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THE NATURE OF DIGITAL TRANSFORMATION. ENERGY OF THE ECONOMY

How to feel, understand and use it

Scientific monograph

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Has digitization left its mark on the modern economic system? What are the "roots" of digital transformation? Is today's digital development the "energy" of the national economy? Does the digital ecosystem contribute to the formation of Industry 5.0? Is it time for the practical implementation of cyber security tools? What role in the modern economic system is assigned to digital enterprises in the conditions of virtual and augmented reality? What is the digital content of green business? What relationships can be traced in the digital cubic space? Does the "energy" of the economy accumulate due to the synergistic effects of network connections?

The authors offer answers to these and other questions, recognizing that they are not definitive. The monograph presents important insider information about the state of affairs, giving the reader the opportunity to draw his own conclusions and join the discussion of this extremely topical topic. In particular, the scientific work considers the conceptual aspects of researching the patterns of digital transformation, its nature. In addition, the authors believe that digital entrepreneurship and Industry 5.0, which are possible under the conditions of effective work of institutions of coordination and trust, are among the most important institutions of digital development in Ukraine as a result of institutional-structural changes and modernization. Authors' opinion: for the deep digitization of the economy and the formation of the X.0 Industry of Ukraine, an objective vision of the situation, high-quality institutions, competent and balanced economic steps, well-thought-out active actions of both government officials and economists-scientists, and entrepreneurs of small, medium and large businesses are needed, and without any doubt taking into account the global experience of digitization of post-industrial countries.

The monograph is intended for scientists, entrepreneurs, civil servants and everyone who is interested in digital, the digital transformation of the economy and the work of a digital enterprise in the ecosystem.

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INTRODUCTION

Ukraine... 2022...
This monograph was written long before 2022
and it was formed in the conditions of martial law...
was improved, refined in the conditions of war...
to the sound of air alarm sirens...,
when light and Internet were available from 2 to 4 hours a day...
or absent at all for days and weeks...
but this did not stop us, the authors...
we thought... pondered... hoped... dreamed... and just lived!
Not thanks to, but in contradiction!
We remain in science and education!
We live in difficult times for our country...
We wrote a monograph about digital quality and bright economic reality!
We hope and believe that it will be like that for our Ukraine!
From the authors

"The first to break were those who believed that everything would end soon.
Then – those who believed that it would ever end.
Survived those who focused on their affairs,
without waiting for what else might happen"
Viktor Frankl, Austrian psychotherapist,
philosopher, writer, former concentration camp prisoner

Implementation of economic and digital transformations, achievement of economic growth due to the high-quality functioning of digital enterprises and the provision by the state of digitized management services to citizens at a high-quality level, the advancement of Ukraine in the direction of European integration – all this is possible only under the conditions of the implementation of a comprehensive digital transformation of the economy that meets the standards of democratic and legal state with a socially oriented market economy.

The effectiveness of digital transformation, its acceptability for society is one of the key factors in the economic development of each country and the successful implementation of reforms in other spheres of social life. That is why the government of Ukraine pays significant attention to the digitization of the economy, which is implemented by the Ministry of Digital Transformation and is carried out in close cooperation with domestic enterprises.

At the same time, borrowing the experience of other countries in this area, it should be taken into account that it is impossible to invent a universal formula for the effective operation of digital tools that would work in all sectors of the economy without exception, even those that are at the same stages of development and in the same technological frameworks. Each country has its own social values determined by historical, cultural, political, territorial, economic and other features that determine different models of digital transformation of the economy. At the same time, the experience of other countries is valuable in that it clearly confirms the possibility of creating effectively functioning digital institutes of development.

Digital is the basis of the formation of a digital state, thanks to which it provides high-quality and instant services and answers to various public requests and needs. Digitization is an attribute and prerogative of both enterprises and the state. Since the state is an institution of public representation, its modern integral component – the number – has a public essence and forms a digital state. Competent and high-quality digital transformation contributes in every way to the accumulation of energy in the economy and the social stability of society.

Therefore, the functioning of business entities in the digital coordinate system is an extremely important modern stage of economic development. It is the digital opportunities that are revealed to enterprises operating in the digital matrix of the digital ecosystem that are the key to its economic growth. The “digital leap” and “innovation virus”, which is characteristic of enterprises in the 21st century, only accelerates the digital transformation and accumulates the energy of the economy. Economic agents at different levels of economic aggregation can only feel, understand and use economic energy correctly and in a timely manner.

The task that the authors of this scientific publication set before themselves is to highlight the issues of digital transformation and to understand the sources of non-linear innovative and digital power of the economy. At the same time, the authors made an attempt to present the role of the number for entrepreneurial activity, indicated its importance for the functioning of the digital state in general and the formation of Ukrainian digital entrepreneurship, in particular.

CHAPTER FIRST IN THE SPOTLIGHT OF THE DIGITAL WORLD OF THE ECONOMY

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1.1. The game of energies of digitalization of the economy: content and meanings

The latest changes in the economy and society are causing changes in world economy. Today's economic concepts and categories are being replaced by new ones, which can be summarized as the emergence of new economy in the world – digital with its specific definitions, laws, models of world development, economic development as a science, as an industry that is gaining new momentum in history (*Kolyadenko, 2016*). In 21st century the interest of scientists and economists in digital transformation has increased significantly in economic research. After all, digitalization offers real opportunities for the growth of the economy of state.

Today, there is a wide field of innovation of companies in all sectors of the economy, through active work through dialogue with the state, intersectoral interaction and joint development of large projects on the basis of "deep" digitalization. In the last two years, global hype surrounding Blockchain and crypto-assets has not subsided, and financial regulators in the most developed countries are barely managing to respond on new challenges. Mobile high-speed Internet has flooded world with its "invisible web", expanding the banking market and challenging traditional approaches. Organizations become "deserted", which minimizes staff costs and speeds up service.

In addition, the fact that digital economy is dramatically changing the nature of labor and its remuneration should not be overlooked. If our planet became de-energized, world would be plunged into universal insanity and global chaos. We are so accustomed to technology that we are more willing to refrain from eating food than from viewing the message bar on a mobile phone screen. We have adapted and learned to live with technology by fully digitizing our lifestyle.

For successful development of digital economy in Ukraine, it is necessary to ensure:

- Development of on-line services (social services, public services);
- Transition to digital technology by government agencies and agencies;

• Development of Internet of things in Individual Consumer (IoT) and Industry (IIoT) sectors;

• Creation of domestic software, modern and perspective information and telecommunication technologies for substitution of foreign production products (*Yefimushkin et al., 2017*).

Program document "Ukraine 2030: Doctrine of Balanced Development" (*Kalvariia, 2017*) states that "for national economy, large-scale borrowing of new technologies is able to accelerate development of the services sector, to reduce transaction costs (on-line financial services, drone delivery), improve overall efficiency and effectively combat corruption (digital payment for administrative services), and improve access to education (on-line courses)". Doctrine states that following areas of digital development are important for Ukraine: additive technologies, new nano and biomaterials, renewable energy sources, highly automated industries; robotics (artificial intelligence and intelligent systems technology); informatics (cloud technology, mobile communications, new generation laptops); humanization (genetic engineering, nano- and biopharmacology, synthetic biology); greening (low carbon wastes, ecosystem restoration technology, pollution control).

Main components of digital infrastructure are:

• Applications (services, analytics, application software, data management);

• Data centers (servers, storage centers, data centers, backup);

• Information and communication networks (Internet, broadband, sensor networks, data networks, Wi-Fi);

• Information gathering systems (sensors, gadgets, smart video surveillance systems, terminals).

The relationship between "soft" and "hard" digital infrastructure and electronic business operations comes from hardware, software, telecommunications. Interaction in the course of business process implemented through computer networks in the framework of virtual interactions between the subjects of virtual market structures e-commerce and e-trade.

In implementing Digital Transformation Model, comprehensive adaptive capabilities that respond to inevitable change must be considered. These opportunities provide the resources to bring all structural layers together to deliver continuous improvement and innovation as digital entrepreneurship develops; to be able to constantly adapt to changing needs of customers and new opportunities in global digital market (*Kupriyanovskyi et al., 2017[a]*).

Digital age of society is changing the way we do business, requires the use of information technology and modern communication tools.

Fundamental in building digital economic relationships is the use of ICT and Internet by business entities to maximize the automation of business processes within the enterprise and build relationships with other business representatives, consumers and government agencies through the use of modern ICT.

Today, Ukraine's advantage lies in highly qualified personnel, especially in the field of technology, the demand for which is constantly growing. Investment is needed to stimulate economic growth and provide long-term opportunities for professional realization to prevent the outflow of labor resources. Country will benefit both from natural chernozems and from its close geographical location to Europe, as well as the potential for the development of an integrated transport network and port infrastructure.

However, this requires significant investment, which, in turn, requires a stable economic environment and access to capital at reasonable interest rates. Ukraine's oil and gas industry also has a chance to become a major player in the market, but years without investment, corruption schemes and fears of being seen in attempts to "distribute" country's resources have historically hindered investment in this area. If the IMF and EU financing continues, and structural reforms and market liberalization are implemented, Ukraine will be able to offer both Ukrainian and foreign investors a wide range of investment opportunities in the coming years.

Today in Ukraine investments in innovative technologies determine:

• The importance of understanding the balance between general and specialized high-quality IT services;

• The level and quality of thinking through the prism of IT to find the right place for information technology in the organization – the holy grail of transformation;

• Models of IT system maturity (reactive model against dynamic; cooperation with the provider of IT solutions or tools, business partnership based on understanding the key role of IT);

• Changes in the understanding of the ratio of value produced and costs;

• Implementing solutions such as Office 365 strengthens and elevates IT equipment.

In the context of economics, innovation is a set of tools that can significantly increase efficiency and create added value. In other words, a person working on a tractor can generate much more added value than a person with a shovel. And all this applies not only to the individual business or company, but also to the country as a whole. There are two simple parameters that are extremely relevant in Ukraine in the context

of innovation. The first is the so-called “basic hygiene”. Physical and legal security of the business, the ability to work quietly and produce a product/service, without fear that at any time may unreasonably take away the business or block the work of the enterprise.

The second is investment. Unfortunately, the institution of venture investment, which at least in some form existed in Ukraine three years ago, is now completely destroyed. And it is impossible to build a business without financial investments – it is porridge from an ax (*Special Edition Kyiv International Economic Forum “Destinations”, 2018*). It is also worth emphasizing the fact that it is not the state that creates innovations, but universities, active and progressive youth, and entrepreneurs. Sectors of Ukraine’s economy that are currently drivers of its growth are presented in Figure 1.

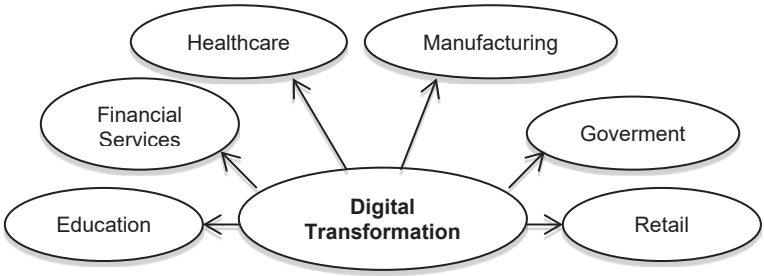


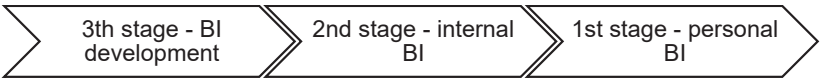
Figure 1 – Sectors that are drivers of economic growth

The industries that will give a new impetus to the growth of Ukraine's economy are the following:

• Hi-tech, R&D, IT solutions for B2B, finance (stock market, ICO), fintech, bioengineering, nanomedicine;

• Basic areas due to production growth: energy, infrastructure, processing industry, education (*Kraus et al., 2018*[d]).

But the development of all these sectors of the Ukrainian economy is impossible without high-quality business intelligence, which is a process of transforming data into knowledge, and knowledge – in business action for profit. The evolution of Business Intelligence (BI) has the following chain:



Opportunities for the economy of business intelligence are as follows: data integration (ERP: 1C, Navision, SAP; CRM: Dynamics,

AMO, BPM, SalesForce; PM: Teams, Trello, Jira, Slack; SM: Google Analytics, Facebook, Twitter; File:.xls,.csv; Payments: Privat24, PayPal, Payoneer; Services: MailChimp, Binotell, GitLab), data model creation, custom visualizations, real-time dashbods, integration with applications, automation.

Turnkey business intelligence as a service is implemented through the practical implementation of the following stages: interviews and analysis of CRI, study of data sources and connection methods, implementation of reporting, refinement and updating, 365/7/24 1ts technical support. Generation Supply Chain is shown in Figure 2.

The quality of business depends directly on strategic thinking, business intelligence and communications. In turn, the quality of technology determines the level of improvement of knowledge and expertise and thinking ecosystem, the development of attention economy (Figure 3).

Figure 3 shows that the amount of input exceeds cognitive capabilities. In addition, efficiency is the ratio between the result obtained and the cost of achieving it.

Efficiency = minimum effort

As for skills, they are also equal to the minimum effort. From this it becomes clear that efficiency is in balance with skills. A visual representation of the place of Attention economics in the coordinate system is given in Figure 4.

Attention economics is an approach to the management of information that treats human attention as a scarce commodity and applies economic theory to solve various information management problems. Characteristic features of individuals in Attention economics are presented in Table 1.

As a result, we note that the current development of Ukraine's economy in the context of innovation and digital transformation should be seen as a factor in increasing productivity, economic growth, job creation and improving the quality of life of Ukrainians. In digital society, citizens must have equal and free access to services, information and knowledge provided through the use of quality information and communication technologies. Ukraine's new progressive economy in the context of innovation-digital transformations and structural changes, which takes into account European values – is about digital skills for the future digital generation, changes in business models and quality cooperation between universities, government and companies in developing interesting innovative ideas.

The institutional environment of Ukraine's economy is characterized by a high level of instability and uncertainty. This is caused by a

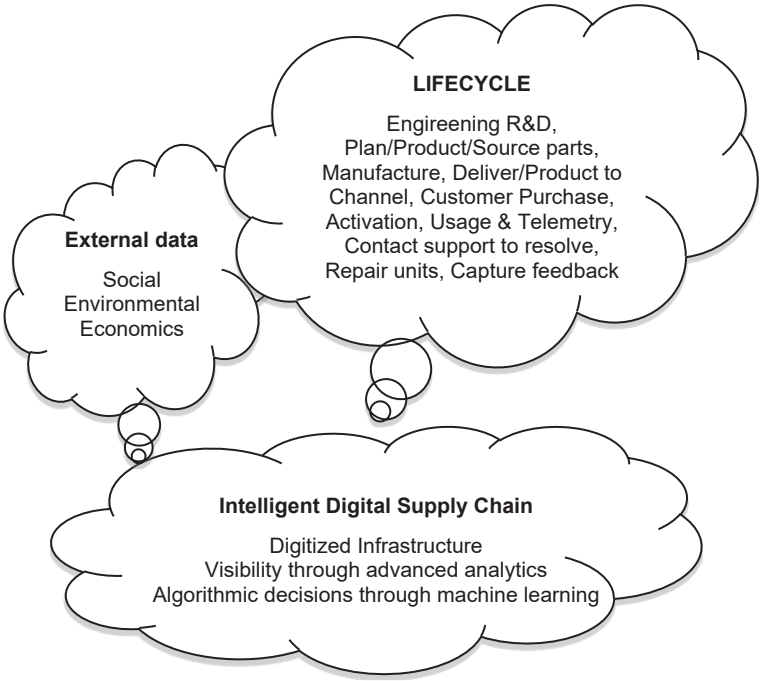


Figure 2 – Generation Supply Chain

special, very incorrect, in some cases even "shock" strategy to move the domestic economy from administrative-command to market form, and therefore fundamental changes in the institutional structure. Main causative mechanism of the development of all kinds of innovation is market competition. To achieve stable economic growth, the state must provide a balance of competition policy. Perspective competitiveness is ensured only by active innovation policy.

Innovative capacity and technological availability are integral components of the competitiveness of national economy in terms of institutional changes. The role of innovation in ensuring competitiveness will increase, because the structure of world industrial production will change in favor of high-tech industries, particularly under the influence of rapid development of nanotechnology, genetic engineering will appeared new production, at the same time ecological, climate threats will cause the activization of ecologically caring industry (*Varnaliy et al., 2013*).

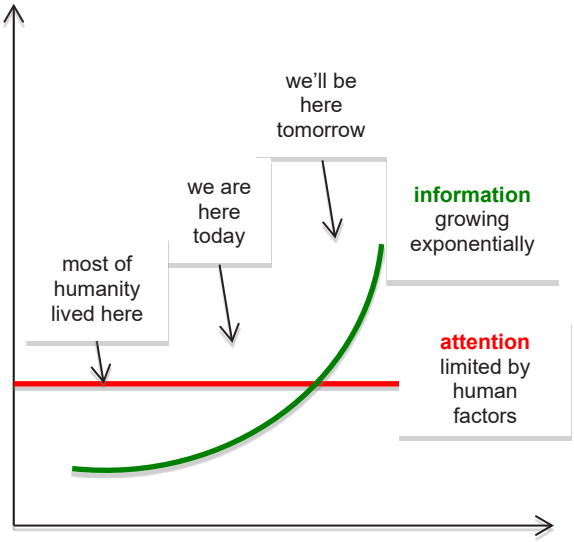


Figure 3 – Graphic interpretation of the development of Attention economy as a result of regular "information booms and explosions"

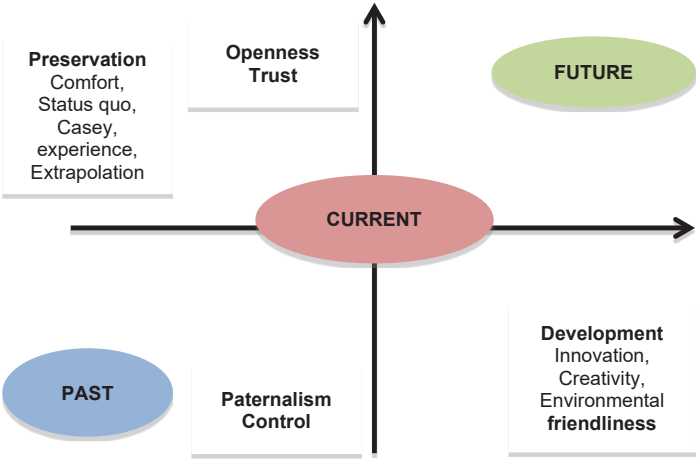


Figure 4 – Visual representation of the place of Attention economics in the coordinate system

Table 1 – Characteristic features of individuals in Attention economics

Born Digital (born digital leaders)	Going Digital (digital emigrants)
1	2
What are they characterized by?	
1. Deep expertise 2. Unidirectional roles 3. Motivates independence	1. Empathy, sociality, cooperation 2. Team building, motivation and development 3. Motivate difficult tasks, need training, growth
Higher	
Adaptive, learn from experience, overcome uncertainty	Impact skills
Lower	
Skills of interaction with other people	Innovation

Competitiveness interpret as the ability to attract and use intellectual capital. Stimulation of the development of innovative entrepreneurship and science and education supporting the experts of EU chose as the most important directions of improvement of the quality of economic growth of its grouping. In most cases, taking into account national features, these should become the foundation for construction of a new Ukrainian competitive economy (*Andrushkiv, 2012*).

According to the Law of Ukraine "On the innovative activity", innovative infrastructure is a "set of enterprises, organizations, institutions, its unions, associations of any form of property, which provide services to support innovative activity" (financial, consulting, legal, educational, etc.) (*Information of Parliament of Ukraine, 2002*).

The definition of innovative infrastructure of T. Ismailova is interesting, because it offers to understand innovative infrastructure as a set of interrelated, complementary industrial and technical systems, organizations, firms and relevant organizational and management systems, necessary for realization of innovative activity and implementation of innovations.

Proceeding from the existing definitions of innovative infrastructure, we can conclude, that undeniably important is the process of institutionalization of the innovative economy in stage of its formation and clarification factors of forming the competitiveness of domestic innovation infrastructure.

Ukrainian scientist L. Mikhailov considers the structure of innovative economy through the prism of types of markets and identifies two components:

• The market of innovations that form the scientific organizations, universities, scientific associations and other entities. On this market the key commodity is a product of intellectual activity that is subject of copyrights, which are decorated in accordance with applicable international, national, corporate and other legislative and normative acts;

– Capital market (investments). This market is a sphere rotation of capital, where, on the one hand, organizations and individuals engaged in the scientific field, and on the other hand – organizations and individuals who invest are the subjects (*Mykhailova et al., 2007*). Main influence on the market of investments exert macroeconomic policy of the state, legislation, securities market, information provision.

However, in our opinion, no full is the consideration of the structure of the innovative economy through the prism of types of markets without market of goods and services. This market gives the answer, by sales of innovative products, to the question: "Was innovative activity successful?". In the market of goods and services, failure can befall even the product that has high scientific and practical value, but does not meet interests of the buyer. For example, it may be high price on innovative product.

An important trend in the creation of innovative products/services is the convergence of new products. Convergence (from the Latin "Convergo" – "rapprochement", "ascent") is seen as rapprochement, assimilation of economies, their economic (institutional) mechanisms and economic structures, and is the inevitable consequence of a glut of product markets of innovations and large variety of product offering of innovations. Under the influence of institutionalization of the innovative economy and the convergence of new products in the market of innovations are forming:

• Novelties that combine products and technology;
• Grocery platforms;
• Co-branding novelties;
• Wellness-products;
• Novelties that bear innovation value or forgotten old;
• nnovations of business models that based on convergence of products, technologies and services (*Markova, 2010*).

The frequency of "exit" on the market with small innovations promotes accumulation of information about consumer preferences, which is a source of knowledge for the next upgrade. However, individual consumer

is not socially isolated person. His behavior is explained not only desires and needs.

Firstly, needs are always institutionally indirect.

Secondly, there are clear folded “chains” of interconnections of goods through technological processes and market agents, which is difficult to track mutual benefits for their individual consumers.

Thirdly, the market of innovations is a complex structure that cannot be reduced only to negotiate between sellers and buyers. When there are a number of producers and consumers appear no-exchange institutional relations. This is so called “horizontal relationships” between different buyers and sellers that are either in a state of competition or in secret collusion. This is also confirms that the market of innovations is characterized by exchange and competition processes (*Apatova, 2004*).

Institutional conditions of raising the competitiveness of Ukraine economy at the expense of innovative factors should be considered as a set of necessary institutions that directly or indirectly contribute to revitalization of innovation processes in the country. As the institutional conditions of forming Ukrainian, innovative economy has not provided yet, so we can understand the institutional changes during the process of transformation of some institutes or transition of institutional system from one state to another.

Determinants, which caused the need for institutional changes during the formation of competitive innovative economy, are:

– Improper development of some institutions and subsystems, which reduces the efficiency of the economic system as a whole;

– Institutional vacuum, that is the absence of some formal institutions, that should promote innovative development and ensure competitiveness.

Competition does not have to be perfect in a theoretical sense, sufficient that it would produce the necessary incentives and be more effectively as a bureaucracy that is not difficult. However, of course, today the competition should be enhanced in order to keep acceptable for the market economy trends of concentration and monopolization (*Yasin, 2007*).

Experience of leading enterprises in the market shows, that innovations are inevitable. A small number of companies are capable to implement radical innovations. The competitiveness of most enterprises is provided with the help of imitation, modification, implementation of existing and those that have proven themselves in the market of innovations. Last theses testify data, gotby scientists as Booz, Allen and Hamilton during researching of 700 firms and 1 300 new industrial and consumer products (only 10% of innovations has a world novelty,

while most of them 70% – additions to the range of existing products or their modifications) (*Andrushkiv, 2012*).

Innovative activity is the main source of the process of expanded reproduction. Innovative activity is primarily directed to overcome technological backwardness, reorientation of production potential for creating competitive industrial enterprises, whose development depends on the susceptibility enterprises to innovations (*Kasich et al., 2008*).

Competition creates incentives for innovations in order to upgrade products, to increase productivity and reduce costs that allow getting revenue some time, until it increases the attractiveness of the market and do not attract competitors. Equal conditions of competition has basic value, that it was impossible to gain a competitive advantages by other methods, than the implementation of the most effective innovations, that their selection was carried out, not because of connections and privilege, but only on economic criteria (*Yasin, 2007*).

Experience shows, that small enterprises are considered more innovative for three reasons: lack of entrenched bureaucracy, more competitive markets and stronger personal incentives to entrepreneurs, who are also owners of firms. In current economy, small enterprises play an important role as innovators and often they are technology leaders. Enterprises can implement technological and organizational innovations through to strategies, chosen by management, and be critical to the success of modern innovation-oriented economy (*Isakov, 2011*).

Implementation of innovative technologies in Ukraine enterprises plays very crucial value in economic development of the country, in its competitiveness in global innovative space. The means to create a competitive economy are close cooperation between scientific advances and using of new technologies of production. Today the dominant way of development has to be the way, which based on the using of strategies to increasing innovative capacity, predefined state priority areas of science and technology progress (*Onipko, 2011*).

Innovative activity of enterprises has a significant positive impact on their economic outcomes. Thanks to the growing volume of production and sales, profitability and competitiveness are increasing, and acceleration of market providing qualitatively new kinds of products. Enterprises, that implement innovations can increase product, improve competitiveness and expand markets (*Kasich et al., 2008*).

For the forming strategy of entrepreneurship development need to define the basic framework of economic activity and the determinants of entrepreneurial behavior, that are determined by society, because the three aspects, that form the “golden triangle”, which is needed to create

a business strategy are prediction or intuition and social processes (*Govorin, 2012*).

In general, the effective functioning of domestic innovative system depends on how effectively participants of the innovative process interact as elements of a collective system of knowledge creation and their use for technological progress and providing competitiveness of the domestic economy. In international practice, different indicators of efficiency of functioning of innovative economy are used.

Summing up the experience of the world theory and practice Z. Varnaliy and O. Garmashova consider, that the effective indicators of a national innovative system may be the volume of innovative products, on which these determinants of development of competitiveness of innovative economy affect:

• Availability of financial security of innovative processes, that is the ability to attract investments in process of providing innovations in production;

• Scientific and technical potential of the country, the result of which is fundamental, applied researches – innovations;

• Development of innovative infrastructure, that contributes to formalization of relationships between science and production, completeness of the innovative process (*Varnaliy et al., 2013*).

In this connection, there is a need for a practical application of some tools from the complex of institutional changes, needed to improve the competitiveness of domestic innovative economy. Among them are development and implementation of programs of modernization of domestic production; setting priorities and introduction of mechanisms to encourage innovative activity; optimization of system of management in the innovative economy through the creation of the Ministry of Education, Science and Innovations of Ukraine (*Kraus, 2017[a]; Kryvoruchko et al., 2017*).

The reorientation to an innovative way of ensuring the competitiveness of the Ukrainian economy will require significant institutional changes in different spheres of social life. Particular attention should be paid to improve the institutions that are involved in innovative processes. An open economy will also contribute the competition, the maximum reduction of program barriers. Only institutional transformation at the making of the innovation model of economic development in Ukraine will enable adaption to the requirements of the global information world society and continuously improve the economic behavior of economic entities and the mechanisms of market self-production production and industrial complex of Ukraine, small and medium enterprises.

This can be achieved by creating an effective institutional framework defined hierarchy of values of the dominant traditions and laws (formal and informal rules) and moral standards. These aspects of the psychology entrepreneurial structures must be based on practices creation, study and formal restructuring, including economic institutions. Good institutional hierarchical system allows for effective governance and regulation of innovative entrepreneurship, social functions and public institutions, providing communication between subjects of by risk enterprise, government, business and society.

The era of information economics, which manifested itself in the transition to the third millennium, influenced on all aspects of economic and public life of man, including social and spiritual. The global development of innovation-information economy can be seen as the expansion of the base of post-industrial society. This allows us to quite confidently characterize the processes taking place in global economy and in world society, as a manifestation of a "paradigm shift".

In an institutional sense, the complexity of the construction of innovation-informational economies related to the birth of a new method of coordination of communications and harmonization of interests. Thus, in the industrial era (industrial paradigm), the world community was based on two methods of coordination:

• The hierarchical order with the system of vertical subordination and the center of administrative management (a rigid model of coordination);

• A market system with price signals, as some deviation from a rigid and clear hierarchy (flexible, but rather atomic).

Post-industrial paradigm is characterized by a non-hierarchical order or the so-called network coordination mechanism. Gobal economy and all its subsystems are stratified in cluster-network structures with horizontal links and a collaborative mechanism (a hybrid model is flexible and simultaneously integrated). As for Ukraine, the transition to an innovation-information model of development on principles of digitalisation is modern, conscious of its choice. In addition, this is required by globalization process, which involves all the countries of the world and which did not escape Ukraine.

With the advent of new technologies there have been significant changes in all spheres of economic life of society. This refers to changes in the mechanism and trajectory of economic progress, based on an increase in the share of innovation and information sector, which has become a powerful source of socio-economic development, its dynamics and growth. Information has become an independent resource with a peculiar value.

It should also be noted that it is the American scientist-economist R. Solou, who is one of the founders of the theory of technological change, in his model of growth proved that the influence of technological progress is manifested in marginal indicators of capital and labor productivity, which are the parameters of the efficiency of national production, and the main factor of economic growth, in the long run, is the development of technology.

Somewhat similar were the studies of French sociologists J. Elliul. The basis of the concept of "technological society" scientist considered the technique which prevails over society and man, develops in accordance with its own laws and is not subordinate to man. It is autonomous with respect to the economy and politics. The technique, in its understanding, is not limited to machines and technologies, but covers all spheres of human activity.

The sociologist distinguished the following types of technology:

• Economic technology (related to production);

– Engineering organization (includes commercial and industrial activities, state, police, military affairs);

• Human technology (covering medicine, propaganda).

The concept of the post-industrial society of American sociologist D. Bell gives an idea of the impact of technological progress on social change. "A post-industrial society is based on a "game between people", in which, based on machine technology is raised intellectual technology based on information... The methodological basis of each society is different and, importantly, there are qualitatively different axial principles, around which the institutional and organizational attributes of one or another society are concentrated".

According to the American sociologist M. Castells, "the information and technological revolution will reveal its transformational potential. 21 century will be marked by completion of global information superhighways, mobile telecommunications... For the first time, person will be able to make significant manipulations with living matter... However, new genetic technologies are permeable, their mutational effects are under-controlled, and institutional control over them is largely decentralized... The way we go depends on social institutions, on human values... The share of wealth that goes to individuals will depend on their access to education, and society as a whole – from its innovation system" (*Maslov et al., 2021*).

We can already see the actual confirmation of M. Castells forecasts today by revealing the directions and problems what are solved and possible variants of sales products of VI and VII technological processes in Table 2 and Table 3.

Table 2 – The core of VI-th technological developments through the prizm of innovation and digitalization

Direction	Solved problems	Possible implementation options
1	*2*	*3*
Unconventional power engineering	Reducing the burden on the environment, saving natural resources	Hydrogen power, synthetic fuel, solar energy converters, AES with a closed cycle, fast reactors, vortex heat generators
Information systems	Globalization of the world economy on the basis of partnership	Bioenergetics, optics, quantum-vacuum computers, artificial intelligence, torsion communication systems
Biotechnology	New level of well-being	Water purification, desalination of sea mode, modified agroculture, treatment of diseases, cloning
Transport	Environmental safety, speed, efficiency	Underwater superliners, string transport, electric vehicles, aerospace transport systems
Ecology	Sustainable development	Non-waste and locking technological "circuits"
Materials	Durability, safety, reliability, efficiency	Nanotechnologies, amorphous metals, memory materials, high-temperature superconductivity, torsion technology of materials processing

Source: compiled from (Krasnoshchekov, 2008) and author's development

Table 3 – The core of VII-th technological developments through the prizm of innovation and digitalization

Direction	Solved problems	Possible implementation options
1	*2*	*3*
Cognitive and socio-humanitarian technologies. Main productive factor is creative intelligence	"Global vacuum capture". New forms of life on the planet. Constructing a new social reality	Technologies of "thermonuclear fusion", psi-technologies, bioenergy, technology related to morality and responsibility. This method is implemented by means of hyperintellectual, hyper-knowledge, hyperinformation, hypercommunication. "Games with the subconscious mind". The availability of 5 cognitive technologies is projected: neuroimaging, cognotropic drugs, cognitive assistants, Brain-Machine interfaces, artificial sensory organs.

Source: compiled from (Krasnoshchekov, 2008) and author's development

American futurists F. Fukuyama and A. Toffler emphasized that "with the technical development of communication tools, reliable information would supplant the unreliable... the information revolution will lead to widespread changes... but the era of large hierarchical organizations has not yet ended... even in telecommunication, fiber optic technology is better able to work when its exploitation is dealt with by one giant and geographically dispersed company" (*Maslov et al., 2021*).

In Table 4 and 5, we provided information infrastructure services and security and cloud-based business transformation based on Microsoft Azure through deep digitization, which today are in demand by medium and large Ukrainian businesses.

Table 4 – Information infrastructure services and digital based security

Areas of activity	Features of application and/or content of activities
1	***2***
Personal data management	User account control. The only point of the system authorization. Formation of user identification within an organization, in all LOB applications, workflows and data repositories. Managing role-based access.
Backup/ Data recovery	Back up for all applications, workloads and data. Independent service and data retrieval on request based on reliable SLA. Restore the work of critically important SLA-based applications with the most effective RPO and RTO.
Configuration management	Manage PCs and servers. Software update. Configuration settings and security policy. Patching, installing updates, password rotation. Verification of service quality, optimization of resources.
Cyber security services	Security audit. Protection testing, vulnerability assessment. Operational safety center (SOC). Business continuity planning. Information risk management. Infopulse Standards Compliance Manager
Monitoring	Round-the-clock support for infrastructure and applications at the levels L1, L2 and L3. Infopulse Service Management: – Cloud Service Desk; – Monitoring solution; – Report management tools.

Source: author's development

Table 5 – Cloud transformation of business through innovation on the basis of Microsoft Azure

Solutions based on Azure IoT Suite	*Migrate to Azure*	*Solutions based on Azure Cognitive Services*
– Smart cities of homes; – Adaptive logistics; – Agriculture; – Industry 4.0; – Health care: diagnosis and monitoring of vital indicators; – Smart office, convenience and safety; – Automotive industry: smart parking, traffic monitoring, vehicle tracking.	– Strategy for the development of cloud solutions; – Transformation of architecture: public, private or hybrid cloud solution; – Assessment of migration process into the cloud; – Transfer of existing infrastructure to the cloud; – Migrate solutions to Microsoft and other providers.	– Development of chat rooms on Azure; – Artificial intelligence (AI) and self-learning machine (ML); – Decision Computer Vision and Face Recognition; – NLP and language understanding (LUIS); – Development of products based on Cortana; – Data-driven marketing; – Detection of anomalies, forecasting.
Office 365, BI, Dynamics 365, SharePoint Online – Implementation of solutions for business process automation and data management (CRM, ERP, CMS, business applications, etc.); – Ensuring compliance with requirements with on-line, local and hybrid implementation; – Integration from any BI platform; – Fast migration from outdated systems to modern technology.	*DevOps on Azure* – Continuous Integration (CI), Delivery (CD) and Release Management (RM) in Azure Repository: improve quality and reduce deployment time; – Automation of testing processes; – Optimization of the development process.	*SAP on Azure* – Deployment SAP on Azure; – SAP implementation of dev-test and development scenarios; – Assessment of migration in SAP; – SAP Architecture for Azure, including SAP HANA, SAP S / 4HANA, SAP SCP and SAP Activate; – Determining the optimal size and consumption of Azure SAP; – Consultancy, licensing, and support from the official supplier of SAP in Ukraine.

Source: author's development

It should also be noted that solutions for modern business are: departmental interaction, document flow, analytics and reporting (BI), customer service management (CRM), resource planning (ERP), data security, support service, corporate content management, virtualization and data storage, mobility.

For innovation-digital development expansion of intellectual space is necessary, which provides a "technological corridor" for promoting innovation. The basis of the mechanism of its expansion is fundamental interaction of knowledge flows and information, which determine the ultimate result of the expansion. If the mass of information in society manages to "crystallize" in the knowledge necessary for an innovative breakthrough, the above mechanism works. "Crystallization" is provided by the formation "content attractors", the core of which is investment.

The construction of such mechanisms, the formation of new content (in which "packed" knowledge) laid the foundation for post-industrial modernization of society. Development of such mechanisms and an understanding of the philosophy of their action, gives a chance "to escape from the impasse of overcoming development" (*Poleshchenko, 2010*). Today the problem of correlation of social and intellectual spaces is traced, which is closely connected with the underestimation of innovative practice of using resource opportunities in the "information – knowledge" dichotomy. Precisely because of the lack of cognitive tools, such opportunities are practically not used to create new content essential for the development of society as the most important products of the knowledge economy.

According to the Ukrainian scientist O. Parkhomenko, the dialectic system of innovation economy "information – knowledge", in which the role of "creative practice" of knowledge production is performed by a person (transforming information into knowledge), built on the application of natural principle of "unification of opportunities", is manageable, and information and knowledge in it operate in an inextricable interconnection.

This principle is based on the innovation-informational economy, because in the process of human creativity, using the dialectical system "information – knowledge", there is a stage of scientific knowledge and it is possible to compare it with "the creative factory of creation of new knowledge and product, the properties of which are larger than the sum of components" (*Parkhomenko et al., 2011*), as the "takes out, is born" new idea. Appropriate from the position of the studied system will be consideration and synergistic effect. The connection existing between parts of the whole, in itself, is part of the whole. The synergetic nature of innovation activity is due to the complex nature of innovation needs.

First, they are not primary, that is, in the multilevel system, the need arises directly for the necessity of solving a set of contradictions between the needs and the possibilities of their satisfaction, and secondly, they are of an integrative nature. According to Ukrainian scientists N. Ryabtseva and O. Alsufeva, innovative needs integrate

creative-cognitive and economic needs. The dialectical unity of these types of needs can be systematically represented by means of the "double helix" model, when the satisfaction of one kind of needs causes an actualization of another kind, but at a higher level of satisfaction. Innovative needs have an objective basis, but they are subjective in their own way (*Ryabtseva et al., 2013*).

