

DOING BUSINESS DIGITALLY

TEXTBOOK

**Edited by
Pierpaolo Magliocca**

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Editor:

Pierpaolo Magliocca (*University of Foggia, Italy*)

Authors:

Antonio Botti (*University of Salerno, Italy*)
Sebastián Bruque Cámara (*University of Jaen, Spain*)
Rossella Canestrino (*Parthenope University of Naples, Italy*)
Rosita Capurro (*Parthenope University of Naples, Italy*)
Ricky Celenta (*University of Salerno, Italy*)
Alessandro Cirillo (*University of Naples "Federico II", Italy*)
Antonio Corvino (*University of Foggia, Italy*)
Chiara Crudele (*University of Salerno, Italy*)
Marek Ćwiklicki (*Cracow University of Economics, Poland*)
Rosangela Feola (*University of Salerno, Italy*)
José Moyano Fuentes (*University of Jaen, Spain*)
Raffaele Fiorentino (*Parthenope University of Naples, Italy*)
Stefano Garzella (*Parthenope University of Naples, Italy*)
David M. Herold (*Vienna University of Economics and Business, Austria*)
Marika Intenza (*University of Foggia, Italy*)
Jacek Klich (*Cracow University of Economics, Poland*)
Kateryna Kraus (*Borys Grinchenko Kyiv University, Ukraine*)
Nataliia Kraus (*Borys Grinchenko Kyiv University, Ukraine*)
Norbert Laurisz (*Cracow University of Economics, Poland*)
Daniele Leone (*Parthenope University of Naples, Italy*)
Pierpaolo Magliocca (*University of Foggia, Italy*)
Juan Manuel Maqueira Marín (*University of Jaen, Spain*)
Jasmin Mikl (*Vienna University of Economics and Business, Austria*)
Anna Mirzyńska (*Cracow University of Economics, Poland*)
Antonella Monda (*University of Salerno, Italy*)
Pedro Antonio Nuñez Cacho Utrilla (*University of Jaen, Spain*)
Agnieszka Pacut (*Cracow University of Economics, Poland*)
Roberto Parente (*University of Salerno, Italy*)
Kamila Pilch (*Cracow University of Economics, Poland*)
Melania Riefolo (*University of Foggia, Italy*)
Francesco Schiavone (*Parthenope University of Naples, Italy*)
Olena Shtepa (*Borys Grinchenko Kyiv University, Ukraine*)
Manuel Valverde (*University of Jaen – Linares School of Engineering, Spain*)
Massimiliano Vesci (*University of Salerno, Italy*)
Michał Żabiński (*Cracow University of Economics, Poland*)

Reviewer:

Krzysztof Wach (*Cracow University of Economics, Poland*)

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6. DIGITAL INFRASTRUCTURE

Learning objectives

After reading this chapter, you will be able to:

- Understand the difference between “hard” and “soft” digital infrastructure
- Identify the impact of Internet of Things on the quality of digital infrastructure
- Investigate digital infrastructure of tourism, medicine, environment and ecology
- Find out technologies, products and services of digital infrastructure
- Analyze the latest Blockchain technology
- Identify socio-economic benefits and threats from digital infrastructure
- Create a smart infrastructure of the city

6.1. Digital infrastructure: essence, types

“The best way to predict future is to create it”
(Abraham Lincoln)

The formation of a high-quality digital infrastructure is the key to the success of the effective functioning of digital entrepreneurship in the innovative conditions of economic management and global challenges. Digital transformation of business lays the foundation for development of digital ecosystem of entrepreneurship through the prism of virtual mobility, which has intensified in the 1920's. The logic of structuring this section is aimed at clarifying the features of the application in digitalization of business components of “hard” and “soft” digital infrastructures. After all, they are aimed at accelerating the development and implementation of new digitized business processes and business conditions in the development of Industry 4.0 and laying the foundations for the formation of socio-economic, innovative, institutional, environmentally oriented foundations of Industry 5.0 to ensure a new quality of life 5.0. The synergetic potential of social, mobile, cloud technologies, data analysis technologies, Internet of Things individually and in combination can lead to transformational changes in doing business in digital age and make digital business efficient, reactive, valuable.

“Hard” and “soft” digital infrastructure

Technological changes that are characteristic of XXI century in terms of “merging” of telecommunications, ICT and innovations, led to the introduction into scientific circulation of the concepts of “digital technology”, “digital infrastructure”, “digital business ecosystem”, “digital entrepreneurship”, “digital economy”. The latter is a type of economy characterized by the active introduction and use digital storage technologies, processing and transmission of information in all spheres of human activity.

“Digital vortex” (Aizekson, 2017) created by digital technologies opens up unique opportunities for the development of all national economies and the improvement of people's quality of life. The rapid and profound consequences of the transition to “digital” will be possible only when digital transformation becomes the basis of society, business and government agencies, will be commonplace and every day, intertwined with our genetic code, will be “a key agenda on the path to prosperity and foundation welfare” (*Digital Agenda of Ukraine – 2020, 2020^b*) and the formation of Society 5.0.

Infrastructure has always been particularly important for poverty reduction: access to minimum infrastructure services is one of the important criteria for determining the well-being of the population. There is a large proportion of the world's population living below the poverty line, without access to clean water and living in unsanitary conditions, with extremely limited levels of mobility and communications (Manzhura et al., 2020).

People with such living conditions have more problems with health, education (lack thereof) and fewer employment opportunities. Such settlements are located mainly outside the cities in developing countries and the least developed countries, do not have sufficient and proper infrastructure (Marchenko et al., 2021^b).

For these reasons, digital technologies of the Fourth Industrial Revolution and Internet are becoming the foundation of society and a universal synonym for digital infrastructure. Although Internet is one of the most important advances worldwide, digital infrastructure is a more complex concept because it also includes cellular infrastructure and satellite networks. Combined with other digital technologies, such as personal computers and smartphones, these innovations have changed the daily life of society and the way of doing business around the world (Chmeryk & Kralich, 2018; Shtepa et al., 2021a).

Digital infrastructures are complexes of technologies, products and processes that provide computing, telecommunications and network capabilities of electronic interaction, data exchange, signals, etc. and work on a digital (rather than analog) basis (Kliushnyk et al., 2019). Today, there are two types of digital infrastructures, namely: basic ("hard") and service ("soft") (Figure 6.1, Figure 6.2).

Digital infrastructure is a system of digitized equipment and technologies, electronic communications, digital services, which provides innovative and digital activities in society. Digital technologies are changing the nature of economic relations, forms of relations between different institutions, areas of digital enterprises. Thanks to modern digital technologies, new opportunities for relationships in the business environment.

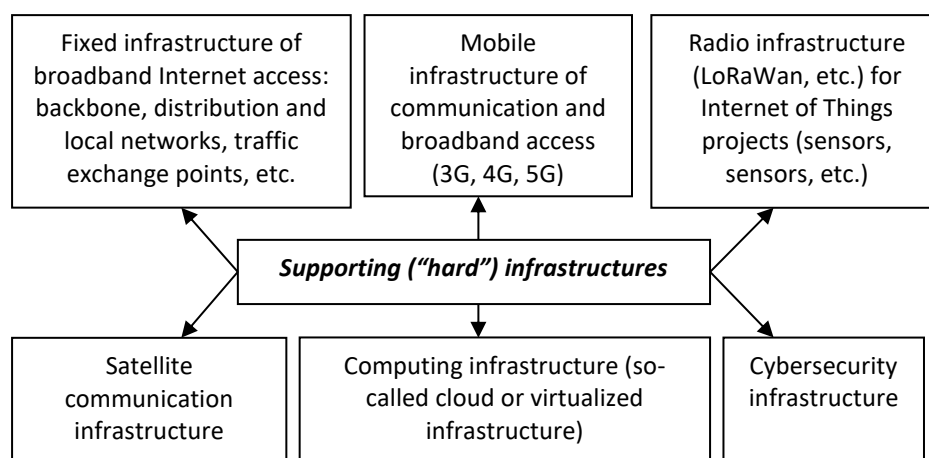


Figure 6.1. Base ("hard") digital infrastructure

Digital infrastructure of Industry 4.0 is primarily an infrastructure access to the latest generation backbone and mobile networks, along with a service infrastructure. Digital infrastructure is a platform for the development of all spheres of society in the country (*Digital Agenda of Ukraine – 2020, 2020b; Menard, 2017*).

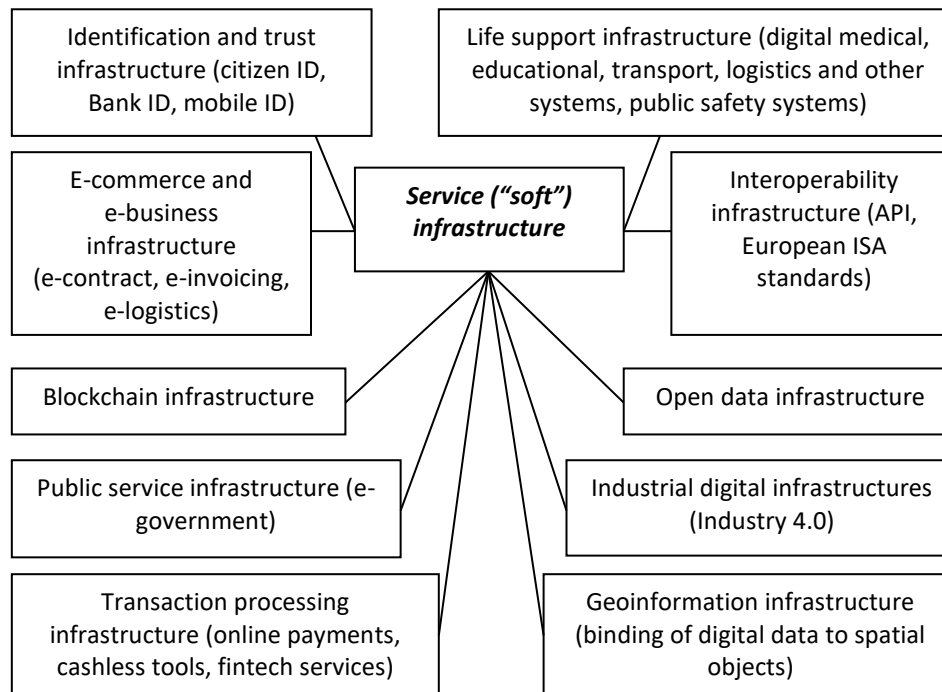


Figure 6.2. Supporting ("soft") digital infrastructure

The "hard" and "soft" digital infrastructure of Industry 4.0 together are special industrial areas with prepared engineering and transport infrastructure, Universities 5.0, a set of necessary services, simplified regulatory procedures and a package of investment incentives, institutional rules and regulations for production, scientific-research and digital enterprises (*Digital Agenda of Ukraine – 2020, 2020b; Manzhura et al., 2020d*).

Not surprisingly, one of the main directions of the previous EU Framework Program "Horizon – 2020" was the development of European research infrastructure (including e-infrastructure) until 2020, which will further promote innovation potential and complement the EU's international cooperation policy. European approach to research infrastructure has made significant progress following the effective work of European Strategic Forum on Scientific Infrastructure (ESFSI) and its "roadmap" for the integration and opening of national research institutions and the development of electronic infrastructure underlying digital infrastructure of European Research Area. The purpose of digital infrastructure is to support partnerships between relevant policy and funding institutions, cartography and monitoring for decision-making, as well as activities in the field of international cooperation in the field of innovation.

With a high-quality digital infrastructure, high-quality fixed and mobile Internet, computing and virtualization, Internet of Things backbones, e-business interaction, e-payments, e-government, interoperability are possible (system units can exchange information with each other. However, aspects related to processes, similarly, distributed systems allow access to information and data of one system by other systems in the network), open data, cybersecurity, blockchain, identification and trust, etc. Information security, cybersecurity, protection of personal data, privacy and rights of users of digital technologies, strengthening and protection of trust in cyberspace are, in particular, prerequisites for simultaneous digital development and appropriate prevention, elimination and management of associated risks (Table 6.1).

