitskyi Oblast	101,280	80,978	64,824	105.6	110,937
Kirovohrad Oblast	74,126	58,813	63,472	104.7	77,656
Kyiv Oblast	189,875	141,469	79,263	102.0	248,808

Luhansk Oblast	69,737	56,864	26,714	103.5	52,190
Lviv Oblast	230,602	178,224	71,150	102.1	240,254
Mykolaiv Oblast	95,579	76,081	68,289	101.8	95,191
Odessa Oblast	248,022	190,206	80,164	104.1	257,155
Poltava Oblast	133,086	106,960	77,547	103.0	135,010
Rivne Oblast	85,701	67,677	58,814	101.6	89,110
Sumy Oblast	93,008	75,448	71,117	103.9	86,631
Ternopil Oblast	72,520	57,493	55,570	106.9	74,553
Vinnitsya Oblast	135,047	108,674	70,691	106.1	136,770
Volyn Oblast	74,204	58,267	56,603	100.6	77,576
Zakarpattia Oblast	81,318	63,943	51,073	102.4	93,153
Zaporizhzhia Oblast	170,770	137,429	81,949	104.8	167,533
Zhytomyr Oblast	99,682	80,752	67,187	104.2	100,681
Kyiv	747,663	531,594	179,302	100.3	674,683

An important condition for the development of the digital economy is the formation of the modern labor market, when the requirements for education and professional skills are increasing, the rules for hiring employees are changing, and the flexibility and mobility of personnel are increasing. On the other hand, the rapid development of digital technology directly affects the quality of life of the population, contributes to the economic efficiency of business and government, and encourages the expansion of new forms of organization of work. Under the influence of information technologies, the digital market is formed, the main characteristics of which are its global nature and the interaction between the employer and the staff on a digital platform in the remote work mode (Lopushnyak & Mylyanyk, 2019).

The Cabinet of Ministers of Ukraine (Order of March 3, 2021. No. 167-p), in the Concept of Digital Competence Development, states that in today's conditions "There is a need to ensure that society is ready for such processes, that it has mastered key combinations of knowledge, skills, skills, ways of thinking, views, and other personal qualities in the field of information and communication technologies (digital competence)" (Order of the Cabinet of Ministers of Ukraine, 2021). In this case, digital competence is understood as a system of knowledge, skills, habits, ways of thinking, and other personal qualities in the field of information and communication and digital technologies, which reflects the ability of a person to successfully carry out professional, further educational activities with the use of appropriate technologies. The experience of successful countries shows that the acquisition of digital competences positively influences the development of the economy and the increase in competitive advantages. In 2018, the European Parliament and the Council of the European Union approved the Framework Program of new key competencies for lifelong learning, which considers digital competence as one of the eight key competencies for the full-fledged life and activity of EU citizens (Association Agreement, 2014).

Therefore, under the conditions of the digital economy, employers impose new requirements on personnel, including initiatives, critical thinking, the ability to solve complex tasks, and the ability to interact with different people and to correctly prioritize (Figure 6).

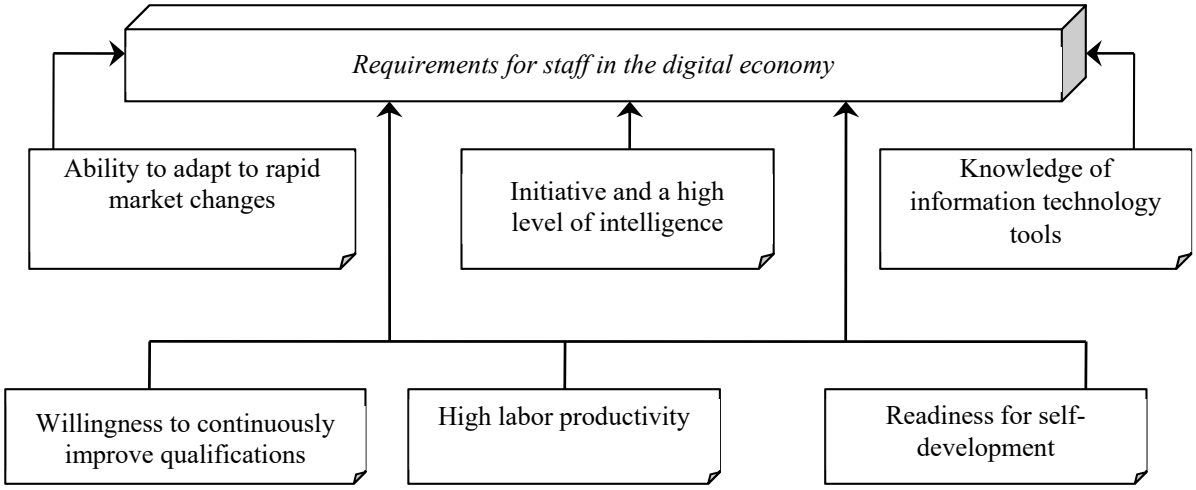


Figure 6. Requirements for the personnel of the company in the conditions of the digital economy
Source: Hryshyna, Pohorielova et al. (2021)

It should be noted that today in Ukraine the number of remote forms of employment is increasing, the implementation of which is carried out through digital communication devices. Digital devices such as computers, tablets, mobile phones, cameras, etc. are means of employment. Digital employment is implemented in two main forms: electronic freelancing and electronic outsourcing (Ukrainian National Platform, 2020). An electronic freelancer performs labor activities remotely using information and communication technologies. Electronic freelancing covers a wide range of economic activities: programming, content creation and translation, marketing research, sales, consulting, financial accounting, administration. Electronic outsourcing is the transfer of part of the business processes to outside organizations using computer programs and the Internet. The greatest impact on the development of outsourcing on a global scale is exhibited such processes as technology, economic and political factors, the introduction of chronic and mobile solutions, etc. According to the Freelancehunt portal (www.freelancehunt.com), in 2018–2020 the largest share of freelancers from Ukraine were engaged in the IT sphere (up to 50%), a smaller part were engaged in design (up to 22%), works with text (up to 20%), marketing (up to 11%), and other activities. Digital platform employees are working in all regions of Ukraine: even without Kyiv, the central region is leading in the share of freelancers together with the south region (21% and 23%, respectively). Workers of digital platforms are also less represented in the Western region (16%). The majority of online employees of digital platforms are located in cities with a population of over 100,000 inhabitants (82%). Among them, the leaders are the most populated cities of Ukraine, such as Kyiv, Kharkiv, Odessa, Dnipro and Lviv, which together account for more than half of freelancers.

Over the past three years, Ukraine ranked fourth among all countries in the world and first among European countries in terms of the number of registered freelancers. According to Forbes, Ukraine was among the top four fastest-growing freelance markets in Q2 2019, growing by 36% compared to the same period in 2018. According to special online services, in 2019 the number of freelancers in Ukraine reached 340,000 employees, among whom most were members of the younger generation (Ukrainian National Platform, 2020). The structure of the Ukrainian freelance market by categories is as follows:

- information technologies (web, mobile & software development), 83%;
- design and creativity, 6%;
- other categories (translation, SMM, sales and marketing, engineering, architecture, etc.), 11% (Top Lead, 2017).

The above data indicate that the current labor market in Ukraine has changed dramatically under the influence of information technology, and this has been followed by a strong scientific and educational base for training competitive IT development specialists.

Conclusions

Thus, an important advantage of the digital economy as compared to the traditional one is the implementation of the possibility of automatic control of the entire economic system and its individual components. This can entail unlimited scaling without loss of efficiency, which will increase the efficiency of the economic management system of the country as a whole, as well as of its individual regions. Therefore, the digital economy is essential for all industries and companies that, under the influence of digital transformation due to technological evolution, are changing their business processes and increasing the productivity and efficiency of using their potential.

Among the most necessary measures to accelerate the processes of digital transformation of the economy in Ukraine are:

- improving the legislative and regulatory framework for the digitalization of the economy;
- popularizing digital technologies among the business community and raising the awareness of businesspeople about the benefits of digital technologies;
- creating state programs for support of cooperation between the public sector and business in the field of digital technology;
- increasing the amount of funding for educational programs on the use of digital technology for various categories of the population;
- forming digital infrastructure and expanding digital platforms in all regions of the country for the purpose of solving digital nervousness among Ukrainian citizens.