In our opinion, the growing expectations of consumer-clients in the 21 century as a result of the formation of information economy in the course of accelerated innovation and digitalisation include:

- Instant access to information and options;
- A new rate of innovation;
- Channel change (transition to mobile and video technologies);
- Democratization of communications (simple and understandable);
- Rethinking the notion of trust (the crisis of confidence in institutions and the need for a guarantee of confidentiality);
- "Death" complicated (simplicity of advanced products and services);
- Consumer power (consumers form and define rules of the game on market).

Consumers demand high-quality services – understandable, fast, simple – that meet expectations, demonstrate honesty and authenticity, provide solutions to problems, are empathic and personalized.

We agree with O. Parkhomenko, which compares synergy with the rule of "leverage" that operates between efforts and the result of creative work of the subject of the innovation process. The change in consciousness at the expense of synergy shifts the point of resistance of the system closer to the result of labor. The greater the synergy, the easier it is to achieve a better result (Figure 5). The effectiveness of the system "information – knowledge" depends on the joint activities of the individual and social environment.

There are two key issues in innovation process: what should a person do? and as? The first question answers philosophy, the second – methodology. Philosophy is the foundation of methodology of innovation and related processes and systems. Innovations are born

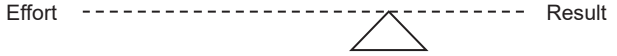


Figure 5 – Model of synergistic influence on the efficiency of creative work of the subject of innovation-information process by O. Parkhomenko

Source: compiled from (Parkhomenko et al., 2011; Parkhomenko, 2009) and author's development

as a result of virtual mental conclusions about objects that do not exist. The more radical innovation, the more it is virtual, and the stronger its philosophical foundation. On the other hand, philosophy of innovation is an accelerator of the development of society, which seeks to successfully solve economic, social and political problems (*Zavadovskyi, 2011*).

Essentially important for understanding the mechanism of functioning of a single innovation field is that all three components (intellectual, informational and material production) of the chain of innovation process do not exist without one. Their development is interdependent. Taken together, these types of production form a single technological chain of production and use of knowledge gained in the process of knowledge.

The production of innovation begins with intellectual production, namely the creation of perfect individual and collective knowledge that gives birth to the idea. The next step is the production of information. It takes place by encoding and distributing innovative ideas. The final stage is the reduction of ideas received in innovative product. A deeper and more understandable innovation field in which company is transformed into an innovation through using of digital technologies is presented in Figure 6.

We agree with Yu. Zaitsev's opinion that "the rapid development of scientific and technological revolution, which covers all spheres of economic and social activity of an individual, a separate state, humanity as a whole and leads to the emergence of "informational", "innovative" and "communicative" rights" (*Zaitsev, 2013*). Information and society are the environment in which a person functions. It is a creative organizational and unifying element in combination of the information environment with society (*Parkhomenko, 2009*).

Economic and institutional contours play an important role in innovation processes. They are based on the system "people – information – knowledge – idea – innovation", in which the transformation of information into an innovative product. The antagonistic tasks of man and society combine to achieve economic benefits. Creating the conditions for the dialectical unity of economic contradictions of man and society is a key point in building an innovation-informational economy (*Parkhomenko, 2009*). Innovative and digital activities need to organize and stimulate, while human behavior is motivated not only by the incentives for maximum personal well-being, but also by psychological and cultural factors. Quality and aimed at a positive result targeted system of information and knowledge preparation of individuals for life and work in an innovative economy and society is needed. Society should be characterized by susceptibility to innovations. This acceptability can be developed in

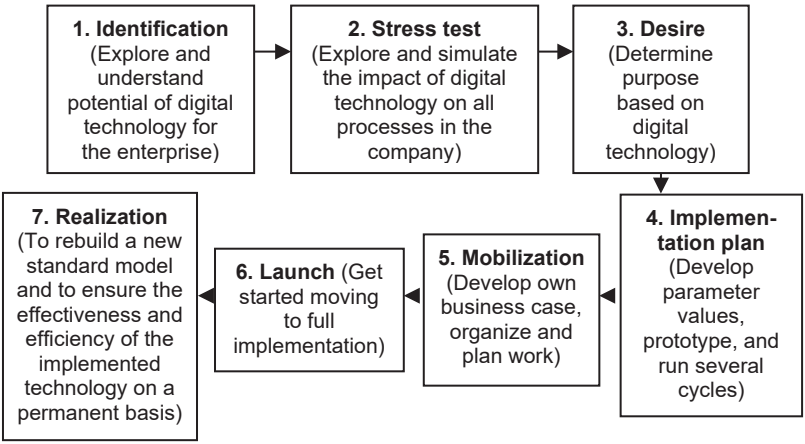


Figure 6 – Enterprise transformation into innovation through using of digital technologies

Source: author's development

two directions: reduction of barriers (forces) of exclusion, rejection and increase of forces for perception, introduction of innovations.

In the end, it should be noted that the transformational processes under the influence of information and technological revolution embraced all aspects of society, transforming it from industrial to post-industrial, innovation-informational, and digital. Already, "young" companies with innovative solutions and approaches easily compete with powerful and long-term corporations. The audience almost completely turned the attention of the TV screens on the display of personal devices. Money transactions and circulation of goods completely lost their borders.

Company that is not represented on Web is not able to locate its customers. If it does not have a single business analysis system, it will not be able to build an effective strategy for competition and development. There is no automation of production – there is no cost savings and product quality improvement. Therefore, for successful business digital transformation is a vital necessity. To do it, you need the right IT tools, verified by time and great data, with excellent user feedback and a diligent professional support service. In spite of the scale of scientific achievements that are already available, it is still important, in future, to conduct research aimed at disclosing an understanding of information

and knowledge in the theory of a "new wave" of growth with endogenous technological progress. It is useful in practice to analyze the dynamic theory of the creation and management of organizational knowledge.

1.2. Digital vector of the management component of economic activity

21st century can safely be called as digital time in management of economic systems, changing the approach to doing business, as well as the requirements for used information technology: marketing, sales and service management systems; telephony and messengers; systems of document circulation and personnel management; accounting systems and many other corporate applications (*Transparency International Ukraine, 2019; Deloitte, 2019; Europa.eu, 2017*).

Newest digital technology in management today is called GovTech. GovTech includes all IT products; solutions; development; services that help solve the problems of coordination and management of public sector. GovTech solve such problems:

1. Participation. Creating platforms for citizens' co-operation, electronic petitions, crowdsourcing. Enhancing e-identification capabilities. These technologies are more commonly known as CivicTech.
2. Infrastructure (digital sensors, control sensors).
3. Provision of services in education, health care.
4. Regulation (decision for the assessment of objects, conducting inspections).
5. Administration – licensing, cloud management, software management (*Tapscott et al., 2016*).

Digitization of Ukrainian economy is a complex of mechanisms, motivations and incentives for the development of digital technologies in management of national economic system, and hence the extensive domestic digital infrastructure, in order to take advantage of country's capabilities, enhance its competitiveness and the well-being of society.

The concept of digital technology development involves the implementation of a series of activities aimed at overcoming "digital divide" by introducing and using the newest communication and data transmission technologies, as well as the comprehensive introduction of digital technologies – from the introduction of digital jobs to digital agenda of modern world and managing them.

The first in the world of Blockchain smart-assets (*Yakushenko, 2017; Efimushkin et al., 2017; Kupriyanovskyi et al., 2017*[c]), built from scratch for productive management of national economic system is NEM. Blockchain NEM technology provides a world-class platform for

practical management of any type of asset of economic system: supply chains, currencies, notarial certifications, registration of ownership, etc.

Regardless of whether a new, better mobile application is being built, or whether Blockchain is being implemented in the existing business infrastructure, NEM makes Blockchain the one that works with maximum efficiency. Blockchain NEM provides an open and self-developed platform for developers, and access to all capabilities is realized through digital simple API NEM. The benefits of using NEM in business management are given in Table 6.

NEM is built from scratch to be easy to use for developers. Regardless of whether consumer wants to build something over NEM using his favorite programming language or interact with NEM core using Java (soon C++), Blockchain NEM has many proposals in power, scalability and ease of use. If an entity is newbie in Blockchain area, NEM can be point of entry into this industry for a new business entity.

If an entity is experienced, NEM has power required to create the most advanced applications on Blockchain. To get started with NEM, only the client will need to access network.

Table 6 – Advantages of using NEM in business management

NEM advantages	Features of NEM in business management
1	***2***
High efficiency management	1. Reducing infrastructure costs up to 90%, which is confirmed by the real Proof of Concept cases. Easy and understandable integration of NEM into business. Full functionality thanks to API, which can be used with any programming language.
Easy to use and manage	2. Maximum flexibility in setup. With the smart-assets system, NEM allows you to focus as closely as possible on the design of what you need: FinTech systems, logistics tracking, ISO, notarization, decentralized authentication.
Enhanced flexibility	3. Speed of work. Blockchain NEM platform is designed, programmed from a clean sheet to achieve some of highest transaction speed and uncompromising performance stability indicators, by consensus proof of the importance of proof-of-importance.
Reliability and safety	4. Reliable protection. Using a unique reputation management algorithm for Eigentrust++ nodes, which provides exceptional protection against malicious attacks and ensures stable operation of all Blockchain NEMs.

Source: author's development

NanoWallet is a client-based browser that will use all features of digital technology NEM with ease. To do this, just download NanoWallet with nem.io., the extended features shown in Figure 7.

Blockchain NEM's own currency is XEM, which can be considered "fuel" for the entire ecosystem. It is used to pay for a transaction and as an incentive for a network of public nodes. This means that XEM has a real fundamental value as the currency of a functioning economy.

Harvesting is a process similar to that of other cryptographic trades, but it uses unique methods of evidence validation and delegated chartering to determine reward recipients (*Pogosyan, 2017*) (Figure 8).

NEM is the first Blokchain that implements delegated harvesting without revealing private keys. To do this, you must connect the account to existing network node and use its resources to complete blocks on its own behalf. Areas of use of harvesting in management of national economic system are presented in Figure 9.

Blockchain is optimized for business data management. For example, Catapult is a full-featured Blockchain engine that can provide both private and public networks with its unique smart contract plugins and manage them. These plugins allow you to create secured digital assets, decentralized swaps, advanced account systems, and business logic modelling. At the next stage, the Catapult will become the core engine of NEM platform.

In addition to offering great improvements in speed and scalability, Catapult offers aggregated transactions and multi-level multi-signature accounts. All this gives you new uses that were not previously available to any of the existing Blockchain.

Aggregated transactions combine many transactions into one, allowing for unwanted swaps, automatic Cross Chain transactions, and other advanced logic. Catapult does this by generating one-time smart-contract. Once all the parties have approved the transaction, all its structural components are immediately executed. Today Catapult is only Blockchain with this functionality.

Another new feature of Catapult is multi-tier multi-signature accounts. For the first time on any Blockchain, it adds a "and/or" logic to multiparty transactions. You can also think of this as a "signed signatures". This allows us to use a wide range of quality business logic management. This example shows how a high-security account can be made easier to use.

Transactions are only confirmed by hardware wallet or phone and an artificial intelligence system to detect fraud (*Karcheva et al., 2017*). This allows protocol-level security configuration kits to protect customers from hacker attacks. You can set up your account so that it can only be

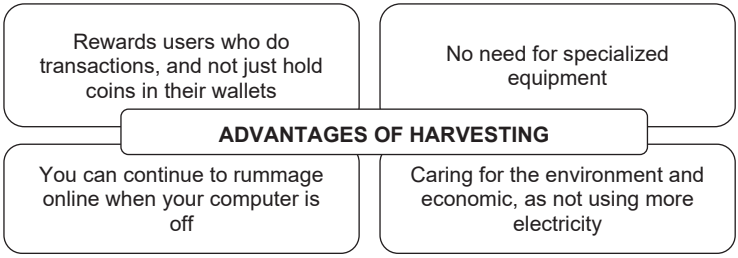


Figure 7 – Advanced Features of Nanowallet

Source: author's development

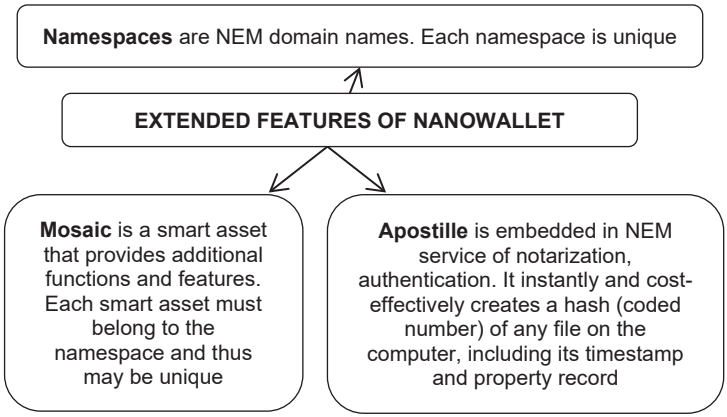


Figure 8 – Advantages of practical application of harvesting in management of economic system

Source: author's development

restored through approval of signatures from special accounts, such as friends or family accounts.

Catapult accounts can be much larger than sending currencies. They are able to send any digital data such as certificates and reports. Multi-level multi-signature Catapult can interact with items such as delivery scanners and automated devices in production.

In this case, the manufacturer delivers product as a pharmaceutical preparation. Product receives a quality certificate only when its record in Blockchain shows its production date, information from safety

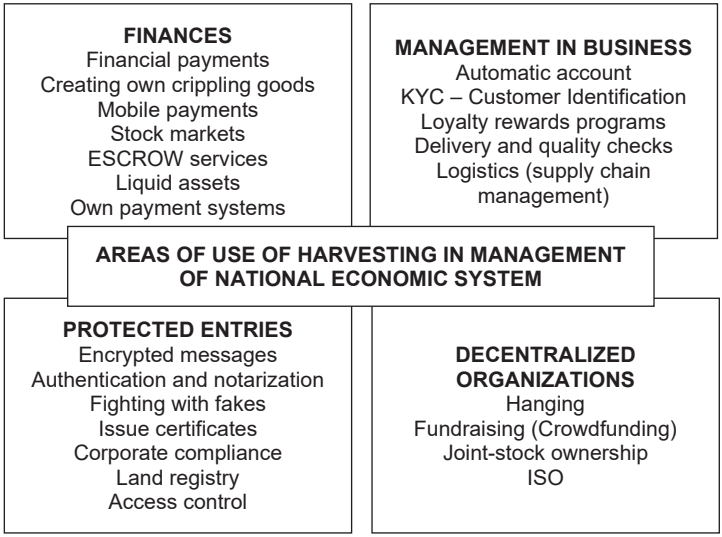


Figure 9 – Areas of application harvesting in management of national economic system

Source: author's development

inspections and the fact that product has been delivered at correct temperature. Sensors in the delivery container notify the temperature data every 5 minutes and collect it in a daily report.

Catapult is fast, because it is built on a four-layer architecture (Figure 10). This allows each layer to be protected from slowing down the influence of other layers so that ARI calls and data requests can respond quickly even at high traffic information. It also allows developers to update any of these layers without interrupting others, improving security and enhancing security.

The positive effects and convenience of multi-level multi-signature Catapult, as newest digital technology, are as follows:

1. Escrow transactions with lots of assets. If a buyer purchases tickets for a concert with payment in XEM, he makes a purchase during a promotional campaign, then he receives a voucher for a live t-shirt. On other Blockchain, these types of combined transactions that don't need trust are quite impractical. Catapult makes them simple and safe.

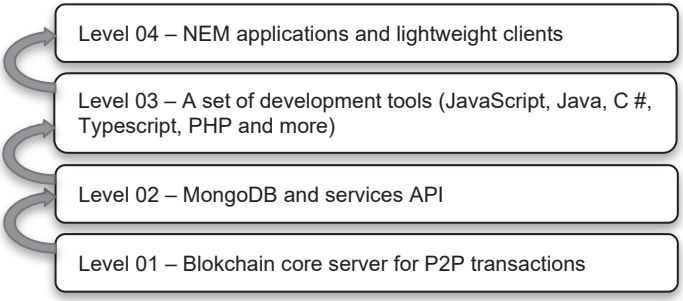


Figure 10 – Four-layer architecture as the advantage of the productivity of newest digital technology Catapult in management of economic system

Source: author's development

2. Decentralized swaps. In the case when buyer wants to purchase a license (for example, media usage rights) for 3000 XEM. The license is for sale on stock exchange, but buyer wants to keep all private keys outside the exchanges. The Catapult automatically creates three remittances required for the implementation of trust a swap:

– 3000 XEMs are passed to seller.

– The license is transferred to buyer.

– Exchange Commission in the amount of 6 XEM is transferred to stock exchange.

3. Automatic commission fee per transaction. If buyer sends $ 50 to seller using a bill for payment, but does not have any XEM to pay for the transaction commission in Blockchain, then Catapult can automatically convert USB to XEM to pay for the commission.

As a result, buyer and seller can use Blockchain Catapult without even having to buy or maintain an XEM. From the moment an account developer can place his own branding on an account for open source payments, buyer and seller may not even know that they are using Catapult. Today there are many options for use Catapult in economic system and they a re presented in Figure 11.

Proof of importance (POI) is one of major innovations in Blockchain industry (Figure 12). This is newest consensus algorithm and reward calculation that uses network data to assign a ranking of the importance of each online account.

Protocols of consensus POI are as follows:

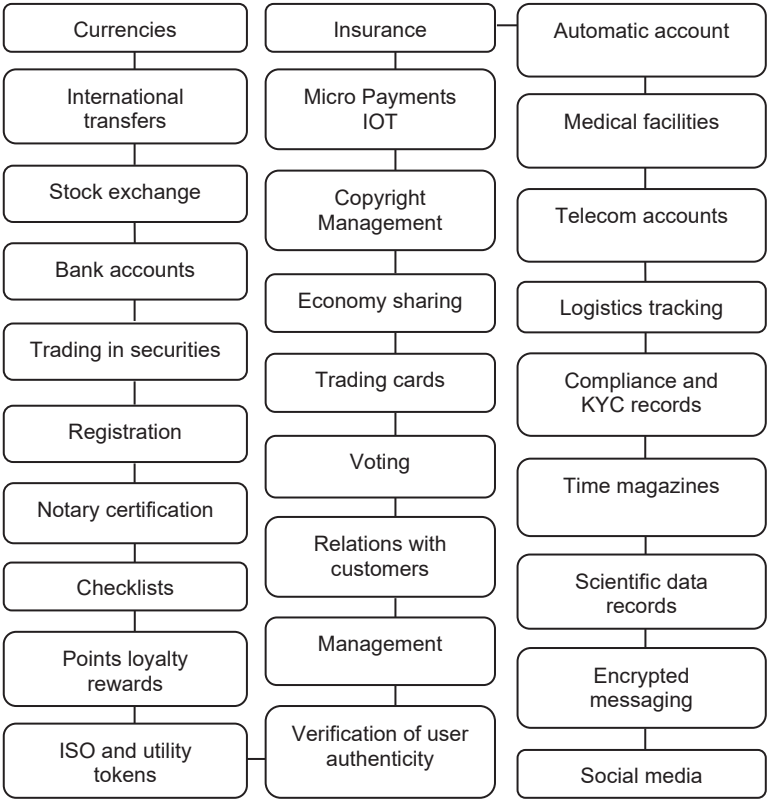


Figure 11 – Options for using Catapult in management of national economic system

Source: author's development

1. PoI is the mechanism of consensus Blockchain presented by NEM. Its function is similar to the proof of the particle, where nodes need to accumulate and keep amount of currency in order to have the right to create blocks. However, in PoI, the importance of users is determined by number of tokens they have and number of transactions carried out with them and their wallet. In POI, and the volume of transactions is also a factor as one of the components of network support and trust.

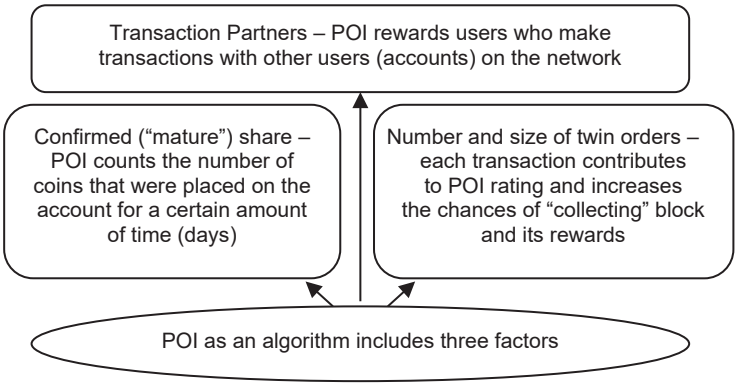


Figure 12 – POI factors for the work of newest digital technologies

Source: author’s development

2. Proof of storages (PoSt) is proof of capacity, a method in which a single node allocates a nontrivial amount of disk space to solve a task that service provider puts in place. PoSt is very similar to proof of work (PoW), the difference is that instead of computing, you use a computer repository. The storage proof is relevant, but differs significantly from functions associated with memory and proof of possibility of their recovery.

3. Proof of bandwidth (PoB) – ProximaX will use several proxy validation mechanisms to report and check the contribution of P2P nodes to network.

Mijin’s newest digital technology is a private Blockchain that addresses the issue of keeping confidential information in business, and combines all the power of NEM platform functionality. Developed by its technological and innovative giant Tech Bureau Corp, and tested by more than 300 companies in real economy sector in Japan.

Main benefits of using Mijin digital technology are:

- Low infrastructure costs;
- Management of access rights;
- High speed;
- Low development costs;
- Lack of idle time;
- Lack of commissions and transactions.

ProximaX's Information and Digital Technology is a decentralized valuable Blockchain-based repository as well as a content delivery network. It is developed by the same creators-innovators that create Blockchain platform NEM. ProximaX is a scientific and technological "leap forward", providing a holistic solution that combines on-chine and off-chan protocols and services.

ProximaX's Information and Digital Technology is specifically designed for real-world use, it is a suitable substitute for traditionally centralized technology architectures that gradually change each other as a result of dynamic development of new digital technologies. ProximaX is a revolutionary Blockchain modification that has been redefined and evolved.

Blockchain 3.0 ProximaX protocol is a thorough extension of distributed registry technology and Blockchain with rich functionality of services and protocols (Figure 13). Business, enterprises and innovators can avoid costly, unsustainable centralized management architecture crashes by using an all-in-one rack platform that provides content delivery, complementary security, repository and streaming media.

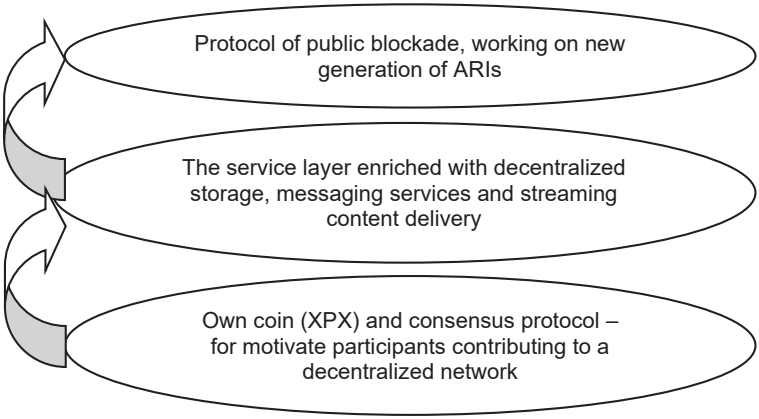


Figure 13 – Blockchain 3.0 Protocols

Source: author's development

ProximaX expands traditional Blockchain protocols by integrating the number of off-chains, peer-to-peer service components, such as Content Delivery Network (CDN) and cloud storage offerings. Primary services include messaging, storage and media streaming – all based on reliable consensus protocols to ensure network integrity. In the future,

services will allow measuring, confirming and stimulating decentralized workforce to prosperity and growth on a scale.

ProximaH is designed to provide solutions to the problems of the past by creating a new platform on Blockchain, which consists of the following on-chains and off-chains protocols, forming a wide range of decentralized services with infinite capabilities (Figure 14).

ProximaX Projections: KYC Policy Processes; ensuring business continuity; management of medical, accounting, IoT records; Big Data application; recording and reporting systems; registers; data tracking; legal and notarial services; video streaming; corporate co-operations and messaging; supply chain management. The components of ProximaX's digital technology are presented in Figure 15.

Following examples of the use of digital technologies in management at macro and macro levels indicate a new high quality in customer acquisition of services/products, thus it becomes obvious that the development of digital technologies for Ukraine has a fundamental and priority character, because stopping economic downturn, accelerating social development on the basis of innovation can only be conditional on digital transformation in part of new quality management of national economic system.

Priority should be given to harmonizing and managing business rules, eliminating barriers to entry into the innovation market for newly created enterprises, new quality management of education systems and training on the basis of digitalisation, overcoming institutional barriers that impede comprehensive implementation of newest digital technologies in management of Ukrainian economy at different levels of economic aggregation.

Blockchain is a multifunctional and multilevel information and communication technology that aims to make the accounting of various assets reliable and instantly accessible. Reliable storage technology for keeping records of all transactions that have not taken place. Blockchain is a chain of data blocks that is steadily increasing as new blocks are added with records of recent transactions. It is a chronological database, that is, a database in which the time when the record was made is inextricably linked to the data itself, making it non-commutative.

One of the major benefits of Blockchain technology comes from being able to speed up processes and reduce transaction complexity and risk. New advantages 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, enabling financial institutions to come up with potentially lower costs, better products and accelerate time to market.

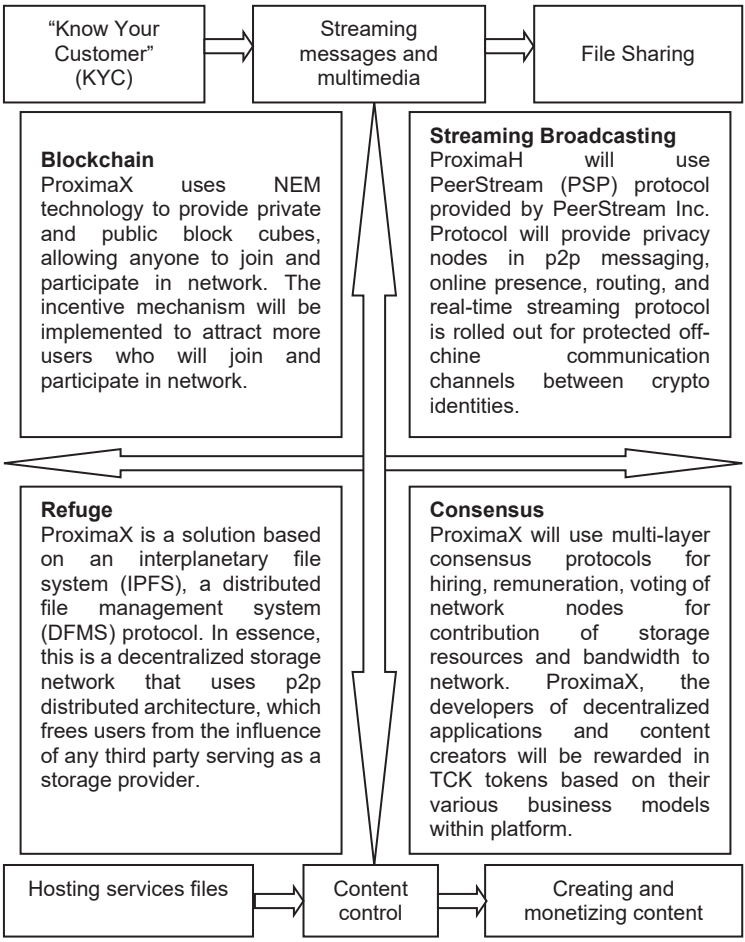


Figure 14 – Protocols and layers of service, on-chine and off-chin protocols, decentralized use

Source: author's development

Blockchain is a global distributed ledger that facilitates the movement of assets worldwide in seconds, with a minimal transaction fee. These assets are different in value and can be represented in digital form.

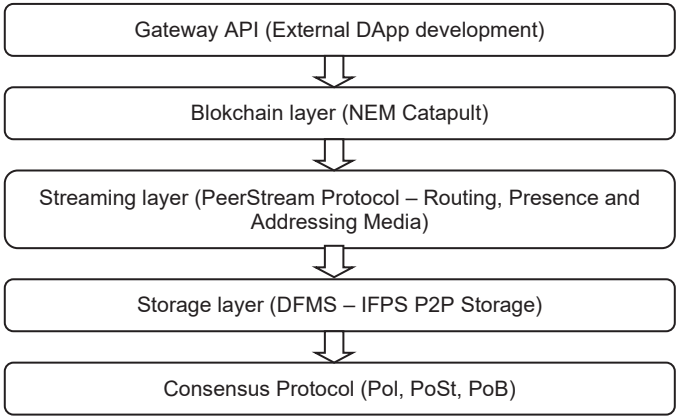


Figure 15 – Components of Proxima X's Digital Technology

Source: author's development

The use of Blockchain technology has great potential in terms of simplifying and improving efficiency in various fields of activity, primarily financial, through the creation of a fundamentally new financial services infrastructure. However, transition to new technology will not succeed so quickly, for a number of reasons. First of all, due to uncertainty in the legal and regulatory spheres. In addition, large-scale implementation of Blockchain requires considerable investment and efforts in terms of standardization and unification. Blockchain multilevel infrastructure needs to be built and consumers and regulators have confidence in this technology. At the same time, Blockchain's capabilities and growing interest in it testify to its great potential and ample opportunity to develop and improve performance across industries.

In the light of global changes in doing business, Ukrainian entrepreneurs have faced a number of challenges that need to be urgently addressed in terms of a new quality of business management and the emergence of Smart-business. The problem of this issue lies in the solution of a number of following issues, namely:

- Optimization of personnel management processes;
- The cost of hiring a new employee should not exceed the cost of his maintenance;
- Elimination of the fact that company incurs losses during the search for a replacement;

• Understanding real reasons for dismissal of employees;
• Strengthening the involvement of employees;
• Reduction of time spent on the evaluation process and training;
• Periodic feedback;
• Reduction of staff turnover;
• Possibility of predictive influence on employee retention;
• Development of reports on results of evaluation, training and history of the results of employees, a single database of employees, modern tools for training, involvement and evaluation of results (*Osetskyi et al., 2020*).

As part of the publication problem, we consider it necessary to mention, for example, the content, advantages and benefits of the latest digital technologies, which are aimed at creating a new quality of business management of the business entity. Thus, the advantages of Teams can be called:

• Single tool for communication between all employees of the company, which makes management transparent;
• Completely safe communication (the effect of security of the internal control system);
• More features than regular messengers;
• The entire corporate structure and contacts of colleagues in the palm of your hand (instant level of communication and increasing the level of the institution of trust, both interpersonal and institutional);
• Joint work on documents (formation of effective teamwork through the work of the institute of coordination and dialogue and elimination of the institute of conflict), the presence of video calls (up to 250 people through Zoom, Google Meet).

The advantages of PowerBI are:

• A single place for all possible sources of information of the business entity;
• Clear presentation of information (graphs, maps, charts, etc.);
• Ability to analyze 3600 information and simple administration;
• Access to information anywhere and from any device owned by the company.

It is necessary to use Teams by the enterprise for the purpose of strengthening of quality of management it is necessary in part of creation of uniform channels of communications where each manager always has access to all information necessary for work (price lists, templates of contracts, technical documentation, etc.); holding “here and now” urgent online meetings (no need to gather people, send them invitations); creation of “information banks” in various fields (updating 1C, updating

sales rules, instructions, etc.); automation of some management processes with the help of bots.

The use of PowerBI in practice of business management allows:

• To quickly and efficiently carry out weekly detailing of the entire business by size and number of criteria;

• To provide assistance in planning and forecasting sales growth;

• To conduct an in-depth analysis of contractors and their needs;

• To increase the speed of decision-making;

• To identify scarce products on the market;

• To control the work of representative offices for the implementation of their sales plan.

Smart-business can be used in the practice of managing an innovative enterprise, namely in the part of:

• HR • automation of internal HR-processes;

• T&D • corporate training center management;

• Sale • training of clients/partners.

Today, the features of Smart-business are inherent in large and growing companies; companies in the field of small and medium business; international companies or companies with offices and branches in the country; companies with a high level of staff turnover; companies with goods and services that need specialized training; organizations interested in automation and structuring of HR-processes.

Functional modules of Smart-business in terms of the formation of a new quality of enterprise management can be called recruitment, work with employees, event management, distance learning, development of skills and competencies, gamification, employee evaluation, AI functionality. In general, all functional modules are aimed at Employee journey as a basis for HR processes, talent search, human capital management, training, development, attracting creative human capital. The content of each of them is presented in more detail in Table 7.

At the same time, the use of outsourcing has a positive effect on improving the quality of the enterprise management system. The benefits for business are as follows:

– Time savings: +240 additional hours per year; tools of “my time”; mobile applications; speed of decision making;

– IT cost savings: flexibility in quality and content; opportunity to try; instant readiness for work; integration of services “out of the box”; always the latest versions;

– Optimization of business processes: teamwork; automation; visualization; Artificial Intelligence.

Formation of a new quality of business management is possible with the related (parallel) use of new ways of doing business, such as:

Deliver personalization; Drive omnichannel customer engagement; Enable collaboration with workplace mobility; Run microservices on a secure cloud platform; Be agile with a connected supply chain; Leverage artificial intelligence across the value chain; Capitalize on service-based revenue streams; Delight with augmented and virtual reality.

Table 7 – General characteristics and content of functional modules Smart-business in terms of the formation of a new quality of enterprise management

Type of functional module	The content and characteristics of functional modules of Smart-business in terms of the formation of a new quality of enterprise management
1	***2***
Recruitment	Integration with employment sites to post vacancies and receive feedback. Vacancy and feedback management. Database of potential job seekers. Setting requirements for positions. Management of the funnel of selection of employees and fixing of results at each its stage. Visualization of hiring results in the form of reports and indicator monitoring panels. Preservation of the full history of communication after hiring a candidate. Marketing HR-activities: a list of companies to attract talent, grouped by customized parameters; list of actions during the campaign.
Work with employees	Adaptation: automatic installation of the adaptation plan and control over its implementation; online testing, distance learning, list of tasks; mentor management; Feedback. Appointment of administrative and functional managers and mentors. Employee profiles. Management of contracts, insurance policies and instructions of each employee. Flexible tools for filtering and visualizing an employee profile. Consideration of the company's projects in which the employee participates. Recording progress in work and projects. Inventory accounting.

(Continuation of Table 7)

1	*2*
Event management	List of corporate events. Management of event participants: waiting list, registration, rejection of applications for participation; presence; collecting feedback through questionnaires. Distribution of roles during the events: organizer, speaker, participant, responsible person. Drawing up an action plan. Automated message by mail or chatbot.
Employee evaluation	Evaluation procedure: 90, 270, 360. Assessment: key performance indicators, competencies and skills, feedback, questionnaires, questionnaires. Creating forms of assessment in accordance with the rules and requirements: immediate supervisor, functional manager, mentor, colleague, employee.
Employee evaluation – KPI	Identification of key employee performance indicators. Procedure for approval of key performance indicators. Monitoring the implementation of key performance indicators. Guide to the categories of key performance indicators. Estimation of key efficiency indicators, calculation of average labor productivity taking into account the coefficient of significance. Key performance indicators in real time.
AI functionality: outflow of personnel	Forecasting the risk of dismissal. Questionnaires on employee values. Analysis of the factors influencing the dismissal of employees. Create an ideal candidate profile for each position. Distribution of employees by risk areas on the main factors influencing the dismissal. Distribution of workload between recruiters for effective planning of hiring campaigns.
AI functionality: chatbot	Channels: Telegram, Teams, Viber, Facebook Messenger. Familiar and user-friendly interface. Authorization via AD. Access to HCM LMS information: knowledge base, my tasks, my competencies. Receiving messages from the system: messages, reminders, mass mailing. Integration with corporate systems (payroll, internal portal).
AI functionality: face recognition	Easy search of photos of employees on all corporate storages and photo albums. Identification of employees added to the corporate photo repository.

(End of Table 7)

1	*2*
AI functionality: face recognition	Post found photos on social media in one click, right from the app. Ability to track employee attendance at corporate events, meetings, trainings without registration forms.
Customer Engagement & Loyalty	In-store customer service and engagement. Digital engagement (Social/Local/Mobile engagement). Digital coupons and integration with digital wallet. Coalitions for services (e.g. shipping) and data-sharing. AI driven digital assistants.
Workforce empowerment	Digital front-line enablement tools. Preventive retention. Dynamic team allocation and task assignment. Dynamic customer service mgmt. Real-time perfomance tracking and personalized incentives.
Intelligent supply chain and optimized fulfilment	Data-driven demand prediction. ML-based assortment optimization. Smart routing orders, logistics, pick, pack and ship (ML-based). Digitally-enabled quality monitoring and management. Intelligent warehouses.

In conclusion, the leading factors of transformation in business and its management are: the need for continuous development (focus on more comprehensive transformation instead of developing such aspects as re-equipment of production facilities, strengthening the sales unit or developing a long-term strategy); new productivity formula (productivity = people + processes + tools); maturing the need for change in the internal culture of the enterprise (deep "employee involvement"; monitoring the working climate of the entity based on feedback from employees; support for bottom-up work initiative in decision-making).

1.3. How digital rules work and how it works in a digital world?

The formation and development of the digital economy depends on the implementation of such advanced technologies as nanotechnology, biotechnology, technology of complex energy systems, quantum technologies. At the same time, it is difficult to further development of the digital economy without the widespread

adoption of information and communications (ICT) technologies, including cloud computing, big data, mobile technology, Internet of things technologies, geolocation technologies, distribution networking, etc. (*Efimushkin et al., 2017*).

Digital technologies are evolving at an exponential rate, radically changing the essence of business, dematerializing, demonetizing and democratizing every industry. Augmented Pixels (known for developing augmented reality technologies and applications) are born of a simple idea; Paymentwall (provides over 120 payment methods worldwide); Kwambio (3D Design Online Store) (*Deloitte, 2019*).

The latest Blockchain technology, which focuses on financial asset trading, is potentially the most interesting for both the transactional banking and payment domain, and for processes within and between organizations. But, in fact, the needs of the market have led to new terms. For example, the term “Value Web” for Blockchain technologies was coined to Fintech by Chris Skinner, but the idea is also known as “Internet values” for other applications. It is worth saying that “Internet Values” refers to the next mass evolution of the Internet, which is expected to be characterized by a combination of different technologies, and Blockchain will be the key. The “world of finance” is expected to be different (*Kupriyanovskyi et al., 2017*[b]).