Table 6.1. Comparison of components of "hard" and "soft" infrastructures

"Hard" digital infrastructure	"Soft" digital infrastructure
-------------------------------	-------------------------------

1. Fixed telecommunication infrastructure (trunk, distribution and local networks, traffic exchange points, etc.) 2. Mobile telecommunication infrastructure (3G, 4G, radio and satellite technologies, wi-fi) 3. Digital television infrastructure (terrestrial, cable, satellite) 4. LoRa radio infrastructure (long range frequency, unlicensed frequencies) for Internet of Things projects (sensors, sensors, etc.) 5. Computing infrastructure – data processing and storage centers (so-called cloud or virtualized infrastructure) 6. Cyber-security infrastructure 7. Specialized infrastructures (special networks, video surveillance, related engineering systems)	1. Interoperability infrastructure (API, European ISA standards) 2. Geographic information infrastructure (binding of digital data to spatial objects) 3. E-commerce infrastructure (b2b digital buying and selling platforms, e-contract, e-invoicing, e-supply chain) 4. Transaction processing infrastructure (online payments, cashless tools, fintech services) 5. Infrastructure of identification and trust (trust services, citizen ID, BankID, mobileID) 6. Open data infrastructure 7. Public service infrastructure (e-government). 8. Life support infrastructure (digital medical, educational, transport, logistics and other services, public safety services) 9. Industrial digital infrastructure (Industry 4.0, cyber systems)
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Source: compiled by authors based on source (Kraus & Kraus, 2018; Smart Sustainable Cities at a Glance, 2021).

For an efficient and well-functioning digital infrastructure, it is important to create a digital institutional environment of the economy. This environment should be in the form of standards, laws, norms and rules, one of which is the decision that digital forms of formal interaction should be the first and analog the second. This applies to the state level, as well as at the levels of interaction between states and business, citizens and business, suppliers and customers of goods and services (Kryvoruchko et. al., 2017; Nikiforov, 2021).

Criteria for the level of development of digital infrastructure and digital business ecosystem are:

- Level of development of national scientific and technical potential;
- Educational level of the country's population and their digital competencies;
- The level of digital development in the country of technopolises, technology parks, technology transfer centers;
- The level of development of small innovation and digital business incubators in the country;
- Level of development of venture financing system;
- The degree of involvement of the subjects of national digital infrastructure in the international exchange of scientific and technical achievements;
- Level of ICT development;
- The level of digital development of the country's financial system (Boldyrieva et. al., 2019; Manzhura et. al., 2019).

The impact of the IoT on the quality of digital infrastructure

It should be noted that advanced technologies such as broadband, data centers, cloud services, big data and IoT – are key factors that will contribute to the next wave of economic benefits from investment in information and communication and digital technologies (Kraus, 2020; Osetskyi et. al., 2019).

Today, the so-called cloud market is in the process of forming demand. The demand for cloud technologies is growing, the initial experience of cloud solutions is gradually accumulating. This fact is reflected in the main level of awareness of the end user about cloud computing. The development of the cloud market as a component of digital infrastructure is directly dependent on the level of use of cloud solutions by IT companies, as well as their intensive study of these technologies. Therefore, the positive experience of end users will ensure the rapid penetration of cloud technologies into the consumer market.

Internet of Things (IoT) is technology (Table 7.2) that supports a network of computer devices with Internet (Burch, 2019; Osetskyi et. al., 2020^a).

Table 6.2. Positive and negative consequences of the impact of IoT technology as a structural element of digital infrastructure

Positive effects of IoT technology as a structural element of digital infrastructure	Negative consequences of the impact of IoT technology as a structural element of digital infrastructure
<ol style="list-style-type: none"> 1. Reducing the cost of providing services 2. Greater transparency and resource efficiency 3. Productivity growth in the industrial sector 4. The emergence of additional knowledge, as well as values based on connected "smart" things reducing the cost of providing services 	<ol style="list-style-type: none"> 1. Loss of jobs by low-skilled workers 2. Violation of confidentiality 3. Loss of control 4. Malicious intrusion (hacking) and security threat

Source: (grouped by authors based on sources (Marchenko et al., 2021b; Markevych, 2021; Prianikov & Chuhunov, 2017).

At the heart of each device in the IoT system are sensors that collect and transmit data to the "cloud" for further analysis, processing and making "smart" decisions. The gradual introduction of high-speed Internet provides a strong connection between millions of devices and sensors, allowing IoT to work efficiently. According to the forecasts of the London market analysis company IHS, the number of IoT devices will increase from 15.4 billion in 2016 to 75.4 billion in 2025 (Chmeryk & Kralich, 2018). In 2020, this technology was expected to spend \$ 749 billion, and the forecast of global spending in 2023 is \$ 1.1 trillion. Studies of the state of broadband access at social facilities show that, for example, less than 1% of total number of health care facilities in Ukraine are connected to broadband Internet. Thus, the gap between available and universal access for hospitals is 99%. In other words, in fact, citizens of Ukraine do not have the opportunity to meet their own needs in telecommunications health care services. This leads to unequal access to quality medicine, although Article 49 of the Constitution of Ukraine obliges the state to create conditions for effective and accessible medical care for all citizens. A study of the state of broadband access in secondary schools shows that only about 47% of them have sufficient channel capacity to transport traffic within the educational process using digital content, and 53% (10 067) of schools are not connected to broadband networks at all (*Digital Agenda of Ukraine – 2020*, 2020b).

Strategy "Europe 2020" envisages the implementation of "Digital Agenda for the Development of Digital Technologies in Europe". The aim of this plan is to achieve a sustainable economy and social benefits by creating a common EU digital market based on broadband access. According to EU Directive IP/10/581 Brussels (19 May 2010), "Digital Agenda for Europe" aims to ensure that by 2020 100% of EU citizens have broadband access at 30 Mbps and 50% of European households up to 100 Mbps. Thus, the countries of Europe and the world have gradually raised the issue of the importance of broadband access to ensure the legal rights of their citizens through their own "Digital Agendas" (*The Digital Single Market designates the 2014-2019 strategy*, 2013). Implementing strategy "Digital Single Market", the European Commission adopted a number of initiatives and legislative proposals on 14 September 2016 (Tapscott & Tapscott, 2016). Thus, it is expected that these and other measures should ensure the competent participation of citizens in the formation of a modern digital society.

6.2. Digital infrastructure in various fields

6.2.1. Digital tourist infrastructure

The sphere of tourism in digital infrastructure has undergone transformational changes. This is due to the fact that the infrastructure of the tourism sector is in constant contact with telecommunications networks and non-cash payment instruments. In addition, the model of Smart Tourist Destination at the regional and local levels is a new model of territorial development, management and marketing of tourist destinations in order to fully meet the needs of modern tourists.

Digital tourism infrastructure is designed to provide:

- Operation of websites of tourist destinations with content localized for the needs of tourists;

- Collection and analysis of statistics in real time using the technology of the Internet of Things, large and open data;
- Creation of virtual tours, 3D-modeling, arrangement of tourist objects with webcams, introduction of QR-codes, RFID-tags, non-cash payment systems;
- Introduction of loyalty programs and electronic tourist cards; creation of tourist mobile applications (with route maps, audio guides, geolocation);
- Electronic tickets at tourist facilities and leisure facilities;
- Digitization of museums (electronic multilingual catalogues, virtual and augmented realities, audio guides and electronic guides) (Andrusiak et. al., 2020).

6.2.2. Digital infrastructure for environmental protection and ecology

Digitized environmental infrastructure is designed to create such national analytical systems that would be easily and instantly integrated into the European online Shared Ecology Infrastructure System. It's worth to analyze short-term and long-term trends in biodiversity change, environmental pollution, weather conditions and ecosystem development. Digitized work of business working with ecological products and services allows to carry out high-quality plan measures to prevent harmful changes; stimulating the creation by the public and business of digital mobile applications of environmental "patrolling" of natural resources with the possibility of notifying law enforcement agencies of illegal activities (pollution, poaching, tree felling, illegal landfills).

In the course of business implementation in digital age, ecological expertise is based on the use of information (any data) about the state of the environment and knowledge about the processes that take place in it. Information recorded in a certain form of storage and transmission suitable for further processing is called data, and an organized array of data stored in a computer system is called a database. The set of databases and special methods and tools (software, organizational, etc.) that allow a digital enterprise to work with information about the state of the environment to a wide range of users is called a digitized information system. Computers have made it possible to process virtually any type of environmental information, and the term "information" has often been used as a synonym for the term "data", which is often used to denote primary digital information about the state of the environment.

The methodology and degree of filling of large blocks of ecological information determine the peculiarity and specificity of the information base and the effectiveness of all systems of digitized environmental management. Currently, only a digital information space is being formed, which is focused on environmental issues. Digital business information systems, which are used in all spheres of public activity, are currently in third stage of their development.

First generation systems (Data Processing Systems) were based on the application of a "task approach" (to solve each problem in the system separately formed data and created an appropriate algorithmic model). Second generation systems (Management Information Systems), focused on operational data processing, which is characterized by a structured flow of information, integration of data processing tasks. These systems have a positive feature for digitized business in the field of ecology – collective access to data, i.e., the creation of a single database with centralized management. Main disadvantage of systems with such a structure is the presence of an excessive database with a description of the data itself.

The structure of third generation information system (Decision Support Systems) focuses on joint data analysis and algorithmic models of decision making for the purpose of effective functioning of digital infrastructure of environmental protection and ecology. They have not only a common information support – a database, but also a common algorithmic software – a database of models. It is the third-generation information system in its capabilities and capacity to meet the class of tasks facing environmental management systems in Industry 4.0. Today the modernization and development of specialized accounting of the ecological direction has practical value for systems of ecological management of digital business. No less important is digitized state natural cadastres, digital environmental monitoring system, digital environmental mapping, environmental economic balances, geographic information systems, digital

environmental certification. Specialized digital information systems are also being developed: protected areas, depressed areas, potentially dangerous objects, basin information systems, etc. Operating within regions (sometimes at the interregional and interstate levels), these digital systems require proper structural and organizational design. The issue of their interaction with regional digital information systems that need to be created needs to be resolved first. In general, the solution of the problem of formation of regional and international digital information systems requires the application of a systematic approach to a set of methodological, organizational, legal and other issues in the field of environmental management information systems.

6.2.3. Digital medical infrastructure

An important element in the development of digital infrastructure medicine is the introduction of telesystems to provide remote medical services to citizens and support the work of doctors, especially in rural areas. Medicine in the XXI century transformed: periodic diagnostics becomes online diagnostics, Internet of Things allows sensors to constantly monitor human health, operators of medical and related services and infrastructure become participants in digital platforms – all this affects the quality, efficiency and functionality of health care and support citizens.

It is expected that digital medicine should provide interaction between patients, healthcare professionals and institutions through information and communication and digital technologies. The transition of medical records to electronic format is one of main tasks of digital infrastructure of medicine. In our understanding, digital medical platform is a dynamic set of systematized electronic data on the state of health of an individual patient, which provides information exchange between participants in the process of production and consumption of medical services (Marchenko et. al., 2020a).

Digitalization in the field of medicine is realized with the help ePrescription (electronic prescription), that is based on 3 procedures:

- eCapture – formation of an electronic prescription by a doctor of a medical institution;
- eTransfer – confidential transfer of an electronic prescription to a pharmacy;
- eDispensation – data transfer from the pharmacy back to the medical institution, confirmation.

The experience of *eHealth* in medical field is interesting. It is characterized by the following semantic features of the application in the course of work, namely:

- introduction of *Blockchain* technology in the formation of a personal single electronic medical card;
- equipping the eHealth system with rating tools from licensed healthcare facilities, doctors and pharmacies;
- patient register (does not contain medical information);
- register of health care institutions of any form of ownership (including private offices, private individuals, LLCs, etc.), providing health care at the primary level of the health care system;
- register of medical workers who provide primary health care (primarily doctors);
- a register of contracts and agreements between health care facilities and the National Health Service, between the primary care physician and the patient; register of medicines; register of prescriptions for medicines reimbursed by the state.