At the same time, Ukraine needs to take low-level measures at the state and regional levels, which should be focused on the development of the domestic technological base, expanding the procedure for improving the conduct of individual digital businesses, reducing corruption, and increasing wages. Then, Ukraine will cease to be a supplier of labor force for developed countries, digital migration will decrease, and digital work will provide wide opportunities for domestic IT workers to ensure their competitiveness and ensure a decent standard of living.

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DIGITAL TOOLS IN THE PUBLIC SECTOR AS AN ELEMENT OF FORMING A DEMOCRATIC SOCIETY

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Abstract *The evolution of modern society, accompanied by radical social transformations in the world and in Ukraine, is moving in the direction of the concept of an information society. At present, completely new relationships are being formed in the economic, social and spiritual lives of people, which are encapsulated in this concept.*
Given the degree of elaboration of this problem, as well as its multifaceted nature, this study aims to explore the problem of implementing digital tools in the public sector as a phenomenon of the information society, and to suggest ways to improve the efficiency of the public sector. The subject of research is modern society, which is developing in the context of the globalization of the information space. The object of research is the range of phenomena and processes that take place in the public sector through the formation of the information society. The research methods are determined by the specifics of this research work and the need for a comprehensive and interdisciplinary analysis of the topic. In the study, the author relied on general scientific methods: the comparative-critical method and the principle of typology, the structural-functional method, the systematic approach, the methods of analysis and synthesis, the historical method, the graphic method, and the methods of comparison, generalization and classification. The paper analyzes the features of regulatory and legal support for development in the field of digital participation in Ukraine as one of the 13 important aspects of statehood. The digital tools that can contribute to the involvement of more people at the local, regional and national levels in decision-making processes are highlighted. A number of pilot local and regional concepts in the field of digital democracy are analyzed, and a general idea of the legal framework for the development of digital democracy in Ukraine is formed. The analysis of foreign experience reveals a global trend in the formation of digital participation processes, namely: in most EU countries and the US, integrated platforms for the simultaneous combination of different online and offline activities that encourage more citizens without using additional resources are being created.

Keywords: *digitalization, democracy, decision-making, smart city.*

Introduction

The historical development of society is the cause of the formation of the information society, and this is a natural phenomenon. All spheres of public life are undergoing transformations and we are entering a new era, among the most important features of which are the accelerated informatization and computerization of all spheres of social production and the formation of a global network of communication links. Today, the activity of public associations is an integral part of the process of democratization of society. Public associations use in their work the principle of involving socially active citizens in the reform of society on a democratic basis. The information age is a fundamentally new stage in the development of civilization, characterized by new qualitative features compared to previous periods of human history. Most importantly, in our time, information and knowledge are of key importance.
The Internet has a special place in the process of formation of the information society. In addition to unprecedented opportunities to improve the material well-being of mankind, modern IT has led to the emergence and intensive spread of fundamentally new models of social integration, communication, socio-political activity, lifestyle, education, etc.
The modern world is characterized by rapid progress in the spread and development of information and communication technologies. New means of telecommunications, in particular

the Internet as a powerful global information resource, attract a wide range of people regardless of age, education, and social status.

In developed countries, the field of information and communication technologies is the key to social, economic, and political prosperity. Since the 1990s, the development of the information society has been a priority of public policy in the world's leading countries.

Various aspects of the information society – in particular, the role and place of people in the processes of globalization and information interactions, and the specifics of the information society in some highly developed countries and developing countries – are analyzed in Ukrainian literature in the works of I. Yu. Alekseev, M. S. Demkov, T. A. Berezi, L.V. Berezovets, O. L. Vartanova, S. T. Kara-Murzi, A.W. Kolodyuka, I. B. Koliushko, V. I. Lysytskoho, L. G. Melnyk, A.I. Rakitova, G. L. Smolyan, D. S. Chereshkina, A. A. Chernova and others.

Well-known researchers of digital tools and their implementation in various areas of organizational activity include K. Young, I. Goldberg, M. Griffiths, J. Grohol, J. Suler and others.

The issues of the activities of public organizations and their role in the process of forming civil society were covered in works by both domestic and foreign scholars: G. Domanski, I. Vitkovska, A. Galai, I. Yevdokimova, V. Kovalenko, J. Laville, A. Lyasota, D. Lewis, V. Kravchuk, A. Matviychuk, R. Patnam, T. Parsons, E. Ponomarenko, S. Ponomarev, P. Plau, E. Reverse, D. Stone, I. Tkachuk, A. Tocqueville , M. Shevchenko, S. Feldman, J. Fischer, R. Haye, O. Yuldashev and others.

The aim of this research is to explore the problem of implementing digital tools in the public sector as a phenomenon of the information society, and to suggest ways to improve the efficiency of the public sector.

The subject of research is modern society, which is developing in the context of the globalization of the information space.

The object of research is the range of phenomena and processes that take place in the public sector through the formation of the information society. Research methods are determined by the specifics of this research work and the need for a comprehensive and interdisciplinary analysis of the topic. In the study, the author relied on general scientific methods: the comparative-critical method and the principle of typology, the structural-functional method, the systematic approach, the methods of analysis and synthesis, the historical method, the graphical method, and the methods of comparison, generalization and classification.

The tasks of the research were as follows:

1. To analyze the features of regulatory and legal support for development in the field of digital participation in Ukraine.
2. To consider pilot and current local and regional concepts in the field of digital democracy and form a general idea of the legal framework for the development of digital democracy in Ukraine.
3. To provide a consideration of the impact of the introduction of digital tools in the activities of local self-government and the impact on democratic processes in the country.

The evolution of modern society, accompanied by radical social transformations in the world and in Ukraine, is moving in the direction of the information society. This concerns the formation of the global information industry, the increasing role of knowledge and information in economic and socio-cultural development, the emergence of new forms of democracy, structural changes in employment and other spheres of society. Now, completely new relationships are being formed in the economic, social, and spiritual lives of people, which are described by the concept of the information society.

In the early 1960s, the most important methodological framework to consider the formation of a new social state was formed from the standpoint of a departure from traditional industrialism

and the development of the service economy. This was associated with the increasing role of technology, science, and education, expanding new class managers and technocrats and a qualitative change in the place of theoretical knowledge and information in social production.
Initially, researchers in the information society focused on improving the means of disseminating and providing access to information, and the discussion was dominated by technological, infrastructural, and economic aspects. This was naturally due to the explosive development and convergence of information and communication technologies, which led to significant changes in the global market (Prins et al., 2017) of the information society was the development of computer and information technology. There were other features: the global nature of information, free from state borders, and the spread of information flows; a significant increase in the ability to collect, process, store, transmit, and access information; the increasing impact of information on the development of various spheres of human activity; the transition to new forms of employment, etc.
Socio-humanitarian aspects of the new information society began to be actively explored as a result of the realization that another qualitative leap in technological development had given rise to a new global social revolution that was not inferior to past revolutions in terms of its scale and impact on human society.
Today, the problems of the further technicalization of society, as it was considered a few years ago, have come to the fore, but the problems of intellectualization and the creation and implementation of new social technologies are based on effective use of the main strategic resource of the knowledge society.
There are several approaches to the definition of the information society. For example, A. Duff (1998) identifies three ways of understanding the information society: in terms of information and the economic approach, the approach from the standpoint of information flows, and the information technology approach. Well-known theorist F. Webster (2014) identifies five main approaches, each of which is based on one or another criterion of the information society that underlies it. First of all, these are technological and economic criteria (based on the most obvious changes in these areas of human life, most researchers build their definitions of the information society on them), the criterion associated with changes in employment (professional), and spatial and cultural criteria (Webster, 2014). Analyzing different approaches to the definition of the information society, F. Webster (2014) notes the existence of another definition, radically different from the previous ones; it is not based on the fact that in our time there is more information, but on the fact that the nature of this information has changed the way we live. This definition assumes that our behavior today is based on theoretical knowledge and information, and therefore relies not on quantitative criteria that are difficult to account for, such as previous definitions, but on qualitative ones.
These approaches are not necessarily mutually exclusive, although information society researchers, according to their ideas, bring to the fore mostly one or another definition. The basis of most approaches is the belief that quantitative changes in the field of information lead to a qualitatively new type of social order. In many respects, theorists proceed from similar considerations: in our time, in almost all spheres of society there is more information, so the society in which we live is informational.
Thus, agreeing with the great importance of such a component of the information society as information technology, we find it very simplistic and incorrect to recognize them as separate, each playing leading roles in social change.
Another approach to the definition of information society, which is no less common, is related to economic transformation. This approach involves taking into account the growing economic value of information activities. If there is an increase in the share of information business in gross national product, it is logical to conclude that the economy has become informational. If in the economic sphere information activity prevails over activity in the field of agriculture and

industry, then we can therefore talk about an information society. Accordingly, the information society is understood here as a society in which the main role is occupied by the production of information products and information services (Al-Dalou & Abu Shanab, 2013). However, recognizing the objectivity of the increase of the information sector in the economy as a whole and the growing economic significance of information, one cannot fail to note the complexity of this approach in trying to identify the size and components of the information sector of the economy.