To give an example from FinTech, we add that the advent of Blockchain and financial record sharing technologies, which offer new opportunities for decentralized identity systems, may be beyond the control of any company or government, ultimately relying on massively used devices. FinTech 2.0 is already considering a product design focused on the support of the following solutions, which is highly dependent on personal requests of users.

Blockchain is able to transform the payments ecosystem by improving the efficiency of financial transactions around the world. Banks and other financial institutions have the opportunity to improve operational efficiencies in cross-border transfers in real time, but as transactions grow, Blockchain algorithms will be exposed to multiple participants, which increase the risk. In the future, the realization of the potential will require significant investment from participants to ensure security and transparency of all agreements (*Pogosyan, 2017*) (Table 8).

Blockchain's innovative technology will determine the trend of the 21st century's global economy, according to expert estimates, Blockchain will completely or partially change the industries that generate a fifth of GDP of USA (about $ 3.6 trillion) (*Shin, 2016*).

Table 8 – Stages of Blockchain technologies development in the context of time

Number of stage	Time period	Contents of the stage of development Blockchain technologies
1	*2*	*3*
Stage 1	2014–2016	Analysis of Blockchain implementation opportunities for the financial services industry.
Stage 2	2017–2018	Review of concepts that can influence business and Blockchain decisions to secure the activities of financial institutions. Today, experts identify seven promising areas of implementation of Blockchain technologies, namely: documentary transactions, syndicated borrowings, clearing and mutual settlement, digital personal identity, lending, contracts.
Stage 3	2019–2020	The appearance of shared infrastructure, APIs and interfaces to extend the scope of Blockchain
Stage 4	2021–2025	Active development of Blockchain networks, completion of formation and approval of standards of interoperability and communication channels.

In essence, Blockchain technology provides a close link between the financial, logistical and commercial components of trade and economic transactions with the ability to unify the payments and delivery. Blockchain algorithm is called the sequence of operations by which the information content of multiple data structures in distributed peer systems is consistent with each other like the system of democratic voting (*Drescher, 2017*).

There is also a separate subtype of P2P systems that is “centralized peering systems”, which have a central node that facilitates interaction between system members, maintains directories describing the services provided by system nodes, or searches and identifies system nodes (*Tanenbaum et al., 2007*).

Blockchain is a multifunctional and multilevel information and communication technology that aims to make the accounting of various assets reliable and instantly accessible. Reliable storage technology for keeping records of all transactions that have been taken place. Blockchain is a chain of data blocks that is steadily increasing by adding new blocks with recent transaction records. It is a chronological database, that is, a database in which the time when the record was made is inextricably linked to the data itself, making it non-commutative (*Pryanikov et al., 2017*).

Data is represented by a sequence of records that can be supplemented. The records together with the supporting information are stored in blocks. The blocks are stored as a single list. Each participant is represented by a node (node), which stores all the actual array of data and communicates with other nodes. Nodes can add new entries at the end of the list, and notify each other of changes to the list.

Each member of the network, upon registration in it and installed the necessary software, receives a set of two cryptographic keys to the workstation: the closed one – for encryption of the transaction, and the open one – for verification of the transaction.

Each regular participant, sending the transaction to the next one, signs the hash of the previous transaction and the public key of the next and adds this information at the end of the transaction. In this way, the recipient can check the entire transaction chain by checking all signatures of previous participants in the transaction.

The hash in this scheme is a data array transformed with the hash function. In the case of crypto currency, this is transaction information; in more complicated systems is information about smart contracts and the current status of Blockchain code. As a result of the transformation, we get a virtually unique, except in the case of hash collisions, alphanumeric string that characterizes the initial element, but cannot be converted in the opposite direction. Cryptographic hash functions have the following properties: rapid calculation of hash values for any data type, determinism, pseudorandomness, irreversibility, resistance to contradictions (*Rogaway etal., 2004*). The combination of public and private keys together with hashes gives Blockchain technology a high level of data security (*Tanenbaum et al., 2007*). A summary of principles of Blockchain construction and operation is presented in Table 9.

Table 9 – Principles of Blockchain construction and operation

Principle	Content of the principle of Blockchain construction and operation
1	***2***
Network integrity	The purpose of having confidence within the system is pursued and, in essence, the participants' consensus, their equality, is mentioned.
Intensity partition	Energy costs are distributed throughout the peering network.
Value as an incentive	The system aligns the incentives of all stakeholders, means that participants are interested in developing technology and maintaining its stability.

(End of Table 9)

1	*2*
Principle	Content of the principle of Blockchain construction and operation.
Privacy and protection of rights	One of the principles of Blockchain is trust. Having 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 privacy and authentication of the print. Each user also has two keys: one for encryption, the other for decryption.

Source: compiled on the basis of sources (Tapscott et al., 2016; Shevchenko et al., 2013)

One of the major benefits of Blockchain technology comes from the ability to speed up processes and reduce transaction complexity and risk. New benefits will appear 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, enabling financial institutions to enter into potentially lower costs, better products and accelerate time to appear in the market (*Kupriyanovskyi, 2017c*).

Researcher and founder of the Blockchain Research Institute, Melanie Swan, identifies three conventional areas of application of this technology:

• Blockchain 1.0 is currency (crypto currency is used in various applications related to financial transactions, such as wire transfers and digital payments);

• Blockchain 2.0 is the contracts (applications in the fields of economics, markets and finance that deal with different types of instruments: stocks, bonds, futures, mortgages, legal documents, assets and contracts);

• Blockchain 3.0 is applications whose scope extends beyond financial transactions and markets (extending to branches of government, health, science, education, etc.);

• Blockchain 4.0 is so-called industry infrastructure based Blockchain ecosystem.

Main advantage of Blockchain technologies from an economic point of view is that it is a transparent, fast, cheap and secure way of conducting transactions with electronic money. E-commerce models (e-commerce,

e-trade), which use Blockchain technology in particular, are gaining popularity not only in the world but also in Ukraine, presented in Table 10. E-commerce or electronic commerce is an intangible business platform which enables the individuals, business entities and companies to sell their products or services and carry out various commercial activities, through an electronic network.

The B2B model is the typical basis for the creation of a digital platform that provides the opportunity to buy goods, services and works online from one business to another. Another example of using this model is digital platforms that provide logistics, for example, for the optimization of marine transport using “smart ships”.

Table 10 – E-Commerce models (E-commerce, E-trade) using Blockchain technology

The subject (manufacturer of goods and services)	The object (consumers of goods and services)		
	Business	Consumers (households)	Government
1	*2*	*3*	*4*
Business	Business-tobusiness (B2B) model. Electronic government procurement	Business-to-customer (B2C) model. Online Stores (ex: Alibaba, Amazon)	Business-to-Government (B2G) model. Electronic government procurement
Consumers (households)	Model Customers to Business (Customer-tobusiness: C2B). Contextual Business Advertising and Electronic Job Exchanges (ex: Google AdSense; Work.ua)	Model Customer to Customers (Customer-to-Customer: C2C). Digital sharing platforms (for example: blablacar; Airbnb; eBay)	Model Customer to Government (Customer-to-Government: C2G). Digital petition platforms)
Government	Model Government to Business (Government-to-Business: G2B). Public services for business.	Model Government to Customers (Government-to-Customer: G2C). Government services for citizens.	Model Government to Government (Government-to-Government: G2G). E-government.

The B2C model is most often embodied in digital platforms that follow the logic of an online store. The most well-known and capitalized digital venues of this type are Amazon and Alibaba Group.

The B2G model implements digital procurement platforms.

The C2B model is about creating customer value for business. One example of this model could be contextual advertising on consumer blogs and online resources (such as Google AdSense). However, households are a provider of workforce resources for businesses, and accordingly digital platforms that aggregate jobseekers 'and employers' registers can be seen as embodying a model of reconciling business and household needs.

The C2C model is represented by digital sharing platforms (such as Airbnb) as well as customers' sales to one another (eg, eBay37).

The C2G model involves the interaction of households with public authorities, for example, to get information on attitudes to particular initiatives (eg, e-petition platforms).

The G2B model is implemented through digital public service delivery platforms for business (tax collection, permitting and miscellaneous information, etc.).

The G2C model involves the interaction of households with public authorities, for example, to pay taxes online or to obtain information in the form of certificates (extracts) from state registers.

The G2G model involves communication between government agencies and is often implemented in the context of e-government. In this case, the positive effect on the national economy is due to the reduction of public spending on public administration.

Information and communication technologies transform all subsystems of society and the state, affecting the growth of all sectors of the economy. To determine the current stage of development of society and economy should use a system of categories: information society, digital economy.

The basic components of digital economy that are evolving through its digitalization today are infrastructure, e-business and e-commerce. The digital economy is the result of the transformational effects of new general-purpose technologies in information and communication. Digital technologies are rapidly transforming society, business relationships, and are an integral part of an innovative, nationally oriented economy of the future. In the "old" economy, or the so-called "traditional economy," the flow of information was physical: cash, checks, invoices, way bills, reports, faceto-face meetings, phone calls, in the new one – information in all its forms is reduced to bits (*Tapscott, 1995*).

In digital economy, e-products/services, produced by e-business and ecommerce, dominate. Payments for services/products in the digital economy are most often due to the use of electronic money.

Due to Blockchain technology, if used comprehensively, it can lead to the transition to a digital person (personality), which will be the result from all transactions involving the individual from the beginning of their birth recorded in the Blockchain type (*Kraus, 2019[a]*).

Digitalization is a significant factor in technological evolution that will help manufacturers to overcome territorial constraints, reduce transaction costs of decisionmaking transactions and formation of contracts, develop new business models based on network effects, engage the customer in the process of creating benefits.

Development of digital entrepreneurship in the conditions of virtual reality is one of the most relevant in connection with the need to ensure the growth and renewal of the economy of modern Ukraine. With each passing year, competition in world markets is only growing, and quarantine restrictions have been added. The question arises about the secret of successful sale of products and services produced by national producers. The principles that ensure digital direction of strategic development of entrepreneurship is the complexity of providing digital technologies in the implementation of business processes; adaptability to the requirements of the digital consumer. We consider it necessary to note that the principles of ensuring the social direction of the strategic development of digital entrepreneurship are accountability, humanity, social responsibility.

Today, companies and entire industries are choosing the path of digitalization of development as the only way to meet the ever-changing conditions of the world around them. Due to this, digital transformation of industry, retail, public sector and other areas is already changing the lives of every person and every enterprise.

The high-tech industry is by nature restless. Leading companies need to make a double effort to defend their positions, because if they lag behind, it will be difficult to catch up with competitors. As a result, in order to stay ahead, they have to constantly develop and implement innovative approaches. The intensity of the competition for the first places is evidenced by the list of 15 most expensive technology companies in the world, which in the period from 1999 to 2009 was updated by about half, and from 2009 to 2019 – by 40%. Only four companies were able to remain on the list for 20 years: Microsoft, Intel, Cisco, Oracle.

The situation is further complicated by the fact that regulatory control is increasing around the world. After all, if earlier the largest companies almost did not enter the “foreign field”, then in the last five

years they are increasingly “encroaching” on each other’s business activities. For example, Amazon.com has challenged Facebook and Google in online advertising, and Microsoft and Google are vying with Amazon for leadership in cloud infrastructure as a service. On the one hand, this makes it difficult to control the acquisitions of some companies by others, and on the other hand, it can threaten innovation and the associated benefits for consumers from scaling up new concepts (*Andrusiak et al., 2020*).

At the same time, newcomers who did not belong to it before are catching up with the technological sector. For example, Walmart challenges Amazon in online commerce, and Disney competes with Netflix, Amazon and Apple in the streaming video niche.

Paul Silverglight, deputy chairman of Deloitte Audit and Consulting, has compiled a list of key strategic opportunities for overcoming the coronary crisis and successful future development, including:

1. Redoubled efforts on digital transformation with a focus on improving cloud infrastructure, data and analytics capabilities, cybersecurity and business model transformation. As many companies have already made significant progress in their efforts to digitize their operations, the pioneer’s advantage has been lost. The only way out for those who are not so advanced is to start right now.

2. Reorientation and retraining of the workforce to optimize remote work opportunities and make full use of advanced technologies such as artificial intelligence. Virtual work environments can also foster innovation and diversity in the workforce by enabling technology companies to leverage ideas and talent from wider geographic areas.

3. Study where and how production takes place, with an emphasis on improving transparency, flexibility and sustainability. Companies need to know how their supply chains are built to quickly adjust their course in the event of a failure. Leaders of technology companies should pay attention not only to changes in the regulatory framework, but do not ignore their most difficult challenges: to anticipate the needs and behavior of customers (in terms of technology implementation) and remain “paranoid” about competition.

A good example of digitization in the service sector is a secure video meeting system with the possibility of authorized voting with an electronic digital signature (EDS). The problem that caused the need is the need for a universal solution for secure video meetings with the ability to keep records and vote using CEP. The decisions that have been made are a course for the development of a modern and fully secure system that simultaneously supports video functions and the ability to work with documents.

The event, which took place using a secure video meeting system, is the G20 Summit in 2020. For the first time in history, the G20 meeting took place in a virtual format. The Cisco Meeting Server (CMS) solution was used as the “meeting place” for the virtual summit.

Among the opportunities provided by the video meeting system are:

- Registration and pre-registration of all participants;
- Preparation of documents;
- Scanning and recognition of document texts;
- Photo fixation of the voter;
- Formation of the schedule of scheduled meetings with date, time;
- Maintaining the voting threshold;
- Voting and displaying the results online;
- Logging decisions and generating reports;
- Flexible search of documents;
- The possibility of including the secretary of the discussion regime on the agenda;
- Registration of participants for a speech on a specific issue;
- Setting the rules of speeches leading;
- Sonducting and managing the queue of speakers;
- Presentation of the results of voting by voters, by groups or after the voting took place: for, against, abstained;
- Maintaining an archive of documents;
- Mupport and recording of audio and video conferences;
- The ability to lock the microphone;
- Formation of the agenda of the meeting;
- Authorization of the participant with the help of hardware keys;
- EDS / CEP voting (*SIEMENS, 2021*).

An example of a speaker’s / voter’s workplace using a secure video meeting system is as follows:

- Online voting results;
- Video speakers;
- The location of the participants is fixed;
- Information that the person is speaking and everyone sees and hears him;
- Voting buttons;
- The issue on which the voting takes place;
- Voting timer;
- Performance duration indicator;
- The speech application button is active when the speaker allows;
- The number of those who signed up for the performance;
- Number in the queue for the performance;
- The number of speakers in the queue for questions.

The Secretary's post is endowed with the following opportunities and access:

- Online voting results;
- Video of speakers;
- The location of the participants is fixed;
- Information on the speaker with timing and information that it is visible and audible;
- Voting timer with the possibility of starting;
- The issue on which the voting takes place;
- The ability to change the layout of the speakers;
- Opportunity for everyone to turn off the microphones;
- Display the current list of participants.

However, among the features of the video meeting system are: logging decisions and generating reports; notification; flexible search of documents; maintaining an archive of documents; recording of audio and video conferences; the ability to lock the microphone; support for audio and video conferences; administration and audit.

Scheduling a meeting takes place during the use of a secure video system by:

- Formation of the schedule of scheduled meetings with the date, time and place;
- Formation of the agenda of the meeting;
- Reservation of premises and video conferencing resources according to the schedule;
- Display in the calendar.

Preparation of documents for the meeting during the application of a secure video system is by:

- Opportunities to submit proposals on the agenda of the meeting and the list of speakers;
- Submission of proposals on inclusion of the draft decision in the meeting;
- Control of terms of preparation of the project of the decision and materials to it concerning each of questions;
- Formation of the list of guests to the meeting;
- Scanning and text recognition;
- Import of documents from external systems;
- Keeping a history of document preparation.

During the application of secure video system, voting takes place by:

- Conducting electronic voting of the meeting members by imposing QES on the draft decision;
- Logging decisions and generating reports;
- Reports are signed with an electronic signature;

• Video recording of voting is conducted;
• Automatic keeping of the minutes of the meeting (with the possibility of modification by the secretary);
• Visualization of the process of discussion of draft decisions and voting;
• Automatic formation of the voting protocol;
• Recording the results of voting with checking the legitimacy of the CEP and the possibility of revision;
• The ability to automatically publish the decision protocol on the website of the institution.

Administration and audit during the application of a secure video system allows all actions of users and administrators to be logged in the system, while the logs are unchanged and cannot be edited.

The general architecture of a secure video system is as follows:
• Construction of a fault-tolerant solution;
• Protection against external interference;
• Secure access using Cisco VPN;
• DataCenter (Rental of communication channels and equipment);
• "Private cloud" (Deployment of the System on the servers of the Organization, Construction of KSZI, Compliance with the requirements of DSTU-4145-2002, Authorization using EDS, Encryption of traffic according to DSTU).

If we consider successful practical examples of the use of innovative services, it is worth focusing scientific attention on the digitized work of Logitech enterprise, which is presented in Figure 16.

Key benefits that users of a secure video system receive:
• Open-source product code Megapolis.DocNet;
• Full-featured web-client – "thin client";
• Support for the use of multiple industrial DBMS Oracle, MS SQLServer, and free DBMS PostgreSQL;
• Support for Windows and Linux / Unix on client sites and servers;
• U-disk (collective work with documents and document library);
• Support for free LibreOffice, OnlyOffice;
• Support of parallel use of EDS of Ukrainian ASCC, EDS of RSA;
• Open API for integration with third-party information systems;
• Built-in document storage;
• Use of Cisco, the world's leading video conferencing system;
• Possibility of integration into the system of interdepartmental communication;
• The opportunity to involve third-party participants in video meetings, such as chairmen of the boards of commercial banks.

Table 11 – Innovative capabilities and solutions on the example of Logitech enterprise

Innovative opportunities, solutions	Contents and general characteristics
1	***2***
Simple portfolio for the entire work environment:	• Personal (BRIO, Zone Wireless) • Small (Tap, MeetUp, Computer) • Medium (Tap, Rally, Computer) • Large (Tap, Rally Plus, Computer)
Tap into better meetings:	• Constant user interface across all rooms • Ease of use • One easy to support architecture
Best-selling huddle room solution:	• View everyone in small rooms • Simple and compact form factor • Computer Vision based Automatic Auto-framing
Logitech solution for medium and large rooms	Logitech's Rally Portfolio delivers a modular design and RightSense proactive technologies for better meetings in mid- to large-size conference rooms. Rally Portfolio: • Premium AV components (Camera, Speakers, Mic Pods) • Wall mounting kits • Table, Display, and Mic Hubs
RightLight with Wide Dynamic Range (WDR) optimizes light balance to emphasize faces, even in dim or backlit conditions	*Without RightSight:* • Manual camera control • In-room participants don't want to change default camera settings • Remote participants can't see facial expressions • Low visual engagement *With RightSight:* • Automatic camera control • RightSight finds human figures in the room throughout meeting • Camera automatically pans, tilts, and zooms to center and comfortably frame participants • High visual engagement, no user action required *Without RightSound:* • Hard to understand: echo and reverb • Distracting background noise • Near voices too loud, far voices too soft *With RightSound:* • Automatic suppression of echo and reverb • Minimized background noise • Beamforming and automatic leveling make every voice comfortable to hear and understand

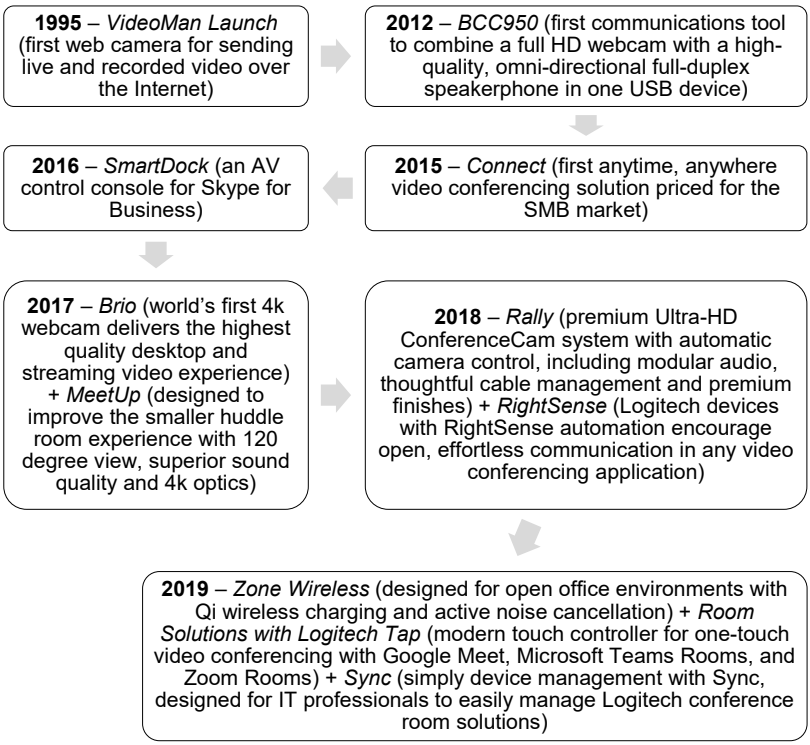


Figure 16 – History of Innovating Since 1995 Logitech enterprise

Source: author's development

A general description of innovation and digital capabilities, new solution protocol on the example of Logitech enterprise are given in Table 11.

Among the TOP 5 benefits of Logitech swytch are the following:

• Flexible: Join any meeting from every room;

• Easy on End Users: Combines simplicity with flexibility, even when changing services;

• Universal: Works with any laptop;

• Affordable: No apps or contracts;

• Capable: Differentiating features like 4K resolution and laptop charging deliver a superior solution.

As a result, we note that the concept of digital transformation of entrepreneurship has three main advantages relevant to any type of business: improving the efficiency of existing infrastructure; emergence of qualitatively new business models; increase revenue or reduce costs in existing business models.

Digital transformation of entrepreneurship goes far beyond information and communication technologies, it has an impact on the entire value chain. In addition, we are convinced that there are three key areas in which new digital technologies can be used in business, namely: customer search (firms can use digital information and social networks to attract their customers in new ways. For example, they can create digital user communities to add value); operational processes (digital technologies allow to achieve great results in operational activities at all stages of the value chain); business models (digital transformation allows you to develop completely new forms of creating and obtaining value).

CHAPTER SECOND FROM AUTOMATION TO DIGITAL TRANSFORMATION OF THE ECONOMY

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2.1. Digital coordinate system of the 4th Industrial Revolution

Digital transformation opens up fundamentally new horizons and opportunities for value added in virtually all areas of the economy. Digital transformation is not only about technology, but also about business strategy towards Industry 4.0 in urban production and urbanization. At the present stage, digital technologies are an integral part of the socio-economic life of society and determine key vectors of development of modern cities.

Digitalization is becoming a driver of their development, as it is able to ensure their innovation, quality and standard of living in them. Big cities are the engine of the world economy, cultural, historical, spiritual, political and innovation centers, where the most acute global problems of today are often posed and solved experimentally. At the same time, large cities are under considerable pressure from factors such as migration, social inequality, environmental pollution and climate change.

Digitalization of business and industry is the core of digital economy and a major driver of growth, including the formation of Industry 5.0 (*Britchenko et al., 2019; Kraus, 2018; Andrusiak et al., 2020*). The use of digital technologies starts the process of modernization of traditional spheres of economy and stimulates the emergence of new innovative industries that accelerate economic growth of cities and increase the level of competitiveness of the country in the world economic system.

Fourth Industrial Revolution is reflected in the change of industry and training. Thus, small and medium-sized businesses use digital sales methods, and large industrial enterprises carry out deep digitalization of production, urbanization is accelerating. Training of specialists in digital entrepreneurship and urban economics and urban planning is announced in educational institutions.

Industry 4.0, which is part of the Fourth Industrial Revolution, provides a number of new technologies that lay the foundations for the formation of virtual-real space for data exchange, testing new quality processes and objects, creating robotic systems in conjunction with Internet technologies in format of smart factories, "smart" enterprises, smart cities.

In the 21st century, we are witnessing the development of industry in light of the trends of new industrial age. We are talking about the transition to fully automated and digitized production, which is controlled by real-time intelligent systems in constant interaction with the external environment, going beyond one enterprise, with the prospect of networking them globally.

Therefore, the issue of digitalization of production and urbanization in Ukraine, namely in terms of digitalization, strategic guidelines for digital infrastructure development as an important factor in achieving competitive positions of Ukraine and its cities in global digital space is gaining national importance.

Industrial revolutions are a factor in the development of human capital, the accumulation of knowledge, the development of technology, the search for innovative ways of processing raw materials, the output of which allows to have minimal costs. Fourth Industrial Revolution is based on a set of stages, factors, resources and processes aimed at implementing the mechanism of digital transformation. We will try to consider the content of digital industry, the peculiarities of all stages of industrial revolutions, present an analysis of inventions of each stage, as well as focus on the essence of the category “Industry 4.0”, indicate the general principles of its operation. To begin with, we propose to reveal the meaning of the concept of “industry”.

For example, industry is understood as a branch of material production that affects the development of the city and its productive forces. Industry is the basis of industrialization of the economy (*Wikipedia, 2022*[c]). As for the modern development of cities, it took place at all times due to industrial coups. Today we are at the stage of the Fourth Industrial Revolution. Each of the stages is presented in more detail in Figure 17.

The first stage of the industrial revolution began in the late 18 century in the UK. During this period there was a need to mechanize the processes of the textile industry. The creation and use of the first steam engine met this requirement. The engine produced energy that powered the mechanisms. This innovation was the beginning of an industrial revolution. As a result of this invention, the then government aimed to transform handicrafts and home-made production into factory (*Zaporozhets, 2019*). It was the steam engine that became the basis for the development of mechanical engineering. Steamers and locomotives have reduced the time to transport people and goods over long distances. The British have been trying for a long time to prevent the spread of their startup abroad. The country banned the export of production technology, equipment and skilled labor. However, such secrecy could not last forever. William and John Cockerill, of British

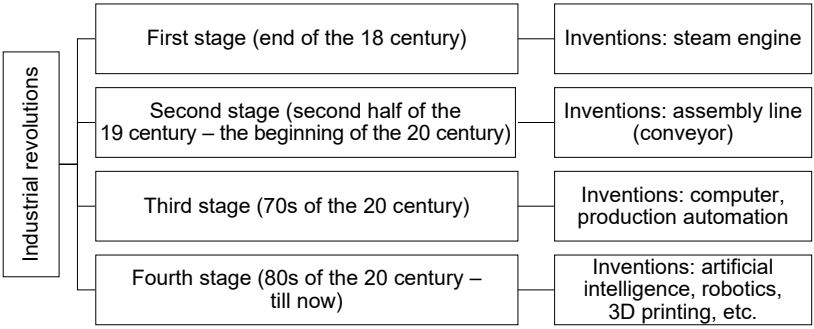

Figure 17 – Stages of the industrial revolution

Source: compiled by authors based on (Zaporozhets, 2019)

descent, mechanized a workshop in Liege. Belgium became the first country in continental Europe to undergo industrial transformation.

Development of industry in France was longer than in Great Britain and Belgium. Because the country was in an unstable political situation. In 1848, France became an industrial state, but did not reach the level of development of Great Britain. Other European countries and cities had somewhat slower industrial development. This is due to the fact that the level of wealth, power and opportunities was lower than that of the British, Belgian and French counterparts (*Britannica, 2021*).

At the first stage, the industry took the first steps towards replacing manual labor with mechanical labor, which increased the efficiency of the labor force. However, new means of production were expensive, and not everyone could afford them. In the initial stages, people became poorer due to the reduction of staff, lack of knowledge and skills to master new technologies. The standard of living became lower, the worker was forced to work for a meager wage for a long time, to live in apartment buildings with unsanitary conditions, to endure abuse and exploitation in the workplace. Over time, ideas for solutions to existing financial problems began to emerge. Actions were aimed at improving the level of material amenities (*Britannica, 2021*).

The second stage of the industrial revolution occurred in the second half of the nineteenth century. Then mankind introduced the use of electricity in the production of goods and created an assembly line that could use conveyor mass production in the 1860's and 1870's. This technology quickly gained popularity in the United States, Western Europe, Japan (*Zaporozhets, 2019*). Henry Ford took the idea of mass

production from a slaughterhouse in Chicago, where each butcher performed only part of the animal's development tasks, not the entire process. He changed his approach to car production.

Now the automotive process took place in stages on the conveyor belt, rather than going all in one shop. This reduced costs and accelerated the production process (*Desouttertools, 2021*). The beginning of the third stage of the industrial revolution came in the 70's of 20 century. At that time, computers were being developed and distributed. These computers made it possible to process high-quality information that was previously done manually. The process of computerization was the impetus for the automation of production (*Zaporozhets, 2019*) and urbanization (the growing importance of cities in society, accompanied by growth and development of urban settlements, growing share of urban population, urban lifestyle in a particular region, country, world).

Modern concept of urbanization is most fully reflected in the publications and studies of UN NAVITAT (*Unhabitat, 2021*). Main provisions of this concept can be reduced to the following:

• Cities are the driving force of modern economy, as they provide a higher level of productivity and welfare;

• The importance of the city as a catalyst for economic development of the country increases with decreasing level of development of the latter;

• Urban lifestyle and typical elements of culture spread from cities to society.

Fourth Industrial Revolution is a new industrial breakthrough, in which there is an interaction of new information and communication technologies in production processes, urban management and life. He introduced the term in 2016. Klaus Schwab, founder and chairman of the World Economic Forum. According to him, Fourth Industrial Revolution will increase incomes and improve the quality of life, but there is a risk of increasing inequality – the poor and low-skilled will work for meager wages, and highly skilled workers will become even richer *(Salesforce, 2020*). This will have the same consequences as globalization, poor countries will not be able to afford new technologies and will lag far behind highly developed countries such as the United States, Germany, Japan and France.

The use of automatic data processing technology in industrial production introduced the concept of Industry 4.0. It is also known as Smart Factory (*Industrial annalistic platform, 2021*). For the successful operation of this system, it is necessary to follow the principles presented in Figure 18, namely:

• The principle of compatibility, i.e. the smooth interaction of sensors, devices and people and communication through the Internet of Things;

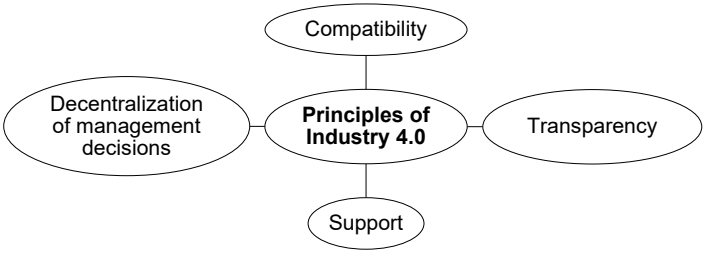

Figure 18 – Principles of Industry 4.0 as the driving force of the Fourth Industrial Revolution

Source: compiled by authors based on (Kraus, 2022[a])

• The principle of transparency arises as a result of interaction. To comply with this, it is necessary to create a digital copy of real objects and functions, which will allow you to display a real physical copy. This will give the most complete information about the current state of the process;

• The principle of computer support – by collecting, visualizing and analyzing information, computers help people make the right decision based on the actual current state of the object. Technical support for these systems can replace humans in hazardous production conditions;

• The principle of decentralization is to replace human labor with machine, where labor will be more efficient without human intervention. Employees will act as a controller in case of response to unforeseen situations (*Kraus, 2022[a]*).

Adherence to these principles of Industry 4.0 will allow the rational use of natural and technical and energy resources, recycling of industrial and domestic waste, to obtain new products or energy. Figure 19 clearly shows the nine components of Industry 4.0 that determine the digitalization of production, namely:

1. Recent Big Data analytics. Due to the use of new information and communication technologies, the amount of data is constantly increasing and there is a need for rapid search for the necessary data and their further processing. That's why Big Data analytics has become an integral part of new industry, digital manufacturing and urban processes.

2. Autonomous robots are devices that solve complex problems based on interaction with each other and working with people and learning from them. These works are more efficient than those used in production.

Components of Industry 4.0
• Big data • Automated robots and cybersystems • Simulation • Horizontal and vertical system integrations • Industrial Internet of Things • Application of cloud technologies • Three-dimensional printing and adaptive production • Use of virtual reality • Cybersecurity

Figure 19 – Components of Industry 4.0, which determine the accelerated development of digital production

Source: compiled by authors based on (RuEmann et al., 2015; Skitsko, 2016; IT Interprese, 2021)

3. Now you can see the use of 3D modeling of inventories, products and materials. Modeling, in the future, will be involved in the production process. This tool will display a real-time virtual model of production processes, machines, people and products. Due to this, you can test and optimize the process in virtual reality before its physical use. This will save time and financial resources of the production process (*RuEmann et al., 2015*).

4. Horizontal and vertical integration is an important part of the production process. Currently, there is a need for interaction of enterprises, departments and companies in a single information environment. Also, in the fourth stage of the industrial revolution, access to the industrial Internet of Things opens up. Connection objects can obtain the necessary information (Skitsko, 2016).

5. Industrial Internet of Things, which is a unified system of computers and sensors connected to them and programs for collecting and exchanging information for control and monitoring of production automated processes (IT Interprese, 2021).

6. Actively used cloud technologies. But under the influence of Industry 4.0, the amount of information increases and there is a need for storage and rapid response. It is in the “cloud” will be used data and functionality of machines, which will increase the productivity of the production process.

7. Three-dimensional printing, which is the basis of adaptive production, which is used to create a prototype of future products or the manufacture of individual parts. When making individual orders using 3D printing, the cost of raw materials and logistics is reduced.

8. Use augmented reality used for virtual learning, improve the effectiveness of decisions and work procedures. Workers can receive instructions on how to repair equipment by looking at augmented reality glasses (*RuEmann et al., 2015*).

9. Cybersecurity as a system to protect computer space, industrial systems and production lines from cyber-attacks and malware. Because Industry 4.0 uses the industrial Internet of Things, the risk of intrusion into a company's computer security increases. For these reasons, at the present stage requires a complex system of identification of machines and users (*RuEmann et al., 2015; Skitsko, 2016*).

Summarizing the above, we can conclude that "Industry 4.0" is a new round of development of industry, production and cities. It differs significantly from previous industrial transformations and combines all the benefits associated with it. This transformation has been a strong impetus for a technological and progressive future. Industry 4.0 combines process speed, interactive management, process control with various information and communication technologies, security at all stages and the formation of smart cities. Today there is a so-called "spread" of cities, the expansion of their territory.

The transition from simple to group forms of urban settlement – from the usual "point" city to urban agglomerations – compact territorial groups of urban and rural settlements is especially characteristic of modern urbanization. The nuclei of the largest urban agglomerations are mainly capitals, the most important industrial and port centers. In addition, we see the next stage of urban transformation, the so-called de-urbanization, i.e. the growth of suburbs, migration to rural areas, planning new cities and more. In developed countries, the average level of urbanization is 71%, and in developing countries – 33%. The pace of urbanization largely depends on its level. Nowadays, the urban population in developing countries is growing 3 times faster than in developed ones. They now account for 1/6 of the total annual growth of urban residents.

The search for ways to accelerate the digitalization of production and urbanization in Ukraine lies in the formation of a new paradigm coordinate system of digital economy, identifying forms and methods of influencing digital development of cities and industry, deploying logical-structural scheme of digital transformation making decisions aimed at ensuring inclusive economic development of cities and finding opportunities to implement the strategy of technological breakthrough in terms of their digital transformation.

With the spread of the fourth stage of the industrial revolution, large cities began to think about the future in the context of intensive

development of smart technologies. Thus, the city has a need to attract new information and communication technologies in the management of the city to improve the quality of life, safety and comfort of residents and guests of the city. All this was combined into one concept of "smart city". Smart city is a new approach to the city, which combines digital, human and physical systems into a single environment, which aims at sustainable development and successful future of the city's residents. Back in the 60-70's of 20 century the Community Analysis Bureau in the United States used cluster analysis, databases, and aerial photography to gather information and prepare reports on disaster relief and poverty reduction. From that moment began the creation of the first generation of smart cities.

Thus, the first generation of smart cities was to provide innovative technologies to monitor current situation in the region. The goal of the second generation of smart cities was to integrate technology into a single system for efficient and timely local governance. In the third generation, there is an integration of public and city leaders (Figure 20).

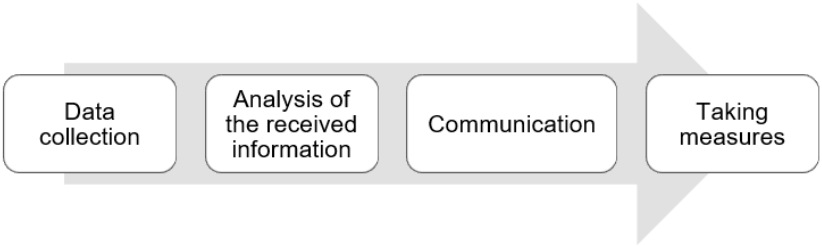

Figure 20 – The process of implementing the concept of a smart city

Source: author's development

Thus, the implementation of the smart city concept includes four such steps – collecting information using smart sensors; analysis of data on the work of city services; communication of the results of the analysis of stakeholders for decision-making; implementation of measures to improve the work of the city. The concept of smart cities is important and relevant, as the population in cities is growing, globalization is taking place. According to UN estimates, about 55% of the world's population now lives in cities, and in 2050 the number will increase to 70%. The planet's population is also projected to increase by two billion by 2050, which will increase the need for sound management of the social, environmental and economic systems. According to the Viennese

methodology, the concept of a smart city consists of 6 interrelated components – smart economy, smart movement, smart governance, smart people, smart living and smart environment (Figure 21).

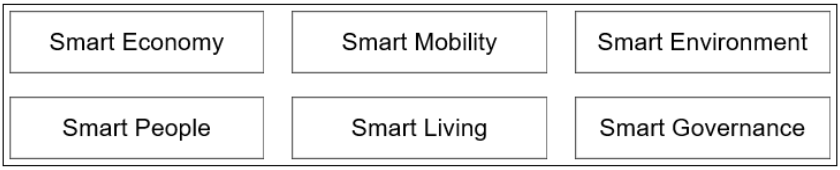

Figure 21 – Component models of Smart city

Source: compiled by authors

Smart economy is a concept that combines e-commerce, e-business, increasing productivity through the use of information and communication technologies and their collaboration. This category includes economic relations and the reputation of the city, the level of entrepreneurship in the region, the ability to innovate, international relations, labor market flexibility, efficiency of economic activity of the city, the ability to change.