6.3. Digital infrastructure technologies

6.3.1. Technologies, products and services of digital infrastructure

Digital technologies, products and services that launch “soft” and “hard” digital infrastructure (they are presented in Table 7.1) (Kraus, 2017; Manzhura et. al., 2020^a), give it signs of virtual reality and which are currently considered innovative trends in the modern

socio-economic environment are presented in Table 6.3 and Table 6.4. For example, *WealthTech* – technology for managing personal finances and well-being of a business entity, an individual; *Biometrics* – the technology involves digitally capturing and storing the unique characteristics of individuals, such as customers (e.g., fingerprints, retina, voice, facial features) primarily to enhance the security (and convenience) of financial transactions.

Table 6.3. Digital infrastructure technologies as innovative trends of the modern socio-economic environment

Technology	General characteristics
BioTech	From the Greek “bios” – “life”, “techne” – “art, skill”) – the use of living organisms and biological processes in production, agriculture and medicine with the use of high technology. Biotechnological processes using microorganisms and enzymes at the current technical level are widely used in the food industry.
RetailTech	From English “retail” and “tech” – “technology”. RetailTech is a technology developed by startups for use in trade. These technologies include: 3D body scanning, consumer tracking by AI-enabled assistants to help retailers and consumers. (AI (Adobe Illustrator) – file format developed by Adobe Systems for storing vector images. Adobe Illustrator uses extensions to store AI files .ai. AI support almost all programs related to vector graphics. This format is the best intermediary for transferring images from one program to another. In general, inferior to CorelDRAW in illustrative capabilities (can contain only one page in one file, has a small workspace – this parameter is very important for outdoor advertising – only 3x3 meters), however, it has the greatest stability and compatibility with PostScript, which is the focus of almost all publishing and printing applications).
FinTech	Technological projects in the field of financial services, which are considered one of the most promising (and therefore in demand) areas for startups, despite the complexity of government regulation, which have to face when working in this area. There are two main types of products based on FinTech. The first, presented on the market for a long time, provides software and financial services, i.e. uses B2B model. The second, which has been actively developing recently, is focused on the end consumer, i.e. covers B2C market, and seeks to fulfill an extremely ambitious task – to compete with traditional financial service providers in the fight for a mass customer.
LegalTech	Digital technologies in the legal field of business, specializing in information technology services for professional legal activities, and since the late 2000’s – in the provision of legal services to consumers using information technology. In the latter case, there may be on-line mediation between the client and the law firm or the provision of tools for legal self-service, which eliminates the need to turn to professional lawyers. In addition, we can talk about legal tech movement, which aims to revise traditional views on legal issues through the introduction of modern information technology in the field of legal services.
InsurTech	InsurTech (the field of the latest insurance technologies) is given a large place in financial and technological arena. Insurtech is the implementation of innovative solutions designed to maximize the efficiency of new technologies in the insurance market. Insurtech – it is the connection and interpenetration of the traditional concept of insurance with the latest technologies by analogy with the concept of Fintech. InsurTech provides an opportunity to change “rules of the game” for insurers, allowing you to innovate, increase the relevance of proposals and grow. InsurTech receives funding along with investments in FinTech sector. InsurTech’s great potential lies not in giving existing insurance products a digital form, but in radically changing the product or the process of concluding a contract for its provision in order to improve the quality of customer service.
GovTech	GovTech includes all IT products, solutions, developments, services that help solve public sector problems. What are challenges of GovTech solutions? <ul style="list-style-type: none"> ✓ participation. Creating platforms for citizen collaboration, e-petitions, crowdsourcing. Expanding the possibilities of electronic identification. These technologies are better known as CivicTech; ✓ infrastructure (digital sensors, control sensors); ✓ provision of services in education, health care; ✓ regulation (decisions for assessment of objects, inspections);

	✓ administration – licensing, cloud technology management, software.
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Source: authors' development.

We believe that in this section, it is worth presenting the content of the popular in the 20s of the 21 century *NanoTech*. It is high-tech centers, enterprises engaged in the development, enclosure, testing of microelectronic products, namely semiconductor wafers, silicon crystals, integrated circuits with high quality control standards. Nanotechnology is the technology of colloidal systems, it is colloid chemistry, colloid physics, molecular biology, all microelectronics. It is no less in demand *SupTech* Supervisory Technology is a variant of RegTech technology for financial regulators that allows you to automate and optimize administrative and operational procedures, digitize data and working tools, and improve data analytics.

Specialized regulatory technology that helps financial institutions meet the requirements of regulatory authorities, providing verification and data protection, reporting automation. *RegTech* provides companies with the necessary tools to address regulatory issues and comply with legal requirements, bringing together trade, fiscal and financial regulations. RegTech technologies help to quickly and easily integrate and adapt ready-made solutions for full compliance with all standards of financial regulators and are used to combat money laundering. Financial institutions will be increasingly interested in RegTech, as this will allow them to play on the lead: to form and submit reports, identify and eliminate risks, effectively comply with ever-changing regulatory requirements.

A popular tool used in digital infrastructure in the 21st century is *Digital marketing*. Digital Marketing is a set of promotion tools that involve digital channels. This is the use of different ways to promote the product to the masses using digital channels. It is not identical to Internet marketing, as it includes channels such as television, radio and even outdoor advertising. Internet marketing has evolved into digital marketing, which uses comprehensive methods of on-line strategy, website development and mobile applications, creative and copywriting, contextual advertising and SMM, as well as other interactive products. The most popular forms of digital channels: search promotion; contextual and teaser advertising; media and banner; promotion on social media and blogs; creation of mobile applications for smartphones, tablets and other media; viral advertising.

Table 6.4. Products and services of digital infrastructure as innovative trends of the modern socio-economic environment

Product name/services	Content of digital infrastructure product/service
<i>Blockchain</i>	Translated from English “block chain” – built on certain rules of a continuous sequential chain of blocks containing information. But it is better to give a definition based on the purpose of blockchain technology. Blockchain was designed as part of a very specific task, namely – how to build a decentralized (without a single control center) financial system, the correctness of which could be verified by anyone. Based on this, you can define a blockchain as a way to store and reconcile the database, a copy of which each participant has.
<i>CRM&BPM</i>	CRM – sales system: ready-made processes for managing all types of transactions. Bpm’online CRM combines the capabilities of a customer relationship management (CRM) system and a business process management system (BPM). This is the first application solution developed on the bpm’online platform.
<i>Grid-technology</i>	Grid computing is a geographically distributed digital infrastructure that combines many different types that a user can access from anywhere, regardless of their location. Grid provides a collective distributed mode of access to resources and related services within globally distributed organizations (digital enterprises that share global resources, databases, specialized software).
	Digital strategy in the insured – it’s not just online sales, but the transformation of the entire business in the direction of working with e-policy. Digital insurance allows insurance companies to reduce costs, increase the speed of customer service. Consumers have the opportunity to receive timely updates on changes in the company’s insurance policy.

<i>Digital-insurance</i>	Digitalization provides standardization and improves the quality of responses and services provided. A significant advantage of Digital Insurance is the presence of social networks, which helps to improve the quality of service and establish a close relationship between the insurance company and the client. A significant advantage of Digital Insurance is the reduction of the probability of fraud and increase the security of insurance operations. After all, if you purchase a policy through an insurance intermediary, there is a risk that the latter will not pay the insurance premium and, as a result, the insurance contract will not enter into force. Speed of data processing and settlement of claims is another advantage of Digital-insurance. Adaptation to digital format has a positive effect for both the insurer and the client. After all, all stages of insurance, from filing an application to settling claims, are much faster. The use of cloud platforms reduces the likelihood of errors, and the process itself becomes open and allows you to track the status of claims settlement. In addition, the introduction of cloud platforms provides insurance companies with greater speed, flexibility and scalability, improve responsiveness and optimize processes.
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Source: authors' development.

Technologies in digital infrastructure are necessary to increase the efficiency of digital industry and the emergence of digital entrepreneurship, and in some sectors, they become the basis of product and production digital strategies (Manzhura et. al., 2020b). Their transformative power changes traditional business models, production chains and causes the emergence of new products and innovations. Digitalization has a positive social character (*Digital Agenda of Ukraine – 2020*, 2020a; Andrusiak et. al., 2021), as it focuses on improving the quality of social security infrastructure, quality of social services, organization of transparency and targeting of social assistance, and reducing costs.

6.3.2. The latest Blockchain technology

We consider it necessary during the analysis of digital infrastructure to focus on the latest Blockchain technology, which is the basis of digital transformation of entrepreneurship. Blockchain is a digital critical technology that underpins digital products/services such as: *BioTech*, *NanoTech*, *RetailTech*, *FinTech*, *LegalTech*, *Digital-marketing*, *Grid-technology*, *GovTech*, *e-ID*, *TeleHealth*, *ePrescription*, *e-democracy*, *Digital-insurance*.

The latest Blockchain technology, which focuses on trading financial assets, is potentially the most interesting for both the transactional banking and payment domain, and for processes within and between organizations. And, in fact, the needs of the market and led to the emergence of new terms.

For example, the term “Value Web” for technologies using Blockchain was introduced in Fintech by Chris Skinner, but the idea is also known as “Internet values” for other applications. It is worth noting that “Internet values” refer to the next mass evolution of Internet, which is expected to be characterized by a combination of different technologies, and Blockchain will be key. It is expected that the “world of finance” will be different (Kupriianovskii et. al., 2017a; Marchenko et. al., 2020b; Marchenko et. al., 2020a).

It is also necessary to mention the role of Blockchain technology in the payment sphere. Blockchain is able to transform the payments ecosystem by increasing the efficiency of financial transactions around the world. Banks and other financial institutions have the ability to improve operational efficiency in real-time cross-border transfers, but as transactions increase, Blockchain algorithms will be affected by multiple participants, which increases the risks.

In the future, the realization of the potential will require significant investment from the participants to ensure security and transparency of all agreements (Paton, 2016). The stages of development of Blockchain technology are presented in Figure 6.3, and the stages of development in time section of Blockchain technology are presented in Table 6.6.

According to leading scientists, Blockchain's innovative technology will determine the trend of global economy of the 21 centuries. Thus, according to experts, Blockchain will completely or partially change the industries that generate one-fifth of US GDP (about \$ 3.6

trillion) (Shtepa et. al., 2021b). And the first in line – the field of financial services (Karcheva & Karcheva, 2017).

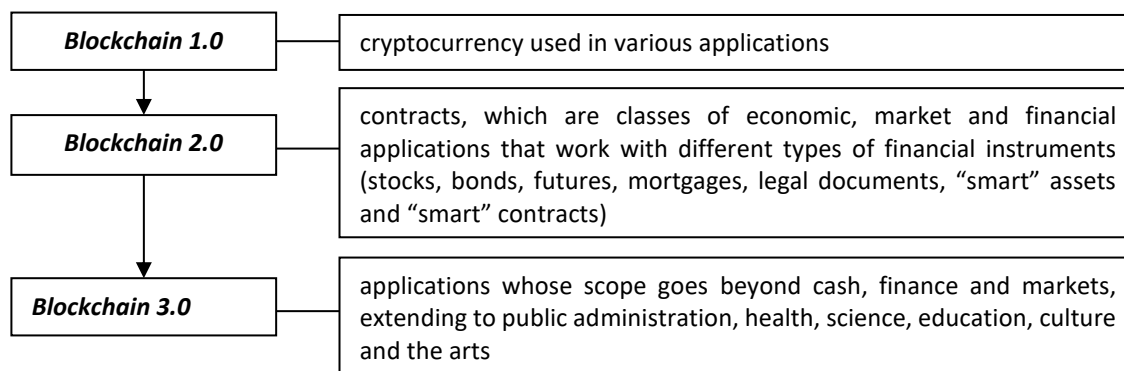


Figure 6.3. Stages of the development of Blockchain technology as a leading technology of digital infrastructure

Source: compiled on the basis of sources (Karcheva et. al., 2017; Kraus & Kraus, 2010; Kraus & Kraus, 2018b).

Table 6.5. Stages of the development of Blockchain-technologies in terms of time

<i>Stage number</i>	<i>Time period</i>	<i>Contents of the stage of development of Blockchain technologies</i>
<i>Stage 1</i>	2014–2016	Analysis of Blockchain implementation opportunities for the financial services industry
<i>Stage 2</i>	2017–2018	Verification of concepts that can affect business and Blockchain solutions to ensure the activities of financial institutions. Today, experts identify seven promising areas of implementation of Blockchain-technologies, namely: documentary operations, syndicated borrowings, clearing and mutual settlements, digital identification, lending, contracts
<i>Stage 3</i>	2019–2020	The emergence of a common infrastructure, API and interfaces to expand the scope of Blockchain
<i>Stage 4</i>	2021–2025	Active development of Blockchain networks, completion of formation and approval of interoperability standards and communication channels

Source: compiled on the basis of sources (How banks will develop blockchain solutions in 2017, 2017; Kraus et. al., 2021).