In addition, the modern economy cannot be considered fully informational – the development of the information sector is logically combined with the existence of traditional industries, which also raises some doubts in an attempt to make the information-economic criterion dominant in the analysis of the information society.

Third, a professional approach to the definition of information society relates to employment. This approach is closely related to the work of D. Bell, the most prominent theorist of post-industrial society. This term is almost synonymous with the term *information society*, and it is used in the works of this author in this sense. Considering the structure of employment and the model of observed changes, D. Bell (1976) suggested that humanity is entering an information society, where most employees work in the information sphere. Decrease in employment in the sphere of production and increase in employment in the sphere of services are considered by Bell as a replacement of manual labor by white-collar work. Since the raw material for non-physical labor is information (as opposed to physical strength, manual labor skills, and its machine characteristics), a significant increase in the share of labor in the information sphere can be seen to represent the emergence of information society (Duff, 1998).

It should be noted that this approach to the definition of the information society is fundamentally different from the technological and economic. The emphasis on change in the field of employment emphasizes the transformational potential of information as such, rather than the action of information technology, where information is promoted and created in the field of employment and implemented in people through training and experience. A number of authoritative authors, from R. Reich to M. Castells, believe that the driving forces of the modern economy are people whose main ability is to use information: today, the main drivers of the economy are those whose work requires the creation and use of information.

Indeed, in developed countries, more than 70% of the workforce is employed in the service sector. The disadvantages of this approach are primarily due to the difficulty of dividing classes into categories such as informational and non-informational. “Such a methodology gives us huge amounts of information employment, but does not provide a tool for differentiating the most significant amounts of information work” (Webster, 2014, p. 122).

The fourth approach to the definition of the information society, although based on economics and sociology, is based on geographical or spatial principles. The main focus here is on global information networks which connect different parts of the planet, and therefore affect the organization of time and space. This concept has become especially popular in recent years due to the increasing role of information networks in the social organization of society and the development of the Internet. One of the leading proponents of this approach, M. Castells (Stalder, 2006), argues that the main feature of the information age is the presence of networks that connect people, institutions and states. Since the 1970s, a new form of capitalism that has emerged as a result of the development of information technology (in the author’s words, “information capitalism”) has used information networks both in production and for marketing around the world. Thus, the information society in this approach is considered as a global network society in which networks permeate the entire social and economic structure (Stalder, 2006).

The advent of electronic superhighways has drawn attention to the revision of the ratio of space-time. Indeed, in a networked society, the challenges of time and space have been largely

overcome, and corporations and even individuals have been able to conduct their business effectively on a global scale. Therefore, many suggest that all of this marks a serious transformation of the social system, which may even be a sign of revolutionary change. At the same time, the recognition of the development of information networks as a leading factor in the formation of the information society requires some reservations.

The availability of information networks is not sufficient to recognize society as informational. This approach also deals with vague definitions – first of all, the vague concept of the network, as it is unclear whether the network should mean only technological systems or all social information relations built on the network principle. In addition, information networks in the form of post, telegraph and telephone have existed for a relatively long time, and if we recognize their existence as leading in the information society, it becomes unclear what the information society is about now, not decades ago.

The approach to defining an information society that uses the criterion of culture is perhaps the easiest to recognize as complete and relevant to modern realities, but cultural artifacts are even more difficult than others to measure and formalize. Indeed, modern culture is clearly more informative than any previous one. People exist in a media-saturated environment: our lives are essentially symbolized, they take place in the process of exchanging and receiving messages about ourselves and others. Recognition of the explosive growth of cultural meanings leads many authors to say that humanity has entered the information society. They seldom attempt to quantify this development, but simply point out how obvious it is that there are far more signs and information today than in previous epochs. First of all, the concepts of postmodern authors who study the information society within text and hypertext, simulacra and rhizomes, hyperreality and pastiche, meaning, sign and other categories of postmodern discourse are descriptive.

The next approach to the definition of the information society is related to changes in the political sphere of society and the nature of international relations in the context of globalization. According to this approach, the state and various political forces are becoming the main actors in the formation and further development of the global information society. Information and knowledge in such conditions are some of the main resources of the state, the scale of which today can be compared with the use of traditional resources, access to which is one of the main factors of socioeconomic development. It is emphasized that the development of information and communication technologies brings about radical changes in the political life of society, especially in terms of its democratization. However, this approach to the definition of the information society, despite all of its importance in highlighting the future prospects of the global community as a global information community, also seems somewhat one-sided because of its attention to only one aspect of this problem.

Thus, the analysis of these approaches to the definition of the information society shows that they are either underdeveloped or one-sided. All of these approaches give very problematic notions of what, in fact, is the essence of the information society and how it can be defined. This is mainly due to the fact that most of these definitions of the information society are based on its quantitative characteristics and suggest that at some point, when information criteria begin to dominate in various spheres of society, it enters the information stage of its development. Thus, the quantitative increase in the amount of information is transformed into a qualitative change in the social system.

Undoubtedly, the ability to quantify the dissemination of information is useful, but it is clearly not enough. We can agree with F. Webster (2014) that for true knowledge of the information society, how it is similar to other social systems and how it differs from them, it is necessary to comprehensively study the qualitative transformations. Thus, the information society can be defined as a society in which theoretical knowledge plays a dominant role. According to this approach, the information society or knowledge society is arranged in such a way that priority

is given to theory, and this is considered to be the hallmark of modernity. Indeed, theoretical knowledge plays a key role in modern society – unlike in previous epochs, when practical and situational knowledge dominated. Today, innovations, on the other hand, originate mainly from basic theoretical knowledge, most clearly in science and technology, although the priority of theoretical knowledge exists in politics, economics and even everyday life. According to this approach, modern society is formed on the basis of reflection and decisions in which risk assessment plays an important role, respectively, and theoretical knowledge is given a central place because it gives rise to reflection.

However, the position of the priority of theoretical knowledge as a determining factor in the information society is also denied and cannot be considered fully valid because of its one-sidedness and inattention to the necessary quantitative analysis of the information society and the meaning of information in the modern world.

Thus, considering the main approaches to the definition of the information society in modern discourse, it becomes clear that none of them can serve as the only reliable methodological basis for studying such a complex phenomenon. The solution of this methodological problem is possible only in the case of integrated use in the definition and analysis of the information society of elements of all of the above approaches, taking into account their strengths and weaknesses. In addition to acknowledging this fact, the author's approach to defining the information society is based on the following provisions.

First of all, it should be noted that it is impossible to understand the essence of the information society without analyzing the meaning-forming category of this concept – the category of information. Today, there is no universal concept of information. According to the theory of semiotics, information is a measure of eliminating the uncertainty of the recipient's knowledge of the state of an object or an event. There are two main approaches to determining information: attributive and functional. The attributive approach considers information as an objective property of all material objects, while the functional one states that information is a condition and result of active activity and is possible only at the social level (Ariola, 2013). In addition, information is considered as all the information, knowledge, and messages that help in solving a problem. Information in this study is broadly understood to include all aspects of the above definitions, as well as audiovisual, entertainment information and databases with specialized information (narrow understanding of information).

According to most scientists, the information society has made information its basic parameter. Information becomes the basis of social and information development, and the main resource of social and economic relations. D. Robertson (1998), based on the idea of the interdependence of civilization and information processes, put forward the formula that "civilization is information." Using quantitative measures of mathematical information theory, the scientist ranks the history of civilization by the criterion of the amount of information produced, highlighting the following levels: zero level of information capacity in the brain of an individual – 10 bits; the first level of oral communication within a community, village or tribe circulating information ~ 10 bits; the second level is written culture, a well-known example of which is the Library of Alexandria, which had 532,800 scrolls that contained 10 bits of information; the third level is that of book culture, where there are hundreds of libraries and tens of thousands of books, newspapers, and magazines are published, the total capacity of which is estimated at 10 bits; the fourth level is the information society, with electronic information processing of 10 bits (Isaac-Henry, 2000).