Smart mobility is a new transport network in which:

A person can easily change several modes of transport;

• Runs several types of transport, which allows the consumer to choose best for the situation;

• The vehicle is replaced with a car with a minimum level of emissions;

• Transport runs on schedule and is guaranteed to arrive at its destination;

• Relocation is accessible to all and provides a better quality of life.

Reasonable movement includes the safety of vehicles, the use of information and communication technologies in infrastructure, domestic and international accessibility of the city. Smart environment is a decision to improve the environment through the use of pollution management systems and the use of alternative energy sources. The aim of the model is to improve the quality of the environment and the use of energy efficiency measures.

A reasonable environment includes the level of pollution, the attractiveness of natural conditions, the rational use of resources and the protection of the environment. Smart people are people who have a desire to learn throughout life, take an active part in public life. In addition, the population of a smart city is educated, creative, open to change. Smart living is a way of life in a city with cultural, educational and healthcare facilities. Such a city has a high level of security of life, access to education for the population and is attractive to tourists.

Smart governance is a way of interactive management, where there is transparent management, public involvement in decision-making for the successful future of descendants.

According to the decision of Kyiv City Council "On approval of main directions of smart specialization of the city of Kyiv" main areas of development of the city as smart are information and communication technologies, pharmaceuticals and creative industry. The development of Kyiv as a modern city is presented in Kyiv Smart City 2020 Concept. The documents describe the existing opportunities for the development of the city, the achieved goals, ways for further development and the expected results from the smart specialization of the city.

The concept has goals such as:

- High standard of living in Kyiv;
- Modern infrastructure of the city;
- City management through the use of modern technologies;
- Adherence to the goals of sustainable development, raising the level of ecology in the city;
- Public involvement in decision-making;
- Take public opinion into account when making decisions.

Kyiv Smart City concept aims to develop and improve the system of management, relocation, education, security, environment, lifestyle and smart innovation (Figure 22).

In Kyiv, several services have been created for residents – Kyiv Smart City application, E-services, resident's office, Kyiv resident's card, electronic kindergarten registration, online doctor's registration, pet register.

In November 2018, the e-ticket system was launched and Kyiv Smart City mobile application was developed. This application combines all electronic services in the city. With its help you could pay for one-time travel, parking, top up your Kyiv Smart City card, make an appointment with a doctor or register your pet in the Register of Pets.

However, the mobile application did not work for long. On January 5, 2021, the application was forced to suspend its work because the property belonged to a public organization, not the city. And the GIOC contract did not continue. To replace the old application, a new one was introduced – "Digital Kyiv". On the official website of Kyiv Digital, everyone can monitor the work of municipal vehicles of Kyivzelenbud, Kyivavtodor and management companies. Each car had GPS trackers. Also, these devices are in public transport. You can monitor movement of vehicles through the Easy Eway application. In "Kyiv Digital" you can see a selection of recommended places for different types of recreation and interests, event posters, virtual tours of cities, useful information and news. Here everyone will find something interesting.

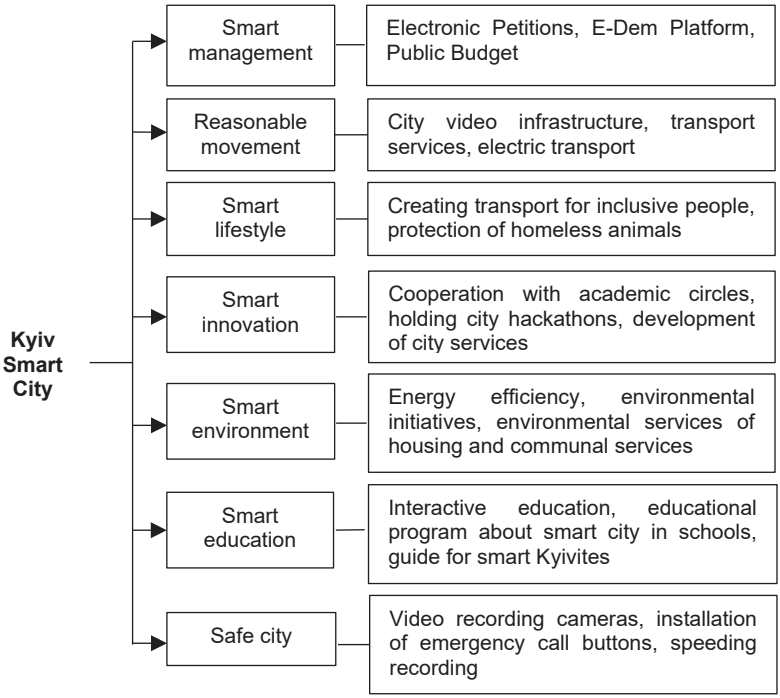

Figure 22 – Directions of development of smart specialization of Kyiv

Source: compiled by authors

Results of using Kyiv Digital application:

• UAH 3.055 million was paid in December 2021 for parking;

• 320,000 transport cards were sold during the year, about 1 million cards were sold during the whole period;

• In November, the application was downloaded by about 100 thousand users.

In 2022, it is planned to increase the capabilities of Kyiv Digital mobile application. You can now submit an e-petition, monitor air pollution and track transport.

From the use of mobile applications, the city receives an economic effect – an additional source of local budget. Kyiv resident's card – a payment card that has benefits for retirees, people with disabilities,

parents with many children, war veterans, etc. Cardholders have free travel, a discount on visits to the zoo, theater, museums, a discount at KP "Pharmacy" and a supermarket.

Also, on the portal of electronic services of Kyiv there is an opportunity to go to the personal account of the resident and have access to all electronic services of the city. Here you can buy an e-ticket, pay a parking fee, enroll in kindergarten, order an e-student, find out information on the RTGC service, apply for a plenary session, get social protection (order rehabilitation equipment, register with the Children's Rehabilitation Center, submit application for financial assistance), register a pet, propose a project that you want to implement at the expense of the city budget, submit a petition, etc.

For transparency and efficiency of the city management system were:

– A single web portal has been created;

– Information on planning and use of the city budget is open;

– Introduction of e-procurement through the Prozorro system. Kyiv became the first city to switch completely to e-procurement;

– Display of open data;

– Information and analytical system "Property". Here you can get information about the objects of the city.

Kyiv Contact Center is an organization to which city residents turn to express dissatisfaction or suggestions regarding the work of structural units of Kyiv City State Administration, utilities and other contractors. So, Kyivans at number 15-51 or on the website of the municipal institution can express their opinion and be heard. City security is one of the city's development priorities. More than 7,000 video surveillance cameras, more than 60 emergency call buttons, speed cameras, face and car number recognition systems have been installed in Kyiv.

Smart lighting has been installed to save local budget costs. In Kyiv, incandescent lamps were replaced with LED lamps with an automated lighting control system. This technology has made it possible to reduce electricity costs in 2019 by UAH 25 million.

Based on the above, it can be concluded that the concept of "smart city" combines components of security, education, innovation, harmony with the environment, favorable environment for economic development in the region, smart governance and movement. Kyiv is following this path. At this stage, there are already electronic services and services for residents, installed CCTV and speed cameras, emergency call buttons. However, much remains to be implemented and improved in the capital.

European continent is currently undergoing a period of change. Automation of production, globalization processes, the use of new

technologies have influenced the current state and directions of development of cities, business and the economy as a whole.

In such conditions, cities find their way to improve their strengths and reduce the impact of threats and problems. This section will consider development strategies and priorities, own development of cities on the way to smart specialization. Smart City Index 2021 published a rating of smart cities (Figure 23). Zurich, Oslo, Lausanne, Helsinki, Copenhagen, Geneva are among the top European cities.

1. Singapore	2. Zurich	3. Oslo	4. Taibe	5. Lausanne
6. Helsinki	7. Copenhagen	8. Geneva	9. Auckland	10. Bilbao

Figure 23 – Ranking of smart cities in the world in 2021

To study the European experience of smart specialization of cities, the features of targeted development programs and an innovative approach to solving pressing problems of the city will be considered. Let's start with Zurich, because this city took first place among the European continent.

Zurich is located in the north of Switzerland. The city is a center of finance and banking. The city estimates that Zurich's territory will increase by a quarter in twenty years. This can lead to a number of problems that the Zurich Strategy 2035 aims to address.

The strategy has the following goals:

• Use of innovative technologies and creation of an attractive business environment;

• Sustainable development of the city and rational use of limited resources;

• High quality of life and equality of the population.

The city of Zurich has taken as its basis such development priorities as (Figure 24):

1. Stimulation of innovation activity. Several types of incentives were planned during the development of the strategy:

• Grants to support innovative projects are funds allocated from the city budget for the initial funding of new projects. Preference is given to projects implemented in conjunction with various services.

• Innovation box for staff – this can be used by employees of the city administration. They are given the opportunity to develop their own idea and take part in an open innovation process. This approach allows you to think purposefully, innovatively, be result-oriented and customer-oriented.

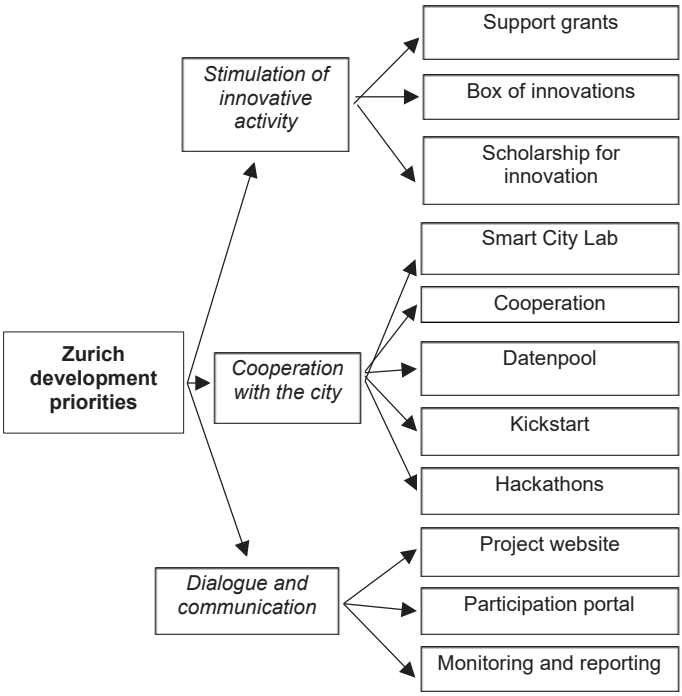

Figure 24 – Zurich development priorities

Source: compiled by authors

• Scholarships for innovation. University students can use computer experts. Fellows work from six to twelve months in the city administration, exchanging knowledge and innovations.

2. Cooperation with the city. The implementation of this priority is through the implementation of:

• Smart City Lab is a place where everyone can come to share and discuss their innovative project with various partners. Projects are also being tested for viability here.

• National and international cooperation.

• Datenpool. Exchange of administrative data with institutions and the public, display of information from sensors of public infrastructures.

• Kickstart is a program that brings together companies, startups and the public sector.

• Hackathons are an event where software professionals develop innovative solutions to solve the city's problems.

4. Dialogue and communication:

• Project website is the creation of a single site that will display information on the implementation of projects.

• Participation portal creating a single page where people can participate in urban processes and projects.

• Monitoring and reporting – publishing annual reports to inform the public and local councils about the progress of tasks. Monitoring tools are constantly tested, evaluated for accuracy and improved and supplemented.

Norwegian capital has a population of about 650,000. Oslo has experience in reducing air pollution. The city has faced the problem of greenhouse gas emissions from vehicles. One third of the gas emissions in the capital are from cars. Oslo has set a goal to reduce emissions by 95% by 2030. To improve the living standards and health of the population, the mayor decided to create bonuses for owners of cars with zero emissions. Buyers of such vehicles do not pay 25% sales tax, have access to the lane, can use free charging, park and transport ferry. The city's electrical infrastructure includes about 2,000 charging stations throughout the city.

Norwegian capital is also attractive for its intelligent lighting. Oslo has used significant investments to improve street lights. These lighting fixtures respond to weather and light conditions and change the brightness as needed. The implementation of this project has saved more than 60% of electricity costs. Oslo was the first city to use such technology in Europe.

Amsterdam is a compact town with a population density of 4,457 people per square kilometer. Until recently, the city was in constant traffic jams, accidents occurred and there were not enough packing places in the city center. However, they managed to eliminate these obstacles by paving bike paths, Roboat plying. Amsterdam managed to create cycling culture in just 20 years. About 500 km of bicycle paths have been laid in the city, and there are 2-3 bicycles per capita. The result of this transformation is a reduction in traffic flow by two thirds. The city also runs a new mode of transport – Roboat. It is a type of on-demand infrastructure that can be used for passenger transport, garbage collection, delivery of goods and temporary infrastructure (connection of several elements of a boat that creates a bridge).

Ships can carry up to six passengers in the city at a time. Due to the use of navigation technology and cameras with a 360-degree angle of

view, the boat can carry passengers from point A to point B without the use of manpower on autopilot. The car can sail at a speed of 12 km/h. Also, the advantages include the fact that the robot ship is powered by electricity, a quarter of the city is occupied by a canal that allows you to move around the city, higher safety due to the use of new technologies compared to conventional boats, another tourist gem. Modification of the garbage collection vessel serves as a means of waste collection in the historic part of the city and eliminates the need for large garbage trucks, which reduces congestion, noise and pollution.

Smart Flow system works to reduce city traffic in the city. This application manages and monitors sensors located throughout Amsterdam, provides information on traffic flow, available parking spaces and service tariff grid in a specific area. As a result, drivers reduced parking time by 43%, opted for a cheaper option, became quieter in the city center, reduced fuel consumption and air pollution, and calmed down the driving process.

In Amsterdam, there is another project to reduce city traffic – Toogethr. This application compares the possible options for passenger transportation and finds people (potential car drivers and passengers) who need to get to the same place at a certain time. Thus, the number of vehicles on the roads and fuel costs are reduced, travel costs are saved, and the negative impact on the environment is reduced.

Another interesting factor in the development of Amsterdam is the initiative to develop a circular economy. Residents strive to reuse resources as many times as possible, and then process them into a new product. Thus, there is a reduction of material for the manufacture of products and waste after its use. To implement this process, a study was conducted, which found that household and household waste accounts for only 18% of waste, and 82% – is household waste. This made it clear that the first thing to look for is a business that needs to be helped to implement a closed-loop economy. That is, the program was aimed at the interaction of the two companies and obtaining the necessary materials from the company that was going to dispose of them to reuse unnecessary resources.

The DGTL festival is taking place in the capital of Netherlands. Here you can listen to modern electronic music combined with lighting and visual effects. By the way, in 2020 it became the first festival to use a closed economic cycle. The following rules apply to DGTL:

- Solar panels provide the festival with light;
- Visitors hand over plastic cups for recycling and receive Eco Coin in exchange. For them you can get a discount on souvenirs and drinks;
- Plastic boards are used to make skateboards;

• Only vegetarian dishes can be bought at the festival, because the meat industry has a negative impact on the environment;

• Food waste after the festival is sent to the farm to create fertilizer;

• Phosphates necessary for growing plants are obtained from collected urine.

In addition, garbage is burned in Amsterdam and benefited from it. AEB operates in the city, where various types of garbage are converted into electricity and raw materials. At the same time, emissions of harmful elements into the atmosphere are minimal. As a result of their activities, 320,000 houses and 600,000 GJ of electricity are produced annually, which provides the city with hot water and heating.

Another option to solve the problem of plastic waste is startup Ozarka. The essence of the project is that company rents reusable containers to restaurants and cooking services at the price of ordinary disposable tableware. Scheme of such a model is shown in Figure 25.

In addition to skateboards, Amsterdam also makes street furniture for the city and play furniture for children from sorted plastic. This is what New Raw is doing, which is convinced that plastic is a new raw material, not garbage.

Summarizing the above, we can conclude about new methods of developing smart specialization of cities on the European continent. Here, cities face problems of population growth, road congestion, insufficient number of packing places, environmental pollution by emissions and waste. To solve these problems, measures such as the

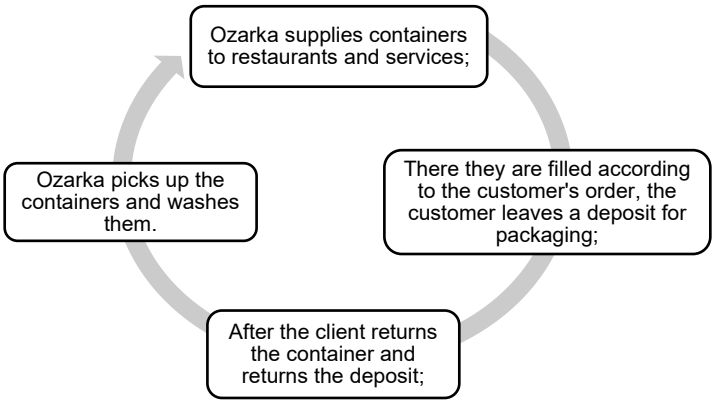

Figure 25 – Ozarka startup scheme

Source: compiled by authors

closed-loop economy, the rational use of limited resources, the use of environmentally friendly vehicles, and the use of tools to stimulate innovative thinking were introduced.

The study of aspects of the industrial revolution, made it possible to draw the following conclusions:

1. In total, four stages of the industrial revolution were passed. The first industrial revolution occurred at the end of the 18 century, as a result of which the first steam engine was created. The second revolution gave humanity an assembly line. During the third industrial revolution, production automation and the computer were invented. The fourth industrial revolution brought together all information and communication technologies for successful city management, comfortable and safe living. This prompted the launch of Industry 4.0 concept. The new level of industry is guided by the principles of compatibility, transparency, computer support and decentralization. The concept includes components such as autonomous work, modeling, big data, industrial IoT, virtual reality, cloud technology, cybersecurity, adaptive manufacturing, horizontal and vertical system integration.

2. Under the influence of new industrial revolution, the city began to direct development in the direction of smart specialization. Based on this, a new term “smart city” was introduced. It combines the economic development of the city, an innovative system of relocation, the rational use of limited resources and the use of alternative energy sources, the circular economy, raising public education, smart governance and living. Kyiv Smart City concept revealed the essence of ways to develop the capital’s smart specialization. This document is grouped by areas of development such as smart governance, relocation, lifestyle, innovation, environment, education and a safe city. As a result of the implementation of the concept, an electronic services portal, Kyiv Digital application, Kyiv resident cards, CCTV cameras and speed cameras, an open data portal, a contact center of the city, etc. appeared in Kyiv. Due to the implementation of the concept in the capital, additional sources of filling and budget savings have appeared, the level of trust in the decisions of local authorities has increased, the city has become safer and more open to innovation.

3. European continent is sailing on the wave of global digitalization and gaining experience in the development of smart specialization of cities. The strategies and development priorities of three smart cities such as Zurich, Oslo and Amsterdam were analyzed. Zurich took second place in the Smart City Index 2021. The city has the following priorities – stimulating innovative development, cooperation with the city, dialogue and communication. The next place in the ranking was taken by Oslo.

The experience of Norwegian capital was interesting because the city has created all the conditions for comfortable and economical travel by electric vehicles. There were also investments in smart lighting, which reduced local budget expenditures.

However, the most innovative city was Amsterdam. There is a developed cycling culture and the Roboat ship, the Smart Flow parking system and the Toogethr application, which combines passenger and driver to move together, reduce road traffic and save on travel, etc. In turn, the city supports the circular economy initiative. Moreover, local authorities are creating programs to help businesses implement waste-free production and reduce waste after using the product. In addition, Dutch capital has a closed-cycle DGTL festival, burning garbage to generate electricity and heat, a startup Ozarka that rents out and washes reusable containers for restaurants and cooking services to reduce use. plastic disposable tableware.

Finally, the technological advances of Fourth Industrial Revolution are becoming key drivers of digital transformation of industry and production, the essence of which can be understood by examining the current changes in the economy and considering new technologies and practices related to digitalization. Different views on what technologies and related practices are determinants of the process of digital transformation of production and growth of cities with a population of millions are an illustration of the fact that we are now at a kind of “boiling point”, and systematically describe what is happening is difficult.

The nature of the processes of digital transformation of production and industry, which act as a qualitative leap, or a civilizational shift, according to the transformational concept of transition states, interrupt the slow evolutionary development.

Digital transformation has led to increased research interests in finding a model for the development of economic systems in these conditions, as such transformations can create incredible opportunities to improve the welfare of the population by addressing pressing social issues: from health and education to the environment; and a large number of negative side effects, including the displacement of labor by machines and artificial intelligence, social and property inequality, the risk of global conflicts over technological supremacy, cybercrime and more.

2.2. Digital ecosystem in the mirror of mutual relations and mutual influence at different levels of economic aggregation

Thanks to the implementation of digital economy, small and medium-sized businesses have received an unattainable opportunity to be global and have an increasingly significant impact on world economy. This trend opens up new prospects for the development of Ukrainian small and medium-sized businesses. After all, Ukrainian companies can integrate into international networks of added value, which some of them are already successfully implementing. This is the way to increase exports and production of products with greater added value.

Are enterprises ready to create such strategic development tools? When they come out, is it possible to launch them at the industry level? Who will be the first in this? Answers to these and other questions must be actively sought, because it is speed, flexibility, and timeliness that will depend on the competitiveness of domestic products and services on the world market.

The term “digital transformation” (TC) appeared in the world back in the 2000s. In 2011, from the submission of GapGemini Consulting and other consulting companies, term receives a powerful conceptual base, which explains how digitalization can radically change business performance. In 2014, the term Industry 4.0 was widely heard at the Hannover Exhibition as next stage of digital transformation in industry, and in 2015 Klaus Schwab’s bestseller “The 4th Industrial Revolution” was published. In 2016, the IT and industrial automation associations that create the “Industry 4.0 in Ukraine” movement will unite in Ukraine.

Since then, attempts to understand the state of digitization in various sectors of industry, in cities and their urbanism and the possibility of accelerating this development have been traced in Ukraine. Actually, the mechanical engineering sector is the driver for the development of the entire industry in the era of 4.0. After all, smart machines are the basis of intelligent production. But this is not the only reason why nowadays the focus is on mechanical engineering.

The dramatic drop in the volume of this industry after 2014 in Ukraine called into question very existence of the industry – on the scale and boundaries that have more or less been maintained since 1991. In addition to the traditional explanation of the loss of CIS markets, the development of exports to other markets, as well as competition domestically, the question of the competitiveness of Ukrainian manufacturers was raised. And among the factors of competitiveness, there is a special interest in those that are directly affected by digitalization.

The results of a survey of mechanical engineering industry conducted by the APPU (*Analytical report of APAU, 2021*) are somewhat controversial. On the one hand, the respondents are well aware of Industry 4.0 trends, recognize Ukraine's lagging behind, but also believe in the significant impact of digital transformation on the competitiveness of their enterprises in the future. On the other hand, the interviewed experts from the market talk about excessive optimism and "advancedness" of these results.

For example, it can only be encouraging that 78% have digital transformation goals, and 55% are implementing digital programs. But it was not possible to get more specific information on these goals and programs. Certain contradictions in the results can be explained by the fact that those who are already approaching the implementation of 4.0, but may not yet be sufficiently confident in the integrity and integration of these strategies in their enterprises, took part in the survey. The role of digital technologies is one of the main factors in the growth of competitiveness.

The fact that 4.0 technologies are among the priority factors of competitiveness has long been recognized in developed countries, and in general, it is still very little in Ukraine. According to McKinsey data of 2016, more than 80% of the heads of industrial enterprises believe that technologies 4.0 will fundamentally change the landscape of Industry in the next 5-10 years. In particular, 30% of them are already investing in these technologies. According to the early data of APPAU in 2016–2017 (before the 2018 survey), > 90% of Ukrainian managers simply do not understand "what it is". Accordingly, it was never about "faith", and even more so about "investment" (*Analytical report of APAU, 2021*). General effect of technologies 4.0 for industry, big four of the world's largest consulting companies talk about revolutionary changes in world's economies thanks to digitalization.

Ukrainian Digital Agenda Ukraine program gives average indicators of contribution to growth at the level of 20-25%. European association Orgalime especially emphasizes and emphasizes the role of Industrial Engineering in mechanical engineering – "The primary focus of digitalization should be on those who start it (enablers) – these are the engineering industries". Industrial engineering is machine-device and other construction, complex engineering and system integration, technology design, industry-oriented R&D centers, etc. The position of Ukrainian movement 4.0 in relation to mechanical engineering. National movement "Industry 4.0 in Ukraine" puts engineering and mechanical engineering sectors as a priority – the focus of national and state economic development programs should be on these sectors:

1. Processing industry (3rd level) consumes ready-made technologies – lines, machines, technological complexes, devices, etc. These products are manufactured in the Engineering & OEM category. If there are no local ones, imports will increase.

2. Main technological innovators in digitization come from another category – developers, system integrators and IT vendors. The speed and power with which they affect categories (food and processing, metallurgy, energy, oil and gas, pharmaceuticals, building materials, urban infrastructure) and is decisive for digital transformation. Such industries as mechanics, electronics and electrical engineering are rapidly degrading in Ukraine, because the conditions for development have not been created for them. Main challenges in Ukraine are:

• For industrial end-users and engineering industries – to change the focus and understanding of key business drivers: from only cost – to those that are important in global world (business drivers) – quality, time to market, productivity, customer experience;

• For technological innovators: to change the attitude of the mechanical engineering categories and innovators 4.0 to digital technologies – instead of being an "appendage" to machines, they should become main ones in creating added value.

There are many studies on the influence of digital technologies on the state of mechanical engineering today:

1. McKinsey report "How to success: Strategic options for European machinery" refers to a survey of more than 240 machine-building companies and focuses on strategic changes in 3 areas:

• Change in growth patterns – both in the geography of presence (including areas of profit growth) and also in the management of value creation chains. Regarding the latter, the shift from products to services is a definite trend. Next, we see the growth towards digital services;

• Increasing rates of digitization – and this calls into question the durability of existing business models;

• Acceleration of organizational changes – which are necessary for the implementation of the above two directions of growth.

2. Back in 2016, Quest Trend Magazine determined in a survey of more than 150 machine builders that 66% of them are already on the way to Industry 4.0, and another 28% are planning these changes. Only 6% of respondents said that they do not plan any movement in this direction.

3. Another report of the same agency was specified for tasks of network interaction of machines, both vertically and horizontally of the enterprise. As you know, easy network interaction of people, machines and systems is the cornerstone of Industry 4.0. Results

show a great awareness of machine builders both with network interaction technologies and a purposeful movement in the direction of horizontal and vertical integration.

4. Hampleton analysts provide a rather extensive report showing the interest of large companies in acquisitions and purchases of technological representatives in the field of mechanical engineering. The acquisition of the robotics leader Kuka by the Chinese Midea is the most revealing here. There are dozens of similar reports and testimonies of digitization strategies of European and global machine builders in the world today (*Analytical report of APAU, 2021*).

Recognizing the primacy of large companies in digitalization processes, commitment to the course of digital transformation and Industry 4.0 is expressed, in particular by market participants – global vendors, integrators, business associations, consulting companies, and even the government. There are many reasons for highlighting the trend "large companies are the drivers of digital transformation". DTEK, Ukrzaliznytsia, Metinvest, Interpipe, KB "Pivdenny", FED, subsidiaries of JSC "Naftogaz", Kernel, MHP and many others have openly declared their commitment to the course of digitization of enterprises. All the above-mentioned companies are seriously investing in new technologies, and some of them have launched their own corporate accelerators. The trend of corporate innovation is also fueled by several IT incubators that seek to involve IT industry and the startup community in the transformation processes of our enterprises.

Despite all the positives of this trend, it is not difficult to see some distortions or "punctures" typical for this early stage of evolution. It makes sense to consider them in the 3 most typical categories of approaches to innovation:

1. Traditional, rigid selection through tendering. This is the classic and most common method of selecting contractors for certain works. For state-owned enterprises, e-tendering through the Prozorro system, where the bid price is the main criterion, is also a mandatory selection condition.

The most telling here is the tender of Ukrgazvydobuvannya (UZD) for the monitoring of wells for gas extraction, and where the American Honeywell won with the sum of more than 10 million dollars. This is a rather complex and large-scale project, in which USD managers managed to correctly conduct pre-qualifications, as a result of which the most qualified contractors made it to the tender finals. Moreover, the bidding price in the final fell by half. The challenges of digital transformation are generally a positive moment for the oil and gas industry, which is rapidly catching up with the modernization opportunities lost in previous years

in terms of investments. However, in terms of digital transformation, this project does not address many other challenges facing such state-owned companies:

• Ukrainian contractors or manufacturers are not visible at all – in this way, state companies increase the import component;

• According to the available information, the technologies that will be used by Honeywell belong to classic 3.0 rather than to innovative ones. The project does not yet solve typical 4.0 tasks of this scale, such as the creation of IoT platforms. Although it was probably a chance – we are talking about a huge distributed system of remote monitoring and control.

2. Partner – through cooperation. This approach involves traditional, long-established cooperation with recognized contractors, system integrators and developers of ACSTP-IT. Private companies are following this path. A vivid illustration of such approaches is the first 4.0 cases in Ukraine from Interpaip and PJSC "FED". In fact, there are many more of them in IT-Enterprise. Thanks to the stability of the relationship, the company was able to develop its own vision of digital transformation and according to the stages of maturity of the customer.

Challenges in relation to digital transformation are, first of all, dependence on one large contractor, whose range of competences is a priori limited. Without synergy and integration, it is impossible to talk about real and deep integration processes of the enterprise – especially vertically, from sensor to ERP. Therefore, in 2018, IT-Enterprise made attempts to create its technological ecosystem and invited other ACS integrators to its ranks.

3. Focus on innovators through corporate accelerators. The leaders of investments in this approach in 2018 were DTEK and Ukrzaliznytsia. The essence of accelerators is to collect the best offers from the market according to predefined needs (cases), with the signing of contracts with finalist companies. The most qualitatively such technique was developed at DTEK. Together with RadarTech (the organizer of the accelerator), DTEK "filtered" more than 400 companies, including not only startups, but also mature companies.

Digital transformation challenges are the right approach widely used around the world to find and encourage innovators. Nevertheless, many questions were raised by general strategy and selection criteria of DTEK – companies that offer "light" solutions and mainly related to control and accounting in non-production processes made it to finals:

• Unified infrastructure solutions as IoT platforms;

• New solutions regarding cyber security (by the way, we are talking about the largest operators of critical infrastructure);

• Asset management systems and predictive equipment diagnostics;

• Solutions that make it possible to make a "digital leap" – that is, how to solve the backlog of the same mines or power plants in the mass digitalization of physical assets.

Without solving such tasks, it is difficult to make serious changes in approaches to digital transformation of such enterprises. And without this, and against the background of a constant increase in tariffs, the question that market participants ask themselves is becoming increasingly acute – "what is the essence of these innovations?" (*Yurchak, 2019*). It is obvious that the above-mentioned approaches can be complementary. What, in general, is already practiced at such enterprises as DTEK? Can this be called true path of digital transformation? Do these approaches solve main issues of acceleration in the field of ACS-IT in 21st century? Rather "no". Mainly because old strategic challenges are not solved, and new ones are growing.

First, there is no clarity in the priorities of digital technologies and the corresponding investments. There have been dozens of traditional 3.0 technologies for a long time, and newer ones belonging to the 4.0 generation are constantly being added to them today.

Classic technologies (3.0+): robots, ERP, MES / APS / APC, SCADA / HMI, authorization, accounting / dispatching, data warehouses, mobile technologies, industrial networks, cloud computing.

New technologies 4.0: IoT platforms, smart sensors, cobots, 3D printing, artificial intelligence, cyber security, VR / AR, Real-time Location Services, Wearable, drones.

Which of them are priorities today and why? For example, with a limited budget, should you invest in AR/VR technologies, IoT, cloud platforms, etc.? Or maybe take up cyber security first? What do priorities depend on – or only ROI? And how can you calculate the ROI for technologies that are completely new? And what about financial indicators in cyber security issues?

Similar questions have been around for a long time, but there are usually no unequivocal answers to them.

Secondly, there are no "digital leap" strategies. Ukrainian enterprises have underinvested in classic (3.0) technologies for years. The level of basic automation of ASUTP-IT does not exceed 50%, while Western countries, China and Asia have mostly passed it.

In conversations about 4.0, a clear answer should also be given to the question of "digital leap" – how to raise the necessary base for data processing technologies. This is the main principle of digitization and it is about the automatic acquisition of data from physical assets. Without

it, talk about artificial intelligence and other smart technologies in most cases sounds like fiction.

And again, there are no clear answers to this question yet. It is not clear why many esteemed customers need new 4.0 technologies, if many of their control-accounting-automation tasks have not been solved. And they are solved by classic, long-available methods and contractors. Without clear answers to these questions, companies will catch up with the developed world in another 10-20 years. But then there will be new technologies.

Thirdly, endless tenders and the practice of "squeezing" – even in the case of quality contractors, have had a bad effect on the confidence of industrialists. The implementation of complex projects is always associated with risk management, teamwork between the contractor and the customer – and on a long-term basis. But if you squeeze and tender all the time, lowering the price – what kind of parity of interests are we talking about? This is also one of the reasons why many leading developers prefer to work abroad. To this it is worth adding, even in tenders, the presence of clear criteria for the selection of the contractors in question.

As for new innovation competitions, the questions are the same. Why did certain companies win in them in past years – the criteria are extremely blurred and unclear? In addition, the organizers of such contests – even if hundreds of companies pass through them – do not make any final analysis of the results. Meanwhile, such analytics are extremely important for the orientation of other customers in understanding "who is who", and for market participants to understand "where to move or where the growth zones are".

As a result, many customers go around in circles – it seems that there are also many developers, and many have already worked with them – and for some reason it is necessary to "launch everything from the beginning".

Fourth, the lack of focus on the ecosystem. The "fashion for startups", which captures the mind of some CEOs, is harmful because it distracts from a much more important strategic question – how to revive and strengthen the innovation ecosystem in your industry? In other words, customers from the easy supply of IT incubators, and today already state structures and international funds, are trying to build an increasingly "sophisticated" system of filters to screen out the best proposals from developers. Absolutely not analyzing at the same time – "Where do these proposals come from and are there conditions for creating a flow of innovative products?".

The innovation ecosystem in most sectors of Ukraine, which includes modern research institutes, project institutes, laboratories,

technology parks, funds, etc., has been destroyed. Most often, it is so obvious that it doesn't even require special evidence. And instead, in order to restore it together, largest market operators continue to "milk" it. All this is really similar to notorious phenomenon – desire to get "milk without a cow".

Fifth, ignoring the standards on which the world Industry 4.0 is based. Talks about interoperability, integration, cyber-physical interaction is completely groundless without consideration of the standards underlying these phenomena. And here is the surprise – it turns out that many directors do not need these things at all. They don't even realize how similar innovative approaches are to the same invention of the bicycle. After all, you will definitely have to redo everything. What then is the meaning of these innovations?

Sixth, uncertainty in "non-technological" factors. The simplest principle of PPT (People, Process, Technologies) was invented in IT in particular to introduce the principle of any technological implementations as complex organizational changes. That is, "you can't automate chaos" – you can't implement a new modern technology without changes in business processes, organization structure, methods and culture of interaction, personnel skills, their knowledge, etc. This high-tech axiom is already 25 years old, if not more (*Yurchak, 2019*).

Having analyzed the level of enterprises, there is a need to focus attention on digitalization of cities, towns and villages. After the full-scale invasion of the Russian army on the territory of independent Ukraine and during the hostilities, many cities were destroyed, and the capital was also damaged. However, Kyiv continues to develop. During the martial law, further development of information and digital technologies is taking place in all spheres of Kyiv, in particular, in the Department of Housing and Communal Infrastructure. In this difficult time for the city, new functions were developed in "Kyiv Digital" application, in particular:

- A map showing a working business. As of March 18, 2022, 400 enterprises were noted (*Official website of Kyiv City Council, 2022*[a]);
- Map of grocery stores, humanitarian headquarters, bread sales points, pet stores and pharmacies (*Official website of Kyiv City Council, 2022*[b]);
- Map of shelters;
- Air alarms (in the application you can include a notification that will inform about the start and end of air alarms);
- Message about tags (a chat has been created in Telegram, in which you can report hostile actions on the territory of Ukraine);
- "Find a shelter" (a site where owners of free housing or rooms publish ads about their willingness to accept refugees for a certain period for monetary compensation from the state);

• “Return alive” (a fund that collects funds for the purchase of necessary equipment for the Ukrainian army, but it does not collect funds for the purchase of weapons) (*Savelife, 2022*).

The “Important to know” section also appeared in “Kyiv Digital” application. In it, you can find answers to common questions that appeared among the population after the start of hostilities, which include the following categories:

• Security during martial law (this category contains information on finding shelter, curfews, evacuation flight schedules, rules of conduct when an air raid signal sounds, detection of suspicious objects, and house collapse);

• Evidence of destruction (contains information on statistics of destruction in Ukraine, the “Russia will pay” project, rules for submitting evidence of destruction and confidentiality of submitted evidence);

• Traffic of city transport. In this category, information is disclosed regarding the movement of land transport, electric train and metro in the territory of the capital;

• Car traffic (there is information on the accessibility of bridges, traffic and parking rules during martial law, rules of behavior when passing a roadblock;

• Services for citizens (information about open grocery stores, pet stores, veterinary clinics, bread kiosks, service stations and gas stations is disclosed);

• Communal services (there is information on notifications of planned works from communal services);

• Health (information is disclosed about open pharmacies, medical institutions, trauma centers, dental offices, necessary medicines and assistance to seriously ill people);

• Humanitarian aid (presented list of humanitarian headquarters, rules for receiving humanitarian aid, information for volunteers and investors);

• Assistance of the army (it is told about the rules of admission to the territorial defense, about the “Return Alive” fund, organizations to which you can inform about the finding of an enemy mark, enemy troops, war crimes of the occupiers and suspicious objects);

• Information security (there is information on protecting your data, blocking hostile information and a list of sources you can trust) (*Official website of Kyiv City Council, 2022*[a]).