In essence, Blockchain technology provides a close link between the financial, logistics and commercial components of trade and economic transactions with the ability to unify payments and delivery. Mail can be the sole intermediary between merchants and customers, reducing their need for coordination and offering more efficient e-commerce solutions. Post offices will promote the growth of e-commerce (in particular, cross-border e-commerce) and increase their market share and increase revenues (Kupriianovskii et. al., 2017a).

Blockchain it is a multifunctional and multilevel information and communication technology, which is designed to make the accounting of various assets reliable and instantly accessible. Technology of reliable distribution of storage of records about all whenever any transaction is carried out. Blockchain is a chain of data blocks, the volume of which is constantly increasing as new blocks are added with records of recent transactions. This is a chronological database, i.e. a database in which the time when the record was made is inextricably linked with the data themselves, which makes it non-commutative (Pogosian, 2017). Blockchain is a distributed database that contains information about all transactions (more generally –

communications) conducted by system participants, while the information is stored in the form of a “chain of blocks”, each of which records a certain number of communications. A summary of the principles of construction and operation of Blockchain is given in Table 6.6.

Table 6.6. Principles of construction and operation of Blockchain as a leading technology of digital infrastructure

<i>Principle</i>	<i>The content of the principle of construction and operation of Blockchain</i>
Network integrity	The purpose of trust within the system is pursued and in fact it is said about the consensus of the participants, their equality
Load distribution	Energy costs are distributed throughout the peering network
Value as an incentive	The system equalizes the incentives of all stakeholders, i.e. participants are interested in developing the technology and maintaining its stability
Confidentiality and protection of rights	One of the principles of Blockchain is trust. The presence of this principle eliminates the need to identify others to interact with them
Security	In addition to the fact that each member of the network must use encryption, security measures are built into the network and provide confidentiality and authenticity of the fingerprint. Also, each user has two keys: one for encryption, the other for decryption

Source: compiled by authors based on sources (Stanislavskiy et. al., 2020; Svon, 2017).

One of the main benefits of Blockchain technology comes from the ability to speed up processes and reduce the complexity and risk of transactions. New benefits will emerge as this technology can be integrated with outdated IT, legal laws and existing assets such as currencies, stocks, bonds. For this reason, existing financial services can be strengthened by Blockchain systems, which allows financial institutions to enter at potentially lower costs, better products and accelerate time to market (Kupriianovskii et. al., 2017a). The use of Blockchain as a technological innovation will help build effective and transparent systems for tracking and recording financial transactions, as well as increase the efficiency of the financial sector, as these technologies allow you to work without third parties and high risks (Karcheva & Karcheva, 2017). Possible applications of distributed registry technology in Blockchain applications in terms of classes and areas of application are presented in Table 6.7.

Table 6.7. Application of digital infrastructure of distributed registry technology in Blockchain applications

	<i>Application class</i>	<i>Scope of applications</i>
<i>Blockchain</i>	Information about a specific transaction and its values, purpose in the system	Cryptocurrencies in various applications related to financial transactions, such as transfer systems and digital payments
<i>Blockchain 2.0</i>	Financial transactions	Securities, shares of companies, crowdfunding, bonds, mutual funds, derivative financial instruments, annuities, pensions
	Warranty obligations	Execution of warranty obligations, tripartite arbitration, multilateral signature, agreements using Escrow accounts
	Documents that need to be certified	Insurance certificates, property certificates, notarization of documents
	Registration of intangible assets	Patents, trademarks, copyrights, reservations, etc.
	Private documents	Debt receipts, contracts, agreements, signatures, wills, power of attorney
<i>Blockchain 3.0</i>	Information and documentation in the field of housing	Data and information on various transactions in the field of housing and communal services: indicators of consumption of electricity, water, telecommunications services, the operation of “smart home” systems, etc.
	Information and documentation in the field of	Data on the medical history of patients of medical institutions, information on the results of examinations, registration of access

medicine	rights of medical staff to certain data and specific patients
Information and documentation in the field of education, science and culture	Data and information about students and teachers, scientists, cultural and artistic workers, various transactions in the field of education, science, culture (including the performance of institutions, individuals)
Certificates certified by state authorities	Identity cards, passports, voter registration certificate, driver's license, birth, marriage and death certificate
Certificates and licenses certified by state institutions	Certificates of ownership of land and real estate, certificates of registration of vehicles, licenses for the right to engage in certain activities

Source: compiled by authors based on sources (Pogosian, 2017; Karcheva et. al., 2017; Stanislavyyk et. al., 2020).

6.4. Socio-economic benefits and threats from digital infrastructure

In 2010, the era of fiber access began in Europe. The most promising solutions are FTTH (Fiber-to-the-Home – fiber directly to the subscriber's home). The number of FTTH access network subscribers is growing in all regions of the world. High-speed broadband access in European countries is financed through EU instruments (for example: European Regional Development Fund, English Rural Development Program, European Agricultural Fund for Rural Development, EU Competitiveness and Innovation Program, etc.).

Existing conditions in Europe make it possible to provide universal access and close digital divide between urban and rural areas in the shortest possible time. The EU's policy of creating various types of development funds has played a significant role in this. The principles of universal access are based on the understanding that all citizens have the right to access means of communication.

In global practice, this provision is formulated as follows: "The state recognizes that access to a variety of unlimited sources of information and means of communication is a fundamental right of all citizens". The information infrastructure of the state cannot be considered complete until it is available in all regions of the country and for all its inhabitants and until proper and inexpensive access to the full range of traditional and latest intelligent technologies and services is provided, taking into account different user needs and taking into account their gender, age, ethnic and linguistic differences and special needs (*Digital Agenda of Ukraine – 2020, 2020^b*).

The International Telecommunication Union (ITU) stipulates that universal service is a long-term goal, which is to ensure the availability of means of communication for each member of society individually or at the family level. The concept of universal access is also formulated – a short-term goal, which is to provide convenient and cheap access to communications at the community or local level by combining public communications (payphones, collective Internet access points, etc.) and individual private services. The basic principles of universal service provision are set out in Directive 2002/22/EC of the European Parliament and of the Council of 7 March 2002 (*Digital Agenda of Ukraine – 2020, 2020^b*).

The state is important in creating both "hard" and "soft" infrastructure. Broadband access using fixed and mobile technologies (4G, 5G) should become a priority for the development of solid infrastructure. Speed, number of connections, and data rates are critical for Industry 4.0 and digital services based on AI and predictive analytics. Socio-economic benefits, utilities, hazards and threats to the functioning of digital infrastructure are presented in Table 6.8.

Table 6.8. Socio-economic benefits, dangers and threats from the functioning of digital infrastructure

<i>Socio-economic benefits from the operation of digital infrastructure</i>	<i>Dangers and threats arising from the digitization of infrastructure</i>
<ol style="list-style-type: none"> 1. Introduction of electronic document management. 2. A more open and accessible market. 3. Increasing the level of production. 4. Simplification of financial transactions, increasing the role of electronic and digital money. 5. Development of remote work capabilities. 6. Reducing the cost of goods and services. 7. Reducing the level of bureaucracy. 8. Enables the integrated interaction of virtual and physical, i.e. creates hyperphysical space. 	<ol style="list-style-type: none"> 1. Cybercrime (quite often even some states are involved in the work of anonymous hacker groups and data theft). 2. For the average user, the issue of preserving their personal data and securing their digital life is more relevant. 3. Digital inequality and discrimination. 4. No guarantee of digital rights.

Source: compiled by authors.

We consider it necessary to note that digital inequality determines the situation that arises when there are social groups in society with different opportunities for access to modern digital communication technologies (primarily Internet), which provides digital infrastructure. This definition, related to the presence or absence of access to technology, can be applied to different societies within one country (internal digital inequality) and to several countries or regions (international digital inequality). The term is used both for differences between countries (for example, in Iceland, more than 86% of the population has access to Internet, and in Liberia – 0.03%), and for differences in the opportunities of different social groups within one society.

Age gaps are associated with young people's desire for openness and innovation, while middle-aged and older people tend to be stable. Gender problems arise in societies in which a woman is seen as an underprivileged person in society due to religious or other beliefs. People with physical disabilities are often deprived of the ability to communicate online, as not all computers are adapted to the needs of visually or hearing impaired, and only a small percentage of sites are equipped with audio programs for text or graphics. As a result, a situation is created when the latest technologies not only do not contribute to the full realization of any individual, but act as a catalyst for "gaps" between different groups. One of the significant inequalities that hinder the implementation of quality network communication is the language disparity, formed on the basis of the dominance of English as main language of Internet and software and hardware support of computer and telecommunications facilities. And although in recent years there has been an active promotion of national languages in digital world, English remains the most common in online information and communication resources.

Digital constraints prevent citizens, including socio-economic disadvantaged groups, from enjoying all the benefits that digital technology can provide. Promoting digital infrastructure in the outermost regions is a key factor in maintaining inclusiveness, but public authorities must also systematically make a number of policy decisions aimed at fostering social and economic cohesion through innovation that enables disadvantaged regions to catch up with more developed urban areas (Vyshnevskyi, 2018).

6.5. Smart infrastructure of the city

High-quality and efficient "soft" and "hard" digital infrastructure contributes to the accelerated development of smart cities. In 2014 The International Telecommunication Union has proposed the definition of a "sustainable smart city", which is proposed to be interpreted as an innovative city that uses ICT and other means to improve the quality of life, increase the

efficiency of urban operations and services and competitiveness while clearly meeting the needs of present and future generations in economic, social and environmental terms (Shyn, 2016). Smart Cities Council defines a smart city as one that collects data from devices and sensors built into its driveways, power grids, and buildings and other objects (Osetskiy et. al., 2020b). With the help of an intelligent communication system, this data is transmitted by wired and wireless communication, which with the use of “smart” software generate valuable information and digital advanced services. Digital technology is a means to an end for the city’s goals. A “smart” city in its system of government focuses on the interests of citizens.

With the efficient use of smart infrastructure, city dwellers will receive a comfortable and safe living environment. This primarily concerns the digitalization of the housing, utilities, energy, construction and public transport sectors, the large-scale use of integrated digital platforms in urban governance, education, medical sector, and environmental monitoring. However, smart infrastructure is not a “panacea” for all the problems of the city, and in some cases can generate a number of challenges: breach of privacy, the risk of technical failure, reduced cultural development and more. The levels of smart-infrastructure depending on the degree of human participation in the decision-making process are presented in Table 6.9. In general, the consequences of smart-infrastructure development will depend on making multidisciplinary and at the same time effective decisions (Marchenko et. al., 2020^b).

Table 6.9. Levels of smart-infrastructure depending on the degree of human participation in the decision-making process as defined by the Royal Academy of Engineering

<i>Levels of smart-infrastructure depending on the degree of human participation in the decision-making process</i>	<i>General characteristics</i>
<i>Smart infrastructure</i>	generates and processes data, resulting in the necessary actions that are completely autonomous, dynamic and adaptable to changing conditions
<i>Intelligent or semi-smart infrastructure</i>	collects and processes real-time data, which is then used by the infrastructure itself or by the operator to make optimal decisions. Examples include a traffic system that detects traffic jams and informs drivers
<i>Semi-intelligent infrastructure</i>	collects and records data on own use, structural indicators, environmental conditions, etc. without any possibility to make decisions on the basis of the received data

Source: (Fang et. al., 2012)

Lack of trust in digital technologies and uncertainty are main challenges that users face. They may be hesitant to use digital technologies because they are unsure of their potential to meet their own needs, and information and evidence that can reduce this uncertainty are often difficult to understand. The development of digital infrastructure is subject to uncertainty, much greater than for conventional innovative products/services. From the beginning, no one knows the critical parameters of digital technologies or how they relate to the desired performance of future products, and potential users can not always determine their needs in terms of using new technology (Marchenko et. al., 2020^b).