Another important component of the approach to the definition of the information society is the recognition of the high dynamics of its development and the profound nature of changes in all spheres of human life. The dominant factor in the current stage of civilization is a phenomenon that some authors define as the information revolution. Thus, according to M. Vershynin (2001), the information revolution is the result of two processes that have developed

in parallel throughout human history – the process of the ever-increasing role and increased amount of information needed to ensure human life, and the development and improvement of information accumulation and dissemination technologies. M. Vershynin (2001) singles out several information revolutions in the history of civilization (as a result of radical changes in information processing): the first information revolution took place around 25,000 years ago and was associated with the emergence of language as a means of communication and interaction in society; the second revolution is related to the invention of writing, which made it possible to transmit information and knowledge between people from generation to generation; the beginning of the third revolution dates back to the middle of the 16th century, the time of the invention of printing; the fourth revolution took place at the end of the 19th century and was associated with the advent of electricity, which made it possible to use technologically new ways of transmitting information, such as telegraphs, telephones, and radio; the fifth information revolution, from the 1950s to the 1970s, is associated with the invention of the microprocessor and the advent of the computer (Vershynin, 2001).

Through information and telecommunication infrastructure it became possible to transmit a huge amount of information, which led to an unprecedented increase in information flows. The result of the information revolution was the emergence of a new type of information society.

In addition, in defining the essence of the information society, it is necessary to use the term *informatization*. Sharing the point of view of some researchers, we note that the informatization of society is a global social process of production and widespread use of information as a social resource that intensifies the economy and accelerates scientific and technological progress and the democratization and intellectualization of society. Informatization involves the mass introduction of methods and means of collecting, processing, transmitting and storing information on the basis of microprocessor and computer technology. Informatization is the intellectual and humanistic restructuring of human life in order to create a new social order, and information is becoming an important factor in social progress (Charalabidis & Loukis, 2011).

Informatization, thus, is a socio-technical and socio-cultural process of changing the life of society, its subsystems and structures by dramatically increasing the efficiency of production, preservation and dissemination of all types of information and knowledge. It is important to note that the informatization of society is one of the laws of modern social progress, and this term is not identical to *computerization*. In the computerization of society, the main attention is paid to the development and implementation of the technical base of computers that provide prompt receipt of the results of processing and accumulation of information. During the informatization of a society, basic attention is paid to a complex of actions directed towards the maintenance and full use of timely knowledge in all kinds of human activity.

Having identified the general methodological basis for the study of the information society, it is advisable to proceed to the definition of its essential characteristics. Obviously, one cannot but agree with the views of a number of foreign and domestic authors that the main features of the information society include: the formation of a single global information space and the deepening processes of information and economic integration of countries and peoples; the formation and further dominance in the economy of the countries that have the most advanced information society, new technological systems based on the widespread use of technological innovations, network information technologies, and advanced means of computer technology and telecommunications; the expansion of services; the dominance in the social structure of the class of intellectuals; the creation of the market of information and knowledge as factors of production in addition to the markets of natural resources of labor and capital, as well as the transition of information resources of society into real resources of socioeconomic development by expanding access to them; the growing role of infrastructure (telecommunications, transport, organization) in the system of social production and the

strengthening of trends towards the joint functioning of the economy of information and cash flows; the actual satisfaction of society's needs in information products and services; raising the level of education by expanding the capabilities of information exchange systems at the international, national and regional levels and, accordingly, increasing the role of skills, professionalism and creativity as the most important characteristics of labor services; and the creation of an effective system of ensuring the rights of citizens and social institutions to freely receive, disseminate and use information as the most important condition for democratic development, improving the interaction of the population with authorities.

Based on the above, it is difficult to analyze the approaches and definitions of the information society of different authors due to their extreme diversity, but it is obvious that all authors consider information and communication links the key to understanding modern society. Perhaps the shortest definition of an information society can be: an information-based society. In fact, this position is the basis of most definitions of the information society.

In general, the concept of information society can be defined in at least three ways. First, by listing the characteristics of this type of society. However, the list of these characteristics depends on the approach to understanding the essence of the information society. In addition, a complete and exhaustive list cannot be achieved, because life will constantly make adjustments. Secondly, one can go the other way by pointing out that the information society is the next stage in the historical development of mankind along the chain of agrarian, industrial, then post-industrial society, linking the formation of the information society with the concept of sustainable development or Vernadsky's noosphere.

A third, compromise option is possible, which combines the methodological foundations of the first two ways of defining the information society.

Summarizing the existing approaches to the interpretation of the concept of information society, we can say that currently this means:

- a new type of society, formed as a result of a new social revolution, generated by the explosive development and convergence of information and communication technologies;
- knowledge society, i.e., a society in which the main condition for the well-being of each person and each state is the knowledge obtained through unimpeded access to information and the ability to work with it. Information in such a society is the most important social and economic resource, the main source of productivity and power, and a condition of well-being of people and the state;
- a global society in which the exchange of information will have no temporal, spatial or political boundaries, which, on the one hand, promotes the interpenetration of cultures and, on the other hand, opens new opportunities for the self-identification for each community.

These characteristics of the information society are enough to understand what we are talking about, and further filling out the content of the concept of the information society should be carried out with the consideration of the leading concepts of the information society.

The emergence of the Internet was a revolution in intellectual activity, cognition and communication. This fact is recognized by the whole global community. The Internet represents the freedom of communication, the provision of information, and the absence of geographical, political, temporary, and ethnic provinces. The evolutionary possibilities of the Internet are endless. Even the smallest nodes of the network are autonomous, which combines globality with independence; maximum publicity does not interfere with almost complete freedom of expression. Network customers are also free to choose the information they need from a variety of sources, not limited to local or national borders.

Only language and cultural barriers remain. According to psychologists, the use of computer networks leads to significant functional changes in mental activity that disrupt the cognitive, communicative and personal spheres.

The use of the Internet also levels the system of traditions, rules, and values that have developed historically and characterize the affiliation of the individual to any community, such as a nation, class or religious denomination. It can be noted, to some extent, that the network strengthens all kinds of relationships and connections between people through information, regardless of social barriers.

At first glance, the Internet is similar to conventional global networks. However, it in fact has a number of very specific features and a unique structure. While a normal global computer network can be considered as a set of geographically distributed local area networks, which are usually connected to each other via telephone network, satellite channels, etc. and are fully supported and managed by one group of specialists from a single center, the Internet consists of many hundreds of freely connected networks. However, there is no single control center responsible for the development and operation of the Internet. Therefore, any enterprise or institution, having its own independent local computer network, can easily access the common information space. To obtain such an output, there is no need to change the internal network structure – it is enough to meet a number of requirements for Internet connection and the organization of internal network address space.

The Internet is a unique conglomerate of local, territorial, global and other computer networks connected into a single information space, for which neither the structure nor the methods of combining its local components matter.

Each of these networks connects to the Internet using special hardware – a router. This device generally performs many functions, including the ability to send directly to the destination information that operates on the Internet. When building territorial and global networks that connect local area networks with the same data transmission technology (Ethernet, ARCNet, etc., 2019), other hardware devices are used – bridges. The functions of such devices include the analysis of all data packets operating in the interconnection in order to deliver them to a predetermined network address from one local network to another.

Unlike a bridge, a router is a device that allows users not only to connect to networks with the same information technology, but also to organize the association of different networks with different topologies and specific communication technologies.

Routers are one of the most important components of the Internet. They are used in almost every Internet connection in order to limit and streamline network traffic and to determine the most efficient way to deliver packets of information to the destination.

To get a better idea of the Internet in terms of its technical and technological nature, as well as the methods and prospects for its use, it would be useful to dwell briefly on the history of the origin and development of the Internet.

In the late 1960s, the US Department of Defense conducted promising research on the creation and military use of computer networks that would have a sufficient margin of technological strength to function in wartime. The concept of building such networks, which was developed as part of this research, today underlies the construction of most global networks, including the Internet. Within the framework of this project, the ARPAnet network was developed – the network of the Advanced Research Projects Agency. The main task in designing and creating this network was to provide the necessary reliability and flexibility to work in special conditions, which would allow operators, if necessary, to replace computers in the network without additional reconfiguration of the network itself (Science Museum, 2018).

As this project developed, the most important components of the new network were identified. Particular attention was paid to ways to optimize the possible way of delivering messages, building e-mail services and offering breaking news services. None of the network's new features were developed as commercial products. The software and technical solutions developed were initially based on the principle of open standards, which could be used by anyone if necessary.