So, on the eve of war, capital was a modern and developed city. The head of the city council made every effort to ensure that the population that remained in the city and did not leave for a safer place had access to reliable information, an emergency response plan,

maps of shelters, working shops, gas stations, pharmacies, etc. The city mayor also focused the attention of enterprises on supporting the municipal infrastructure of Kyiv. Therefore, in case of destruction of the infrastructure, the inhabitants of the city have access to water, electricity, gas and heating as soon as possible.

The solution to the above problems of strategic development is the road map of digital transformation. It can be at the city, enterprise and industry level. We are talking about a visual representation, where time intervals are applied horizontally, and all necessary for complex changes of the category are applied vertically, for example:

1. Business goals: what are the main business tasks and goals of the enterprise to be solved within the next 3-10 years.

2. Products: what innovative products and services should enter the market during this period.

3. Technologies: what support technologies should be implemented.

4. People: what kind of people (skills, knowledge) and where (structure) should appear in the organization.

5. Culture: what elements of culture should change.

This is a fairly high-level scheme. Such maps are an indispensable element of strategic planning and management of large organizations. Needless to say, the availability of such tools – and even more so available to a wide range of contractors, developers, technological partners from their ecosystem – not only removes most of the problems mentioned above, but also dramatically increases the level of trust in the company's management. And this, perhaps, is the main significance of such road maps at the initial stage. They are a coordination and communication tool for all industry stakeholders. And operators like DTEK or "Ukrzaliznytsia" have hundreds of them! (*Yurchak, 2019*).

Digital infrastructure, like 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, etc. analog infrastructure of innovations, for example, clusters. Clusters combine several important elements of the ecosystem at once – R&D centers, laboratories, incubators, accelerators, educational institutions, venture funds, innovation teams, technological business, as well as industry. One of the variants of the cluster is inter-industry alliances.

The ecosystem allows the introduction of incentives and motivations for modernization, scaling and acceleration of business development. Digital infrastructure resources can encourage businesses and citizens to consume and use information, 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.

Some institutions of digital business ecosystem are presented in Table 12. The issue of consideration of possible support for the development of innovative ecosystems in cities (innovation/technological hubs, centers, parks, clusters, etc.), the innovation policy of municipalities and the stimulation of citizen involvement in the development of smart city solutions (start-up movement and live laboratories).

Currently, issues for urgent resolution remain relevant in the course of the formation of digital business ecosystems in most countries in terms of:

• Creation of a new quality of the ecosystem of interaction of citizens with social programs, services and information necessary for the selection of services;

• Creation of regional innovation and digital networks and activation of international cooperation. As cities lack the capacity and experience to implement smart solutions, they can join forces with others who have similar challenges and with technology partners to develop, implement and apply them, as well as share lessons learned. and finding financing;

• Creation of a high-quality ecosystem of interaction of social services, departments, non-governmental organizations, service providers for joint agreed actions to meet the needs of citizens;

• Formation of consortia and expansion of the public-private partnership mechanism for the introduction of new technologies;

• Creation of urban innovation centers and “living” laboratories of digital business ecosystem. Innovation centers and laboratories can become platforms for the demonstration of new ideas and concepts. “Living” laboratories (a place for conducting innovation experiments) will allow experiments to be carried out and can be used to test, develop and spread innovations to build a digital infrastructure.

• Creation of an innovative industrial hi-tech ecosystem, which involves the following development tasks:

1. A complete independent audit of the existing elements of the ecosystem, such as design bureaus, the ZVO system, science parks, etc., with a reference to target indicators.

2. Their development to the target model of the innovative ecosystem of industrial high-tech segments.

3. Establishment of technology transfer from scientific institutions, science parks, R&D laboratories, as well as from international centers and corporations to end customers.

4. Creation of networks of the most effective structural elements of the Industry 4.0 ecosystem – centers of expertise, R&D laboratories, technology parks, incubators and accelerators of Industry 4.0 startups.

Table 12 – Institutions of digital business ecosystem

Institute of Innovation and Digital Development	Content, features of functioning and general characteristics
1	*2*
Key Enabling Technologies Technology Centres	help industrial enterprises, in particular small and medium-sized businesses, develop and produce new products based on technologies that include micro- and nanoelectronics, nanotechnology, industrial biotechnology, advanced materials, photonics and advanced manufacturing technologies that have applications in various industries. Such centers carry out applied research, helping companies to reduce the time needed to implement innovative ideas and enter the market. Services provided by the centers may include: access to technical expertise and inspection facilities; laboratory testing; development and testing of prototypes; pilot production and demonstration/pilot lines; product verification/certification.
Factories of the Future	created by applying the public-private partnership mechanism in order to increase the technological potential of production. As part of the Horizon 2020 program, more than € 100 million was invested in pilot lines.
European Institute of Technology	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 resources.
Digital Innovation Hubs	non-profit complexes that support companies, in particular SMEs, in their efforts to digitize their activities. In the communication on the digitalization of European industry, adopted in April 2016, the EC announced plans to invest € 500 million from the Horizon 2020 program (2016–2020) to develop digital innovation hubs, their networking and innovation experiments for SMEs. Thanks to such centers, it became possible to obtain access to knowledge and testing tools for companies from various industries focused on digitization processes. On the basis of such centers, there is a technological organization or a university laboratory that offers various services (conducting experiments with smart technologies, such as artificial intelligence, supercomputing computers, blockchain, 3D printing) to understand new opportunities, learning with the aim of maximum use digital innovations (expansion of partnership relations, exchange of educational programs and materials).
Joint Research Centre	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 (EIT, 2021; European Commission, 2021)

5. Establishment of cooperation with international standardization bodies for the purpose of developing interoperability standards and other standardization measures necessary for the implementation of technologies related to digital infrastructure.

6. 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 an emphasis on the quality of internal business processes to the improvement of external communications between platform users;

• From maximizing value exclusively for consumers to the overall value of the entire digital ecosystem.

Among the key characteristics of digital platforms are the following:

• Network structure, network effect;

• Resource creation (1+1=3);

• Internal currency, tokenization (one of the directions in the future);

• "win-win-win-win" – manufacturer – seller – buyer – owner of the platform;

• Digital twin – functioning in two economic formats at once (virtual and analogue);

• Scaling platform – Internet;

• Capitalization of data, data is a resource.

The principles on which the positive quality of functioning of digital business ecosystems is based are presented in Table 13.

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, communication and digital technologies;

• Make digital infrastructures accessible;

• Increase in economic activity, creation of new jobs, increase in tax revenues and domestic demand, simplification of modernization of outdated assets and creation of new ones.

Industry 4.0 is about the rapid and massive introduction of new digital technologies. Evidence of this is presented in Table 14.

Returning to the main intrigue of the last three years – the "big – as drivers" trend – today success is decided precisely in the ability to create and implement effective strategic development plans. So far there are none. Perhaps they are not there because large enterprises, in fact, act in the old way – they try to create important things of a strategic

Table 13 – Principles on which the positive quality of functioning of digital business ecosystems in the regions and the country is based

Principle	General characteristics
1	***2***
Of the system approach	It consists in the introduction of a wide range of interrelated activities and tools for the development of digital entrepreneurship, which reinforce each other, will contribute to the establishment of cooperation of various subjects to achieve a common goal – to increase the level of provision of quality services/goods.
Of ensuring the interaction of interested parties	It is involved in the development of digital infrastructure of central and local authorities, private and state enterprises, leading TNCs, business associations, banking institutions, NGOs, educational and research institutions, as well as the population in order to realize their interests during development of such infrastructure.
Of strategic orientation	According to this principle, the actions of subjects (both local authorities and businesses) involved in the process of building digital business ecosystems are aimed at achieving long-term development goals.
Of equal participation of all interested parties	It involves establishing and maintaining a balance of interests between all involved entities, which helps to achieve a synergy effect in the interaction between the parties, development institutions, i.e., business agents of digital ecosystems.
Of social responsibility	Provides effective and social benefits for the public and digital entrepreneurship. Mandatory observance of this principle is required when forming a digital business ecosystem.
Of safety and control	It involves evaluating the results and analyzing the factors of implementing smart technologies into the physical infrastructure. The principle is extremely important, given that any technology, as has been repeatedly noted, is associated with risk.

Source: grouped by the authors based on (Markevych, 2021)

Table 14 – The world's most popular technologies 4.0 for the field of mechanical engineering

Technology	Characteristics of the technology	Fields of application in Ukraine
1	*2*	*3*
Predictive analytics (service) based on data processing	Predictive maintenance is a new type of machine and equipment maintenance that replaces traditional methods such as scheduled preventive maintenance (PR). Stoppage of production can cost an enterprise from several thousand dollars per day (FMCG) to 2.5 million per day (automotive industry). Today, smart machines can provide data on why and when a particular part or assembly might fail. Applying predictive analytics with new data processing methods and models can save up to 40% on maintenance and reduce unplanned downtime by up to 50%.	The most active in Ukraine is the Ukrainian company IT-Enterprise, whose product SmartEAM is the winner of the 2017 4.0 competition. SmartEAM uses the RCM method, which is the next step in maintenance in relation to PPR.
Product life cycle management (PLM)	Product Lifecycle Management (PLM) is especially relevant for machine builders when it comes to innovation and constant change. Main trends in this area concern the transfer of PLM to the cloud environment, the emergence of Product-Data-asa-Service (PDA AS), which turns product data into valuable assets, collaboration platforms, micro-services, as well as blockchain integration.	The greatest effect from the application of "Engineering Data Management PDM" is achieved when integrated with the typical configuration of "Management of a manufacturing enterprise for Ukraine": this is how PLM technology is implemented – product life cycle management technology.
Augmented and virtual reality	To master new machines, put them into operation, and then in service, operators and operating personnel used to use instructions in pdf or printed format. But when it comes to quickly finding the information you need, as a rule, such things do not work – it takes too long! It is another	Companies active with these technologies in industrial segments are currently unknown. Although their number is growing rapidly – the first classification and landscape were made in Unit.city.

(Continuation of Table 14)

1	*2*	*3*
Augmented and virtual reality	matter when the image of the necessary unit or part is presented in a visual form in 3D and also with all the accompanying information in real time about the state of the mechanism. This is how virtual and augmented reality (VR & AR) technologies work. The use of AR significantly reduces the cost of personnel training and equipment maintenance, as well as reduces unplanned downtime.	The Sensorama company is included in the 4.0 movement from this list.
Vertical and horizontal integration of machines using OPS UA	The “chips” of 4.0 are realized by interoperability – both vertically and horizontally (the value creation chain) of the enterprise – this is the OPC UA standard (MEC 62541). This is the de facto standard for 4.0 projects (included in the RAMI model), and supports a number of other protocols and mechanisms – TCP, HTTPS, UPD, AMQP, MQTT. Available implementations are today in Java,.Net, ANSIC/C++. OPC Foundation has more than 500 companies that support and implement in their developments.	OPS UA has long been widely used by many market players at the SCADA/HMI level. New controllers (such as the Schneider Electric M241/M251) allow the use of an OPC UA server “on board” – this provides more opportunities for integration into the cloud environment and work in distributed architectures.
Production management systems (MES)	Production management systems are not a new thing in industry. We are already talking about the 4th generation of MES (Manufacturing Execution System) – software for managing production processes in real time. From stand-alone, on-premise solutions, through integrated and modular, up-to-date platform-based solutions that allow easy integration of third-party solutions and applications (apps).	It seems that Ukraine has missed 3 generations of MES – it is extremely difficult to find them at our (any) factories. This is additional evidence of gaps between the levels of IT and OT (ASUTP) – after all, there are already many ERP systems on the one hand, and ASUTP on the other in enterprises.

(Continuation of Table 14)

1	*2*	*3*
Smart devices and mobile applications	The transfer of intelligence to any device is a characteristic of IoT and 4.0. Decreasing the price of sensors and many other field devices makes it possible to significantly increase the intelligence of physical objects into which they are integrated.	"Smart" (more intelligent) devices that are easily integrated into the network have long been offered by a lot of manufacturers in Ukraine, primarily Western ones.
Smart devices and mobile applications	Typical use cases are better monitoring of equipment, including predictive analytics, tracking of wagons or machines, mobile personnel, optimization and better management of production, etc. One of the best cases described by us in Industry 4.0 where mass use is mentioned of smart sensors in production is Intel's case.	Yes – sometimes they are more expensive, but even in such cases, the benefits of using them compensate for the initial cost. One of the best examples of the use of the new Real-Time Location Services technology with new type sensors and the use of mobile applications is demonstrated by Kyiv-based Leantegra. Company is widely implementing this technology in Turkey for tracking rolling stock and personnel in underground mines.
Cloud platforms and services	Digitalization is impossible without IT infrastructure. Its central elements are the network and data centers (data centers). Maintaining your own, modern data center is an expensive "entertainment" for most enterprises, so most manufacturers today switch to using cloud services and platforms. It is important for industrialists to know that the trend in Industry 4.0 is the use of ready-made platforms-as-services (PaaS). Almost every manufacturer of CAE/CAD/PLC/SCADA and even field devices offer integration into them today. Platforms such	Ukrainian industrialists are very cautious about new opportunities. Bias with regard to cyber threats, ignoring global trends, reluctance to pay for subscription services, etc., collectively throw us back into the last century. Still, there is movement. In the field of industrial platforms, good examples are shown by the winners of the 4.0 competition in 2017 – IT-Enterprise,

(Continuation of Table 14)

1	2	3
Cloud platforms and services	as Mindsphere (Siemens), Predix (GE), Ability (ABB), Ecostruxure (Schneider Electric) are increasingly used, including machine builders.	Indusoft and Novatek-Electro (Overvis).
Cyber security	Cyber-attacks on Oblenergo, “Petya” and other (including many non-public) attacks are eloquent evidence of the vulnerability of Ukrainian customers. Centrifuges at the Iranian nuclear power plant went “down” due to the	Technical Committee 185 and its group on cyber security are actively working on the harmonization of Ukrainian DSTU to international
Cyber security	Stuxnet virus, which “broke” control algorithms in Siemens controllers. Does this mean that we should then ban the Internet and close ourselves off in our environment, “on proprietary protocols”? Obviously not! The whole world is moving to cloud technologies and the Industrial Internet of Things (IIoT), where cyber security issues are one of the main ones. The IEC 62443 standard is mandatory for industrialists to follow this path and build their systems and products to be safe. For machine builders, the MEK 62451 (OPC UA) standard is also important, which allows you to “build” the ORS server into the machine in a safe manner.	standards. It is worth knowing and following the best practices of brand leaders present in APPAU and the 4.0 movement – from Siemens, Schneider Electric, Phoenix Contact and others. But you should not ban the Internet, as the heads of some Ukrainian enterprises still do – this path is a dead end.
Simulation, virtualization and digital twins	Machine builders increasingly use virtualization and simulation technologies in the process of developing new products. This makes it possible to reduce the cost of production many times over and speed up the pace of development. Therefore, digital simulation – in all its varieties – becomes a mandatory part of the PDP (Product Development Process). Simulation and digitalization capture the entire life cycle – for example, from the	Such things are completely new for Ukrainian machine builders. We do not have any information about development or implementation.

(End of Table 14)

1	*2*	*3*
Simulation, virtualization and digital twins	design of a mechanical product to the programming of the machine on which it is produced, and to its introduction into production. Here is a classic example from Dassault Systemes from the Hannover Exhibition 2017. In 2018, Hannover demonstrated even more similar cases. An even more advanced level are digital twin models that virtualize the behavior of a real object at all phases of its life cycle.	
New business models	The transition to service models is a typical characteristic of Industry 4.0. Paradigms and 'xxxas-a-Service' approaches are beginning to be applied to everything around – SaaS (Software-as-a-Service) models, products and platforms (PaaS) have been in use for a long time. Now it's the turn of the Machines. Similar approaches are available thanks to the digitization of machines. After all, the main problem of operation is machine maintenance. Thanks to predictive maintenance, including a whole set of 4.0 technologies (digital twins, cyber security, cloud computing – analytics...) all this becomes a reality.	Ukrainian OEMs have known about service models for a long time. At least, such giants as Corum Group had their own attempts to switch to them 3-4 years ago. We still have a long way to go to the level of Kaeser Kompressoren, which actually already sells a service (compressed air), not compressors, in Germany. If only because none of the machine builders has yet fully implemented the technologies that provide the Product-as-a-services or Machine-as-a-service model. And they are all based on 4.0 technologies.

Source: author's development

nature (sometimes – at the level of the entire country) in their closed environment – without involving best market experts, without analyzing world trends, without a strategic focus on the wider ecosystem.

Industry 4.0 will change people's lives beyond recognition. This will be the most global transformation in human history. And those countries that want to have high competitiveness and an efficient production system in the future should take part in it. This transformation will lead to a change in economic relations and customer needs, the way of production. Therefore, the city of Kyiv needs to take an active part in the global trend of development in order to occupy an important place among developed cities.

We hope that ahead of us is the wide implementation of innovative technologies in production, increasing the efficiency of business operations and, accordingly, increasing its competitiveness. Of course, for this it is necessary to overcome a number of challenges that the modern world poses to Ukraine, but main thing is that the country is on the right path, which will not only significantly increase the level of business, but also help accelerate economic development of the entire country.

CHAPTER THIRD ASYMMETRIC HORIZON OF DIGITAL TRANSFORMATION AT THE MACRO AND MICRO LEVELS

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3.1. The digital matrix in the light of the new economic augmented reality

Recent changes in the economy and society have caused adequate changes in the world economy. Today's economic concepts and categories are replaced by new ones, which can be generalized as the emergence of a new economy. This digital economy has its specific definitions, laws, models of world development, economic development as a science and as an industry that gains pace in history (*Koliadenko, 2016*). In the 21st century, the interest of researchers and economists to digital transformation has significantly increased in economic research. After all, digitalization provides real opportunities for economic growth.

There is a wide space for innovation activities of corporations in all sectors of the economy to be implemented through dialogue with the government, intersectoral cooperation and joint development of large projects on the basis of "deep" digitalization. In the last two years, the global hype about Blockchain technology and cryptocurrencies has not abated, and the financial regulators of the most advanced economies hardly keep up in responding to new challenges. The high-speed mobile Internet has caught the world in its "invisible web", expanding the banking market and challenging conventional approaches. The extensive use of sensors, distance learning and Big Data have been changing the paradigm of risk assessment and assets management.

Organizations are getting "unmanned", which minimizes staff costs and speeds up the service process. In addition, we shall keep in mind that digital economy has been radically changing the nature of labor and remuneration. If our planet became de-energized, the world would plunge into universal madness and global chaos. We have got used to technology so badly that can refrain from eating rather than from reading messages on the screen of a mobile phone. Mankind has adapted and learned to live with technology, fully digitizing our way of life.

Today, within the post-nonclassical discourse, the practice of postmodernism as an epistemological concept of real space research is transformed into a meta-modern paradigm based on cognition and creation, in the economic context, of virtual economy and its basic component, financonomics, the space of financial relations, that is more and more evidently separated from the real sector economy into a specific area of research (*Paton, 2016*). Digital economy is the result of transformational processes of the general-purpose state-of-the-art technologies in the field of information and communication, the formation of which testifies to a new level of the use of information technologies in all areas of socio-economic activity. Robotics, artificial intelligence, cloud technology, 3D printers, and BlockChain have been already come into general use. Smart cities, courier drones, and driverless cars "printed" in one day at home are our tomorrow reality. Fantasy novels have come true. Technological progress has conquered the world of business and forced all industries to change.

In the 21st century, such a categorical apparatus as "virtual reality" and "augmented reality" has deeply rooted into economic and engineering academic literature. The terms "expanded reality", "improved reality", "enriched reality" are sometimes used as synonyms.

The term "augmented reality" is used to describe all projects aiming at supplementing the reality with any virtual elements. Augmented reality is an integral part of mixed reality that also includes "augmented virtuality" (when real objects are integrated into a virtual environment). There are several definitions of augmented reality. In 1997, Ronald Azuma (*Azuma, 1997*) identified augmented reality as a system that combines the virtual and the real things; interacts in real time; operates in 3D. Paul Milgram and Fumio Kishino give a slightly different interpretation. They interpret virtual reality as a space between reality and virtuality, between which there are augmented reality (closer to reality) and augmented virtuality (closer to virtuality).

We believe that virtual reality of the multiuser world is based on the exchange of virtual goods within the on-line environment. It creates an opportunity to interact with the artificial world through virtual platforms with available information funds of on-line innovation market and to work with cloud technologies. We use augmented reality as a contactless information interaction that gives an illusion of direct entry and real-time presence in a stereoscopically represented "digital world" with the help of complex multimedia operating environments. We interpret "enriched reality" as a digital space created by computer technology, which has all hallmarks of reality as one that can be penetrated and transformed through globality and interactivity. "Improved reality" means

a reality that is modeled in real time due to the impact of a computer on human consciousness (for example, a person wears "electronic gloves"). "Extended reality" can interact with all other realities, affect the world around us and have feedback. Augmented reality as a component of mixed reality is a combination of virtual and real spaces through hardware and software, telecommunications, computer networks, and shapes the digital economy.

Digital economy is a system of relationships in the field of production, sales, and supply of products through computer networks, using digital technology. Digital economy is an economy in which the key factors of production are digital data and their use, which enables a significant increase in efficiency/productivity in economic activities. Noteworthy is the definition of digital economy as the possibility of creating a measurable real world or its digital model that with the introduction of new dimensions, in addition to the three-dimensional physical world, creates opportunities to account the features of the real environment, which were inaccessible before and both physical and business processes that take place in it (*Kupryianovskyi et al., 2017*[b]).

Global innovation centers in Silicon Valley, New York, and London continue to accumulate global venture capital, talents, and innovative corporations of the planet. Countries and cities, which focus on innovation development, create exclusive conditions for the introduction of start-up ecosystems. Corporations have been shifting to open innovation platforms, learning to develop new solutions involving the society of global talent. Foreign investors more and more often choose target teams with creative ideas and support potential opportunities instead of detailed business plans.

The experience of Switzerland, Germany, Canada, Finland, and Great Britain has shown that digital economy is characterized by much faster return on investment in specific projects and a higher profitability of individual projects (*Kupryianovskyi et al., 2017*[a]).

The models of cloud services in the above mentioned countries include as follows:

• Infrastructure as a Service (IaaS) renders computing resources in the form of virtual resources with a given configuration, required quantities, and software;

• Platform as a Service (PaaS) provides a platform for developing, testing, deploying and supporting applications as services;

• Software as a Service (SaaS) involves the provision of software as a service (*Efimushkin et al., 2017*).

Modern government agencies in different countries have focused on simultaneously improving the quality of services, optimizing the number of

employees and reducing costs. “Digital” platforms (ERP, CRM) systems allow solving these problems and dramatically raising efficiency through reducing operating costs and execution time. Government agencies use “digital” platforms to simplify and to optimize internal processes, to improve communication with citizens, and to reduce costs (*HITECH office, 2016*). The cost of access to infrastructure depends on both the level of income and the development of infrastructure, as well as on territorial specificity (mentality, traditions, norms of behavior, and prohibitions). Theoretically, the cost of access shows the balance between supply and demand in the Internet services market and varies consistently with changes in other indicators, but this is not always the case.

For successful development of Ukraine’s digital economy, it is necessary to provide the following conditions: development of on-line services (services of social significance, public services); transition of government bodies and departments to digital technologies; development of the Internet of Things in the individual consumer sector (IoT) and in industry (IIoT); creation of domestic software, modern and promising information and telecommunication technologies to replace foreign products (*Efimushkin et al., 2017*).

Ukraine 2030: the Doctrine of Balanced Development (*Kalvariia, 2017*) states that for national economy, large-scale adoption of new technologies can intensify the development of the services sector, reduce transaction costs (online financial services, delivery of goods by drones), increase overall efficiency and effectiveness in combating corruption (digital payment for administrative services), as well as improve access to education (online courses). The Doctrine assumes following areas of digital development are important for Ukraine: additive technologies, new nano- and biomaterials, renewable energy, highly automated production; robotics (technology of artificial intelligence and intelligent systems); IT development (cloud technologies, mobile communication, and new generation of laptops); humanization (genetic engineering, nano- and biopharmacology, synthetic biology); and the go green initiative (low-carbon waste-free production, ecosystem remediation, and pollution control).

Similar to the well-known “Magic Cube” designed by Hungarian sculptor Erno Rubik (*Wikipedia, 2018*), it can be stated that the formation of an effective digital economy is possible provided there are achieved simultaneous harmonious relations “science – business”, “government – science”, “government – business”, “education – science”, “education – government”, “education – business” (obtainment of cube faces of the same color). As a result, a special environment – digital cubic space of the new economic augmented reality – is formed (Figure 26). It gives innovative

opportunities for communications, exchange of knowledge, ideas, and experience between government, universities, and business through the use of digital computer technology in real time, space, and laws of existence.

On the horizontal axis (Figure 26), point $Рц_1$ denotes the initial state of the digital products / services market before the implementation of

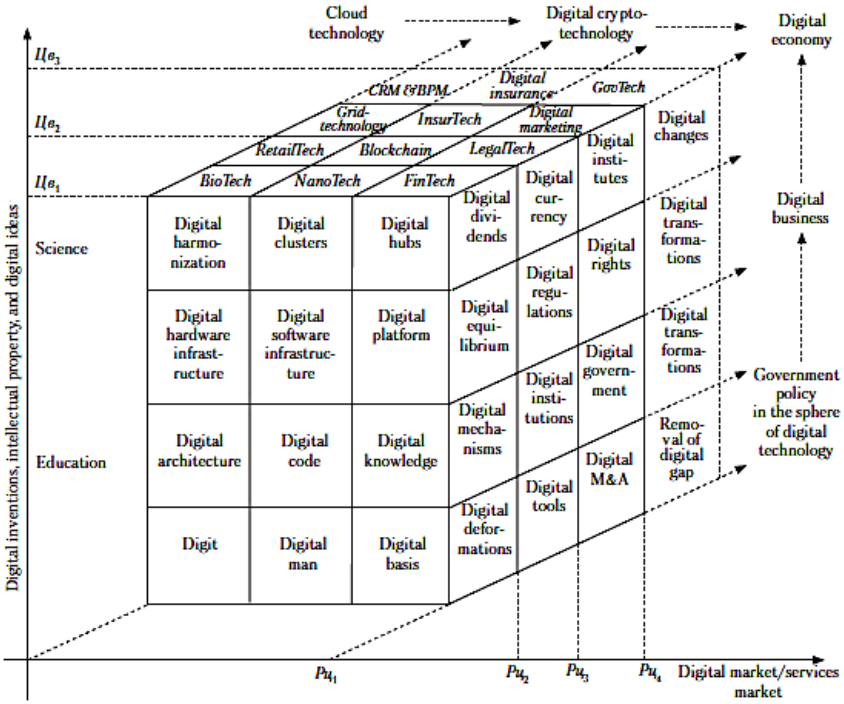

Figure 26 – Digital cubic space that forms new economic augmented reality

Source: author's developed

$Рц_1$ is the reference point of the status of digital products/services market before the appearance of disruptive technologies used in education, business, and governance;

$Рц_2$, $Рц_3$, $Рц_4$ are the points of variations in the status of digital products/services market, as a result of implementation of critical digital and cloud technologies;

$Цe_1$ is the initial number of patented discoveries, inventions, and ideas;

$Цe_2$, $Цe_3$ – are the increased numbers of digital discoveries, inventions, and ideas in various industries.

the latest technologies in education, business, and government, and points $Ри_2$, $Ри_3$, $Ри_4$ show changes in the status of the digital products / services market as a result of implementation of critical digital and cloud technologies. On the vertical axis, point $Цв_1$ corresponds to the initial number of inventions, discoveries, and patented ideas, and points $Цв_2$, $Цв_3$ indicate growing number of digital inventions, discoveries, and ideas in various industries.

Speedup of digitalization of Ukraine's economy is possible through an effectively functioning digital cubic space that implies the integrated use of software and IT solutions to make learning (education) more qualitative and interesting, city life more comfortable, doing business and to advance to a new level of interaction between the community and the government. The digital cubic space of the new economic augmented reality is a way of development, progress, and transition to a new level of civilization rather than a trend.

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

Digital infrastructure (Figure 26) provides the necessary conditions for the implementation and operation of smart innovations. Main components of the digital infrastructure are 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); and information collection systems (sensors, gadgets, smart video surveillance systems, terminals). The "soft" and "hard" digital infrastructure and electronic business operations are connected by means of hardware, software, telecommunications.

We believe, in the digital cubic space, it is necessary to focus on the latest BlockChain technology as basis for the economy digitalization. BlockChain is a critical digital technology that is the basis of digital products / services, such as: BioTech, NanoTech, RetailTech, FinTech, LegalTech, Digital-marketing, Grid-technologies, GovTech, e-ID, TeleHealth, ePrescription, e-democracy, and Digital insurance. The

content and specific features of the cutting-edge technology that form a digital cubic space are given in Table 15.

Digital products/services and their types are presented in Table 16.

The BlockChaintechnology of a distributed peertopeer public network can store information about transactions on a permanent basis, without the possibility of its change, as it is protected by cryptographic means. BlockChain networks provide many options for various purposes, especially in the public sector (ereferendums, epetitions, evoting, egovernment, etc.). The advantage of this technology is that it ensures an unprecedented level of information protection and allows users to create fully decentralized systems. A high resistance of the system to attacks allows its use in such sensitive areas as efinance, public procurement, ebudgets. A quarter of the worldclass BlockChain projects has Ukrainian origin. Therefore, Ukraine is the territory where research into this technology shall continue and new developments shall be

Table 15 – Some Cutting-Edge Technologies that Define the Formation of Digital Economy

Advanced technology type	Content and specific features of advanced economy
1	***2***
BlockChain technologies	Form a new space of trust for digitization of large databases (cadasters, property registers, etc.) *BlockChain* technology is a digitized, decentralized event register that operates online within a single network of nodes (e.g., computers) and is constantly updated with new blocks (events, transactions) in chronological order without centralized accounting. With regard to *BlockChainplatforms*, the key unresolved issue is personal responsibility or collective irresponsibility. The use of *BlockChain* enables transition to a new model of “shared” economy that prevents the monopolization of certain market segments, like in the case of Uber (which is an aggregator of information). Thus, we can predict escalating competition between the existing digital platforms and *BlockChain* platforms.
RegTech	Special regulatory technology that helps financial institutions meet regulatory requirements by data verification and protection, automation of reporting. *RegTech* provides companies with the necessary tools to address regulatory issues and to comply with legal requirements, bringing together the commercial, fiscal, and financial regulations.

(End of Table 15)

1	*2*
RegTech	*RegTech* technologies help to quickly and easily integrate and to adapt readymade solutions for full compliance with all standards of financial regulators and are used to combat money laundering. Financial institutions are increasingly interested in *RegTech*, as it gives a competitive advantage and allows them to generate and submit reports, to identify and eliminate risks, to effectively comply with everchanging regulatory requirements.
SupTech	*SupTech* is a supervision technology, a variant of RegTech technology for financial regulators that allows users to automate and to optimize administrative and operational procedures, to digitize data and working tools, and to improve data analytics.
FinTech	The benefits of *FinTech* for financial institutions are reduced transaction costs for finding and attracting customers; technological solution to the problem of information asymmetry while interacting with customers and with financial markets in general, which was previously solved by rationing methods (although *FinTech* does not exclude this approach). The benefits for customers are getting the products they really need, without any additional fees and unnecessary payments that increase the real interest rate; round-the-clock access to financial resources 7 days a week and 365 days a year. This is especially important for smart companies that implement the principles of digitized customeroriented work. The main disadvantage of *FinTech* companies is the limited use of their services today.
WealthTech	Technology for managing personal funds and wellbeing of an economic entity or an individual.
Advanced industrial technologies of Industry 4.0 – cyber-physical systems (CPS)	3D-technologies (printing), genetic engineering, customized pharmacy, Internet of Things, creation of a quantum processor. This list of cuttingedge technologies that radically change production in the near future may be extended.
Neurocomputer interface	Brain-computer technology is the control of objects through commands directly from the brain, robotics, artificial intelligence.
Biotechnology	Genetic engineering, organ and tissue engineering, creation of prostheses and artificial organs.
Biometrics	The technology involves digital capture and storage of unique characteristics of customers (e.g., retina, voice, facial features) primarily to enhance the security (and convenience) of financial transactions.

Source: grouped by authors

Table 16 – Digital Products/Services and Platforms Created in the Course of Economy Digitalization

Advanced technology type	Content and specific features of advanced economy
1	*2*
Digital platforms	In the context of the key principles of digital economy, digital platforms are based on IT infrastructure, on the one hand, and are the basis for not only ecommerce and ebusiness, but also for the whole range of communications in the triangle "business – consumers – government", on the other hand. The digital procurement platform provides the following benefits for the customers: maximization of the number of suppliers and the possibility of their expansion without increasing the cost of attracting them; optimization (minimization) of procurement costs; automated selection of supplier; reduction of corruption risks.
Platform companies as basic link of new economy	The digital platform is a convenient place for the formation of digital barter when digital values unaccounted by national statistical services and fiscal authorities are exchanged. This creates problems for the formation of a fair system for meeting public needs through tax revenues.
Digital education platform	Platform is a technological capability for *value proposition* to customers, based on the use of *open source* solutions, machine learning, and cloud technologies with required security level. Allows employers to search potential candidates and to check the quality of their training online. Also, the digital educational platform can act as a crowdfunding platform for business cofinancing of promising areas of education. Using BlockChain technology enables automatic transfer of certain cryptocurrencies to the authors of training courses, depending on the number of students who have completed the training. Students can automatically receive certificates/ diplomas subject to the requirements of smart-contracts.
Digitalization of medical services on *eHealth* platform (National electronic health-care system)	Introduction of *BlockChain* technology while forming a personal 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 entities of any form of ownership (including private offices, self-employed, LLCs, etc.), which provide medical care at the primary level of the healthcare system; register of medical officers who provide primary healthcare (mainly, doctors); register of

(End of Table 16)

1	*2*
Digitalization of medical services on *eHealth* platform (National electronic health-care system)	contracts and agreements between healthcare institutions and the National Health Service of Ukraine, between the primary care physician and the patient; register of medicines; register of prescriptions for medicines reimbursable by the government.
Neurocomputer interface	"Brain – computer" technologies enable control of objects through commands directly from the brain, robotics, artificial intelligence.
(Application Program Interface (API) Digital money (in particular, cryptocurrencies) and new financial instruments *Cryptography*	A set of readymade protocols, functions, and structures, which determine the interaction of different programs. Money of this type will lead to radical changes in the financial market and speed up the investment processes. It differs from conventional currencies as not created or controlled by any government. Protects information by converting it to a secure format (for example, by encryption).
Smart contracts	These are contracts that are executed automatically in the *BlockChain* environment, under certain conditions. This type of contract enables direct exchange of values. At the same time, there is an opportunity to simplify and increase reliability of realization of B2B and B2G transactions. Digitizing information and combining it into systems (graphs) that compete with each other is a new era in searching and accessing information.
Artificial intelligence (AI)	Capabilities of computer programs to perform tasks such as problem solution, language recognition, visual perception, decision making and language translation. AI has many applications and is increasingly used in the financial sector (robotic consulting, transaction authentication).
Internet-banking (e-*banking*, or *on-line Banking*, or *web-banking*) Ecosystem New logistics	One of the types of remote banking, which provides access to accounts and transactions at any time and from any computer via the Internet, using a standard browser, such as *Google Chrome, Internet Explorer, Opera, Mozilla* etc. This technology enables bank customers to manage their accounts by electronic means, via the Internet. Digital-organization based on a technology platform that allows real-time formation of the best offer for client through connecting external providers, on the basis of big data. Based on standard infrastructure solutions (Uber, car sharing, drones).

Source: prepared by authors based on (Vyshnevskyi et al., 2018; Liashenko et al., 2018; Toronto Leadership Centre, 2019) and their own research

created. The public sector and the national institutional environment shall create the most optimal, efficient, transparent, and highquality conditions for implementing such projects (*HITECH office, 2016*).

The evolution of FinTech development, its key elements, the structure of FinTech market by types of companies have been successfully demonstrated by authors using matrix method (Table 17).

Thus, digital economy based on network-cluster structures for interaction of all involved in digitalization, within digital cubic space model, can be one of effective tools on the way towards innovationdriven digital economy in Ukraine. With targeted government support of digital development institutions, it is possible to achieve the widespread use of modern scientific technologies in production processes for manufacture of competitive products (*Egorov, 2011*), thereby significantly increasing share of digital services/products in the total gross domestic product.

Successful digital transformation programs mean the creation of successful processes, new products and services. To achieve the desired results in all areas of the economy and in the life cycles of corporations, products and services, it is necessary to expand the scope of rights and opportunities concentrated in the point where all the organization resources are strategically directed to work together in today's digital market (*Kupryianovskyi et al., 2017[a]*). It is also important to believe that this can be achieved through digital citizenship that is characterized by digital literacy interpreted as the ability to work with a large amount of information obtained from several sources; the ability to assess its reliability and usefulness using established criteria; the ability to solve problems that require skills for searching information related to an unfamiliar context, in the presence of ambiguity and without explicit instructions (*Kupryianovskyi et al., 2017[b]*).

Convergence with an activated blockchain connection transforms the value chain. Autonomous robotics, AI, IoT, and BlockChain digitize logistics and distribution, reducing its importance and thus increasing the ability of corporations to make a profit. Manufacturers are able to get more value that they create, while consumers pay less. In long run, technical deflation will be in the depth of exponential curve, as 3D printing, together with virtual and augmented realities, makes its design cheaper and allows printing products at home. It is a certain new technology that in future will be determined by economic benefits (*Kupryianovskyi et al., 2017[c]*). The stages of transformation of digital technologies are shown in Table 18.