6.6. Conclusions

The values pursued by digital infrastructure are: self-control and accuracy of decision-making; reliability; efficiency and cost savings; security, protection and resilience; interaction and empowerment of users; optimization of decision-making to ensure sustainable use of resources; minimization of excess components in the system, which reduces energy consumption and saves resources; response time (early detection of critical events, preventive maintenance and rapid overcoming); minimization of GHG emissions and energy consumption;

improving the quality and expanding the range of services provided by the infrastructure to improve living conditions.

Today, within the post-classical discourse, the practice of postmodernism as an epistemological concept of real space research is transformed into a metamodern paradigm based on cognition and creation, in the economic context, of virtual economy and its basic component – finance, the space of financial relations, which is increasingly separated from the economy of the real sector of production in a specific area of research (Liashenko, 2018; *Our Vision*, 2012). With a well-functioning digital infrastructure, efficient and productive use of digital technologies and services by businesses, the state, and citizens is possible, which is enhanced by the relevant digital culture and ecosystem. In digital infrastructure, data is generated and provides electronic communication through the operation of electronic devices, tools and systems.

Digital infrastructure is the result of transformation processes of the latest general-purpose technologies in the field of information and communication, the formation of which testifies to new level of use of information and communication technologies in all areas of socio-economic activity. Robotics, artificial intelligence, cloud technology, 3D printers and *Blockchain* – are already firmly entrenched in our daily lives. Smart cities, courier drones, driverless cars, “printed” in one day at home – are waiting for us tomorrow. Ideas of fantasy novels become reality. Technological progress has arbitrarily invaded business and forced all industries to change. Digital businesses will accelerate the work to distribute their capacity between digital and off-line customer service channels. The belief that digital innovation will break down the boundaries between divisions in companies and create some integrated business. Brands will eventually build holistic service models that will go beyond contract points.

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9. DIGITAL BUSINESS ECOSYSTEMS

Learning objectives

After reading this chapter, you will be able to:

- Develop the infrastructure of digital business ecosystem
- Find out the competitiveness and benefits of digital business ecosystem
- Investigate the experience of some institutions of digital business ecosystems
- Describe digital platforms and areas of operation of digital business ecosystems
- Consider digital business ecosystems through the prism of different realities
- Visualize digital business of augmented reality space
- Identify innovative changes in ecosystem enterprises in the context of digitalization

9.1. Introduction to the features of digital business ecosystem

Digital business ecosystem, which is characterized by network interconnections and interactions in the future, will have synergetic effects for digital business. Digital business ecosystem is the key to the success of the effective functioning of digital entrepreneurship, as it allows through network interactions to respond quickly to overcome socio-economic challenges in terms of innovation. Digital transformation of business and its systematic modernization lays the foundation for the formation and development of Industry 5.0 on the basis of digital ecosystem of entrepreneurship. The logic of structuring this section is aimed at presenting the features of digital business ecosystem, in particular using some visual representation. During the study of this section, students will be able to get acquainted with the features of the infrastructure elements and components of digital business ecosystem, the operation of digital platforms, areas of ecosystem functionality (Value Chain, Innovators, Incubation, Experience and Testing). In addition, the section presents the structure of the ecosystem, identifies its competitive conditions, and points out the advantages. The material of the section gives an idea of the content and features of the functioning of such organizations of digital business ecosystem as: Key Enabling Technologies Technology Centers, European Institute of Technology, Digital Innovation Hubs, Factories of the Future, Joint Research Center. As a result of studying this topic, students will get acquainted with the visualization of digital business ecosystem through the prism of augmented and virtual reality.

9.2. Digital business ecosystem infrastructure

9.2.1. Digital business ecosystem

Recent changes in the economy and society cause adequate changes in world economy. Today's economic concepts and categories are being replaced by new ones, which can be generalized as the emergence of a new economy in the world – digital with its specific definitions, laws, models of world development, economic development as a science, as an industry gaining momentum in history (Koliadenko, 2016). In the 21st century, the interest of scientists and economists in the formation and development of digital business ecosystems has grown significantly in economic research. After all, they provide real opportunities for economic growth. The development of “digital” infrastructure and digital business ecosystem is a matter of harmonization of initiatives and development programs of 3 levels: telecommunications infrastructure, data management, services and digital skills. Focus and resources at one level or

another are determined by the priorities of digital ecosystem. Thus, the regulator is a tool for harmonization and development of digital ecosystem (*Digital Agenda of Ukraine – 2020*, 2020).

Digital infrastructure, like the data, creates the conditions and forms the ecosystem for the development of digital innovations. A broader view of infrastructure indicates the need for development, in particular, the so-called analog innovation infrastructure, such as clusters. Clusters combine several important elements of the ecosystem – R&D centers, laboratories, incubators, accelerators, schools, venture funds, innovation teams, technology business, and industry (Shtepa et. al., 2021). One of the cluster options is intersectoral alliances. In addition, digital age is changing the approach to doing business, as well as the requirements for the information technology used: marketing management systems, sales and service; telephony and messengers; document management and personnel management systems; accounting systems and many other enterprise applications.

Digital business ecosystem is a network of organizations, including suppliers, distributors, consumers, competitors, government agencies, etc., that are involved in producing a particular product or service through both competition and collaboration. Digital business ecosystem is a set of own or partner services united around a number of companies (Senyo et. al., 2019^a). The ecosystem can be centered around several areas of the client's life or penetrate into several of them at once. Digital business ecosystem is not a monolith and not a set of identical business units (Adner, 2017). The idea is that each business participant in digital ecosystem influences and is influenced by others, developing relationships that are constantly evolving and have synergistic effects from cooperation. Digital business ecosystem is not possible without the synergy of the state, business and research environment. It is aimed at collective action in the field of knowledge flows, support for technological development and commercialization of innovations (Senyo et. al., 2019^b).

Ecosystems are forms of collaboration in which companies combine their individual offerings into integrated solutions that are ready to satisfy the consumer (Adner, 2006). Digital ecosystem can also be considered as a dynamic set of organizations and institutions, a mobile set of their multidimensional internal connections (Bramwell, 2012). An ecosystem is a system of energy exchange and mutually beneficial connections between its members.

It is believed that the ecosystem is also some territorial communities aimed at collective action in the field of creating flows of knowledge, supporting technological development and commercialization of innovations (*Entrepreneurial ecosystems around the globe and company growth dynamics*, 2013). An ecosystem can be understood as a networked community, whose members combine their resources on mutually beneficial principles for the joint achievement of innovative results (Chessell, 2008). That is, digital business ecosystem is a dynamic and adaptive “organism” that creates, consumes and transforms knowledge and innovative and digital products/services. Relationships in digital business ecosystem must be flexible and transparent, and participants must be quickly adaptable to challenges and changes to survive as in a biological ecosystem.

Digital business ecosystems create strong barriers to entry into the industry. Non-digital business ecosystems must compete with a whole system of independent, but complementary, in the process of implementing business projects, each other's enterprises and suppliers, forming a network with strong digital interconnections. As part of business ecosystem, digital enterprise can apply the mechanisms of technology use, excellence in research and business competence, and effective competition against non-ecosystem companies. Goals of the business ecosystem also include:

- promoting new cooperation to address social and environmental challenges;
- use of creativity and innovation to reduce production costs or allow ecosystem members to reach new customers;
- acceleration, on the basis of deep digitalization, of the educational process for effective cooperation and exchange of ideas, skills, experience and knowledge;
- creating new ways to meet basic human needs and desires.

It is for these reasons that in today's fast-paced business world, companies are joining digital business ecosystems.

Digital business ecosystem with its infrastructure is able to guarantee maximum efficiency of investment in innovative-digital projects and encourage innovators to produce innovative products and digital services (Holubka et. al., 2019). Digital entrepreneurship in the business ecosystem combines both organizational and technological innovations and involves the use of IT based on internal and corporate information networks.

The ecosystem allows the introduction of incentives to modernize, scale and accelerate business development. Digital infrastructure resources enable businesses and citizens to consume and use information and communication and digital technologies. The ecosystem, in turn, makes digital technologies quickly available, increases economic activity, creates jobs, increases tax revenues and domestic demand, simplifies the modernization of obsolete assets and creates new ones. The ecosystem is a digital organization based on a technology platform that allows in real time on the basis of big data to form the best offer for the customer by connecting external providers.

The issue of considering possible support for the development of innovation ecosystems in cities (innovation/technology hubs, centers, parks, clusters, etc.), innovation policy of municipalities and stimulating the involvement of citizens in the development of urban smart city solutions (startup movement and living laboratories). Author's presentation of digital business ecosystem with its infrastructural elements and innovation-digital development institutions is presented in Figure 9. 1. The subjects of digital business ecosystem are all participants involved in the process of creating innovations (students, universities, entrepreneurs, professionals, private investors, organizations, research centers, investors, foundations, companies).

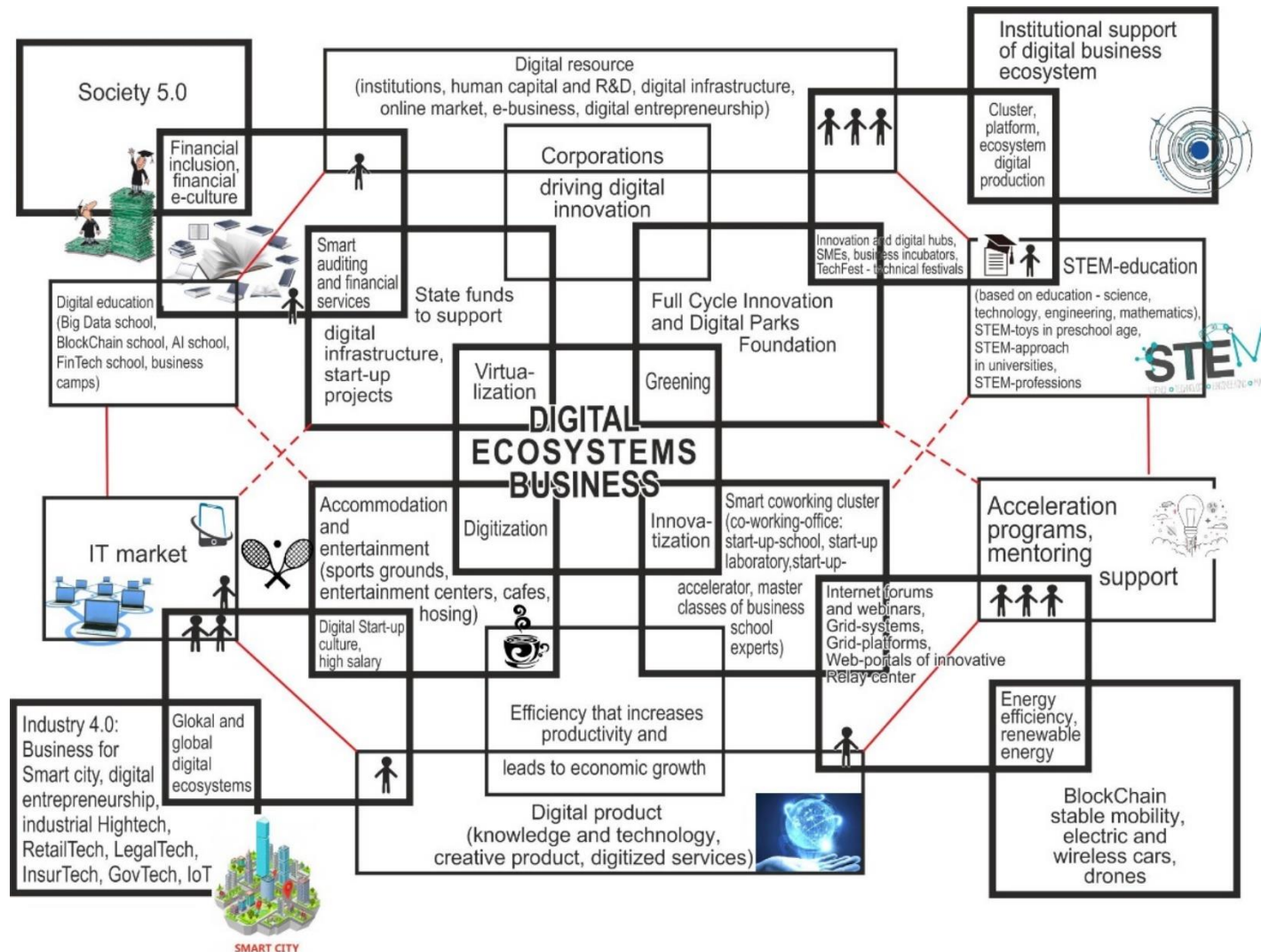


Figure 9.1. Digital ecosystem and its scientific-educational, technical-technological, social-ecological, innovation-entrepreneurial structural components

Source: authors' development.