It is due to the fact that the concept, technology and standards of information exchange (with the exception of only some classified elements) were and are open that this network has become so popular. The main idea of network openness was that such an approach to the design and development of such a large-scale software and hardware complex provided maximum stability and reliability of the entire network, making it more accessible and useful.

Therefore, the ARPAnet, originally developed exclusively for military purposes, began to be used more often for peaceful purposes in the mid-1970s. It is at this time that it acquired a general education direction. Most of the users of this network were university research centers and university scientists. However, the most striking changes in the ways and methods of using the new global network have occurred in the last decade. The ubiquitous commercialization of the network today allows anyone to buy access to the global information space, while receiving a full range of information, advertising, entertainment and other services provided by a variety of companies and firms.

In the 1990s, the network, already known as the Internet, underwent the greatest changes and began to cover truly global spaces, spreading around the world and providing users with new types of information sources and services. There is no need to provide an overview of the development and use of the network by the US Agency for Policy Studies. A group of organizations, such as the US National Science Foundation, has undertaken the long-term development and support of the Internet. However, even after seemingly fundamental transformations that could radically change the very essence of the network, the basic elements laid down as the technical and organizational foundations for the creation of the ARPAnet network remained unchanged (Science Museum, 2018)

The most significant difference between the Internet and other territorial and global computer networks, as already noted, is that there is no single point of management of this network, which would coordinate its work as a specific control center. In terms of technical and organizational structure, the Internet is the whole set of computers and individual local area networks, a set of telecommunications equipment (telephone networks, communication satellites, dedicated communication channels, etc.) connected into a single information space around the world. Any personal computer or user can rightly be considered an integral part of a single cyberspace, which covers more and more areas every day and attracts more and more users to its field.

Another important aspect of the existence and development of the Internet is the fact that this network does not and cannot have a single owner who manages the entire network and has sole property rights. Any company that provides information services on the Internet, any research or training center, has only a certain, very limited part of the network in the form of hardware and software, which is responsible for combining disparate computers into a single whole. In terms of the information content of the Internet, it should be noted that all information circulating in the bowels of this network has no owner and is distributed freely.

However, this does not mean that the Internet is a meaningless accumulation of information pollution, among which it is difficult to find useful and necessary data. There are considerable misconceptions about the Internet as a spontaneous union of a huge number of computers which cannot be organized. There are specialized voluntary and public associations and organizations that monitor the development of the network and coordinate its work. The main group of such Internet enthusiasts is the Internet Society or ISOC – the Society of Internet Advocates. This organization has no official authority to manage the network, but has become an unofficial center that determines the main directions of the development and improvement of the Internet. The unofficial Internet engineering center for the development, development, implementation and maintenance of new Internet technologies, specifications and standards is the Internet Engineering Task Force – the IETF. The main functions of this center can be formulated as follows:

-solving urgent technical and technological problems of the Internet;
- developing rules for the use of network protocols;
- developing and standardizing terminology for solving the technical problems of Internet operation;
- developing recommendations related to the standardization of data exchange protocols on the Internet;
- monitoring the significant spread of new technologies on the Internet;
- conducting various events on the exchange of information between users, researchers, distributors of information services and network administrators of the Internet.

During the COVID-19 pandemic quarantine, all organizations realized that the process of digital transformation is not a beneficial element, but a necessity for NGOs. Many underestimated the digital component in their work, so they were unprepared for active communication in a socially distant environment.

In this period we all faced new challenges, but we also faced new opportunities. The main question for everyone was how to adapt and effectively continue their activities in the new reality.

According to research by Ridde et al. (2020), 79.4% of NGOs have shown their flexibility and adaptability and switched to an online format of work, using all possible digital tools and applications. Quarantine restrictions became the catalyst for the implementation of digital solutions for public organizations. However, unfortunately, the implementation of these tools began chaotically and unreasonably. Each organization has its own characteristics, needs and opportunities, areas of work and target audience, which is why the implementation of digital solutions requires analysis and an individual approach. Modern information technologies expand opportunities in access to information, the development of personal competencies, interaction and communication, as well as for expressing one's own opinion, creativity, self-realization, the protection of one's rights and civic activism. This not only concerns messages on social networks, but also the adaptation of traditional formats to new realities. Here it is important to let go of old habits, proven methods, stereotypes and not be afraid to experiment.

A digital communication strategy can be defined as planning the most effective use of information and digital technologies in the organization to raise awareness of the organization, change the behavior and thinking of a target audience, solve a problem or bring to the public certain topics and more. The essence of this strategy is not to make maximum use of various technologies and tools, but to effectively solve urgent problems with their help. Organizations that have made use of digital technologies in a system or part of their development strategy tend to assess their future more confidently.

The digital communication strategy allows organizations to give reasonable answers to the questions of why, to whom, when, what, where and how to provide information about their organization, its activities, new projects or initiatives. This is done based on objective data – the trends and attitudes of civil society, partners, target audience, stakeholders, etc. As a rule, it is developed simultaneously with the communication strategy and covers issues related to ways of disseminating information about the organization and its activities on the Internet.

In order to form their own digital communication strategy, organizations need to answer 6 questions:

1. WHY: who they are and why. Formulate the goals of the digital communication strategy taking into account the key goals of the organization. Here it is important to clearly understand the purpose of the organization, its values, differences from others, and so on. The result of answering this question will be:

1.1 Identification of opportunities and challenges for the organization as a whole and, more specifically, where digital applications and solutions can help.

1.2. After defining values, it is important to describe the target audience for whom this value is important and to understand whether the organization can build digital communication with them.
1.3. Analyzing and prioritizing the needs of the target audience, which the organization can help solve or meet.
1.4. Identifying partners. An analysis of organizations working in the same field will provide important data for a digital communication strategy – the organization can adopt successful solutions, establish effective partnerships, initiate joint flash mobs, hashtags, thematic frameworks and more.
1.5. Determining the organization's positioning. It is important to take a position that will distinguish the organization from others. Positioning is based on individual strengths – functional and emotional.
1.6. Forming a unique value proposition. This should be clear, accurate, and short – literally 5 seconds, because that is all the time that an organization has to attract and hold a user's attention. What value this is to the audience depends on what the organization can provide. This is done by creating a list of benefits, and then combining all these benefits into one unique value. This analysis is easily accomplished via brainstorming, and the following tools can be used: Padlet, Jamboard, Coggle.it, Mind42, XMind and more.
2. WHO: study the target audience and define the main and additional target audience. To build an effective digital communications strategy, an organization needs to know its target audience well. It is necessary to understand whether what they know about their target audience is still relevant, whether their assessment and attitude towards the organization changed, and how the organization can meet new expectations.
2.1. This involves needs and opportunities, as an organization must clearly understand the needs, capabilities and characteristics of each target audience. A deep understanding of the target audience will allow the organization to build truly individual communication. However, the target audience cannot be all of civil society or all of the community, because by communicating with everyone the organization will not be able to communicate its message effectively to anyone.
3. WHEN: understand the path of the target audience. This involves analyzing when (at what time: morning, evening, Saturday or Wednesday, etc.) and where (in which social networks or platforms, messengers or sites, etc.) the target audience is, how it decides what materials, articles, and posts to read, what sites they visit, etc.
4. WHAT: what is the organization talking about. Quality content is the key to success. This involves thinking about content strategy, determining the tone, audience, method and time of distribution of content. The goal is to communicate appropriately, timely and effectively. There are times when one approach or tone resonates more in one audience than in another, and this is worth remembering. Every target audience needs to be addressed in its own language. For example, Facebook highly values unique content created specifically for this social network, so for successful promotion it is very important to pay attention to the quality of content, publishing something original and authentic. What matters is not so much the frequency of publications and the number of posts as the value for the target audience, so the preparation of content for publications on Facebook should be taken seriously and responsibly.
Text should be structured, diverse, easy to read, interesting, have relevant illustrations and pictures. Information that is presented in a continuous stream is perceived negatively. If an organization has a lot to say, they should use a method such as storytelling to capture the reader's attention and provide them with the necessary emotion.
To be effective in social networks, organizations need to stand out, be clear, concise and useful. Of course, they must also remember that most people are visual, so photos, videos,