While implementing the digital transformation model, it is necessary to take into account comprehensive adaptive capabilities that allow responding to inevitable changes. These capabilities provide the resources

Table 17 – FinTech Matrix Structure in Terms of Time, Key Elements, and FinTech Market Structure

FinTech evolution	Evolution FinTech			
	FinTech 1.0	**FinTech 2.0**	**FinTech 3.0**	**FinTech 3.5**
1	***2***	***3***	***4***	***5***
Time	1866–1967	1967–2008	2008 – till now	FinTech 3.5
Territorial allegiance	Global economy, advanced economies	Global economy, postindustrial countries	Postindustrial countries	Developing countries / Emerging markets
FinTech market structure by types of companies	Formation and development of financial institutions and payment systems	Platforms (online systems that allow users to raise money and to get access to products aggregated together)	Payments and currency (mobile and electronic payment systems, cryptocurrency, transfers). Analytics (Big Data oriented data collection and analysis technologies). Applications (new software that enables optimizing the processes of back- and middle-offices). Middle office is a bank subdivision where business processes, procedures, regulations, directories, printed forms, organizational and staffing documents, which underlie the preparation and decision-making are concentrated. Examples of MO units are Borrower Verification Unit of Security Department, Risk Management Unit, Credit Scoring Unit, etc. Examples of MO information systems are system of position accounting, system for checking borrower's credit report history, scoring system, etc. In practice, many domestic banks do not have MO. Its functions are divided between front office and back office		

(End of Table 17)

1	*2*	*3*	*4*	*5*
Key elements	Infrastructure, computerization	Conventional, innovative, Internet	Mobile devices, Startups	Digital, new members
Examples	Transatlantic cable (1866), telex (circuit-switched network designed to send and receive text messages, conceptually similar to a telephone network, but with teletypes as subscriber devices (1966)	First ATM (1967), SWIFT (1973), On-line banking (1983–1985) Internet / Dot. Combubble (1999)	iPhone (2007), BitCoin (2009)	*MyBank, WeBank* (2015) Chinese online banks without physical outlets
Changes	Communications, interactions, interdependencies	Innovatization	Financial crisis 2008, smart-phones, iPad, netbook, mobile Internet devices	Digitalization, mobility advantages, tablets, ultrabooks

Source: prepared by authors based on (Vyshnevskyi et al., 2018; Liashenko et al., 2018; HITECH office, 2016; Leonenko et al., 2016; Toronto Leadership Centre, 2019; Arner et al., 2015) and their own research

to involve all the structural strata in order to implement continuous improvement and innovation while forming digital entrepreneurship and make it possible to constantly adapt to changing customer needs and new opportunities in the global digital market (*Kupryianovskyi et al., 2017*[a]). The expected result of the effective operation of economy in the digital cubic space that forms a new economic augmented reality, is the formation of digital citizenship and digital entrepreneurship in Ukraine (Figure 27).

Having a website gives corporation the following opportunities:

- Customer service;
- Online supply of products and services to customers;
- The ability of visitors to form orders for goods and services online and to monitor the status of orders;

Table 18 – Gradual Transformation of Digital Technologies Based on Disruptive Changes

Stage of transformation	Step-by-step description	General ideas of gradual transformation of digital technologies	Specific features of transformation of digital technologies
1	*2*	*3*	*4*
1st wave transformation (2000–2010)	*Front office:* 1. Mobile technologies 2. Digital marketing 3. Digital engagement of customers	*Front office* is a group of departments or processes in the organization, which are responsible for direct servicing of clients/customers	1. The activity 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.
2nd wave transformation expected in 2020)	*Back office:* 1. Digital transformation of corporation 2. Digital supply channel *Middle office:* 1. Leading business models 2. Digital business strategy	*Back office* is an organization unit that conducts business processes, increases productivity by optimizing workflows and eliminating inefficient manual operations throughout the lifecycle of business processes. *Middle office* is a group of divisions or processes, which is responsible for risk management, estimate of profits and losses and for IT development. The middle office attracts resources from both the front and the back offices.	1. Digital focus only at the 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 the middle office and back office than in the front office.
	Omni-business	*Omni-business* business is approach based on integrity and consistency of user's 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 developed

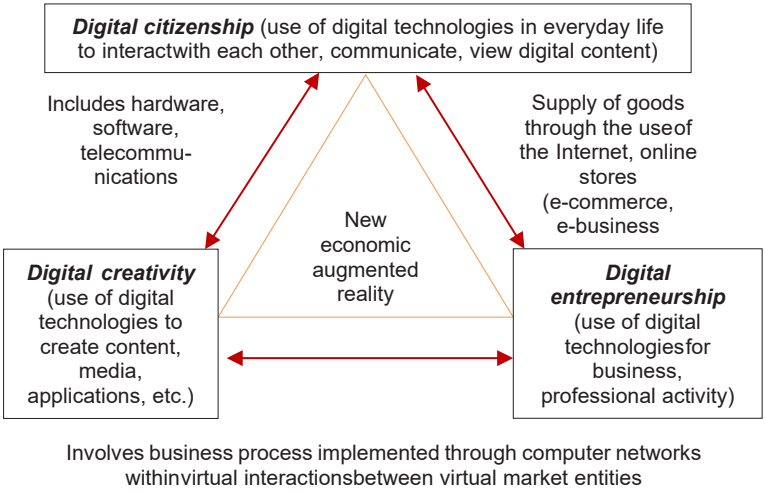

Figure 27 – Expected result in the course of effective operation of the economy in the digital cubic space

Source: prepared by authors based on (Koliadenko, 2016; Vasylenko, 2017; Leonenko et al., 2016)

- Personalized information content of the website for loyal customers;
- Links to the website in social media;
- Announcement of job vacancies or application for vacancies online;
- Staff training and acquisition of digital competencies.

Thus, the digital era of society is changing the approach to doing business, requires the use of information technology and modern means of communication. The use of ICT and the Internet by businesses to maximize the automation of business processes within corporation and to build relationships with other businesses, consumers, and government agencies through the use of advanced ICT is crucial for building digital economic relations.

As a result, it should be noted that the economy that uses digital technologies is called “digital economy”, and the industry that creates, implements, and maintains them is named “digital industry”. Digitalization and development of “digital” economy (antonym is “analog” economy) require titanic organizational and legislative efforts from the government, but success is impossible unless the government relies on the innovative and creative potential of domestic business and citizens (*HITECH office, 2016*).

Authors are deeply convinced that the digital cubic space of the economy of new augmented reality is the driving force of Ukraine's competitiveness, innovation, productivity, and swift economic growth in the global digital virtual and real environment.

Despite impressive scientific achievements of today, it is still important in the future to conduct research aiming at understanding the ideology of the *shared economy*, in order to form a digital reality in Ukraine. There is a need to find high-quality tools for speeding up the digital development of Ukraine, as well as to focus attention on the development of highquality and effective legislative and institutional opportunities for digitalization of the national economy. Further research is needed to find answers to the following questions: "What is the difference between an innovation system and an ecosystem?" "How to work in the ecosystem and with the innovation ecosystem?" "How can a corporation, city, and country influence and benefit from digital development of innovation?".

3.2. Digital virus of business processes of enterprises of the Industry 4.0 ecosystem

The structure of Ukrainian economy is raw materials: more than 60% of exports are raw materials, and our GDP is 98% correlated with the raw material price index in the world. No matter how hard we try, when world raw material prices fall, our economy falls. Ukraine is constantly deindustrialized and we are already losing our industry. Today the same system errors are observed in business, which do not allow business to grow economically and technologically and develop innovatively. What exactly are these mistakes? The answer is as follows:

Mistake 1. Financial statements, or rather its absence. According to our statistics, 34% of entrepreneurs do not have financial statements. Entrepreneurs often understand how much money goes into the account, but few keep track of net operating income. In the future, this leads to confusion in financial flows. In pursuit of the goal of large system business, it is necessary to deal with finances and "deeply digitize" them.

Mistake 2. 32% of businesses do not have a development strategy, an idea of the reserves of economic growth. And this is something without which even the "coolest" businesses find it difficult to conquer the market. This will be especially difficult if competitors have a strategy. In particular, in our opinion, it is worth taking into account the fact that you have to work in the same conditions in virtual reality.

Mistake 3. 20% of business owners are not ready for a partnership. According to their mentality, Ukrainians are really individualists, but we

need to understand that by attracting strong specialists, we can grow economically twice as fast, digitize business processes, automate them in terms of the formation of Industry 4.0.

Mistake 4. More than 12.5% of entrepreneurs do not understand the market, let alone virtual-real and the peculiarities of its operation. To achieve success, it is necessary to focus on the trends that can be traced in the field in which the company operates, what competitors do and what opportunities there are in foreign markets.

The readiness of Ukrainian enterprises for large-scale application of Industry 4.0 depends on: the degree of involvement in the digitalization of Ukrainian industry and energy of the IT sector and science; creating conditions for the accelerated development of industrial high-tech segments as key to the development of digital economy in terms of virtual reality; support for innovation and export activities of innovators 4.0; creation of "road maps" of digital transformation in priority areas; accelerating the transition to European standards in the field of 4.0 (*Briukhovetska et al., 2020*).

In today's business environment, on the one hand, companies have identified a list of necessary changes: technological (automation, digitalization, investment incentives and reduction of operating costs) and no less important service (building relationships and communication with customers). On the other hand, the state through regulatory changes creates an environment that would stimulate business to develop and invest.

Industry 4.0 as part of the fourth industrial revolution includes many technologies, main purpose of which is to create a single space for data exchange and virtual visualization of business processes and objects, and also provides for the creation of robotic systems combined with Internet technologies in the format of "smart" enterprises. Currently, all countries of the world are developing industry taking into account trends of new industrial era – the transition to fully automated digital production, controlled by intelligent ecosystems in real time in constant interaction with the environment, going beyond one enterprise, with the prospect of merging into global industrial network of things and services (*Briukhovetska et al., 2020*).

One or even ten successful examples are not enough to make the ecosystem of Industry 4.0 operational. The country as a whole should be assessed comprehensively and objectively. For example, Finland, which is only five times larger than Lithuania, has 50 times more startups in Silicon Valley. Here is an indicator of success (*Special Edition Kyiv International Economic Forum "Destinations", 2018*). The experience of innovation implementation is presented in Table 19.

Table 19 – Features of innovation implementation in Agrohub

Agrohub was created for introduction of innovations		
1. Consulting. Innovation Agenta – enterprise analysis, identification of needs and innovation priorities, development of startup maps.	*2. Scouting and innovation development.* Innovative Solutions Database – base of available innovative solutions, ready for application; "Growing" new ideas: MHP Accelerator in conjunction with Radar Tech.	*3. Popularization and changing culture.* Video course How to Startup together with MHP, trainings "Practical methodology of innovation implementation".

Source: author's development

Today, a number of companies that have decided to digitize their activities are called to the results of digital transformation include:

• Execution of orders on time – up to 97%;

– Reduction of downtime;

• Transparent control and accounting of resource movements;

• Reduction of resource reserves by 10%;

• Analysis and elimination of bottlenecks in the operation of equipment;

• Improvement of OEE by 10-15%.

Among the problems that arise during the digitalization of business processes of enterprises indicate: historical orientation of production to mass, "running" sizes and large batches; large-scale production load; the complexity of cooperation and logic between production sites.

Policies to strengthen innovation in the conditions of digital modernization of enterprises are given in Figure 28. To qualitative and effectively operating tools of innovative-digital transformation in the conditions of virtual reality name:

• A single system of on-line order management for all enterprises: application registration – technical examination – planning – performance control – shipment;

• Smart Factory, Predictive Maintenance, IIoT, CRM, SCM.

For LMICs such as Ukraine:

• Diversifying continuously into higher value-added activities;

• Innovating through the adoption of existing knowledge elsewhere in the world and increasingly through the development of local technological capabilities;

• Regionalization;

• Reforming product, labour and financial markets as well as development schemes;

• Focusing on sectors with export potential.

Skilled workforce	Supportive business environment
Strong and efficient system for knowledge creation and diffusion	Policies to encourage firms to engage in innovation and entrepreneurial activities

Figure 28 – Policies to strengthen innovation in terms of digital modernization of enterprises

Source: author's development

Significant volumes and analytics are used in the framework of digital transformation. Responsibility for its accuracy and clarity always lies with the leader. The ideal picture of data collection and the system of predictive analytics of consumption forecasting is based on the algorithms formed as a result of the analysis of current situation.

The issue of forming the principles of analysis – is a matter of priorities of the company, which are based on the platform of analysis of the situation and the requirements of the regulator. Today, the biggest challenge is to generate this data, create a model for automated retrieval of information about the state of networks, transfer this information to a single database and analysis of the entire array. This could provide information on the most critical ones that need to be replaced.

The problem is that other countries started this path 13-15 years ago, and in Ukraine investment conditions haven't even been created for a large-scale start of such programs, but country wants to do everything quickly. That is why it is so important to change the investment system and priorities. Levels of digital transformation in part of the formation of enterprises of the ecosystem of Industry 4.0 (Figure 29).

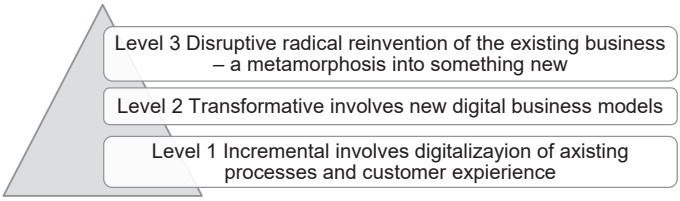

Figure 29 – Digital transformation in terms of the formation of enterprises of the ecosystems of Industry 4.0

Source: compiled by authors based on (Accenture, 2020[a]; Accenture, 2020[b]; Kraus et al., 2018; Milgram et al., 1994)

As part of the problem, we consider it appropriate to analyze the opportunities and benefits of using Azure cloud platform in enterprises

(Table 20), which includes more than 200 products and cloud services designed to help create new solutions for current and future challenges. before the company during digitization of business processes. This platform allows you to create and run applications and manage them in multiple clouds, locally and on the periphery, using convenient tools and platforms in virtual reality.

Azure supports open source technologies, so companies have the opportunity to use tools and technologies they prefer and they (tools, technologies) are useful. This allows enterprise to run virtually any application that uses its data source with the existing operating system on the device. When using Azure, the company always has a choice.

Digitalization of business processes of enterprises has certain threats, one of the main – cybersecurity. The more open the exchange of information and communication channels, the greater risks.

The comprehensive protection services provided by Azure team of experts include precautionary measures, which are trusted by businesses, government organizations and startups. Security and privacy are very important to Azure. Microsoft adheres to the highest levels of trust, transparency, compliance with standards and regulatory requirements with the most complete set of proposals for compliance among cloud service providers.

Azure provides solutions for all industries through proven combinations of cloud products and services. Businesses are able to solve their industry business challenges instantly and are always ready for the challenges of the future, implementing innovations through Azure solutions. Today, Azure is perhaps only hybrid cloud that is so well-coordinated that provides unsurpassed performance for developers, provides comprehensive multi-level security tools, including maximum coverage of compliance requirements among all cloud service providers. In addition, Azure is not as expensive as AWS when used with Windows Server and SQL Server workloads (*Azure.microsof, 2020*).

Laboratory Information Management System (LIMS) is a specific application that provides a simple extension of the system from a single computer to many service systems with a large number of enterprise customers. Types of client applications with different functionality are presented in Table 21. Microsoft SQL Server is used to store regulatory information and metadata. The results of laboratory tests are also stored in Microsoft SQL Server, but can be stored in parallel on the real-time data server of the corporate MES.

Requests from customers are processed in Digital Lab by a server data processing module (licensed by the number of simultaneous connections), which can be supplied with extensions to implement tasks of laboratory business process automation and for integration with MES, top-level ERP systems.

Table 20 – Possibilities of using Azure cloud platform during digitization of business processes of enterprises of the ecosystem of Industry 4.0 in the conditions of virtual reality

Problems:	1. Difference between environment; 2. Dev dependencies; 3. Lack of tools on your platform; 4. Predictable environment; 5. Speed of development.
History of containers	1979 – chroot in Unix v7; 2000 – Free BSD Jails; 2003 – Borg (predecessor of Kubernetes); 2006 – Process Containers; 2013 – Docker; 2014 – Kubernetes; 2015 – Windows Containers.
Containers in Azure App Services	1. Both Windows and Linux; 2. Deploy from any registries; 3. Use deployment slots and slot swaps Auto-scale; 4. App Service Log Streaming; 5. Connect directly into your containers.
Container Instances	1. Starts in seconds; 2. Billed by seconds (CPU/Memory); 3. Good for data processing jobs; 4. Work with Logic Apps; 5. Virtual Kubelets for AKS.
Docker Orchestrators:	Docker Swarm, DC/OS, Kubernetes.
Kubernetes:	1. Open-source system for automating deployment, scaling, and management, of containerized applications; 2. Easy command line interface; 3. Declarative configuration via YAML/JSON files.
K8s Aspects:	Cluster, Nodes, Pods, ReplicaSets, Deployments, Services, StatefulSets, Volumes, Jobs/Cron, DaemonSets, Namespaces.
Serverless Apps on Top of K8s:	Kubelets, Fission, Apache OpenWhisk, Funktion (deprecated).
Azure Kubernetes Service (AKS):	1. 100% Kubernetes; 2. Easy deployment and management; 3. Scale with confidence (Azure Traffic Manager, Virtual Kubelets); 4. Secure with Azure AD; 5. Accelerate development with connected environments (Azure Dev Spaces).
Container Use Cases:	1. “Lift and shift”; 2. Refactor existing applications for containers; 3. Develop new container-native applications; 4. Microservices architecture; 5. Continuous integration and deployment; 6. Repetitive jobs and tasks.
Why to use in Clouds?	1. Cost effective; 2. Smoother development experience; 3. Many IT specialists available; 4. More tools at our disposal; 5. Runs anywhere.

Source: compiled by authors based on (Azure.microsof, 2020)

Table 21 – Client applications in terms of their various typical functionality

Types of client applications of different functionality			
Full-featured APM engineer for administration, configuration and system configuration	Laboratory assistant APM for data entry and settlement	APM view to get results as screens and reports	APM web browsing

Source: author's development

The convergence of Web 3.0 technologies and service architectures will introduce new business models, information exchange and social networks based on the Internet of Services (IoS). In the future, network architectures will promote full integration of the Internet of People, the Internet of Things and the Internet of Services.

Ability to integrate Grid and Cloud computing into NGN; introduction of adaptive technologies for the creation of information systems. The concept of a smart enterprise involves virtual integration of structures and processes with adaptive information links and a common set of standards that are produced as a result of joint activities of distributed competence centers (*Missikoff et al., 2012*).

Today, SYNTEGRA, a data integration service that provides interactive analytics, can help modernize data storage and management, optimize company reporting, and provide real-time analytics. SYNTEGRA provides data models and dashboards. This service is available by subscription. SYNTEGRA is implemented using Microsoft Data Services and Power BI.

SYNTEGRA includes: data integration; creation of data models, metrics; automation of data update; cloud infrastructure; technical support; training of business users to work and edit dashboards.

Advantages of using SYNTEGRA data integration service for business: reporting with updates every hour; group access rights policies; interactivity, availability of reports via the web; professional data model collection; high-tech data integration on a cloud platform.

No less interesting than the previous software solution presented by us in today's virtual real conditions, is the solution of Aruba for tracking contacts in the fight against COVID-19.

Aruba technology helps to locate (Aruba access points 300/500 series): a platform for tracking contacts and analyzing location data based on two technologies (BLE, WiFi); allows you to implement flexible solutions based on Aruba Partner Ecosystem using USB interface.

Aruba is a solution for tracking office contacts in the office using WiFi technology (Table 22), which is implemented by the chain type:

Access points “listen” to WiFi devices of users → The application in the cloud or on the server analyzes location data transmitted from Aruba Central or Airware, using AI/ML models → Personnel service receives a message about an employee who is ill → Tracking contacts (searching for contacts of all employees with infected colleagues) → Tracking locations (determining the average time spent by a sick employee in different areas office).

Table 22 – Aruba contact tracking technology: a comparison of WiFi and BLE

	WiFi based	BLE based
Cost	Included	Asset Tags Meridian Licenses
Accuracy	~10 m accuracy	~2-5 m accuracy
Deployment	Central: Feature drop On-prem: Airwave upgrade / Central dashboard	Meridian asset tracking Enable BLE radios on APs
Additional Hardware	None	Asset tags
Data Exportability to other BI tools	CSV & Templates for PowerBI and Tableau	CSV & Asset tracking APIs
Est. Availability	July / August	July (beta)

Source: author’s development

Aruba is a solution for tracking employee contacts in the office using Meridian BLE (Bluetooth Low Energy) technology is as follows:

Employees receive BLE tags → Aruba access points “communicate” with employee tags → Meridian cloud application determines the location of tags → Data is transmitted for processing and visualizations in the external application → Personnel receives a message about a sick employee → Personnel determines the number of the employee’s tag and searches for contact information in the external application → Tracking contacts (searching for contacts of all employees with infected colleagues) → Tracking locations (determining the average time spent by the sick employee in different areas of the office).

Key features of Aruba are that:

1. Uses BLE (Bluetooth Low Energy) technology.

2. Modern points of Aruba WiFi 300 & 500 series provide the necessary coverage.

3. The solution is scaled to 1,000 labels.
4. Battery life 3-4 years.
5. Exact indication of the location on the map, not the approximate area.

BLE is:

1. Bluetooth Low Energy – one of the two Bluetooth standards, often called Bluetooth Smart.
2. Used for wireless transmission of information over short distances. Depending on the type of BLE lighthouse from 25 to 300 m.
3. Uses 2.4GHz band. To reduce level of energy consumption and increase the efficiency of information transmission, the entire frequency range is divided into 40 channels, divided between it by 2MHz.
4. Available on all smartphones and tablets released since 2012.
5. There are 2 BLE standards: iBeacon (Apple), Eddystone (Google).
6. Battery life: from 3-4 days (printed beacons) to 8 years.
7. The cost of a lighthouse is from 2 to 40 dollars.

BLE beacon includes the case (there are cases for external use), the processor on the basis of ARM, Bluetooth Smart module, the antenna which is connected to the processor, the power supply battery. Aruba Meridian allows you to get a map of the room, find the necessary objects/goods, route from the current location, API for integration with other applications. Aruba Meridian:

- The first task is to create your access token;
- To generate your access token, from the Meridian Editor web console, in the left-hand navigation pane, click Beacons, and then click Generate your access token to get started;
- The values you'll need are shown in the Controller Configuration section.

SMEs need tailored policies to support innovation in terms of the formation of Industry 4.0 and Main policy choices for innovation tools of the ecosystem of Industry 4.0 are presented by us in Table 23 and Figure 30. We believe in "angel capital", which in the seventh world is a decisive force in the range from 0 to 100 thousand euros and is able to make a significant contribution to the development of startup industry. For example, the United Kingdom has significantly increased the efficiency of investment, creating benefits for "angels" 7 years ago. The investor, in fact, gets a choice: either pay a few thousand taxes, or invest in a startup. This not only ensured the inflow of investment, but also allowed to involve a large number of people in innovation. As a result, everyone won – both business and the state (*Special Edition Kyiv International Economic Forum "Destinations", 2018*).

Table 23 – SMEs need tailored policies to support innovation in terms of the formation of Industry 4.0

	Financing	Other
Non-innovative SMEs		Build basic capabilities and provide incentives to innovate
Innovative SMEs	Project-based Financial support Loan guarantee	Develop innovation networks
NTBFs	Equity financing (venture capital, business angels) Seed capital Tax neutrality	Incubators, science & techno parks
Science-based Spin-offs		Conducive regulation in public research organization

Source: author's development

The beginning of the real implementation of standards in Ukraine in the field of industrial automation began on September 1, 2019 by the order of UkrNDNC № 249. It was this order that put into effect national standards harmonized with European and international standards, the method of confirmation and validity in Table 24.

In addition to legislative reform, a key factor is stability in both the political arena and the economy. As Ukraine currently ranks 76th in the ease of doing business index, there is still work to be done. Further simplification of the regulatory framework will lead to market liberalization and, thus, will contribute to the formation of a more attractive business climate for foreign investors.

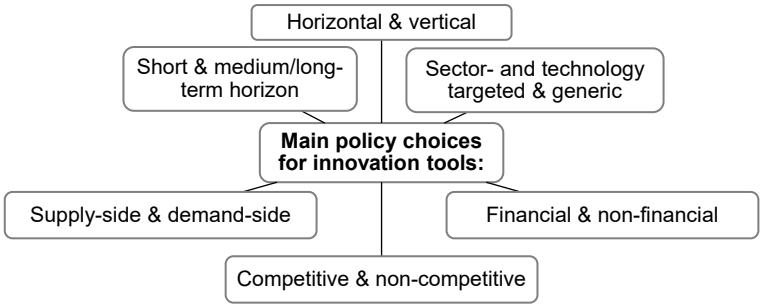

Figure 30 – Main policy choices for innovation tools of the ecosystem of Industry 4.0

Source: author's development

In addition, a stable and predictable tax regime and customs clearance process will also contribute to investment attractiveness, and a number of positive changes are already being taken into account (for example, replacement of corporate income tax and income tax of non-residents with a source of origin from Ukraine (income repatriation tax in Ukraine) by income distribution tax to limit the outflow of funds from Ukraine and encourage reinvestment of profits again in the company their development).

However, it is necessary to explain the perception of the reality of investing in Ukraine in world economic space. Some investors believe that the risks of doing business are unacceptably high in Ukraine, often based on a limited understanding of risks and/or a willingness to consider ways to transform companies and stimulate economic growth. Responsible promotion of Ukraine as an attractive area for investment is a collective commitment of business community (*Special Edition Kyiv International Economic Forum "Destinations", 2018*).

Table 24 – Implementation of national standards and their harmonization with European and international standards aimed at accelerating the digitalization of enterprises

DSTU EN 61508-1: 2019 (EN 61508-1: 2010, IDT; IEC 61508-1:2010, IDT)	Functional safety of electrical, electronic, programmable electronic systems related to safety. -//- Part 1. General requirements
DSTU EN 61508-2: 2019 (EN 61508-2: 2010, IDT; IEC 61508-2:2010, IDT)	-//- Part 2. Requirements for electrical, electronic, programmable electronic systems related to safety.
DSTU EN 61508-3: 2019 (EN 61508-3: 2010, IDT; IEC 61508-3:2010, IDT)	-//- Part 3. Software requirements
DSTU EN 61508-4: 2019 (EN 61508-4: 2010, IDT; IEC 61508-4:2010, IDT)	-//- Part 4. Definition and abbreviation
DSTU EN 61508-5: 2019 (EN 61508-5: 2010, IDT; IEC 61508-5:2010, IDT)	-//- Part 5. Examples of methods for determining security completeness levels
DSTU EN 61508-6: 2019 (EN 61508-6: 2010, IDT; IEC 61508-6:2010, IDT)	-//- Part 6. Guidelines for IPP 61508-2 and IEC 61508-3
DSTU EN 61508-7: 2019 (EN 61508-7: 2010, IDT; IEC 61508-7:2010, IDT)	-//- Part 7. Overview of methods and measures
DSTU EN 61512-1: 2019 (EN 61512-1: 1999, IDT; IEC 61512-1:1997, IDT)	Prescription production management. -//- Part 1. Models and terminology
DSTU EN 61512-2: 2019 (EN 61512-2: 2002, IDT; IEC 61512-2: 2001, IDT)	-//- Part 2. Data structure and how-to

(End of Table 24)

DSTU EN 61512-3: 2019 (EN 61512-3: 2008, IDT; IEC 61512-1: 2008, IDT)	-//- Part 3. Models and presentations for general and local recipes
DSTU EN 61512-4: 2019 (EN 61512-4: 2010, IDT; IEC 61512-4: 2009, IDT)	-//- Part 4. Recipe production records
DSTU EN 62264-1: 2019 (EN 62264-1: 2013, IDT; IEC 66226-1: 2013, IDT)	Integration of enterprise and production management systems. -//- Part 1. Models and terminology
DSTU EN 62264-2: 2019 (EN 62264-2: 2013, IDT; IEC 66226-2: 2013, IDT)	-//- Part 2. Objects and attributes for integrating enterprise and production management systems
DSTU EN 62264-3: 2019 (EN 62264-3: 2017, IDT; IEC 66226-3: 2016, IDT)	-//- Part 3. Models of activity management of production operations
DSTU EN 62264-4: 2019 (EN 62264-4: 2016, IDT; IEC 66226-4: 2015, IDT)	-//- Part 4. Attributes of object models for integration of subsystems of production operations management
DSTU EN 62264-5: 2019 (EN 62264-5: 2016, IDT; IEC 66226-5: 2016, IDT)	-//- Part 5. Commercial and production transactions
DSTU EN IEC 62443-4-1: 2019 (EN IEC 62443-4-1: 2018, IDT; IEC 62443-4-1: 2018, IDT)	Safety of industrial automation and control systems. -//- Part 4-1. Requirements for the residential cycle of development of safe products.
DSTU ISO 22400-1: 2019 (ISO 224001-1: 2014, IDT)	Automated production control systems. KPIs for production process management. -//- Part 1. Overview, General Provisions and Terminology
DSTU ISO 22400-2: 2019 (ISO 224001-2: 2014, IDT)	-//- Part 2. Definition and description
DSTU ISO 22400-3: 2019 (ISO 224001-10: 2018, IDT)	-//- Part 10. Describe work operations for getting data

Source: author's development

The reason for this was the turbulent economic and political situation that Ukraine has faced recently, which has undoubtedly affected the opportunities of domestic investors and the appetite of foreign investors in the market of mergers and acquisitions.

Only on this basis it is clear that in the future Ukraine may become a more significant player in the global investment landscape (*Schaeffer, 2017*). The focus of innovation policy in terms of the formation of Industry 4.0 should depend on the stage of the country's development is shown in Figure 31.

STAGE 1	STAGE 2	STAGE 3
Building management and organizational capabilities; Start collaborative projects; Need to develop STEM skills and engineering; Need for basic infrastructure – NQI and incubation; Elimination of barriers to physical, human and knowledge capital	Building technological capabilities; Incentivize R&D projects; Link industry academia; Improving quality of research, innovation and export infrastructure	Long-term R&D and technological programs; Minimize innovation gap between leaders and laggards; Collaborative innovation projects

Figure 31 – The focus of innovation policy in terms of the formation of Industry 4.0 that depends on the stages of development of the country (should depend on the stage of the country's development)

Source: author's development

The socio-economic effects of the development of Industry 4.0 in the conditions of virtual reality should include:

• The growing rate of expansion of cluster network space;

• Wide introduction of advanced IT technologies in business processes of enterprises that transform the basic features of economic processes and expand communication opportunities, gradually advancing the world community to new digital era;

• Global transformations or shifts, which are accompanied by the emergence of innovative business models, disruptive impact on traditional business strategies and radical changes in production, consumption, marketing and marketing;

• Formation of a hybrid environment in which new economic and social ecosystems are created, based on modern IT technologies, adapted to interaction through digitized financial and material resources and functionally aimed at creating added value (*Huley et al., 2018*) and the search for reserves of economic growth.

Useful examples of different countries regarding national strategies and their implementation in terms of economic growth are presented in Table 25.

Direct economic effect of digitalization of key business processes in enterprises is difficult to assess, so it is advisable to focus on indirect economic effects, including indicators of the level of quality and productivity of their work in terms of different industries. Qualitative changes in the course of digital transformation in general should be assessed through indicators of business and community satisfaction

with the implemented programs, which include: creation of digital infrastructure, support of domestic developers and manufacturers in IT field, regulatory mechanisms, training of competent personnel, digital specialists, development of e-medicine, IT systems in transport and e-logistics, energy efficiency, e-security, e-education and many other areas of life (*Huley et al., 2018*). Digitalization is precisely the element that can significantly positively affect quality and efficiency of planning and management processes in the enterprise. The ultimate goal of the implementation of digitalization processes in economic activities of enterprises is to gradually increase the profitability of production and improve investment attractiveness in various sectors of the economy.

Table 25 – OECD is working with countries on National Strategies and their implementation in terms of economic growth

1. Supporting the implementation of National Strategies: *Georgia* Financial literacy survey using the OECD Toolkit in 2016; National Strategy designed and launched in 2016; Preparing an Action Plan to outline concrete implementation steps, roles of responsibility; Creating a finding model for implementation
2. Evaluation of National Strategies: *Hong-Kong/Netherlands/Peru/UK* Evaluation approach to be integrated the NS, linked to indicators/feedback mechanisms; No one approach for all but clear lines of responsibility, multiple and transparent flows of data, incentives for accountability; Manageable governance structure and open feedback from implementing stakeholders; Communication strategy for evaluation results; Dedicated funding
3. Improving the financial literacy of youth and in schools: *Armenia/Kyrgyz Republic* Developing core competencies, based on the OECD CCs for youth Agreeing on clear lines of responsibilities Adapting, existing school curricula Committing, resources to teacher-training Developing content Evaluating pilots

Source: generalized by author's

As a result, it should be noted that indeed the digitalization of business processes of enterprises opens new horizons and opportunities for the formation of added value in almost all sectors of the economy. In addition, in the post-pandemic period, digital technologies will become an integral

part of the socio-economic life of Society 5.0 and identify key vectors for the development of government digital policy. Digitalization is becoming a driver for the development of Industry 4.0, as it is able to increase the efficiency of the economy at all levels of aggregation, the formation of new quality and standard of living. The use of digital technologies lays the foundations for the process of modernization of traditional sectors of the economy and stimulates the emergence of new innovative industries that accelerate Ukraine's economic growth and bring to a new level of competitiveness in global economic system in virtual reality.

Based on the results of our research, we came to the conclusion that the lack of state support for enterprises seeking to introduce digital technologies into production slows down the digitalization process in Ukraine; imperfection of the regulatory framework for digitization of industry and production in terms of the formation of Industry 4.0; lack of priority of digitalization in the strategy of state development; technological backwardness from the leading countries of the world, because in some sectors of the economy we have 3 and 4 technological systems. Considering the positive effect of digitalization for business, we can identify a number of opportunities: increase productivity; reducing the level of fraud, increasing the level of transparency and ease of operations; production automation; expanding sales channels through new opportunities that open up virtual reality.

3.3. Digital entrepreneurship and X.0 Industries in virtual reality

Global digital transformation in the direction of transition from Industry 4.0 to X.0, possible due to the accelerated transformation of production on the basis of innovation, digitalization and glocalization. Modern companies are ready for significant investments and solutions. Evidence of this is the $ 1.2 trillion that business spent in 2017 on transformation technologies alone; 96% of organizations consider digital transformation as critical; 42% of managers who formed new positioning of their companies as "essentially digital" or "primarily digital"; 63% of managers consider main obstacle in digital transformation "difficulties in transition to agile corporate culture"; 36% "overcoming resistance to new methods of work" considered the second important problem; ⅕ managers are convinced that digital transformation projects are a waste of time; the best leaders of "digital emigrants" are 28% more likely to be successful in building relationships; "innate digital" leaders are 20% more likely to become "digital emigrants" more active and flexible.

Urgency of the problem of this study is evidenced by the fact that 86% of CEOs (Chief Executive Officer) consider digital technology

as a priority № 1 for business development; 30% of organizational change projects succeed; 16% success of digital transformation projects in companies is even less; 43% of transformation projects fail because project does not take into account the peculiarities of corporate culture; 33% of digital transformation is not sufficiently involved in top management. The data presented by us show that there is an urgent need to present the practical features of innovative-digital entrepreneurship as a key link in the future of Industry X.0 in the face of new global challenges such as living and working in virtual reality.

Industry X.0's innovation network helps companies to use and implement and scale the latest digital technologies and services quickly and efficiently. Thanks to the brightest individuals-innovators, the latest technologies and deep industry experience, united in an immersive innovation space, we are able to transform enterprises in the direction of their digitalization. This can also be achieved through the use of creative energy of advanced technology to ensure continuous digital transformation, new growth and improved customer service. In addition, it is immersive technologies that are technologies of full or partial immersion in the virtual world or can be considered as different types of mixing of real and virtual reality. Immersive technologies are also called augmented reality technologies. Their list includes virtual and augmented reality, as well as 360°-video.

The formation of Industry X.0 is of great socio-economic importance for society, as it allows to provide the population with new quality of services, digitized economic relations, promote the acceleration of digital entrepreneurship, increase trust in all branches of government through the initiative of the President of Ukraine and strengthen the competitiveness of domestic products in foreign markets, giving services/products signs of innovation.

In addition, the emergence of new type of economy, namely digital economy, has become a scientific response to cluster, platform, ecosystem production, STEM education, digital entrepreneurship, industrial Hightech, RetailTech, LegalTech, InsurTech, GovTech, IoT. This, in turn, leads to systematic emergence of new digital technologies that allow Industry X.0, growth of digital competence of the population.

Industry X.0 is a new approach to organizing production in virtual reality environment. It is based on highly intelligent integrated new products and digital ecosystems, which form a fully innovative digital value chain, add new competencies and implement profound cultural changes in the direction of becoming new virtual reality. Reality-Virtuality is interpreted by Paul Milgram and Fumio Kishino (*Milgram et al., 1994*) as a space between reality and virtuality, between augmented reality (closer to reality) and augmented virtuality (closer to virtuality).

We believe that virtual reality of the multiplayer world is based on the exchange of virtual goods within on-line environment. It creates an opportunity to interact with the artificial world through virtual platforms with available information funds on-line innovation market, the ability to work with cloud technologies (*Kraus et al., 2020*).

Consumers are already used to living in digital world. Now industrial enterprises, as well as their employees, need maximum digitization. This new format of "industrial consumerism" undermines decades-old habits, traditions and operating models of enterprises and companies. Not only the reasons for digital transformation in the manufacturing sector are important to industrial enterprises. Each company must find its own way to move to digital rails (*Accenture, 2020*[a]) and form their own ecosystems with professionals with digital competencies.

"Live" devices, smart assets, smart services, data management are the basis of the concept of Industry X.0. This type of device and service is equipped with software-controlled and Internet-connected sensors that collect various data, analyze it and send it to other connected devices. It is important to implement digital R&D processes, ie to implement a new approach to product lifecycle management. In fact, in new era of "live" data-driven devices, product development begins with digital lifecycle management strategy in the digital enterprise.

This strategy is designed to provide a hyper-personalized user experience. We are talking about the complete digitization of the product life cycle in digital enterprise in new virtual reality. We are convinced that today it is urgent to ask questions like this: Is digitalization part of the DNA of a modern enterprise that creates the latest product/service? How to achieve digitization of business activities? What are the competencies of digital employee of the company? We will try to answer these and other questions in this publication.

Exploring innovative-digital entrepreneurship as a key link in the formation of virtual reality of Industry X.0, it should be noted that there are important differences between innovation in services and manufacturing:

1. Service-sector innovation derives less from investments in formal R&D. More reliance on acquisition of knowledge/IP from outside sources acquisition and collaboration.