Figure 9.1 shows a conditional visualization of some digital business ecosystem. Each individual square represents technological, educational, innovative, financial, technical, marketing, etc. structural component of business ecosystem. Since they are all in a close constant relationship, they result in the products of their interaction. These interaction products/services within business ecosystem are represented at the intersection of squares. Dark lines show close interaction, light lines – weaker cooperation.

Explaining the meaning of Figure 9.1, it should be noted that digital business ecosystem is based on five key components, such as:

- Science, engineering and technical communities, institutions of higher education, which play the role of major suppliers of innovative ideas for commercialization;
- Digital infrastructure that ensures the functioning of innovative companies, the implementation of digital entrepreneurship. It can be both tangible (technology parks, business incubators, development institutes, etc.) and intangible (a variety of services specifically tailored to the needs and specifics of innovative companies, e-business (Adner, 2017; Leong et. al., 2016), such as intellectual property protection services, on the introduction and promotion of innovative and digital product/service in foreign markets);
- The venture capital industry, which provides the attraction of financial resources and business competence in digital ecosystem, necessary for the formation of innovative companies and their transformation into full-fledged digital business structures;
- Steady demand for high-tech products, technologies and startups (primarily the demand of big business and other real sector companies for high-tech products, technologies, as well as innovative companies together with all their developments and intellectual property (as promising objects for acquisition);
- Legislative legal field (Stanley & Briscoe, 2010), which provides comfortable conditions for innovators and researchers.

Main goals of digital ecosystem, which we clearly show in Figure 1, are accelerated growth, modernization and improvement of competitiveness of key sectors of national economy, growth of new segments through better preparation for digitalization, perception of innovation, new business models. It would be most productive to consider digitalization as the introduction of business processes and methods that allow organizations to effectively compete with competitors in an increasingly digital world. Figure 9.1 shows how we visually present the infrastructure of digital ecosystem, under the influence of open innovation, service prices, digital entrepreneurship, access to broadband Internet, takes the form of a chain of type:

“Developers-Owners-Providers-Advertisers-Regulators-Users”.

In addition, author’s vision and understanding of digital business ecosystem is presented through the following components, namely: cluster, platform, ecosystem digitized production; a full-cycle foundation for innovation and digital parks; digital coworking cluster (co-working-office: start-up-school, start-up laboratory, start-up-accelerator, master classes of business school experts); STEM education; digital education (Big Data school, Blockchain school, AI school, FinTech school (Leong et. al., 2017), business camps); Industry 4.0: business for Smart city, digital enterprise, industrial Hightech, RetailTech, LegalTech, InsurTech, GovTech, IoT.

The functioning of the ecosystem is ensured by the availability of innovation and digital resources (institutions, human capital and R&D, digital infrastructure, digital market, digital business), stable mobility, mentoring, acceleration programs and results in an innovative product and digital service (knowledge and technology, creative product). Under the conditions of an effectively functioning digital business ecosystem, we can trace the acquisition by national economies of all the features of circular, blue, green, digital, platform, sharing and innovation economies.

When studying the institutions of digital business ecosystem development, one should not ignore hackathons, which are modern forms of virtual-real meetings. Hackathons are held as virtual events-meetings, during which a large number of innovators in the field of software development work intensively and cohesively to solve a current problem or create a new application or service. Hackathons last from one day to a week. Groups from representatives

of research, design, production divisions of innovation and digital enterprises from other branches of science and technology are involved in hackathons.

For the purpose of high-quality functioning of digital business ecosystem, it is necessary to realize effective start of accelerators of industrial hi-tech, to develop X.0 Centers, to involve venture funds, grants, to carry out timely audit of ecosystem for the purpose of timely monitoring of quality of work of digital business ecosystem.

Today, due to the need for managers of institutions and organizations to have access to Internet always and everywhere (the concept of Access Anytime and Anywhere), wireless networks have been developed. Today, there is the emergence of Internet of Things – an ecosystem of billions (and by some estimates trillions) of autonomous devices that interact with each other: sensors, controllers, robots, appliances, cars, machines and more.

In the near future, we are looking at what is called 5G, i.e., a set of organically integrated radio access technologies. We are on the verge of an incredible revolution that will change the business world forever. In this new world, every controller, every device, no matter where they are, will share information in real time. Over the next 10 years, managerial and business technologies and innovations will undergo more changes than over the last 100 years (Kraus & Kraus, 2018; Levchynskii, 2018).

Partner, technology ecosystems include hundreds of developers from around the world – from large and well-known companies, as well as innovative startups and system integrators at regional level. Digital business ecosystems form coordination centers, where universities and companies that form clusters meet in the framework of innovative cooperation (Figure 1). By working with small and medium-sized businesses and startups, investors have the opportunity to eliminate inaccuracies that occur in projects. In the course of the functioning of the ecosystem, identify and inform the government about the “bottlenecks” that exist in the legislation of the country in which the ecosystem operates.

9.1.2. Competitiveness conditions and advantages of digital business ecosystem

Digital business ecosystem can quickly achieve a synergistic effect by combining private, regional, European and national sources of funding. In the future, it is worth carefully, reasonably considering the quality application of the latest basic conditions and investment tools and mechanisms to strengthen the existing digital business ecosystems. Work and functioning in the ecosystem can take place in a startup school, digital business incubator, intellectual property center, and be presented, for example, at the events “Festival of innovation and digital projects” or “Startup Fights” (Figure 9.1).

Among the benefits of digital business ecosystem may be:

- Large resource base – the flow of students, graduates, graduate students and scientists with engineering education, as well as in other technological areas;
- Scientific-technical and digital infrastructural support of innovators by departments;
- Opportunities to create startups in various scientific and technical fields and in industry (and not only in IT);
- The possibility of developing new leading and breakthrough markets for digital goods/services;
- The work of foreign trade missions, which act as a multiplier of EU efforts and exponentially increase the combined efforts of digital business ecosystems;
- High level of management of innovation and digital projects;
- Development of full-scale demonstration projects;
- The possibility of transition to the sixth and seventh technological structure of the economy;
- Organization of an international trade mission;
- The possibility of strengthening cooperation between industrial enterprises, research organizations in the course of achieving synergy;
- A unique method of growing startups and innovations.

Partnerships of high-tech companies with innovation and entrepreneurship universities in digital ecosystem should take the form of innovation and be extended to all categories of education workers and training providers, taking into account advanced training. Close collaboration between existing companies and startups provides opportunities to effectively combine the resources of large companies with creative innovators and the flexibility of innovative startups.

Conditions for the competitiveness of digital business ecosystem can be considered:

- Corporate startup cooperation;
- Targeted funding of innovations;
- Coordinated cooperation between e-government and society and their full involvement in the effective operation of digital business ecosystem;
- Support for entrepreneurial talent and gender equality;
- Digital compatibility of business entities;
- Harmonization of legislation and standards.

A well-functioning digital business ecosystem is a seamless process that requires flexible thinking and the creation of an organizational structure that will enable businesses to engage in digital trends, solutions and digital skills at all times. Digital business ecosystem digital solutions strategy is focused on digital products/services with the addition of information that provides new value to customers. Working with information in digital business ecosystem can be represented by a chain such as: *“Search-retrieval-recognition-analysis-filtering-enrichment-constructing information-application”*.

Strategy of digital solutions of business ecosystem stimulates the introduction of diversified digital products/services into integrated solutions. At the same time, these products/services themselves are being improved due to the accumulation of information and experience, which allows to solve customer problems quickly and efficiently. Over time, digital solutions can transform business model in such a way that main revenues will bring unprecedented sales and value proposals. They are the most effective way to provide a regular income.

9.2.3. Experience of some institutions of digital business ecosystems

In countries with developed innovation and digital sphere, small and medium-sized businesses are increasingly involved as a structural component of ecosystems of universities, institutes, research centers, literally “sticking” them to jointly develop advanced technologies (this is one of the embryonic forms of sharing economy, i.e., economies of sharing, use, participation), which are then transferred to large business.

Global innovation centers in Silicon Valley, New York and London continue to accumulate global venture capital, talent and digital innovation. In turn, countries and cities that focus on innovation and digital development create exclusive conditions for the introduction of start-up ecosystems. Corporations are moving to open innovation platforms, learning to develop new solutions not within a single company, but by turning to a society of global talent. Foreign investors are increasingly inclined to choose target teams with creative ideas and support potential opportunities instead of detailed business plans.

Modern government agencies in different countries are focused on simultaneously improving the quality of services, optimizing the number of employees and reducing costs. Digital platforms (ERP, CRM) systems and digital business ecosystems allow to solve these tasks and dramatically increase efficiency, reducing the cost of activity and execution time. Government agencies use digital platforms to simplify and optimize internal processes, improve interaction with citizens and reduce costs (*Digital Agenda of Ukraine – 2020*, 2020). The cost of access to digital infrastructure depends on both the level of income and the development of digital infrastructure, as well as on territorial features (mentality, traditions, norms of behavior and prohibitions). Theoretically, the cost of access should reflect the balance between supply and demand in the Internet services market, respectively, changing consistently with changes in other indicators, but this is not always the case.

The general pattern of projects implemented by digital business ecosystems is consumer-oriented and comprehensive use of information as a driving resource, taking into account the specific features of a particular consumer in a particular place, and global use of digital transformation technologies of real business processes. For these reasons, digital projects produced by the ecosystem are characterized by very specific circumstances of their implementation in a particular place and only with the accumulation of economically positive results can become the subject of standardization and other regulations. One of the features of building a tree of goals of digital transformations is the implementation, maturity of opportunities and their completeness at the present stage of certain digital projects and accounting for risks in their implementation. Digital teams of business ecosystem should focus on three key functional activities, namely: to develop a digital strategy, manage digital activities through their national companies, as well as turn their digital performance into an operational advantage (Kupriianovskii et. al., 2017).

Collaboration in the field of startups is increasingly seen as an attractive option, as small companies that produce them have the maneuverability to move dynamically, quickly adapting to new market trends and requirements. In addition to attracting talented young people, the latest technologies and creative ideas, the starts are usually free from the infrastructure, culture and regulatory burden of large companies.

The main reasons a startup may need a partnership are gaining access to a wider customer base and benefiting from the resources and brand of a large corporation. A well-planned exit strategy helps to maximize the benefits to both parties. Strategic alliances with other major market players are another potential model, although many companies face difficulties due to cultural differences, income sharing disputes, and conflicts over future business. The general characteristics and features of the functioning of some organizations on issues of digital development are presented in Table 9.1.

Table 9.1. Some organizations of digital business ecosystem

<i>Institute of Innovation and Digital Development</i>	<i>Content, features of functioning and general characteristics</i>
<i>Key Enabling Technologies Technology Centres</i>	help industrial enterprises, including small and medium-sized businesses, to develop and produce new products based on technologies that include micro- and nanoelectronics, nanotechnology, industrial biotechnology, modern materials, photonics and advanced manufacturing technologies used in various industries. Such centers carry out applied research, helping companies reduce the time required to implement innovative ideas and enter the market. The services provided by the centers may include: access to technical expertise and means of verification; laboratory testing; development and testing of prototypes; pilot production and demonstration/pilot lines; product verification/certification.
<i>Factories of the Future</i>	created by applying the mechanism of public-private partnership in order to increase the technological potential of production. More than € 100 million has been invested in the pilot lines under Horizon 2020.
<i>European Institute of Technology</i>	supports the development of partnerships between leading universities, research laboratories and companies within the EU. Among main areas of activity of the institute: climate change, digital products, innovations in the field of energy and extraction of raw materials.
<i>Digital Innovation Hubs</i>	non-profit complexes that support companies, including SMEs, in their quest to digitize their activities. In a notice on digitalization of European industry adopted in April 2016, the EC announced plans to invest € 500 million from Horizon 2020 (2016-2020) in the development of digital innovation hubs, their networking and innovation experiments for SMEs. Thanks to such centers, it has become possible to gain access to knowledge and testing tools for companies from various industries focused on digitalization. On the basis of such centers there is a technological organization or university laboratory that offers a variety of services (experiments with smart technologies, such as artificial

	intelligence, supercomputers, blockchain, 3D printing) to understand new opportunities, learning to make the most of digital innovations (expansion of partnerships, exchange of training programs and materials).
<i>Joint Research Centre</i>	whose activities are aimed at attracting researchers working in the fields of nuclear and chemical research, biological and physical sciences, as well as ICT.