infographics, animations are necessary. One-dimensional content for all platforms (Facebook, Instagram, Tik-Tok, Messenger) cannot exist – each platform requires an individual approach.
5. WHERE: selection of promotion channels. At this stage, the organization chooses a relevant channel for the target audience to convey information. This involves analyzing the organization's external and internal digital tools and channels, evaluating those that are available, acceptable, but not yet used, and formulating the goals, objectives and main challenges for each channel (website, social networks, blogs, e-mail, chatbots, mobile applications, messengers, etc.). The rules often change on social networks, which means that organizations should review their content strategy, and not assume that it will work for many years. This is especially true now that most people spend more and more time online, especially on social media, after quarantine restrictions. This trend should also be reflected in the digital communication strategy, taking into account the moods, preferences and needs of each audience, any age group, status, etc.
6. HOW: implementation. This is a question of implementing strategy. Here, the organization must:
6.1. Prescribe goals and key performance indicators.
6.2. Make a to-do list. Once the organization has identified the tools and their key performance indicators, they prescribe a work plan for each digital channel used – with deadlines, steps and responsible people. Project management solutions (task managers) can help with this, in which each employee can add their own tasks and write comments that other colleagues will see. The most common options include: Trello, Asana, Miro, Mural, and Worksection. Most of these tools can be customized to the organization's own needs and preferences – from design to synchronization with messengers and other services.
It is important to understand the algorithm of how the organization will check and evaluate the results of each step and the overall success of digital communications. This involves analyzing the results and adjusting the next steps. Analysis, social media statistics, online surveys, etc. will help with this. Tools that can be used for surveys include: Polleverywhere, Kahoot, Mentimeter, Padlet, Google Forms, Sli.do, etc. With analytics, the organization will gain insights that can be used to improve their digital communications.
The strategic approach avoids many mistakes, unnecessary steps and the inefficient use of resources. Modern realities are rich in both challenges and opportunities for public organizations, which is why it is necessary to transform and adapt to new technologies and needs of society to offer better services and have a greater impact on creating quality change.
The following are the author's recommendations for public organizations for the effective implementation of digital solutions:
• Do not try to start implementing digital tools or technologies used by others without first determining what is necessary in the organization's case. The success of the implementation of digital transformation in a public organization requires a deep understanding of stakeholders;
• Introduce and deepen the digital competencies of representatives of public organizations. This requires a rethinking of functions, the training of employees, and perhaps it would even be useful to attract new people to help the rest of the organization to introduce a more digital mentality and gradually adapt the global organizational culture to this new environment;
• Start digitizing all possible processes immediately. However, keep in mind a holistic approach to digitization, including visions and priority steps, tools and techniques. This process can be facilitated through cooperation, exchange of knowledge and experience, pooling of funding and partnership with other NGOs, etc.;
• Effectively use social networks to promote their public organization and activities and the dissemination of key messages;
• Use digital tools to communicate with a wide audience, involving partners, potential partners, donors and volunteers.

Table 1. Tools for NGOs for working in an online environment
Source: compiled by the author

Tools for visualization	Tools for sites creation	Digital timing tools
● canva.com (pictures for social networks, presentations, reports, short animated videos, etc.); ● pictochart.com (creating infographics); ● easel.ly (from text to infographics); ● venngage (creating posters, billboards and infographics by dragging template elements); ● viewbix.com (a marketing tool that allows you to create interactive videos very quickly); ● vyond.com (to create videos with animated characters); ● slide.ly (to create slideshows); ● wistia.com (a convenient service for inserting video on various pages). ● TurboScan is a mobile application that allows users to scan/photograph documents and images and convert them to PDF.	• Drupal • WordPress • Joomla • Textpattern • Tilda • Google Sites • Wix.com	Timeline JS – a tool that allows users to quickly and easily create an interactive chronicle and add hyperlinks, maps, photos, data, quotes, tweets, etc. TimeToast – for creating interactive timelines and share them online. Navigating the site is very simple, the timeline can look like a sequence of event points where descriptions appear when the user hovers over a date, or as a list with a long description.

The tools of digital democracy provide an opportunity to bring the decision-making process closer to the population, increase its efficiency and transparency, create a digital culture of responsibility, implement cooperation between government and its community, and constantly search for new participatory forms and methods for sustainable community development.

There are many tools, methods and forms of involving citizens in the processes of formation and implementation of management decisions. However, it is worth paying attention to the situation in each locality, because sometimes the tools that work effectively at the national level may not work as effectively at the local level and vice versa (Gorokhova, 2019).

Consider the example of the Mariupol United Territorial Community (UTC). According to the Monitoring of the Implementation of e-Government Instruments in Local Self-Government Bodies (hereinafter – MHI) conducted by the NGO Podilsk Regional Development Agency together with the Association of Local Self-Government Bodies "Cities of e-Government in Ukraine," Mariupol Council took 1st place in "The degree of implementation of electronic participatory instruments in local governments."

This ranking examined three aspects of digital participation at the local level: the availability of public feedback tools on the city council's website, the level of implementation of electronic petitions, and the availability of information on the budgets of civic initiatives (Petrushenko, 2014).

As of December 1, 2019, Mariupol had 157 e-democracy tools (map of appeals, local e-petitions, budget of public initiatives, online chats, online polls, online appeals on the website of Mariupol City Council, https://mariupolrada.gov.ua/) – a sufficient number. However, among the existing tools there is a lack of those that monitor the implementation of electronic petitions and the degree of influence on local government decisions. There is no information on the website of the city council about changes in resolving the issues that became the subject of petitions, which received the required number of votes of city residents and were supported by the city council.

The tool of electronic petitions in Mariupol began operating in 2015. Here, users can submit or sign an existing petition on the e-petitions portal: https://edet.ip.ca/mippuizia. In order for the e-petition to be considered, it must receive 350 votes within 14 days.

Since 2015, city residents have been able to address e-petitions to the Mariupol City Council. If a petition does not receive the required number of votes, it is still considered, but as a collective appeal. For example, in 2015, city residents submitted 331 petitions, of which 66 received the required number of votes, and all others were considered collective appeals. As of December 2019, 1,385 petitions had been submitted, of which 175 petitions had received the required number of signatures for further consideration. A total of 176,911 votes (signatures) were cast for the petitions submitted to the Mariupol UTC.

The digital tool of petitions has been seen as a problem-solving mechanism since the beginning. It was found that the effectiveness of such a tool largely depends on the political will and resource capacity to implement the decision. Today, such a tool is an indicator of the problems and needs of residents, which should be taken into account by government officials.

On the other hand, residents often lack an understanding of the powers of certain institutions, so the incorrect addressing of issues can often discredit the instrument itself (especially at the national level). In Vinnytsia, most petitions concern 158 housing and communal issues.

Another participatory instrument operating in Mariupol is the participation budget. Online submission and voting for projects online takes place on a nationwide platform at: https://mariupol.pb.org.ua/.

The key problem of the public budget in Ukraine, as well as a number of other democratic instruments introduced in the state (consultations, public councils, etc.), is not in the formation of additional legislative initiatives (budgets, expenditures, instruments), but is related to the approach to key inquiries from society and public administration as to what results are desired within these instruments.

Usually, in the formation/functioning of the public budget, the emphasis is more on the use of budget funds, not on teaching people the responsibility for decision-making and participation in the formation of their own quality space.

However, there are real obstacles to the effective functioning of this tool:

- the low level of digital competencies and understanding of citizens on the role and objectives of the draft public budgets;
- the lack of a unified approach in the perception of both the organizer and the executor of the public budget both in the settlement and in Ukraine;
- the lack of ethical standards for the implementation of public budgets;
- the threat of politicians using public budgets as steps to implement their own strategies;
- a formal approach to evaluating the effectiveness, monitoring, control and support of public budget projects.

The example of the Mariupol UTC can be traced to how this instrument changed. The first pilot stage of the competition started in February 2016. Funding in the amount of 5 million UAH was provided for 159 projects under the Participation Budget. During the first pilot stage, 174 projects were submitted to the competition, the vast majority of which concerned the improvement of the city. According to the terms of the competition, the projects were divided into two categories: small (up to 200,000 UAH) and large (from 200,000 UAH to 1 million UAH) in the ratio of 50905 to 50905. In total, 80 projects were put to a citywide vote, 43 of which were small.

Voting took place from April 1 to 11, 2016, both in paper form and online on the website of the Mariupol City Council in the “Participation Budget” section by filling out a questionnaire through identification in the electronic office of the resident.