2. Human resource development is especially important to service firms. Indications that a lack of highly skilled personnel is a major impediment to service innovation in most OECD economies.

3. The role of newly established firms in innovative activity is greater. Entrepreneurship is a key driver of service innovation (but small firms tend to be less innovative than larger firms).

4. IPR protection is more important, especially on software and business method patents. Changes in policy regimes governing software-related patents and business method patents would impact service-sector firms, regardless of their actives.

Key innovation problems and limitations that need to be addressed on the way to the formation of Industry X.0 in virtual reality are presented in Figure 32.

In addition, the innovation system of any country requires coordinated action from a range of entities:

– *Demand for innovation:* consumers, government (final demand), producers (intermediate demand).

– *Framework conditions:* financial environment – taxation and incentives; propensity to innovation and entrepreneurship; mobility.

– *Industrial system:* large companies; mature SMEs; new, tech-based firms.

– *Intermediaries:* research institutions; technology transfer support organizations; technology services providers.

– *Education & research:* TVET; higher ed. & research; public research.

– *Political system:* government; governance; STI policies.

– *Infrastructure:* finance; intellectual property regime (IPR); innovation & business support; rules & norms.

Industry X.0's innovation network today has more than 20 innovation spaces strategically located around the world and is part of Accenture's annual innovation investment of more than $ 1 billion. Table 26 presents the world's innovation and digital spaces, which form the Industry X.0 network.

Table 26 – Global innovative-digital spaces that shape the virtual reality Industry X.0

City	Name of innovative-digital space	Specialization and focus on innovation in the following areas
1	*2*	*3*
Anne Arbor	Forge	Connect digital products and services
Bangalore	Innovation Center	Digital engineering, digital manufacturing and various digital operations
Barcelona	Analytical Innovation Center	Analytics and supply chain, digital production and various kinds of digital operations
Bilbao	Industry X Innovation Center	Connect digital products/services, digital engineering, digital production and operations

(Continuation of Table 26)

1	*2*	*3*
Budapest	Center of Excellence in Industrial Automation	Digital engineering, digital production and operations
Cluj	Center of Excellence in Industrial Software	Connect digital products and services, digital engineering, digital manufacturing and operations
Columbus, Ohio	Forge	Connect digital services and products
Des Moines	Forge	Connect digital services and innovative products
Detroit	Industry X Innovation Center	Connect digital products and services, digital production and digital operations
Dublin	Dock	Artificial intelligence, analytics and the Internet of Things with a focus on connecting employees, “deep” manufacturing, digital entrepreneurship
Essen	Industry X Innovation Center	Digital engineering, digital production and operations
Garching	Industry X Innovation Center	Connect digital products and services, digital engineering, digital manufacturing and operations
Houston	Center for Innovative Resources	Digital production and connection of digital products/services
Istanbul	Industry X Innovation Center	Connect digital products, digital production and digital operations
London	Industry X Zone	Connecting digital products and services, digital engineering, digital manufacturing and operations
Modena	Industry X Innovation Center	Digital production and operations
Paris	Industry X Innovation Center	Digital engineering, digital manufacturing and digital operations, digital product connectivity and digital services
Perth	Innovation Center	Digital transformations of energy companies, digitalization of mining industry in terms of strengthening their competitiveness and growth

(End of Table 26)

1	*2*	*3*
San Francisco	Innovation Center	Digital production and operations, digital engineering, digital services and product connectivity
Shanghai	Digital Center of Greater China	Digital engineering, digital product and service connectivity, digital manufacturing and digital operations
Shenzhen	Innovation Center	Digital products and services, digital engineering, digital manufacturing and digital operations
Singapore	Center for Innovative Resources	Center of production and operations
Sofia Antipolis	Resources of innovation center	Digital engineering, digital production and operations
Tokyo	Innovation Center	Digital manufacturing and operations, digital engineering, digital product and service connectivity
Turin	Center for Automotive Industry Solutions	Connect digital products and services

Source: compiled by the authors based on (Accenture, 2020[c]; IAMOT, 2020)

Key principles of transformation management, we propose to include: prioritization of projects (business results, not technical implementation, CAM, business cases, MVP); responsibility for the result (COS, CSI, OLA, SLA, MVP); right to error (R&D, Innovation); confirmed approach (pilot circulation); cross-functional approach (project office; roles, stages, goals, results). Technologies that change traditional business in the direction of its digitization are presented in Table 27.

As part of the research problem in this publication, it should be noted that of course, without proper financial analysis, strategy and understanding of the company's bills can be paid, but management will not always be able to make the right decisions for the most successful and effective problem solving, cost reduction and withdrawal business to new level, namely digital. In addition, mistakes and lost opportunities for the company become more likely. The strengths and weaknesses of "digital managers" at the stage of formation of Industry X.0 in the conditions of virtual reality are presented in Table 28.

Table 27 – Technologies that change the business in the direction of its digitization

Elements of business processes	Technology
1	*2*
Management	BD, ML, RA, Rent
Finance and Accounting	BD, ML, AL, SC
Strategy	BD, AL, BD, AI, Analytics interpretation, ML, SH
Marketing & Sales	BD, Soft, New channels, targeting, personalization, online, time
Logistics	Automatically storages, delivery, better logistic, just in time, drones, Storage like services
Production	Automatically, robots, 3D printings, custom design, quality control, ML
Security	Cyber, IT, BD, sensors, video, AI, SH
Right	AI, ML, chat bots, SC, BD
Frames	BD, remount, office cut, ML, AI, SC, e-learning
Purchases	Just in time, storage outsourcing

Source: author's development

Identifying key innovation issues and constraints

I. Innovation infrastructure and financing innovation: innovation infrastructure; quality system; financing innovation.

II. Firm innovation capabilities: technological capabilities; management and organizational capabilities; capacity to learn and to collaborate; role of markets.

III. Capability to generate knowledge: by firms; in education and training organizations; in public research institutions.

IV. Capability to learn and disseminate knowledge: technical & vocational training; higher education; agricultural extension services; capacity to learn on the job; technology transfer opportunities.

V. Governance of innovation: identifying priorities; designing and implementing innovation policies & instruments; policy coherence and coordination; innovation indicators, monitoring and evaluation.

Figure 32 – Key innovation problems that need to be addressed in the context of the formation of Industry X.0

Source: author's development

Table 28 – Strengths and weaknesses of "digital managers" at the stage of formation of Industry X.0 in the conditions of virtual reality

Strengths and weaknesses of "digital managers"	
+	-
pure-play digital / vc / tech R&D	
experience in digital (pure-play) business; high customer orientation; deep understanding of modern technologies and innovations	poor understanding of traditional business with long chains and production processes
technology ventor	
deep and detailed understanding of technology, innovation	potentially a "technological" narrowness of vision limited solely by technology
consulting / science / education	
technological awareness and a wide range; strategic thinking; powerful communication skills and vision of negotiations	lack of experience in implementing and implementing changes
cio / cto / ciso	
technological literacy and a wide range; knowledge of technological architecture; considerable experience in the implementation and implementation of projects	lack of understanding of the needs of the consumer/client
successful in digital transformation	
strategic thinking; understanding the impact of technology on business processes and customer/consumer behavior	lack of understanding of technological architecture

Source: author's development

Financial reporting alone is not always the best source for assessing the state of digital business or forecasting its trend. These are sophisticated tools that can be used in conjunction with other available data that need to be processed and analyzed for optimal answers. For example, a profit and loss statement and balance sheet may show a profit, but if you don't look deeper, it's likely that a decision will be made, as they say, "based on a picture, not a feature film".

A good example: staff reductions are not always the best solution if the decision is not made in combination with capacity analysis (including revenue flow analysis), matching resources to business goals. Management needs an impartial third party that interprets and

explains exactly what the data indicates and what full impact it can have on the business.

For these reasons, CFO 360 (Chief Financial Officer – Chief Financial Officer/Vice President of Finance, Chief Financial Officer, Deputy Chief Financial Officer) was founded by Bob Pantaliano, a US CFO with 25 years of experience (*Pantaliano, 2020*).

The goal of CFO 360 is to enable small and medium-sized companies that cannot afford to hire a full-time CFO for competitive support. Knowledge of B. Pantaliano, a professional American financial and operational advisor, is based on many years of experience in strategic management of functions of financial and operational director.

The developer is convinced that each company needs a unique plan, and each task requires an individual solution. With extensive experience working with organizations in the service, non-profit and manufacturing sectors, he proposed the so-called CFO 360, which provides flexibility to work on a project or permanent basis, on site or remotely, spending as much time as mutually agreed and required for any choice of services to best meet customer needs. CFO 360 allows you to work honestly, stating fees, deadlines and expectations from the beginning and working closely with clients. In fact, the level of service is so high that it allows you to limit the number and types of tasks taken to provide the highest level of professional attention and service.

We consider it necessary to note that CFO – 3600 has several levels, namely:

1. Strategic level (10%): strategic thinking, deep understanding of business models, innovation (financially sound), leadership skills and ability to implement.

2. Communication level (30%): ability to communicate, deep understanding of best business process practices, managerial skills.

3. Technical level (60%): 80% of financial staff perceive the CFO according to the level of his professional competencies.

Table 29 presents CFO Time-management for today and expectations for future.

CFO tools:

• Increase competencies within the financial service and delegate (dependence on individuals);

• Actively use outsourcing (the ability to build partnerships);

• Actively use cloud solutions (readiness of architecture, economy) (Table 30).

Changes in the role of CFO are as follows:

• Strategic positioning/analysis: environmental analysis (competitors, market, regulation) – helps to find opportunities and threats; analysis

Table 29 – CFO Time-management

	Now	There must be
1	*2*	*3*
Financial analytics	30%	30%
Strategy	10%	50%
Accounting	30%	10%
Financial statements	30%	10%

Source: author's development

of resources and competencies – helps to identify strengths and weaknesses;

• Determining the expectations of major stakeholders;

• Strategy choice: strategic options (organic development, purchasing, vertical integration); evaluation of options and choice.

Regarding the competencies of CFO – 3600 innovation and digital enterprises in the formation of Industry X.0 in virtual reality are as follows: skills of planning, forecasting, business process management; focus on success and strategic thinking; ability to effectively conduct dialogues and establish business contacts. However, in the group of financial competencies of the CFO at a digital enterprise and allotment remain:

Table 30 – Expectations in the near future from the use of tools in the activities of innovative-digital enterprise

Direction	Internal competencies	Cloud solutions	Outsourcing
1	*2*	*3*	*4*
Cloud ERP, CRM, CMS		+	
Cloud tools for analyzing information – Power BI		+	
Team management tools – MS Team		+	+
Strategic planning	+		+
Business Intelligence	+		
Valuation of investment returns	+		
Accounting		+	+
Payroll calculation		+	+
Compilation of financial statements	+		+

Source: author's development

• Organization of risk management system;
• Mastery of methods of valuation and value management of the company;
• Knowledge of international financial reporting standards.

The managerial competencies that should be inherent include:
• Ability to form a team and work in it;
• Strategic thinking;
• Reasonable disposal of their time;
• Ability to delegate authority;
• Ability to effectively negotiate, both with external counterparties and internal;
• The ability to find ways to develop the enterprise, company.

For digital enterprise, specialists with a wide range of competencies are valuable for the implementation of global tasks of business entity, such as the formation of financial policy, setting up a system of budgeting and accounting in the enterprise. It is these needs that necessitate digital transformation of the enterprise from Office 365 (Table 31).

However, in order to be able to quickly and efficiently implement digital management through the Boards of Directors (Figure 33) requires a number of innate and mastery, acquisition and expansion of such competencies as:

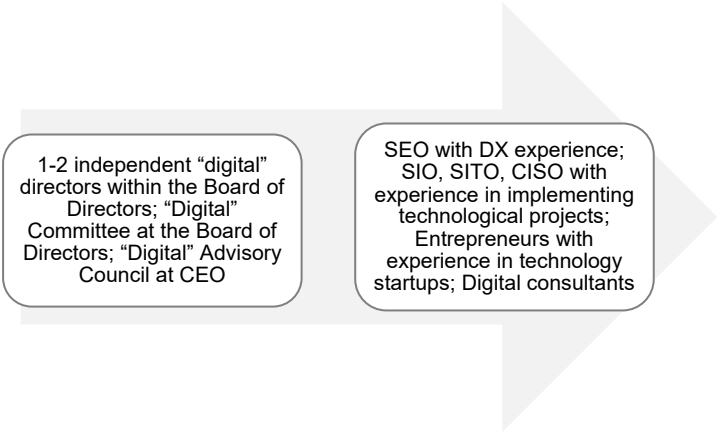

Figure 33 – Implementation of “digital management” through the Board of Directors

Source: author’s development

- Communication;
- Cold-bloodedness;
- Discipline;
- Confidence;
- Innate leadership qualities;
- Possession of developed analytical skills;
- Ability to maintain professionalism under any circumstances;
- Modernity, innovation, competence (ability to use modern technologies);
- Team player, the inherent team spirit;
- Fluent in several foreign languages;
- Curiosity.

Table 31 – Digital transformation of the enterprise with Office 365

Tasks that are being decided within the framework of digital transformation project of enterprise:	1. Migrate part of on-premises IT infrastructure services to the cloud: Exchange Online and Office 365 2. Improve mobility and communication for 250+ internal users with external customers and mercenists: Skype for Business 3. Configure cloud integration with your own mobile applications 4. Ensure dynamic expansion and more flexible connection of external users
Top challenges and threats from implementing Office 365 Enterprise	1. Narrow and strict timeframes 2. Features of deployment on different types of tools (Windows, Android, iOS, MacOS) 3. The need to carry out work remotely
The expected result of migration in Office 365	1. Start digital transformation of the company 2. Improve the functionality and integration of internal systems 3. Optimize support costs
Office 365 as a Technology Transformation Tool: *1. Office 365 E3* *2. Enchange Online* *3. Skype for Business* *4. Microsoft Intune*	Changing the paradigm of labor relations: not working for a company, but cooperation: 1. The growing potential of Microsoft teams is to allow people to suddenly create their own groups, manage the workforce (depriving management of the need for micro-management). 2. Skype, Yammer – means of free communication between people. 3. Open opportunities for broadcasting creative ideas – convenient processes, forms, applications. 4. One drive – a single data access drive without file servers with personal folders. 5. Personal productivity – task lists, calendars.

(End of Table 31)

Results:	1. Building a Hybrid Exchange Infrastructure: Debugged Integration with On-Premises Systems and Own Applications 2. Creation of a basic policy on remote management of mobile means 3. Created installation package Office 365 Pro Plus 4. Migration of mail boxes of the selected group (250+) users 5. Full technical support from Info pulse is provided 6. Training of technical specialists was conducted
Values for entrepreneurship	1. Migration has passed without disrupting business processes – invisibly for end users. 2. Unified sphere work on different types of means is ensured (Windows, Android, iOS, MacOS) 3. Improved communication between users: external and internal 4. The benefits of cloud technologies are provided: great flexibility, safety, reliability, access anywhere 5. Savings on the cost of migration and license 6. Optimized technical support costs 7. Increased handling and security of mobile means

Source: author's development

It is in the course of formation of digital entrepreneurship, formation of competencies, improvement of knowledge, acquisition of new skills that are the steps that need to be taken for both career advancement (Figure 34) and the formation of digital entrepreneurship in new virtual reality of 21 century, which is also exacerbated by both global economic challenges and COVID-19 pandemics.

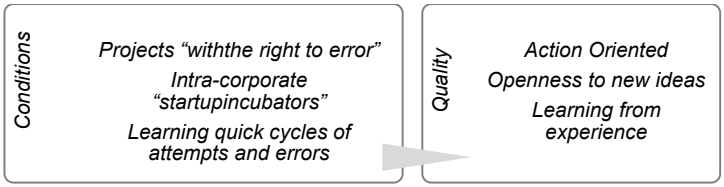

Figure 34 – Reserve potential

Source: author's development

Due to the difficult financial and economic situation, the values of both CFOs and employees with digital competencies are growing many times

if they also have the basics of strategic marketing, crisis management and risk management.

It is impossible to achieve high efficiency and confidentiality without security through the implementation of innovative projects within the digital enterprise. The implementation of the achievement of confidentiality through the work of the Security Institute is presented in Figure 35.

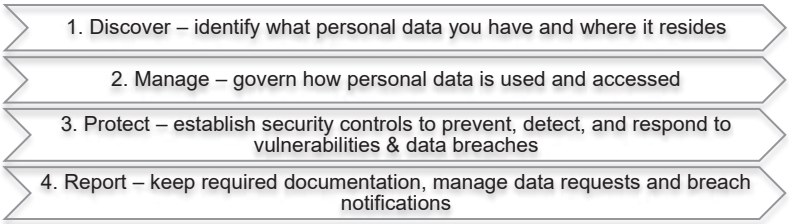

Figure 35 – The process of achieving confidentiality in digital enterprise

Source: author's development

Pursuing the goal of fastest possible development of digital entrepreneurship as a key part of Industry X.0. in the context of virtual reality, we consider it necessary to suggest key areas in which to reform innovation policy (Figure 36).

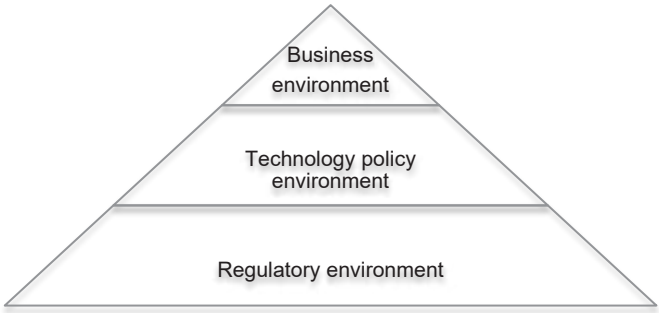

Figure 36 – Levels of innovation policy in terms of the formation of digital entrepreneurship in virtual reality

Source: author's development

Business environment (Finance, strategies and institutions):
– Vibrant capital markets;
– Chum and change accepted, embraced;
– High level of entrepreneurship;
– Cooperation and collaboration part of culture;
– Strong ICT adoption, especially among business;
– Strong managerial skills.

Technology policy environment (Supportive key building blocks of innovation):
– Education and skills;
– Technology research and commercialization infrastructure;
– Digital technology infrastructure and ecosystem.

Regulatory environment (Innovation enabling framework for organizations):
– Pro-innovation tax system;
– Competitive and open trade regime;
– Ease of starting business;
– Transparency and rule of law;
– Support for competitive product;
– Limited regulations on the digital economy;
– Government procurements based on performers standards.

In the world of data-driven digitization, all traditional industrial enterprises in new virtual reality must become part of a single digital ecosystem, and many of them require separate platforms. Using the platform in combination with the ecosystem, you can make your business a generator of innovation and growth.

Two-thirds of world's leading next-generation companies believe that building trusting, mutually beneficial relationships with all business participants is the key to digital success. Many industries are increasingly turning to platforms and ecosystems to drive further innovation and digital growth. In the 21st century, revolutionary changes are "in full swing", changing the rules of the game in a competitive modern virtual-real market. You need to be able to predict change and be at the forefront.

In conclusion, it should be noted that indeed the development of innovative-digital entrepreneurship is the foundation on which national Industry X.0 is built, in addition, in today's new virtual reality. Digital component of Industry X.0 is the element that helps companies use, quickly deploy and scale the latest digital technologies and services. Thanks to the brightest innovators and their high professionalism, the latest technologies and existing industry experience, companies can innovate using advanced technologies to ensure continuous digital transformation, new growth and improve customer service.

As a result of the formation of digital entrepreneurship as a key component of Industry X.0 in terms of virtual reality is expected to stimulate innovation (product diversification, innovative business models, flexible organizational structure); formation of consumer value (increased choice, convenience, market transparency, distribution of resources and financial assets); opening of markets (possibility of access to the market of small and medium digital business entities, expansion of export opportunity); reduction of transaction costs (low information, communication, logistics costs); increasing the density of disparate economic digital agents, intensifying interactions through digital technologies in new virtual reality; digital transformation of the role and significance of the state, change of relations of society, business, science and the state in the direction of their digitization; improving well-being (allocation efficiency, standardization, trust, efficient use of digital technologies, generation of quality information data, which can be of added value); digital transformation of the institution of intermediaries through the integration and unification of interaction processes throughout the value chain; growth of labor productivity and efficiency of innovative entrepreneurial activity.

Whether the goal is to digitally transform operations, upgrade products, improve customer and employee service, or implement new business models, it is the innovative space of digital enterprises that is the ideal place to explore and realize new business opportunities.

CHAPTER FOURTH DIGITIZATION AND ECONOMIC GROWTH: ILLUSION AND REALITY

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4.1. New digital technologies: the main outpost of the innovative future of economic agents

In modern business in Ukraine are widely used technologies of information retrieval systems Internet, advertising and sale of goods on Internet, electronic payments, electronic tenders, electronic card payments (including payroll), automated systems of salary accounting and reporting processes, electronic systems of protection and fire safety, electronic systems of information collection of control and measuring devices, mobile and selector communication, etc.

The concept of digital twinning has already become widespread in industrial production, but its benefits for the logistics industry are just beginning to show. For example, DHL in its Next Generation Wireless Logistics Review identified digital twinning as a new direction for growth. Digital duplicate is useful where access to main system is difficult or impossible (as in the case of a spacecraft), or it is costly (creating a costly product with a high degree of complexity: a large conveyor, powerful turbine or aircraft engine, and the cost of design error is very high), or it is associated with destructive phenomena (crash tests of new car models involve the destruction of expensive physical samples).

Digital double allows to reduce as much as possible delay time at natural tests. During the Fourth Industrial Revolution, digital duplicates became part of the “perfect storm” that combined the Internet of Things, robots, artificial intelligence, and automation. But interest in digital duplicates has spread far beyond production. A study by analysts at MarketsAndMarkets indicates that digital counterpart market will grow from $ 3.8 billion in 2019 to $ 35.8 billion by 2025 due to the great interest in this technology from pharmaceutical and defense industries.

Digital duplicate is a virtual copy of a physical product, process, or ecosystem. It is used to create a simulation that can be updated and changed to a greater extent in the real world, and to reflect any actions that occur with physical object. Digital dual device consists of making decisions based on various assumptions. Tests are performed on virtual

analogue without the need to interfere with the work of real, usually expensive, objects.

In today's business environment, the principles of digitalization of business are as follows: interoperability, operational interaction, integration (interoperability), virtualization, decentralization, real-time interaction, service orientation, modularity, training and continuing professional education, synergy and emergencies. So, it is not surprising that the concept of digital duplicates is attributed to Industry 4.0 and digitalization of production, the origins of this concept originated much earlier than the 2010s.

This concept continues CALS and PLM methodologies that emerged in the early 21st century. Product Life Cycle Support or CALS (Continuous Acquisition and Life Cycle Support) involves the continuous integration of CAD, CAE, CAM, MRP, ERP, SCM and CRM systems used in design, manufacture and operation of high-tech products. Product data management systems are responsible for data integration.

The product lifecycle management technology itself fits into the concept of PLM (Product Lifecycle Management) – an organizational and technical system that supports all information about the product and related processes from design and production to decommissioning. One of the goals of CALS/PLM technologies is to create virtual productions, where the development of specifications for software-controlled process equipment is distributed in time and space between several autonomous organizations to accelerate and optimize the development and production of products. In the leading countries of the world for the development of CALS/PLM-technologies standards for electronic data exchange, electronic technical documentation and manuals for process improvement are being developed (*Wikipedia, 2022*[a]).

However, since 2010, when the term Big Data appeared, the popularity of CALS/PLM has been rapidly declining. The concept of virtual production is embodied in the form of a digital double, because it is from the second half of 2010 that computing power allowed to create almost identical copies of real physical objects and processes in real time (*Wikipedia, 2022*[b]). Due to this, as well as the development of Big Data and the Internet of Things (IoT), the ideas of CALS/PLM were continued in Industry 4.0. Interactive data collection from IoT devices allows you to monitor and even control an object or process online. For example, Apache Kafka together with Spark, Storm, Flink or NiFi provide continuous aggregation and online processing of operational data. And the Apache Hadoop ecosystem is responsible for the reliable storage of this information and data from CAD, CAE, CAM, MRP, ERP, SCM, CRM, and even SCADA systems.

In addition, digital duplicates are actively using another trend technology Industry 4.0 – augmented and virtual reality (AR/VR). This allows you to simulate almost any situation and clearly represent the internal structure of complex systems, from living organisms to space satellites. Thus, digitalization of industrial enterprises, which develops digital duplicates of industrial objects and processes, has become a modern embodiment of CALS/PLM-ideas, significantly expanding their original scope. Digital duplicates are created on the basis of a specialized platform. Such platforms are manufactured by both global fans such as Siemens and Dassault Systemes, and small companies such as Xcelgo. The choice of vendor depends, first, on the specific tasks of the digital duplicate. For example, Siemens is targeting its digital dual hardware platform, and Xcelgo's solution is better suited for modeling production systems. In particular, the conditions for checking the operating modes of the platform are formed in the execution of instructions that can be edited.

Having digital duplicate for the created object provides a significant increase in efficiency for all project participants. The developer creates a quality system faster, radically reducing system debugging time. Client receives a thoroughly tested system in all possible modes with increased reliability. In this sense, digital counterpart is a tool to radically reduce the risks of large technical systems projects. The use of digital duplicate changes the application to the knowledge and experience of a specialist in the subject area of the customer's business: these specialists write scenarios to test the future system, form a checklist, which is then irradiated in full finished digital dual system (*Kraus et al., 2022*[b]).

Digital enterprise offers tangible benefits through the operation of digital duplicates, which are a virtual representation of the actual system. They allow you to get an idea of the entire life cycle of equipment and optimize it – both for new and existing plants and projects (*SIEMENS, 2021*). The creation of a digital duplicate takes place at the design stage of a new system (Figure 37). After that, as the object is completely designed, a static model of digital dual device is created on the basis of CAD-models in the CAD system or 3D-models of objects. It essentially describes the architecture of the object, the location of the system equipment in the workspace.

In the next stage, the static model "comes to life" describes the workflows, moving to a dynamic model system. This is not just a visualization of what is happening in the system. Digital dual must reproduce systematic control in the same way as the physical system. In order to write algorithms for controlling digital dual devices, such algorithms are created for the purpose of a real system. If you connect

algorithms on digital duplicates, you can get algorithms that will work exactly on a real system.

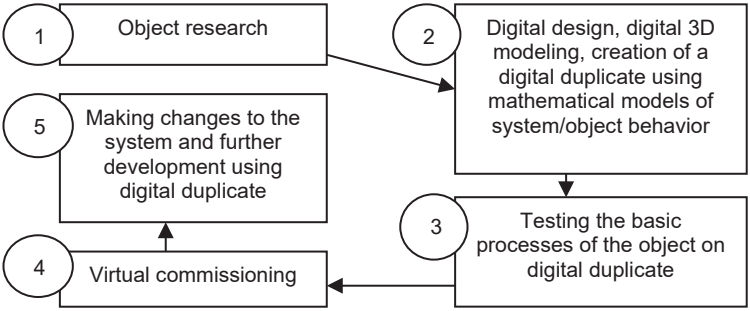

Figure 37 – The process of creating and using a digital duplicate

Source: author's development

Internet of Things (IoT) technology allows you to control devices remotely. In addition, the new method of digital duplicates can create copies of these devices. Digital duplicates are virtual copies of real objects that can be used to test the performance and efficiency of an item or system. Using digital duplicates, engineers can now quickly and easily test new sensors and products, as well as maintain and monitor their condition in a timely manner. Practitioners suggest that digital twin is a virtual interactive copy of a real physical object or process that helps to effectively manage it by optimizing business operations. For example, digital duplicate of the plant allows you to simulate the location of equipment, employee movements, work processes and emergency situations (*Kraus et al., 2022*[b]).

In essence, digital duplicate is a model of a real-time system that provides a virtual representation of physical assets. It allows you to manage both digital and physical assets as a whole. Digital duplicates have revolutionized the aerospace, manufacturing, engineering and energy sectors by optimizing design, development, production and management of all aspects of a physical product throughout its life cycle (*Logist.fm, 2020*). The integrated concept of digital business duplicates consists of three forms: digital product duplicate, digital production duplicate and digital product and production performance duplicate. With extensive expertise in this field and optimized tool, Siemens is the only company to offer a holistic approach. Value of

digital duplicate lies in the execution of scenarios and forecasting future performance (Table 32).

Table 32 – Contents of digital duplicates at new and working enterprises

Digital duplicates for new businesses	Digital duplicates for working enterprises
1	2
Creation of virtual production is carried out at the stage of designing processes and installations. Siemens provides a comprehensive set of tools for the design, modeling and construction of manufacturing enterprises. Using as a basis for collaboration platforms such as	At existing enterprises, technological processes, hardware and software can be used unchanged for decades. However, even in this case, digital duplicate can be very useful for optimizing existing processes and facilities. This digital duplicate allows
COMOS, and ensuring full data integration in the stages from design to design and commissioning, the system developers automatically create a digital duplicate installation with process automation, ready for implementation in real production with minimal effort, which allows you to reduce design costs and reduce production time.	you to analyze information on the operation of the plant. In this case, modernization and maintenance measures are based on the documentation in its original form and the relevant data on the operation of the plant. This significantly reduces the search time and the number of errors.
In the real world, Siemens' Process Management and Production Operations Management (MOM) systems ensure reliable production operations and help collect the data needed to create digital duplicate. This duplicate, created on the basis of real production systems and enriched with data obtained from Internet of Things, optimizes the production and maintenance of critical facilities.	Thanks to the integrated workflows, created digital duplicate is constantly updated until the end of the service life of the installation – the connection between virtual and real production is carried out in a closed loop.

Source: grouped by authors based on (SIEMENS, 2021)

Digital duplicate technology is one of the fastest growing concepts in Industry 4.0. It is the growth of the IoT industry and cloud technologies that has a significant impact on digital counterpart market. According to Gartner, digital duplicates are used in 13% of organizations implementing IoT projects, while 62% are either already implementing the technology or planning to do so. According to the

latest MarketsandMarkets report, digital counterpart market will grow to $ 35.8 billion by 2025 with an average annual growth rate of 37.8%. Digital duplicate technology is already widely used in industry, but it is no less important for manufacturers. Table 33 presents the advantages of using digital model of duplicates and the factors that should be considered before its implementation.

In logistics industry, the development of digital duplicates for complex infrastructure supply chains, such as ports and large warehouses, is still at an early stage. However, major ports around the world, including Singapore and Rotterdam, are turning to digital counterparts to design, plan and manage their operations. Having digital duplicate, such as a storage room, can significantly increase operational efficiency. Every process that takes place on the site and every piece of equipment will be reflected in a digital mirror, ensuring a constant flow of operational data.

There are many advantages: you can quickly detect the inefficiency of certain areas of handling or identify problems with the maintenance of equipment before they affect the throughput (*Logist.fm, 2020*). In addition, digital duplicate is not limited to collecting data obtained during product development and manufacturing, but continues to collect and analyze information throughout the life cycle of a real object, for example, using Internet of Things (IoT) devices (*Andrusiak et al., 2020*). Factors to consider before implementing digital duplicates in virtual reality are presented in Table 34.

From a practical point of view, it matters for what essence digital duplicate is created. For example, an aircraft engine is a separate object, which would correspond to a very difficult set of complex mathematical descriptions of how it works. This digital duplicate is necessary in order to test on a mathematical model all its capabilities and performance in various situations, including freelance. Another example is the logistics company's sorting center automation system. The sorting system consists of many relatively simple elements (for example, for transporting the conveyor), but for a logistics company it is important not one element, but the entire sorting system, and a digital duplicate is created for the entire production system (*Kraus et al., 2022*[j]).

The benefits that an enterprise receives from digital transformation of business processes depend on the type of tasks performed by employees. The more complex the task, the deeper the level of digital transformation the company needs to increase overall efficiency. According to the level of complexity, the tasks are ranked as follows (from the simplest to the most complex):

- Epetitive tasks;
- Administrative tasks;

Table 33 – Advantages of using digital duplicates in virtual reality

Advantage	Content and characteristics during the application
1	*2*
Operational assessment of risks and production time	With the help of digital duplicate, companies can control the quality of a product before it appears in the real world. Because digital duplicate is a copy of the planned production process, experts may notice any process failures before the product goes into production. Thanks to digital duplicates, you can increase the intensity of testing by 10 times and reduce by 85% the labor resources involved in design process. In general, engineers can restructure the system by generating unexpected scenarios, studying the system's response, and creating mitigation strategies. Thus, new technology allows for better risk assessment, accelerate the development of new products and increase the reliability of production lines.
Improving interaction within teams	Process automation and round-the-clock access to system information can increase productivity and efficiency. Yes, in the team, developers can pay more attention to creating new elements, rather than monitoring and checking once again already running.
Intelligent service	Because digital duplicate IoT sensors generate big data in real time, businesses will be able to analyze internal statistics and detect any system failures in advance. This allows companies to move to intelligent service, while increasing the efficiency of the production line and reducing operating costs.
Improving financial decision-making process	In the virtual model, you can also specify the cost of materials and labor costs. As a result, companies can make faster and more efficient decisions in financial sense: whether the value is calculated correctly, what can affect it, and so on. You can also use digital duplicates to avoid financial losses due to reduced productivity. For example, previously business owners had to stop all workflows to test new warehouse modules. Now it all happens virtually and the effectiveness of the settings is easy to check again.
Remote real-time monitoring	When working with a large system, it is simply impossible to check any of its elements at once. However, digital duplicate can be accessed anywhere, allowing users to remotely monitor and control system performance. In practice, engineers have created a warehouse structure with all the necessary technical characteristics. Yes, digital duplicates mimic the operation of a warehouse. Thanks to it is possible to estimate productivity better and to choose the optimum approach at the organization of industrial warehouses in reality.

Source: grouped by authors based on (Arnautova, 2020)

Table 34 – Factors to consider before implementing digital duplicates in virtual reality

Factors	Characteristic features
1	2
Update data security protocols	Gartner estimates that by 2023, 75% of digital duplicates for OEM products connected to the IoT will use at least five different types of integration endpoints. The amount of data collected from the many endpoints is huge, and each is potentially vulnerable. Therefore, before implementing digital duplicate technology, companies need to analyze and update their security protocols. It is worth paying special attention to: – data encryption; – access rights, including a clear definition of user roles; – principles of the least privileges; – elimination of known defects of the device; – regular security checks.
Team training	Companies need to make sure that their staff have the necessary skills and tools to work with digital duplicate models.
Data quality management	Duplicate digital models use data from thousands of remote sensors through unsecured connections. Companies should be able to exclude irrelevant data and manage gaps in data flows.

Source: grouped by authors based on (Logist.fm, 2020; Arnautova, 2020)

- Unit level tasks;
- Tasks of the enterprise level;
- Xpert tasks.

Ultimately, main goal of digital transformation is to ensure that employees perform only expert, ie the most unique tasks that are difficult to copy or accurately replicate. The rest of tasks can be performed with minimal employee participation and with the maximum involvement of powerful digital tools and increase the efficiency of their work. Features of the implementation of projects involving digital duplicates in terms of virtual reality in terms of stages are disclosed in Table 35.

For example, DHL named three main challenges in promoting digital duplicates in logistics: cost, accurate asset representation, and data quality. Next-generation wireless and 5G can solve the last two problems. The exact reproduction of digital duplicates depends on the ability to communicate in real time between the physical asset and its virtual display. Given the complexity of modern warehouses and the growing number of automated logistics tools, the collection, transmission

Table 35 – Peculiarities of project implementation with the participation of digital duplicates in the conditions of virtual reality

Stages of the project	Content and characteristics
1	*2*
Technical	Digital dual platforms are an objectively new phenomenon in the market. In particular, it provides clarity that not all pieces of equipment used in a particular project can be adequately represented by the platform. Then, these or those complex elements either come to create (construct) independently, which is not always a trivial task, or to ask the vendor to work with the platform. However, it should be noted that the vendor platform responds to operational requests at all times if they are interested in ensuring that their product is optimal as required.
Financial	If only the company decides to create digital duplicate, then this project will have to defend before the CFO in part the need to purchase licenses on the platform, and obviously a foreign vendor, and therefore the costs will be quite significant. If the production system is created by external contractors, such as an integrator, then the cost of acquiring a license is borne by the company's partner. To do this, it is important that the integrator constantly executes projects using digital duplicate platforms: then the cost of the platform will not become a separate item in the cost item required by the project. Because customers are often not ready to increase project budgets, for the sake of digital duplicates in the design services.
Terms of designing with the participation of digital duplicates	The timing of such projects depends on the system. In general, they are equated to the duration of the design phase. The expert conducts an empirical pattern: in the project, which takes 8 months, work on digital double adds to the duration of the first phases of development from 2 to 4 weeks, ie a maximum of 1 month. In the future, work with the digital double is carried out in parallel with the planned work on the system.
Improving the quality of design	Improving quality systems using digital duplicate is reflected in the best solutions at an early stage.

Source: grouped by authors on the basis of sources (Wikipedia, 2022[a]; Kraus et al., 2022[j])

and visualization of data into dynamic virtual models have so far been limited by the capabilities of existing wireless networks. Now, thanks to 5G, this problem can be solved. Digital duplicate can be thought of as a virtual prototype of a real object or process that contains all the data about it, including history and information about the current state. The criteria for digital duplicates are given in Table 36. Interactive analysis of this data using Big Data technologies allows you to effectively perform the following important management functions:

- Obtaining accurate information about system performance;
- Forecasting future conditions using ML-models of predictive analytics;
- Remote control of the object in real time.

Table 36 – Categories of digital duplicates

Categories	Characteristic features
1	***2***
Duplicate (Digital Twin Instance, DTI)	data describing the physical object. For example, an annotated three-dimensional model, information about materials and components of the product, information about work processes, test results, records of repairs, operational data from sensors, monitoring parameters, etc.
Prototype (Digital Twin Prototype, DTP)	virtual analogue of a real physical object. It contains all the data for this product, including information from design and production stages, such as product requirements, three-dimensional model of the object, description of technological processes, disposal conditions, etc.
Aggregate double (Digital Twin Aggregate, DTA)	a system that integrates all digital duplicates and their real prototypes, allowing data to be collected and exchanged in real time.