Source: compiled by authors based on sources (EU SCIENCE HUB, 2021; European Institute of Innovation and Technology, 2021; Proposal for a Decision of the European parliament, 2016)).

9.3. Ecosystem enterprises in the conditions of digitalization

9.3.1. Digital platforms and areas of operation of digital business ecosystems

Platforms and clusters play a leading role in creating digital business ecosystems. Among the key characteristics of digital platforms of the business ecosystem are the following: Network structure, network effect; Resource creation ($1 + 1 = 3$); Domestic currency, tokenization (one of the areas in the future); “Win-win-win-win” – manufacturer – seller – buyer – platform owner; Digital twin – operation in two economic formats (virtual and analog); Scaling platform – Internet; Data capitalization, data – resource.

In addition, digital platforms encourage industrial transformations on the ground, offering solutions for system upgrades, opportunities to experiment and scale innovations. SMEs working in digital ecosystems are more innovative in terms of innovation, register more patents and create more new jobs than when they operate outside clusters and platforms. Figure 1 shows a fairly detailed picture and explains how at the output we receive innovative products and digital services or do not have them (and accordingly they are replaced by imports). Thus, during the operation of digital business ecosystem, we observe the passage of several zones, namely:

- Value Chain area (innovation cycle management). It consists of actors who play the role of enablers & policy makers. Their mission is to manage the challenges and gaps that arise at different stages of the innovation cycle and at different levels, from national to sectoral. Typically, these are a variety of digital clusters and associations, development, innovation and investment agencies;
- Zone of innovators. It includes institutions that typically generate innovation (Table 1). We are talking about innovation and entrepreneurship universities, their research laboratories, design offices of large companies, research institutes or startups;
- Incubation zone, as includes organizations that create opportunities for incubation and acceleration of innovators. This is a fairly simple area to understand, but a relatively complex and unusual area for industrial entities. We are talking about incubators, accelerators, the presence of business angels (Figure 1), various funds, donor institutions, because without this type of organization, it is impossible to further move the innovative idea to the prototype;
- An area of experience and testing that contains elements that allow innovations to be tested for viability. This area is final one for rapid testing and innovation in the market. There is a big difference between industrial markets and B2C (consumer). For these reasons, there should be organizations in this area that promote faster testing, testing and certification (if necessary) of new innovative products and solutions (*Landscape Industry 4.0 in Ukraine*, 2019).

Production networks represented by the industrial core in digital ecosystem of economic entities with different functions, competencies and resources are interested in cooperation and joint creation of various values. Cooperation in the cultivation of innovations may include the joint production and active management of intangible assets.

Digitalization is a significant factor in technological evolution of business ecosystem, which allows manufacturers to overcome territorial constraints, reduce transaction costs of decision-making and agreements, allows to develop new business models based on network effects, involve consumers in the process of creating goods (Babkina, 2017).

Working within digital business ecosystem allows you to achieve:

- Success in digital entrepreneurship through a synergistic effect, combining the capabilities of partners;
- Reduction of transaction costs due to the refusal of intermediary services;
- Opportunities to combine the needs of the corporation with the capabilities of people outside it;
- Acceleration of digitalization and innovation of the economy.

In addition, the presence of spatial coherence in digital business ecosystem allows: to bring together novators and innovators from different fields of knowledge in order to identify the competitive advantages and disadvantages of individual countries and to develop ideas and strategies for digital development; “build” effective business interaction.

At present, in the course of the formation of digital business ecosystems in most countries, the issues for urgent solution remain in the part of:

- Creation of a new quality of ecosystem of interaction of citizens with social programs, services and information necessary for the choice of services;
- Creation of regional innovation and digital networks and intensification of international cooperation. As cities do not have sufficient capacity and experience to implement smart solutions, they can team up with others with similar difficulties, as well as with technology partners to develop, implement and apply them, as well as share experiences and search financing;
- Creation of a high-quality ecosystem of interaction of social services, departments, non-governmental organizations, service providers for joint concerted actions to meet the needs of citizens;
- Formation of consortia and expansion of the mechanism of public-private partnership for the introduction of new technologies;
- Creation of urban innovation centers and “living” laboratories for digital business ecosystem. Innovation centers and laboratories can become platforms for demonstrating new ideas and concepts. “Live” laboratories (a place for innovative experiments) will allow experiments and can be used to test, develop and disseminate innovations to build digital infrastructure.
- Creation of an innovative ecosystem of industrial high-tech, which provides for the implementation of the following development tasks: full independent audit of existing elements of the ecosystem, such as design bureaus, the system of higher education institutions, science parks, etc., with targets; their development to target model of the innovation ecosystem of industrial high-tech segments; setting up technology transfer from research institutions, science parks, R&D laboratories, as well as from international centers and corporations to end customers; creation of networks of the most effective structural elements of the “Industry 4.0” ecosystem – examination centers, R&D laboratories, technology parks, incubators and accelerators of Industry 4.0 startups, etc.; establishing cooperation with international standardization bodies in order to develop interoperability standards and other standardization measures necessary for the implementation of technologies related to digital infrastructure; attraction of investments and funds.

The formation of digital ecosystems is undergoing a transformation from a linear to a network model of value creation, which involves the transition:

- From the use of own resources to the coordination of others;
- From the emphasis on the quality of internal business processes to the improvement of external communications between users of the platform;
- From maximizing consumer value alone to the overall value of the entire digital ecosystem.

The content and general characteristics of the principles functioning of digital business ecosystems are presented in Table 9.2. In particular, the basic principles of forming digital business ecosystem include:

- The principle of decentralization and balance of interests (management of the digital business ecosystem is distributed among the state, key partners, venture investors, innovators);
- The principle of taking into account the innovation-digital potential (key areas of research are determined within the digital business ecosystem as a result of interaction of management parties, with 80% of resources focused on priority research areas with high commercialization potential);
- The principle of adaptability (activities aimed at developing industries attractive for commercialization);
- The principle of publicity and information transparency (the system is open to new participants with innovative ideas (no information asymmetry between participants and external parties; positive return on investment, high investment risk is offset by portfolio diversification);
- The principle of taking into account changes (provides for the need to study and use a problem-oriented approach in the development and implementation of innovations).

Table 9.2. Principles of functioning of digital business ecosystems

Principle	General characteristics
The principle of a systems approach	It is the introduction of a wide range of interrelated measures and tools for the development of digital entrepreneurship, which reinforce each other, will promote cooperation between different actors to achieve a common goal – to increase the level of quality services/goods.
The principle of ensuring the interaction of stakeholders	Is involved in the development of digital infrastructure of central and local authorities, private and public enterprises, leading TNCs, business associations, banking institutions, NGOs, educational and research institutions, as well as the population in order to realize the interests of the parties during development of such infrastructure.
The principle of scientificity	It is based on real opportunities and takes into account the specifics of the national economy using the world experience of digital business ecosystems.
The principle of strategic orientation	According to this principle, the actions of actors (both local government and business) involved in the process of building digital business ecosystems are aimed at achieving long-term development goals.
The principle of equal participation of all stakeholders	It involves establishing and maintaining a balance of interests between all stakeholders, which helps to achieve the effect of synergies in the interaction between the parties, development institutions, i.e., business agents of digital ecosystems.
The principle of focusing on market needs	It involves a thorough study of market needs and identify types of innovations that can meet the needs of consumers and ensure competitive advantage.
The principle of social responsibility	Provides effective and social benefits for the population and digital entrepreneurship. This principle must be followed when building a digital business ecosystem.
The principle of safety and control	It involves evaluating the results and analyzing the factors of implementation of smart technologies in the physical infrastructure. The principle is extremely important, given that any technology, as has been repeatedly stated, is associated with risk.

Source: (grouped by authors based on source (Markevych, 2021; *Entrepreneurial ecosystems around the globe and company growth dynamics*, 2013; Chessell, 2008)).

The positive expectations from the functioning of digital ecosystems include:

- Introduction of incentives and motives for modernization, scaling and accelerated development of digital business;
- Encouraging businesses and citizens to consume and use information and communication and digital technologies;
- Make digital infrastructures accessible;

- Increase economic activity, create new jobs, increase tax revenues and domestic demand, simplify the modernization of obsolete assets and create new ones.

Digital business ecosystems representing high-tech industries must pursue the goal of working “without borders”, as this will allow to reach a critical mass in the specific sectoral innovation ecosystems of each country.

9.3.2. Digital business ecosystems through the prism of varieties of realities

Given current global challenges and provoked by the limitations of the COVID-19 pandemic around the world, there is a need for scientific analysis of the features of digital business ecosystem in the context of virtual and augmented realities, due to the fact that business is increasingly moving to an online format. In the course of our research, we also attempted to outline the content and distinguish between these new categories (Table 9.3). Today, these categories are often used by both economists-theorists and economists-practitioners, and not everyone fully understands the semantic and deep, significant differences between them.

Table 9.3. Functioning of digital business ecosystems through the prism of different realities

<i>Types of reality</i>	<i>Content and characteristics of reality</i>
Virtual reality	is based on the exchange of virtual goods within the online environment of digital business ecosystem. Virtual reality creates an opportunity to interact with the artificial world with the help of virtual digital platforms with the available information funds of the online innovation market and “numbers”, the ability to work with cloud technologies.
Enriched reality	contactless information interaction, which realizes with the help of complex multimedia-operational business environments the illusion of direct entry and presence in real time in a stereoscopically represented “digital world”.
Augmented reality	combining virtual and real spaces through hardware and software, telecommunications, computer networks, forming a digital infrastructure and business ecosystem.
Mixed reality	is formed by a combination of several and/or all of the above types of reality; means various innovation and digital projects, the action of which is aimed at complementing reality with any virtual elements on digital sharing platforms.

Source: (developed by the authors).

Virtualization reduces the initial capital cost of deploying the necessary digital ecosystem infrastructure through the use of cloud technologies and software-defined architecture. Virtual business space is gradually covering more and more segments of people’s daily lives. Already today, Internet has become an indispensable tool for the implementation of numerous financial transactions, trade in various goods, exchange of scientific and technical achievements. Virtual reality has already demonstrated the ability to exert an unprecedented impact on people’s consciousness, overcoming state, national, cultural, religious and other borders (Manzhura et. al., 2021^a; Manzhura et. al., 2021^b). World practice shows that the permanent staff of virtual innovative business structures is minimal. Virtual innovative business structures use the potential of both research institutes and, if necessary, industrial enterprises (often informally). That is, such business structures are engaged only in the promotion of ideas and the organization of their commercialization, giving all other functions to third-party institutions.

Thanks to digital technologies, the system of economic contracts is moving to an interactive mode, which is not based on market price signals, but on the direct connection of sellers and buyers of innovative products and digital services through web-sites. In an environment where production is increasingly industrialized and the manufacturer determines its parameters in direct cooperation with the consumer, traditional resellers are being replaced by digital and network platforms owned by Internet companies. By forming databases on the requests of numerous users and grouping them by preferences, these companies create an on-line institutional environment and develop various hubs, around which global innovation networks, digital business ecosystems are formed (Katukov et. al., 2012; Manzhura et. al., 2019).