The second stage of the tender for the implementation of the “Participation Budget” tool took place in 2016. In fact, the tender budget for 2017 has already amounted to 6.5 million UAH with a ratio of 8,590 for large projects and 1,590 for small projects. From July 15 to September 5, 2016, users continued to submit projects for the City Day 2016, and voting took place from October 1 to 10, 2016.

The third stage took place during 2017. It is planned to spend 7 million UAH on the implementation of projects in 2018. The relationship between project funding remained the same. The submission of projects took place from April 1 to May 15, 2017. One author had the opportunity to submit one large and one small project, and voting took place from October 1 to 10, 2017.

The fourth stage of the competition was held in 2018. The budget for the implementation of the ratio between project financing in 2019 remained the same. One innovation was the ability to submit a project and vote through the all-Ukrainian platform "Participation Budget." Developments were submitted from April 1 to May 15, 2018. In addition, seminars on project writing and the Project Fair were held, where authors presented 160 of their own works. A total of 76 projects were submitted, 2 of which were removed at the request of the authors, and 41 projects were put to a vote. Voting took place from October 1 to 15, 2018. The innovation was that each resident of the city was given the opportunity to vote for 4 projects – two large and two small.

The fifth stage of the competition took place during 2019 – the submission of projects took place from April 1 to May 15, 2019, and their evaluation took place from May 16 to August 1, 2019. As part of the information campaign of the competition, 3 authors and potential authors of projects met and held a Project Fair. Here, they presented their works and presented ideas for citizens and executive bodies to adjust the components of the project to allow more developments to vote and real opportunities for their implementation in the territory of Vinnytsia city OTG. In 2019, 36 projects were admitted to voting with the opportunity to vote for 4 projects – two large and two small. Thus, the residents of Vinnytsia cast 32,262 votes for the draft Budget of Public Initiatives, of which 20,510 were cast via paper voting (6,490), and 11,752 via electronic voting (369).

During the entire period of the instrument's operation, 485 participation budget projects were submitted, of which 62 were winning projects and 124,090 votes were cast for them. In general, it should be noted that the Participation Budget tool is amended each year, according to new proposals and the needs of residents and the public, to make the participation process more effective for all stakeholders. In addition to electronic petitions, on the website of the Vinnytsia City UTC there is the opportunity to submit an address to the representatives of the city council in order to obtain a prompt solution to issues.

Thus, as of the beginning of 2020, almost 17,000 appeals had been officially registered. According to focus group discussions held in November 2018 by representatives of the NGO Podilsk Regional Development Agency within the development of the Concept of digital participation of the Mariupol UTC 2019–2025, one of the tools that would be easy to use was termed the "Map of appeals," on which it would be possible to leave appeals or problematic questions using CP5 coordinates. This map of citizens' appeals, which is located on the geoportal of Mariupol (available at https://kkc-mariupol.bissoft.org/contactcenter/map) allows users to leave appeals regarding problems or emergencies. Despite the fact that from 2016 to 2021 residents left more than 156,662 appeals, this tool needs additional promotion.

In order to make digital tools inclusive and available for use by different target audiences, the city has introduced an online chat function for direct communication with representatives of the Mariupol City Council. In fact, the idea of forming this chat was primarily to supplement the existing tool of the round-the-clock availability (24/7 telephone consultations on city issues) for people with hearing and speech impairments. However, the chat has become very popular and in 2019 there were almost 3,500 consultations. The issue of effective communication and receiving targeted messages from local governments with the ability to provide a response or suggestion was the idea behind the creation a mobile application: "Accessible Mariupol."

The “Accessible Mariupol” application allows residents to use a variety of information and services. It can be downloaded on Android and iOS. The development of the application was made possible by the Department of Social Protection and the US Agency for International Development under the USAID Democratic Governance in Eastern Ukraine project.
Here, anyone can learn about the work of public transport, choose a club for their child, pay for utilities, register for kindergarten, receive free legal aid or psychological advice online, leave a review about a school or kindergarten, find the nearest pharmacy with a ramp, read the news about the activities of city services and look for vacancies.
In July 2021, a pilot version of the application was launched together with the Mariupol City Council. Today, the tool can be downloaded for the Android and IOS operating system. In order to make the tool more user-friendly, in demand, and easier to use, city council representatives jointly updated the service through integration with messengers, chatbot development and the planned possibility of integration with a number of other services.
The issue of public consultation is still one of the most important issues at both the national and local levels. A survey is conducted by the authorities on the website of the Mariupol City Council on various issues directly related to the life of the settlement.
In addition, the Mariupol UTC became one of the pilot settlements that began to use the platform of digital democracy. One of the tools offered on the established platform of digital democracy is the possibility of interactive consultations, but at the moment this is sporadic and not systemic. According to the above information, it is obvious that Mariupol has a significant number of working tools of digital democracy, but not all services are sufficiently popular among citizens. Hence, the following problems of digital participation in the city of Mariupol can be observed:
- the low level of demand for products and the e-participation system due to the low awareness of residents and integrated services;
- the insufficient level of legitimacy of decision-making processes, transparency and efficiency;
- the low level of systematic attempts to effectively implement e-participation tools, and a number of others.
Because of these factors, the idea of a smart city with smart citizens became the basis for the formation of the Mariupol Strategy – 2030, where residents will use 163 digital tools to shape the design of their future in the city.
Analyzing the functioning of digital democracy tools in Mariupol according to the proposed model, it should be noted that each tool has a back office, the product itself, as well as a front office – i.e., a person or group of people responsible for the product (Figure 1).

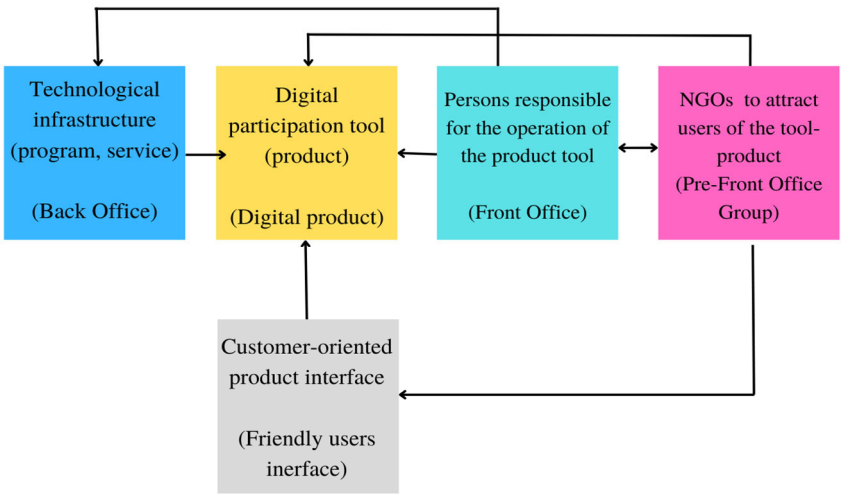


Figure 1. Digital participation ecosystem model
Source: compiled by the author based on Ridde et al. (2020); Stancu et al. (2017)

Thus, due to the changing demands and needs of residents, the evolution of technology is taking place, and the implementation process takes into account the two components of the following model, which were not used in other cities and regions together.

The first is the user-friendly interface. At the same time, in addition to accessibility and clarity, personal data security will be taken into account.

If this aspect is more technological, the other, which is not sufficient for the effectiveness of the tools themselves, depends on the available resources and methods available for use.

Second is the front-office group – a group of people who will stimulate the involvement of citizens in decision-making processes and, consequently, in the use of digital democracy tools. This is a component that is proposed to be added so that the government can receive feedback from citizens. In addition, this component involves ongoing activities (various animation processes) that would teach residents to co-create policies, solutions and specific products to make the community better. In this case, this will be a high-quality functional system that has requests from society, that is ready to change and, most importantly, that will bring effective change.

Paying attention to the functioning tools, it should be noted that digital democracy is not only a tool for controlling power, but also a tool for reducing the distance between power and the citizen. At the moment, thanks to digital technology, citizens do not need to be physically present at government sessions to understand how voting takes place and what issues are raised. The tools of digital democracy should encourage participation in decision-making and become tools of analysis for the changes that society expects. Digital democracy aims to move from an anonymous or unidentified consumer to a responsible conscious user who knows of existing problems and is ready to join in solving them. Digital democracy encourages the use of information technology, but focuses on the transition from citizens who criticize the government on social media to those who want to change something, who become smart citizens, who are willing to invest time, resources and energy and who affect the environment and decision-making in it.