Today, one of the tools that can quickly and effectively initiate the perception and search for innovation by both small and large business structures is the creation of on-line communities for the search and exchange of digital technologies. In most developed countries, either public portals of “open innovation” or portals of private venture enterprises already operate. Internet portals of “open innovations” maximize the information base of digital enterprises in the field of innovation and facilitate the search for the necessary information. After its analysis, assessment and possible non-compliance, the information goes to various decision-making units. It formulates and makes the necessary changes to short-term and long-term innovation plans of digital enterprises. In the end, a package of necessary innovations is formed, both internal and external, obtained through “open innovations” (Dzhazovskaia & Khokhlova, 2010; Manzhura et. al., 2020^a).

9.3.3. Visualization of digital business space augmented reality

By analogy with the construction of the well-known Rubik’s cube (“Magic Cube” by Hungarian sculptor Erno Rubik) (*Rubik’s cube*, 2021), we tried to visualize, for better perception and understanding, some digital space that forms a new business economic augmented reality. From Figure 10.1 we see that the formation of an effectively functioning digital business ecosystem is possible under the conditions of achieving simultaneous harmonious relationships “science – business”, “power – science”, “power – business”, “education – science”, “education – power”, “education – business” (obtaining a square of faces of a cube of one color). As a result, a special environment is formed – digital cubic space of new business economic augmented reality (Figure 10.2), which provides the implementation of innovative digital opportunities for communication, exchange of knowledge, ideas and experiences between government, universities and business through the use of digital computer technology in real time, space and laws of existence.

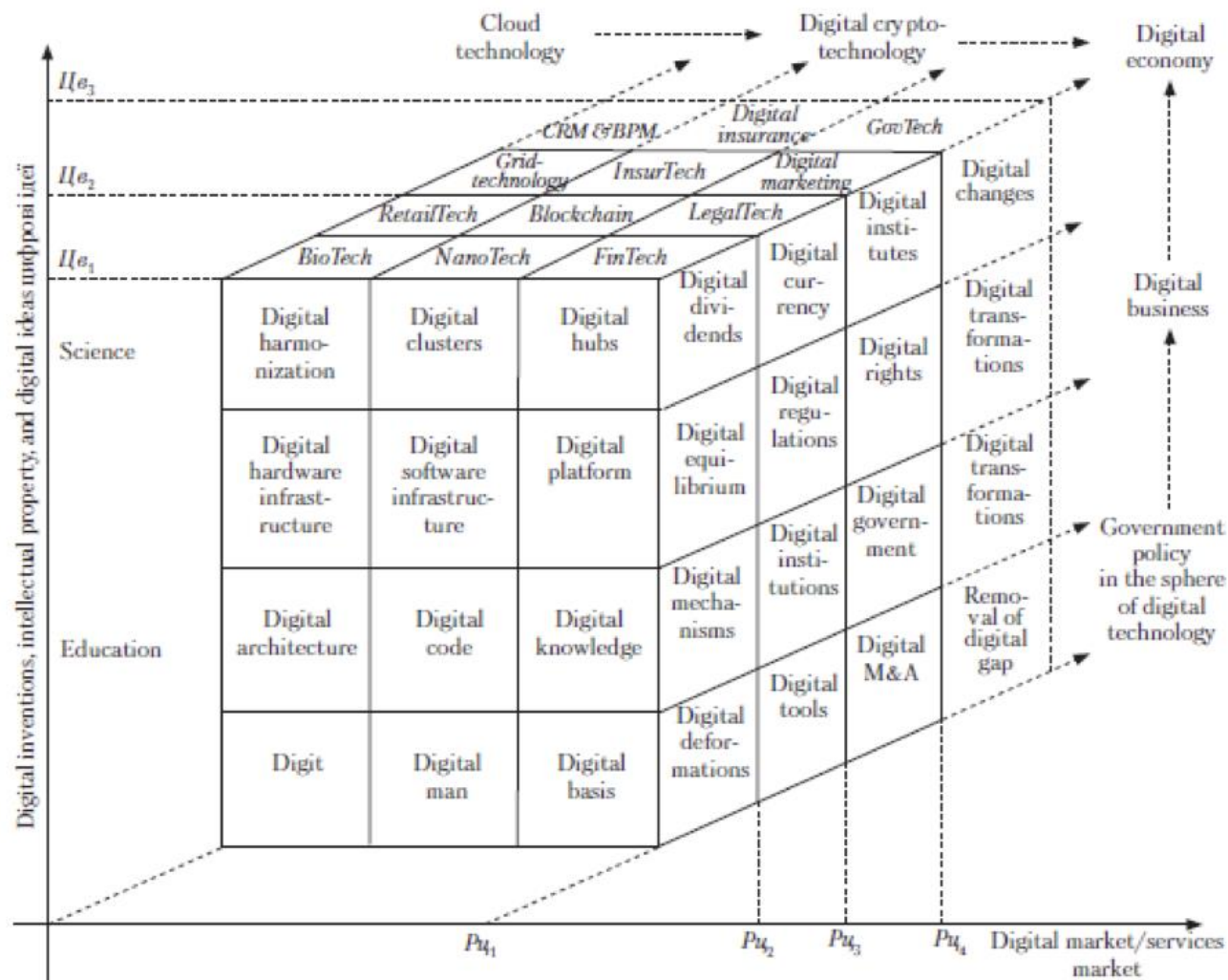


Figure 9.2. Digital cubic space, which forms a new business economic augmented reality

Source: (authors' development).

In Figure 9.2 on the horizontal axis of the point P_{u1} reflects the initial state of digital products/services market before the emergence of the latest technologies used in education, business and government, and points P_{u2} , P_{u3} , P_{u4} – changing the state of digital products/services market as a result of the introduction of digital critical and cloud technologies. Along the vertical axis on the graph is a point U_{e1} demonstrates the initial number of inventions, open and patented ideas, while points U_{e2} , U_{e3} – a growing number of digital discoveries, inventions and ideas in various sectors of the economy.

An effectively functioning digital business ecosystem is possible under the conditions of integrated application of software and IT solutions that will make education better and more interesting, living in cities – more comfortable, doing business – easier, and will bring the interaction of community and government to a qualitatively new level. Digital business ecosystem of new economic augmented reality is not a trend, but a way of development, progress and transition to a new level of civilization (Manzhura et. al., 2020^b; Osetskyi et. al., 2020).

It is this space that contributes in every way to the creation and distribution of digital goods/services. At the same time, science and education are both generators of knowledge and innovative ideas, digital initiatives, the owner of intellectual property, in the commercialization of which are interested and actively involved both government (government support in the form of digitalization policy) and business (profit through Institute of Digital Market). It should be noted that for the full operation of digital environment, education requires constant systematic work on the stable functioning of digital system in the regions of the country based on effective interaction of major participants in digitalization and aimed at creating new areas of digital business, entrepreneurship.

Convergence with a blockchain connection enabled transforms the value chain. Autonomous robotics, AI, IoT and Blockchain will digitize logistics and distribution, reducing its importance and thus increasing the ability of companies to make a profit. Producers working in digital ecosystem will be able to get more value that they create, and consumers will be able to pay less. In the long run, technical deflation will curve the exponential curve, as much of 3D production, as well as virtual and augmented reality, make it cheap to design and allow you to print products at home. And it will also be a certain new technology, which in the future will be determined by economic benefits (Kupriianovskii, 2017).

Digital business ecosystem provides the necessary conditions for the implementation and operation of smart-innovations. The main components of digital business ecosystem are the following digital infrastructure elements:

- Applications (services, application software, data management);
- Data-centers (servers, data storage centers, data processing centers, redundancy);
- Information and communication networks (Internet, broadband networks, sensor networks, data networks, Wi-Fi);
- Information collection systems (sensors, gadgets, smart-video surveillance systems, terminals) (Maslov et. al., 2021).

The connection in digital ecosystem between “soft” and “hard” digital infrastructures and electronic business operations is due to hardware, software, telecommunications.

9.3.4. Innovative changes of ecosystem enterprises in the conditions of digitalization

Stages of transformation of digital technologies by businesses and enterprises operating in the ecosystem are presented in Table 9.4.

Table 9.4. Step-by-step transformation of digital technologies by an enterprise operating in an ecosystem based on the introduction of innovative changes

<i>Stage of transformation</i>	<i>Step-by-step characteristics of the stage</i>	<i>General ideas about the step-by-step course of digital technology transformation</i>	<i>Features of digital technology transformation</i>
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I. Wave of transformation (2000–2010)	<i>Front office</i> 1. Mobile technologies 2. Digital marketing 3. Digital customer engagement	<i>Front office</i> – a group of departments or processes in the organization, responsible for direct work with the client, customers	1. The activity was focused on the front office and the quality of customer service. 2. Organizations sought digital opportunities through strategic acquisitions (e.g., startups). 3. Startups entered the market and played a significant role.
II. Wave of transformation (2011, completion is expected in 2022)	<i>Back office</i> 1. Digital transformation of the enterprise 2. Digital supply channel <i>Middle office</i> 1. Leading business models 2. Digital business strategy	<i>Back office</i> is a division of an organization that conducts business processes, increases productivity by optimizing workflows, and eliminating inefficient manual operations throughout the lifecycle of business processes. <i>Middle office</i> is a group of divisions or processes in a company that manages risks, calculates profits and losses and is responsible for information technology. The middle office attracts resources from both the front and back offices.	1. Digital focus only at front office does not provide a competitive advantage. 2. In order to implement a full-scale digital transformation, organizations are required to focus on restructuring operations that go beyond customer service. 3. Organizations will spend more on digital technology in middle office and back office than in front office.
	<i>Omni-business</i>	<i>Omni-business</i> is an approach whose principles are the integrity and consistency of the user experience	Its main advantage is that users are free to switch between information channels, such as mobile device, laptop, social networks and off-line store.

Source: (author's development)

During the implementation of the model of digital transformation, enterprises must take into account comprehensive adaptive capabilities that allow them to respond to inevitable changes. These opportunities provide resources to engage everyone structural layers in order to implement continuous improvement and implementation of innovations during the formation of digital entrepreneurship; be able to constantly adapt to changing customer needs and new opportunities in global digital market (Kupriianovskii et. al., 2017; Maslov et. al., 2019). Digital citizenship and digital entrepreneurship should be the expected result of the effective functioning of digital business ecosystem, which forms a new economic augmented reality.

The presence of web-site for digital enterprises provides the following opportunities:

- Customer service;
- Supply of innovative products and provision of digital services on-line;
- The ability of visitors to form orders for innovative products and digital services on-line;
- Monitoring the status of placed orders;
- Personalized information content of web-site for regular or repeat customers;
- Links to web-site of digital enterprises in social media;
- Announcement of open vacancies or submission of an application to fill vacancies on-line;
- Staff training and acquisition of digital competencies (Marchenko et. al., 2020; Marchenko et. al., 2021^a).

Thus, digital age of society is changing the approach to entrepreneurship, requires the use of information technology and modern means of communication. Fundamental in building digital economic relations is the use of ICT and Internet by businesses to maximize automation and digitization of business processes within the enterprise and building relationships with other business representatives, consumers and government agencies through the use of modern ICT (Osetskyi et. al., 2021; *Proposal for a Decision of the European parliament*, 2016).

9.4. Conclusions

Digital business ecosystem is a set of organizational, structural and functional institutions and their relationships involved in the creation and application of scientific knowledge and technologies that determine legal, economic, organizational and social conditions of the innovation-digital process and ensure the development of digitalization and innovation both at the enterprise level and at the level of the region and the country as a whole on the principles of self-organization and synergy.

The clarity and detail of the relationship between the subjects of digital business ecosystem will have a positive effect on reducing uncertainty, information asymmetry and risks, improve the quality of project implementation, which will signal further joint activities. An effectively functioning digital business ecosystem will demonstrate the ability to interact for a set of other actors involved, the number of which will increase over time as investment projects increase. As a result, it should be noted that the ecosystem that uses “digital technologies” is called “digital”, and the sphere that creates, implements and maintains them – “digital” industry. Digital entrepreneurship and the development of digital business ecosystem require titanic organizational, legislative efforts on the part of the state, but success can be achieved only by relying on the innovative and creative potential of e-business and digital individuals (*Digital Agenda of Ukraine – 2020*, 2020; Marchenko et. al., 2021b). We deeply believe that digital augmented reality business ecosystem is the driving force behind the competitiveness, innovation, productivity and brilliant economic growth of each country in global digital virtual-real environment.

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