However, this is possible only when a high-quality ecosystem of digital participation with the involvement of citizens has been formed. It should be understood that the modernization of instruments must go hand-in-hand with the government's willingness to be open to the development of public consultation. In addition, there is a demand for the creation of comfortable products to improve living standards, as well as services that need to be modified. This may include quality control of condominiums and road services and other services that improve living standards.

Another example is air quality sensors, which are currently in demand, because these are tools that will lead to some changes in environmental quality. In addition, for digital participation tools to work effectively, there must be constant communication with other actors in the digital economy. In fact, this means giving back data and encouraging the intensification of the open data process, including the preservation of human rights, Internet security and many others. It is the digital economy that can provide the resources for this and use the tools of digital democracy in partnership. After all, a person, first of all, should be perceived not as a user of a smartphone, but as a user of the environment and a subject of socio-political relations. The main approach should be to focus on a person who is ready to learn and to join the existing processes of digital transformation.

In order to effectively involve residents in decision-making processes, the following model of balance of levers of intercommunicative influence of the subjects of digital participation is proposed (Figure 2).

This scheme demonstrates that in the interaction of public authorities or local self-government the method of this interaction is important, i.e., the instrument of digital participation, as well as constant communication that promotes balance in these relations.

Digital tools of participation are the optimal mechanisms for ensuring effective inter-subject communication to solve the problems of citizens and optimize the needs of public authorities (balance of levers). Citizens' use of digital tools of participation as levers of influence on the authorities will depend on how simple and accessible they are. The more optimal these levers are, i.e., the less functionality is embedded in the concept of tool management and the more effort citizens will need to spend on its use, the less effective the digital participation tool will be and the fewer problems it will solve.

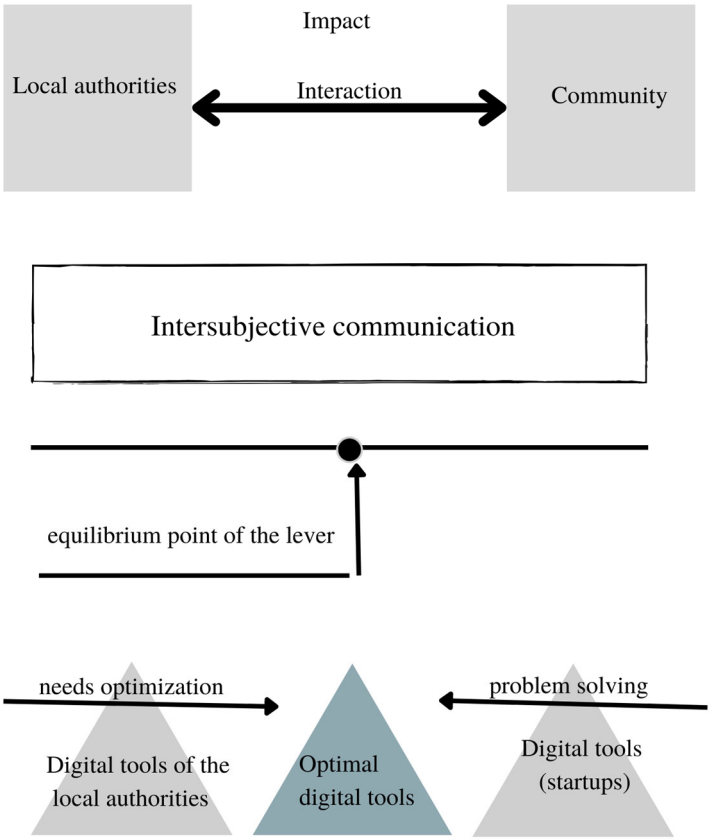


Figure. 2 Model of balance of levers of intercommunicative influence of subjects of digital participation
Source: compiled by the author based on Stancu et al. (2017); Chappelet & Kilchenmann (2005)

Digital tools of participation in this case become opportunities to reduce the path and time interval to resolve citizens' issues. If this lever is not effective, accordingly, citizens will not use it. The use of digital tools of participation to ensure the process of effective interaction between citizens and the authorities is intended to create a situation where both citizens and the authorities are on the same plane. Otherwise, this will not provide proper involvement of residents and joint decision-making.

A number of practical recommendations for public authorities on mechanisms of interaction through digital participatory instruments are proposed, which would be effective levers for interaction between citizens and public authorities both at the stage of formation and development of digital participatory instruments and at the stage of their implementation:

1. Identifying the analysis of citizens' problems through sociological research, focus group surveys, online surveys and other methods.
2. Carrying out joint activities on the capabilities and functioning of digital participation tools.
3. Preparing the design of a digital participation tool for the specific requests of citizens, in particular on the procedure, implementation process and specific social groups targeted by the specific tool (in particular, for people with disabilities, youth, organizations that contribute to community decision-making).

4. Developing digital services and their architecture.
5. Integrating related participatory tools for interaction with other components of digital governance.
6. Evaluating the effectiveness of service activities of public authorities in the process of using digital tools of participation.
At the stage of the formation and development of digital participatory instruments, the central executive bodies are recommended to:
1. Involve a wide range of stakeholders to develop the design.
2. Ensure coherence in the functioning and cost of managing the digital instrument by local governments before its implementation.
3. Ensure the presence of a front office and the principle of product universality as a basis for its development.
At the stage of implementation (realization) of digital participatory instruments in public authorities and local governments, it is recommended to:
1. Carry out testing, adjustment and its adaptation in accordance with the needs of citizens and together with them.
2. Promote the tool for individual target groups and for the entire target audience.
3. Create and disseminate information on successful cases and practices of digital participation tools.
4. Promote the standardization of digital democracy instruments, in particular in legal documents (strategies, programs, regulations, etc.) of public authorities and local governments.
5. Develop a plan for the life cycle of the digital tool, in particular with: the implementation of animation processes (creation of events and the inclusion of these events in the process of using the tool); the formation of sustainable information drives (creation of working groups to improve the tool, adapt to local conditions, etc.); the training of both representatives of local self-government bodies and members of territorial communities on the use of digital participation tools and dissemination of new experience in their modernization; the organization of working meetings on the development of new participatory services, the expansion of functions, and the improvement of the tool interface; the creation of local groups of activities that will work together on the support, networking and activation of this tool; and linking these groups to target audiences.
6. Create conditions for the integration of the digital instrument of participation in national, regional and local systems of digital democracy in accordance with common standards and approaches.
7. Replicate, launch and implement digital participatory tools in other areas in line with the effectiveness of pilot projects.
In addition, an extremely important element of effective involvement of citizens in the use of digital tools of participation is constant information support – namely, the activities of positioning and support of the product with the blogosphere and media. Also, a very important aspect is the combination of activities in the digital world and physical events (competitions, hackathons, various activities to stimulate attention to the problems and needs of residents, including the use of digital technologies).

Conclusions

This research has identified the peculiarities of normative and legal support of development in the field of digital participation in Ukraine as one of 13 important aspects of state formation. It should be noted that digital tools can contribute to the involvement of more people at the local, regional and national levels in decision-making processes.

The research has systematized a number of pilot local and regional concepts in the field of digital democracy, and a general idea of the legal framework for the development of digital democracy in Ukraine has been provided.
It is substantiated that the legal framework in the field of digital participation needs to be improved. Existing documents have laid the foundation for the development of digital processes involving citizens in the development and implementation of strategic and operational decisions at various levels. However, it is necessary to create an ecosystem of digital participation for territorial communities, based on the national concept and pilot regional and local concepts with the use of additional recommendations according to the needs of a particular locality.
The analysis of foreign experience revealed a global trend in the formation of digital participation processes, namely: in most EU countries and the US, integrated platforms for the simultaneous combination of different online and offline activities are being created that encourage more citizens without using additional resources. It is noted that the phenomenon of digital participation is associated with the actualization of citizens' participation on their initiative in the formation and implementation of public policy, public administration and local government, which provides interactive interaction of management decision-makers with digital technologies in cyberspace according to established rules and digital hygiene standards.
It is justified that regional or municipal (local) Concepts of Digital Democracy should become legal acts that will define clear mechanisms of digital participation. To this end, principles have been defined and recommendations for their development have been proposed: first, the principle of having expert groups that will monitor trends in the development of digital transformations; second is a security principle for the development of digital democracy, which must be used to ensure the protection of personal data by authorities; third is the principle of transformation, according to which e-democracy is transformed into digital democracy; finally, fourth is the principle of manufacturability, which is the formation of integrated digital platforms with a single point of access to content and a variety of services and tools for digital participation, which will save time.

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