Source: grouped by authors based on (Kraus et al., 2022[j])

In terms of data quality, digital duplicates today have to collect data from many sources, both traditional IT systems and many sensors in the physical world. These can be boxes with RFID ort. All this needs to be coordinated and coordinated through a single high-speed wireless network, which DHL suggests will be based on 5G (*Logist.fm, 2020*).

Successful scenarios for the introduction of digital duplicate technology in different sectors of the economy are presented in Table 37. The ultimate goal of digital duplicate in manufacturing industry is to create a closed feedback loop between virtual and real production

Table 37 – Successful experience in the implementation of digital duplicate technology

Field of application	Brief description, content of the work
1	*2*
Energy sector	In the energy sector, digital duplicates are used to create virtual wind farms, or as they are sometimes called, "wind farms" based on cloud technology. Each wind farm has its own unique structure, like DNA or a fingerprint. Thanks to digital twin technology, engineers can combine and select different turbine configurations, depending on the conditions of the wind farm. As soon as the turbine is put into operation, its virtual copy begins to collect and analyze environmental data in real time, which leads to the creation of more efficient models.
Sphere of hospitality and service	Digital duplicates help to create simulations of real events and situations, and this creates a significant impact on the development of the Industry. For example, in the CKE Restaurants Holdings fast food chain, digital duplicates allow restaurants to work more productively. Digitization has affected the halls for visitors and kitchens, so companies are testing different options, thereby reducing staff rotation and creating more favorable conditions for visitors.
Urban environment	The technology helps city planners better understand and refine factors such as energy consumption. Digital copy of Singapore already exists, and copies of other cities are expected in the future.
Retail	The technology of digital duplicates has recently entered the field of retail, but could be very useful, especially when it comes to modeling the behavior of shoppers. Analytical firm Pygmalios singles out virtual duplicate technology as part of the Retail 4.0 digital retail transformation process, an approach that collects detailed real data from the physical retail environment and then uses it to better understand visitor behavior and actions.
Healthcare	Since a virtual image of any real object or environment is created, it is possible to create a "digital patient" – a model of the human body that gives an idea of the state of human health during his life. This is how Philips sees the future of healthcare. The idea of creating a whole digital patient is still far from being realized, but the technology is already being applied to certain parts of the body, which is encouraging. Philips has developed the HeartModel application, which creates a detailed 3D image of the human heart based on ultrasound images. One day, a virtual heart can help save the real thing.

Source: compiled by the author based on (Logist.fm, 2020)

through the use of the right digital infrastructure. Due to this connection, the duplicate characteristics of real production allows you to develop optimization scenarios in virtual production. After successful modeling and implementation of these scenarios, the cycle begins again.

Based on the analysis of literature sources, we concluded that digital transformation of the enterprise is the introduction of modern technologies in its business processes. This understanding involves not only the installation of modern hardware or software, but also fundamental changes in approaches to management, corporate culture, external communications. As a result, the productivity of each employee and the level of customer satisfaction increase, and the company gains a reputation for progressive and modern. The latest digital technologies of the "digitization" process lead to innovative transformations in all spheres of enterprise activity and encourage the creation of new business models.

In conclusion, it is worth noting that new technologies help companies reduce costs, increase productivity and efficiency, as well as optimize maintenance. In particular, it is the technology of digital duplicates in combination with the tools of machine learning and artificial intelligence allows to achieve this without compromising workflows. With this content, digital technology makes it possible not to stop the line to test a new element. Therefore, for manufacturers, the technology of digital duplicates is important not only to improve efficiency, but also to bring the product to market faster.

We remain true to the opinion that it is still important to conduct future research aimed at presenting the effects of digital transformation. Among them, we believe: significant release of working time of employees to focus on more important tasks, reducing the number of specific tasks, improving the coherence of business processes within digital enterprise, accelerating the processing of analytical information for management decisions, etc.

Raising the issue of servation, which has a powerful impact on the results of economic activity of digital entrepreneurship, it is impossible not to mention the new European Regulation on protection of individuals in relation to the processing of their personal data, namely General Data Protection Regulation (GDPR), which is mandatory for the implementation and application of all European Union states in the legislation.

The GDPR principles are as follows:

- Legitimacy, transparency, fairness;
- Goal restrictions;
- Minimization of data;
- Accuracy;

• Limited storage;
• Integrity and confidentiality;
• Accountability.

We are talking about the following data:

• Name, gender, age, race;
• Passport data, identification number;
• Residence and location data;
• Mobile phone number, e-mail;
• IP-address, cookies;
• Payment card data;
• Biometric data;
• Medical information (*Kraus et al., 2020*).

As part of the problem of our study, it is worth noting that personal data is any information relating to an individual by which it can be identified. As for understanding the content of the "individual" category, it is a person who can be identified directly or indirectly, in particular by linking to a specific identifier; e.g. name, identification number, passport data, location data, mobile numbers, payment cards, IP-addresses, e-mail, etc.

Grounds for legitimate processing of personal data are as follows:

• Consent of the data subject to fulfill the contract;
• Public service;
• Legitimate interest;
• Lital interest.

The reasons why Ukrainian digital business should meet the GDPR are as follows:

• Extraterritorial principle of the regulation;
• Targeting of clients from the EU;
• International commitments: association agreement with the EU;
• Adaptation of the NPA to GDPR liability;
• Counterparties from the EU.

In the context of digitalization of entrepreneurial activity, whose companies will be affected by the need to meet the GDPR will be with the following characteristics, namely:

• Process, store, transmit personal data of entities from the EU;
• Perform works, provide services to citizens or residents of European Union countries;
• Have counterparties from the EU (*Marchenko et al., 2020[b]*).

As for the existing experience of "high-profile attacks", they are as follows:

1. TICKETMASTER

• 23.06.2018 – attack on data of 40 000 clients;

• 27.06.2018 – notice, possible fine of 2% or 10 million euros, looking that more.

2. DIXONS CARPHONE

• 06.2018 – attack on these risk for 5 million 900 thousand customers;

• possible fine – 4% turnover, about 423 million pounds.

Violation of the requirements for the protection of personal data in the world:

• FACEBOOK – data transfer to Cambridge Analityca;

• YOUTUBE – collection of information about children without their parents' consent;

• UBER – 20 million people were injured.

Illegal data transmission in Ukraine:

• Banks – sale of customer data;

• Postal services – 18 million customers;

• Carriers – constant transfer of data to third parties;

• Online stores – data transfer to third parties, further blackmail of the client (*Manzhura et al., 2019*[a]).

In order for the enterprise to fully meet modern requirements of quality functioning it must take main steps in terms of the application of a new service, which is aimed at fully digitizing its economic activity, namely:

• Audit of company's activities in terms of the collection of personal data: what data, for what purposes, in what form, including technical audit;

• Work with the staff and its training;

• Development of typical documents: consent, contract, instructions, private policy;

• Development of software for process automation: notification of subjects, logging of incoming queries.

Changing business models in terms of their digitalization provides an increase in customer loyalty through the omnichannel experience; allows employees to provide a popular service; simplifies daily routine work; allows you to manage strategic planning and merchandising; provides integration with supply chain management; unify business processes by different communication channels (websites, directories, mobile applications, contact centers, social media, etc.). Implementation of entrepreneurial activity at an effective level in the conditions of digitalization of the economy is possible only if there is a favorable general social situation, high-quality work of institutes of entrepreneurial environment, market system of relations, as well as personal freedom of entrepreneur, i.e. his "healthy" personal independence, which allows to make such entrepreneurial decisions, which from his point of view will be the most effective, effective and profitable.

Main focus today: optimizing IT for successful digital transformation, cybersecurity, privacy. GDPR: enhanced personal privacy rights, increased duty for protecting data, significant penalties for non-compliance.

Under the influence of new Internet technologies and online platforms, the global economy will gradually "get free" from the numerous barriers that divide it and will be characterized by a special "spatial plasticity" designed for the dynamics of communications and the driving force of innovation. Already today we observe both the economies of different countries inherent clustering, direct connection between economic participants; collective way of responding; hyperminous institutional environment. Digitalization of the economy, which is actively taking place today in Ukraine, to some extent "touched" all spheres of business. Its actors, aimed at long-term success and development, are forced to accept the challenges of the modern economy – only way they can become leaders in business. Digital transformation and servation of economic activity at the micro level can help them.

Cloud services are key to today's its strategies. 1,181 different cloud services are used by enterprises on average. 61% of cloud applications IT isn't aware of. 75% of companies consider SaaS tools essentials to their business. 80% of workers use non-sanctioned cloud apps (*Holoborodko et al., 2019*).

Cloud Access Security Brokers (CASBs) are defined by Gartner as: on-premises, or cloud-based security policy enforcement points, placed between cloud service consumers and cloud service providers to combine and interject enterprise security polices as the cloud-based resources are accessed. CASBs consolidate multiple types of security policy enforcement. Estimated to be the fastest growing security market. Top security project planned in the next 2 years. By 2020 85% of large enterprises will use CASBs.

Elevate the security for all your cloud apps and services. A uniquely integrated CASB: Threat Signal Clustering (Microsoft Intelligent Security Graph), Security Analytics & Guidance (Microsoft Secure Score), Cloud Security Posture Management – IaaS (Azure Security Center), Unified Endpoint Management (Inture), Data Loss Prevention (Azure Information Protection), Identity & Access Management (Azure AD & Conditional Access), Endpoint Detection & Response (Windows Defender ATP).

Shadow its management lifecycle by Safely adopting cloud apps, namely:

1. Discover Shadow IT – Identify which apps are being used in your organization.

2. Identify the risk levels of your apps – Understand the risk associated with discovered apps, based on more than 70 risk factors including, Security factors, industry- and legal regulations.

3. Evaluate compliance – Evaluate whether the discovered apps meet the compliance standards of your organization against factors like GDPR or industry-relevant standards like HIPAA readiness.

4. Analyze usage – Understand the usage patterns and identify high risk volume users.

5. Manage cloud apps – Start managing cloud apps and leverage one of several governance actions such as Sanction, Unsanction, onboarding an app to AAD to leverage SSO, marking them for review or blocking them from your network.

6. Continuous monitoring – Be alerted when new, risky or high-volume apps are discovered in your environment for continuous monitoring and ongoing control over your cloud apps (*Kryvoruchko et al., 2017*).

Discovery process is as follows:

1. Identify cloud apps and services:

• >16,000 cloud apps and services from catalog;

• Custom apps.

2. Understand usage patterns

• Traffic data Top users and IP addresses App categories;

• Machine-based investigation via native integration with Windows Defender ATP.

3. Understand the risk:

• Assessment across >70 risk factors;

• Regulatory certifications, compliance standards (e.g. GDPR), industry standards and best practices;

• Risk score calculation – can be customized based on the priorities of your organization.

4. Take control:

• Sanction or un-sanction apps;

• Onboard apps to Azure Active Directory;

• Block apps natively with Zscaler;

• C-level report & recommendations.

Cloud Discovery with Windows Defender ATP consists in:

• Discovery of cloud apps beyond the corporate network from any Windows 10 machine;

• Single-click enablement;

• Machine-based Discovery;

• Deep dive investigation in Windows Defender ATP.

Protect sensitive files in the cloud occurs as follows:

1. User uploads a sensitive file to a cloud app

2. A classification label is automatically applied to protect the file
3. User tries to share sensitive file with external users
4. External user is not able to access the file due to classification and protection
5. Admin receives event alerts

Contents of work of Unified Data Classification Service consists in: unified labelling with Microsoft Information Protection; 90 built-in, sensitive information types you can choose from; ability to configure custom sensitive information types (supports complex patterns with Regex, keywords and large dictionary).

Azure ad conditional access:

1. Controls: allow access, require MFA, limit access, deny access, force password reset.
2. Conditions: users, devices, location, apps.

Protection against cloud threats is as followed:

1. Malicious Insider. Protect against disgruntled employees before they cause damage.
2. Malware. Detect malware in cloud storage as soon as it's uploaded.
3. Ransomware. Identify ransomware using sophisticated behavioral analytics technology.
4. Rogue Application. Identify rouge applications that access your data.
5. Data exfiltration. Detect unusual flow of data outside of your organization.
6. Compromised Accounts. Combat advanced attackers that leverage compromise user credentials.

Malware Detection happens by: Scan cloud storage apps; Identify potentially risky files Powered by Microsoft Threat; Intelligence.

Automatic detection and revocation of risky 3rd party apps possible in case of: monitor cloud permissions authorized by your users; act on suspicious apps; automatically revoke apps to the entire org or specific users and groups.

4.2. Green business in the blue economy with digital content

Ukraine ranked 60th in Global and Digital Competitiveness Rankings IMD-2017 (*Liga, 2019; Portulans, 2018*) of the International Institute for Management Development (IMD). However, in digital competitiveness ranking for the implementation and study of digital technologies that are transformative in government practice, business models and society as a whole, Ukraine is in the last positions alongside Indonesia, Mongolia,

Peru and Venezuela. Innovation has become a major factor in the success of states and businesses today.

Countries and corporations seeking to become world economic leaders are investing heavily in research and development, new manufacturing and quality management. Among the countries that invest the largest share of their GDP in research and development (R&D), South Korea leads by a large margin of 4.3% and Israel of 4.1%. Japan invests 3.6% of GDP, Austria, Germany and Switzerland – about 3%. Whereas, by comparison, Ukraine invests only 0.2% of its already insignificant GDP in scientific development.

In terms of money in R&D investment, in purchasing power parity, the absolute leader is the US – $ 480 billion and China – $ 371 billion a year. For comparison, in Ukraine – $ 2.5 billion. Expenditure on R&D 1000 corporations, the world's largest R&D investor, increased 3.2% in 2017 to $ 702 billion.

In 2017, the Government of Ukraine presented a National Report on "Sustainable Development Goals: Ukraine" (*Sustainable Development Goals, 2017*), which set the benchmarks for achieving them. However, there are now many concepts that are based on utility estimates such as energy, water, waste management, transportation, and complicate long-term smart community planning.

The European Strategy for Intellectual, Sustainable and Inclusive Development by 2020 (*EUROPE 2020, 2019*) has declared the achievement of objectives as a common interest on the basis of three complementary economic policy priorities: Smart growth (economic development based on knowledge and innovation); Sustainable development (promoting a more resource-saving, green and competitive economy); Inclusive growth (stimulating the employment economy, ensuring social and territorial cohesion).

Valuable in the scientific sense of the study of green entrepreneurship are scientific works and practical achievements of such well-known scientists as A. Merts, K. Richter, N. Fontsein, A. Shchulst. The theory concerning the future modern development of the economy, the so-called "blue economy" theory, by a scientist economist, a member of the Roman Club of G. Pauli, deserves due attention.

Economists from Ukraine are also actively involved in research and development in the field of doing business which seeks to combine environmental concerns, fair treatment of employees and economic success and the issues of quality management of environmental business. But at the same time, there are a number of pressing issues of type:

• The particularities of problems and risk management at the various stages of green business in blue economy;

• Previous recommendations regarding the control and quality management of green production at the stage of its growth;

• Ranking of the most promising green business ideas that allow us to join green market and lay the foundations for the development of blue economy in Ukraine remains poorly understood.

Finding out the specificities of problems and risk management in the various stages of green business in blue economy. Substantiation and disclosure of previous recommendations regarding the control and quality management of green production at the stage of its growth.

Green business (Sustainable business) or circular (non-exhaustive) business is an activity that has minimal adverse impact on the global or local environment, society or economy – a business that seeks to combine environmental, equitable treatment and economic success (*Wikipedia, 2019[a]*). Most green companies have progressive environmental principles and policies on human issues. A business is generally considered green if it meets the following four criteria:

• Is guided by the principle of "circulation" in making all its business decisions;

• Supplies environmental goods or services that replace the demand for non-environmental goods or services (*Kyiv International Economic Forum, 2018*);

• "Greener" than typical competitors;

• Has long been committed to environmental standards.

The Brundtland Commission (*Wikipedia, 2019[b]*) emphasized that the understanding of inexhaustibility rests on three pillars: people, the planet and profit. Circular business in its content aims to balance these three factors, using circular production and distribution in order to influence the environment, economic development and society (*Wikipedia, 2019[c]*).

In general, all types of businesses affect circulation in the context of world market and our planet in some sense. The development of a circular principle in business can be significant for the buyer, the investor, and it is also environmentally friendly. The circular business must meet the needs of the buyer and be environmentally friendly.

A scientist economist, a member of the Roman Club G. Pauli put forward his theory about the future of the latest economic development, the so-called "blue economy" theory. Her content was revealed in her research paper entitled "Blue Economy: 10 Years, 100 Innovations, 100 Million Jobs". In her research, the scientist is devoted to the aspects of becoming an innovative economy in the context of the transition of society to sustainable environmentally sound development. G. Pauli argues that economic development and the restoration of environmental balance must be interrelated processes.

G. Pauli's scientific postulate is that "there is nothing superfluous in nature", so the rational use of resources at every stage of humanity's economic activity is necessary condition for humanity's competitiveness. "Blue economy" demonstrates how many environmental and environmental degradation problems can be avoided through the conservation of material resources and the adaptation of production processes to the laws of nature. G. Pauli gives examples of the interrelationship between nature and economy and points to the ways of harmonious environmental and economic development of society.

Based on the existing concept of green business, which is based on the principle of "circulation" and theory, regarding the future modern development of the economy, the so-called "blue economy" theory, it can be stated that their implementation in practice pursues the same goal, namely: a consistent and reasonable combination of economic and environmental development on a circular basis in business with complete satisfaction of the customer's needs.

For these reasons, we consider it appropriate to present the core of VI and VII technological frameworks that lay foundations for green business formation in blue economy, which are presented in Table 38.

Regarding the functions performed by green business, most of them relate to all possible lines of business. For example, setting prices for goods and services sold, conducting research and development work and creating innovative goods, methods and technologies, creating new jobs.

Functions specific only to green business entities include: meeting public needs for environmentally friendly products, protecting the environment, minimizing environmental-destructive environmental impacts, shaping the environmental awareness of society and its environmental culture, and preserving natural capital. It is the fulfilment of these functions that distinguishes green business in blue economy, among other areas of activity.

It should be noted that the functions that are inherent in all areas of activity in the green business are manifested in a more environmentally rational way. For example, efficient use of resources not only minimizes the amount of their use, but also is based on the choice of those resources, the use of which will have the least possible environmental impact (*Wikipedia, 2019*[a]).

Specific features of problems and risk management at the various stages of green business in blue economy are presented in Table 39.

Previous recommendations regarding the control and quality management of green production at the stage of its growth are presented in Table 40. The forms of manifestation of green production today are: eco-company; direct green entrepreneurship; production of environmental goods and services.

Table 38 – The core of VI and VII technological strucrures that lay for green business in blue economy

Direction	Problems solved	Possible implementation options
1	2	3
Characteristics of VI technological way		
Non-traditional energy	Reducing the burden on the environment, saving natural resources	Hydrogen energy, synthetic fuel, solar energy converters, closed-loop nuclear power plants, fast reactors, vortex heat generators
Information systems	Globalization of the world economy through partnership	Bioenergy, optics, quantum-vacuum computers, artificial intelligence, torsion communication systems
Biotechnology	A new level of well-being	Water purification, seafood desalination, modified agro-culture, disease treatment, cloning
Transport	Environmental safety, speed, efficiency	Underwater superliners, string transport, electric vehicles, aerospace transport systems
Ecology	Sustainable development	Waste-free and closed technological “circuits”
Materials	Durability, safety, reliability, efficiency	Nanotechnology, amorphous metals, memory materials, high-temperature superconductivity, torsional materials processing technologies
Characteristics of VII technological way		
Cognitive and socio-human technologies. The main production factor is creative intelligence	“World vacuum control”. New forms of life on the planet. Constructing a new social reality	Fusion technologies, psi-technologies (advances in modern psychology that include new tools for human management), bioenergy, technologies related to morality and responsibility. This way is realized by means of hyper intelligence, hyper knowledge, hyper information, hyper communication. “Subconscious and mind games”. It is projected that there are 5 cognitive technologies: neuroimaging, cognotropic drugs, cognitive assistants, brain-machine interfaces, artificial sensory organs

Source: Krasnoshchekov, 2008; own experience

Table 39 – Characteristic features of problems and risk management at different stages of green in blue economy

Possible life-cycle options "green business (WB) – innovation market (RI) – new products (NP)"	Preliminary diagnosis for questions major problems and risks of GB
1	*2*
1. WB growth is the embryonic state of RI – the technical idea of creating an NP	The problem is related to the need for rapid implementation of the technical idea and the emergence of NP in RI. The most significant risk is the mismatch of the expected and actual consumer response to the NP
2. WB growth – crystallization of RI – technical idea of creation of state of emergency	The problem is the same, but time is limited. Main risks are events that can slow down the process of RI production (counterparties, internal inconsistencies)
3. WB Growth – RI growth – technical idea of Creating an NP	The problem is the same, but the time resource is almost exhausted. Main risks are the same
4. WB growth – RI saturation – technical idea of creating a NP	Technical idea was "late"
5. WB growth – RI maturity – technical idea of creating a NP	
6. WB growth – decline of RI – technical idea of creation of state of emergency	
7. ST growth – embryonic state of RI – development of NP	There are no visible problems. There is a good chance for the successful development of the ST in the future. Main risk is the mismatch of the expected and actual consumer response to the NP
8. WB growth – crystallization of RI – development of NP	There are no visible problems. However, the time resource for RI output is limited. Main risk is the same + events that can slow down the output of RI (counterparties, internal discrepancies)
9. WB growth – RI growth – NP development	Main problem is the limited time resource for the NP to enter RI. Main risks are the same
10. WB growth – RI saturation – NP development	Development is "late". It is obvious that there are problems in management: marketing "sleeping", organization of the basic processes "limping". Main risk is the deterioration of financial condition
11. WB growth – RI maturity – NP development	
12. WB growth – decline of RI – development of NP	

(End of Table 39)

1	*2*
13. ST growth – embryonic state of RI – exit of NP to RI	Has a chance for successful development of the WB in the future. Main risk is the mismatch of the expected and actual consumer response to the NP
14. WB growth – crystallization of RI – output of NP on RI	
15. WB growth – RI growth – NP output to RI	Unbeatable/wonderful! There are no problems. Of paramount importance are the risks of an internal nature: will the company "drive" such rapid/rapid growth?
16. WB growth – RI saturation – NP output at RI	Exit to RI NP "a little late". Underestimation of management. Difficulties with the financial state of the ST are possible
17. WB growth – RI maturity – NP output to RI	The same, but financial problems can be more serious
18. WB growth – decline of RI – exit of NP on RI	The exit of the NP at RI was too late. Obvious problems in management and marketing. Financial losses can be critical to the ST
19. WB growth – crystallization RI – sales growth of innovation	The situation is quite promising for the WB. Main problem is to maintain a position in the emerging market. Main risks are actions by competitors
20. WB growth – RI growth – NP sales growth	Fantastic situation! The problem is to save it. Risks of internal character are most clearly seen: in the part of the analysis of trends of development of RI, as well as the organization of the basic processes of ST
21. WB growth – RI saturation – stable sale of NP	There are no obvious problems. Main risk is the financial loss that can occur if the ST "hangs" on RI with "old" product
22. WB growth – RI maturity – stability of NP sales	The problem is the limited time available for "production upgrades". Most important are marketing risks as well as risks related to reorganization of internal processes

Source: Medvedeva, 2011; Wikipedia, 2019[a]

Table 40 – Previous recommendations regarding the control and quality management of green production at the stage of its growth

Possible options for the life-stage ratio "green production (DR) – innovation market (RI) – new products (NP)"	Previous recommendations
1	*2*
1. WB growth is the embryonic state of RI – the technical idea of creating an NP	Develop a rigorous timetable of activities to ensure a rapid and efficient transition from a technical idea to a serial issue of an NP. Clearly motivate managers to implement the plan in terms of time and quality
2. WB growth – crystallization of RI – technical idea of creation of state of emergency	
3. WB Growth – RI growth – technical idea of Creating an NP	Mobilize all resources for organizing activities to bring the NP to RI
4. WB growth – RI saturation – technical idea of creating a NP	Use a technical idea for a second product that addresses the needs of a more promising sector of RI (second market niche)
5. WB growth – RI maturity – technical idea of creating a NP	
6. WB growth – decline of RI – technical idea of creation of state of emergency	
7. ST growth – embryonic state of RI – development of NP	Perform continuous analysis of the state of RI. Develop the program for the fastest and most effective product promotion
8. WB growth – crystallization of RI – development of NP	Develop a timetable for activities that provide a quick and effective transition from product development to production. Clearly motivate managers to implement the plan
9. WB growth – RI growth – NP development	Mobilize all resources to accelerate the exit of the NP in RI
10. WB growth – RI saturation – NP development	Use the development for a second NP focused on the needs of a more promising sector of RI (other market niche). Reorganize the main processes
11. WB growth – RI maturity – NP development	
12. WB growth – decline of RI – development of NP	

(End of Table 40)

1	*2*
13. ST growth – embryonic state of RI – exit of NP to RI	Continuous monitoring of the consumer response to the state of emergency and the state of RI. Develop a program for the fastest and most effective promotion of NP
14. WB growth – crystallization of RI – output of NP on RI	
15. WB growth – RI growth – NP output to RI	Analyse and refine basic processes. Pay more attention to discipline, responsibilities and responsibilities
16. WB growth – RI saturation – NP output at RI	
17. WB growth – RI maturity – NP output to RI	The same NP + modified to more promising sectors RI (other niche market)
18. WB growth – decline of RI – exit of NP on RI	Reorganize the management system and main processes of the EE. Modify NP for a more promising sector of RI (other market niche)
19. WB growth – crystallization RI – sales growth of innovation	To carry out constant analysis of the state of RI, and especially the actions of competitors. Ensure the readiness of the EE (in terms of organizing major processes) for its potential growth
20. WB growth – RI growth – NP sales growth	Constantly analyse the state of RI. Ensure that the VP is ready to move to another product line or to another sector (niche) of RI
21. WB growth – RI saturation – stable sale of NP	Develop a production upgrade program: move to another product line or to other sectors (niches) of RI
22. WB growth – RI maturity – stability of NP sales	Implement the production upgrade program

Source: Medvedeva, 2011; Wikipedia, 2019[c]

The first form of green production is the introduction of environmental management, which is mainly related to the administrative regulation of the enterprises in the country. As a result, the enterprise contributes to the reduction of environmental pollution, but as a rule, not at will, but in accordance with the requirements of laws and regulations or regulations of world organizations.

The peculiarity of the second form of green production is that, in addition to minimizing the harmful environmental externalities from production activities, the enterprise has managers and employees forming an ecological consciousness, which is based on providing environmental needs not only for the modern generation, but also for creating favourable living conditions for the future by minimizing the environmental impact of production over the long term.

The third form of green production is manifested when the company, at its own discretion, switches to energy-efficient, environmentally-friendly technologies for the production of goods and services and promotes environmental improvements through the use in the process of activity of methods and raw materials that minimize the environmental-destructive impact on the environment and lead to improved living conditions (*Lanovenko et al., 2013*).

Green technologies are production processes that are nature-friendly and produce a product that meets high quality standards. For example, the largest vehicle companies have turned their attention to hybrid and electric cars, eco tires and eco gasoline, which are still in high demand today. One should not ignore the fact that in these areas there is an active cooperation between business and science.

Scientists from different universities in the world are opening up new opportunities in the use of solar panels, growing organic crops and creating an "eco-culture" (*Yurinova, 2019*). Rating of the most promising green business ideas that allow you to join the environmental market and a basis for the formation of a blue economy in Ukraine is presented in Table 41.

Key features of the future patterns of development of the blue economy in Ukraine should be:

- Institutional order of cluster structure based on innovative hubs;
- Direct communication between its members;
- A collective way of creating innovation;
- An effectively functioning harmonization institute;
- Structure of production of V and VI technological structures.

The strategic priorities for the development of green production of innovative type in the course of R&D include: development of new technologies of energy transportation, introduction of resource-saving technologies, modernization of power plants and technological updating of the agro-industrial complex, high-tech updating of machine and instrument making, systematic modernization of health care.

Table 41 – Rating of the most promising green business ideas that allow you to join the green market and lay the foundations for becoming a blue economy in Ukraine

Green business idea of green direction	The content and overall characteristics of green business idea that underlies blue economy
1	*2*
Eco-consulting services	Ideal for those who are well versed in green technology. Companies operating in the sector provide environmental expertise for residential buildings, office space, and are developing options for improving eco-equipment, ranging from energy-efficient technologies to waste management programs. In order to gain the trust of potential clients, you need to get a certificate, better international, that allows such activities
Bicycle repair	This service is in dire demand in a number of CIS countries. Not only the desire to preserve the environment, but also more rational arguments (high prices for gasoline, endless traffic jams and accidents) make citizens abandon cars. In addition, having ridden a bicycle about ten kilometres away, you do not have to go to the fitness room, so you can save money and burn calories, which will not be unnecessary. For these reasons, there is a need to open bicycle repair centres.
Cleaning of ventilation systems	Provides services that improve the energy efficiency of buildings. The fact is that dust and other small particles in any case enter the ventilation systems, but you can get rid of them. This may come in handy for a company that will show you how to save money on gas and electricity. Potential clients can certainly be allergy sufferers: they are always willing to pay a lot of money just to get rid of the allergens
Growing vegetables and fruits	This industry clearly demonstrates the desire of many to eat properly, favouring those fruits and vegetables offered not by large companies but by small farms. It is important that there are certificates that confirm that no chemicals were used when growing the crops. You should also be prepared for the approval of such activities to be agreed with the local authorities
Release of organic cosmetics	A real hit in today's market. Nowadays, girls and women are striving not only to be beautiful, using a huge amount of products every day, but also to want cosmetics to be safe for the skin. At the same time, most beauties simply do not have the time to prepare their own scrub or balm, so it is much easier to buy the finished product
Furniture restoration	A service that is not cheap but is of interest to many. The content of the service is to "revive" old furniture, which may have been inherited from grandparents and which are just so easy to say goodbye to
Eco-cleaning of the house	Actual service for people who are constantly employed. Cleaning up with clean, non-chemical cleaners is a difficult job, but it is essential for families with small children or allergic family members

Source: compiled by authors based on (Yurinova, 2019)

4.3. Risks of investment activities of digital enterprises

Comprehensive development of a system of actions aimed at intensifying investment activities, effective use of investment potential, attracting investment in the real sector of the economy is an urgent problem for Ukrainian businesses that needs to be addressed. The fundamental importance, the diversity of the problem of identifying and minimizing risks of investment activities of enterprises necessitate the study of classification, assessment processes and features of risk management of investment activities, taking into account all factors of influence.

Investment activity is one of the key forms of economic activity of the enterprise. Opportunities for enterprise development and economic growth are largely determined by investment projects. The investment process is implemented and managed through the investment policy of the enterprise. Investment policy is aimed at the use and formation of investment potential, which, in turn, is the result of investment processes and is based on investment.

Risk is an integral attribute of a market economy. Every company strives to increase profits through optimal solutions and minimize risk. This requires risk assessment and forecasting.

Close attention to the problem of risk regulation of investment activities of the enterprise is due to the fact that the negative trends of its development pose a serious threat to the economic security of the enterprise. Irrational use of available investment potential hinders the dynamic and balanced development of the economy.

All investments involve some degree of risk. Risk is an important component in assessing investment prospects. Investors, making investments, consider less risk more favorable. The lower the investment risk, the more profitable the investment. However, the greater the risk, the better the return.

As investment risks increase, investors seek to increase profits to compensate for such risks. Each savings and investment product has different risks and returns. Differences include: how easily investors can get their money when they need it, how fast their money will grow, and how safe their money will be. Main factors influencing investment risks are shown in Table 42.

The investment policy of the enterprise is a complex set of measures that ensure a profitable investment of own, borrowed and other funds in investments in order to ensure stable financial stability of the enterprise (*Stolbov, 2016*). An integrated approach to risk management considers the relationship between different sources of risk and their impact on the overall business. Key word of modern risk management is the use of

Table 42 – Factors influencing investment risk

Influence factor	Characteristics of the influence of the factor
1	2
Wrong decisions	Usually based on erroneous calculations
Terms of investment	Long-term investments are more risky than short-term ones because the future is not stable
Investment level	The larger the amount of investment, the greater the risk
Field of activity	Growing industries are less risky
Political, legal factors	Changes in government policy and legal statutes

Source: summarized by authors based on (Kolomiiets et al., 2016)

probabilistic models (*Kolinko, 2019*).

Considering the scientific approaches to understanding the concept of "investment risk", we can conclude that it is associated with possible losses and deviations from the expected financial results of the investment project. Diverse classification of investment risks depending on the stage of investment policy, sources, areas of manifestation and factors of influence simplifies the process of identifying risks of investment policy of the enterprise and facilitates the choice of strategy to prevent, eliminate or minimize them.

Approaches to understanding the essence of "investment risk management" of the enterprise include three components (Figure 38).

For a balanced and sound implementation of risk management of investment activities of the enterprise, you need to go through several main stages:

1. Risk identification is the systematic identification and study of risks that are characteristic of investment activities. Dangers that pose a threat are identified; resources that may be affected; risk factors; loss, which expresses the impact of risk on resources.

2. Risk measurement – determining the degree of its probability and the size of potential damage. Use special methods of risk assessment based on the development of scenarios for its occurrence (*Shyshkin, 2018*).

3. Control is divided into physical and financial. Physical control is the use of methods that reduce the likelihood or extent of damage associated with certain costs. The rule is that the costs of the system of preventive measures to prevent risk and reduce losses should not exceed the possible amount of damage. Financial control of risk is to find sources of compensation for possible losses in cash. In the economic scientific literature there are several key areas of risk management of investment activities of the enterprise (Table 43).

All investments carry a certain degree of risk. By better understanding the nature of risks and taking measures to manage them, the company better fulfills its financial goals. Limiting the percentage invested in one sector can save you from devastating losses due to hard times or overstatement in one sector

Investment risk management has become a critical aspect of value maximization, it increases the value of the firm by reducing its instability of cash flows, the likelihood of default and underinvestment

Risk management allows to direct the activities of the enterprise to anticipate risks and reduce their negative impact, ensures the economic security of the enterprise

Figure 38 – Scientific approaches to understanding the essence of "investment risk management"

Source: compiled by authors based on (Koroluak, 2019; Nymoshek, 2019; Mostenska, 2015)

The peculiarity of risk management of investment activities of the enterprise is the relationship of stakeholders, because unexpected events affect shareholders, debt holders, managers, employees, customers. The basis of economic relations between these participants are special principles of risk management of investment activities of the enterprise (Table 44).

Starting the investment activity of the enterprise, in order to minimize the risks at the initial stages, it is necessary to determine the following aspects: planned time of receipt of funds, possible amount of funds for emergencies and debt coverage, security level for the enterprise, action plan in case of unsuccessful investments, acceptable level of investment reduction. To avoid risks or minimize their negative impact on enterprises, a whole system of methods for managing the risks of investment activities can be used (Table 45).

There are five main strategies for managing the investment risk of an enterprise.

Strategy 1. Allocation of assets. By including various asset classes (such as stocks, bonds, real estate, and cash) in its portfolio, an enterprise increases the likelihood that some of its investments will return satisfactorily, even if others equalize or lose value. Thus, the risk of large losses, which may be the result of excessive emphasis on one class of assets, is reduced. Asset allocation planning is the first step in managing investment risk. Most investors invest too aggressively when valuations are high and too conservative (out of fear) when deals are available. Calculating the probable maximum loss for the company will help determine what risk to take (*Fedorovych et al., 2018*).

Table 43 – Areas of risk management of investment activities of the enterprise

Direction of risk management	Risk management measures
1	2
policies aimed at direct risk reduction	– redistribution or addition of resources; – adjustment of calendar plan; – conducting additional marketing research;
policies aimed at minimizing the possible negative consequences of risk	– insurance; – attraction of co-investors.

Source: summarized by authors based on (Koroliuk, 2017)

Table 44 – Principles of risk management of investment activities of the enterprise

Principle	Characteristics of the principle
1	2
risk awareness	the company does not seek to avoid any risks in its activities in principle, and works with a level of risk that allows to ensure the expected profitability
controllability	availability of projects with managed risks, with the ability to use various tools to neutralize them
compatibility	compatibility of the level of accepted risks with the level of profitability
comparability	comparison of the level of accepted risks with the financial capabilities of the enterprise
accounting	accounting for a temporary factor in risk management; compliance with the company's policy in relation to the level of acceptable risk
taking into account the possibility of risk transfer	projects with a level of risk above the standard, but only if the probable financial losses can be shared with contractors

Source: summarized by authors based on (Yarovenko, 2015)

Strategy 2. Diversification is the process by which an enterprise distributes money allocated to a particular asset class, such as inventories, to different categories of investments belonging to that asset class. Diversification with an emphasis on diversity allows for the distribution of assets. In a diversified investment portfolio, the yield on securities and stock prices will be different. Diversification reduces

(End of Table 39)

risk by combining investments that reduce the ratio of assets and is attractive to anyone who does not like risk and prefers a certain future rather than an uncertain one.

Table 45 – Methods of risk management of investment activities of the enterprise

Method	Peculiarities of using the method
1	2
Risk transfer	the ability to transfer risk from one company to another on a contractual basis
Risk retention	availability of reserve funds that can cover the negative effects of risk
Risk avoidance	refusal to conduct financial transactions related to risk

Source: summarized by authors based on (Koroliuk, 2016)

Strategy 3. Hedging is the purchase of a security to compensate for a potential loss on another investment. The purpose of hedging is to eliminate the uncertainty of future cash flows (both negative and positive), which will give a complete picture of future income and expenses arising in the process of financial or commercial activities (*Garmatii, 2019*). Main task of hedging – the transformation of risk from unpredictable forms to clearly defined. It aims to change the risk of interest rates, commodity and currency risks through derivative instruments.

Hedging aligns the incentives of managers with the interests of shareholders and increases their responsibility and self-awareness. Hedging improves the compensation of executive contracts and the evaluation of efficiency. Hedging helps to reduce the asymmetry of information between managers and shareholders about the source and extent of the risks faced by the company. Employees benefit from the practice of hedging because the security of their work is associated with the risk of bankruptcy (*Kolosivska et al., 2016*).

Individual investments can increase or decrease the price without any correlation with the market. This is a specific risk for an individual investment or a small group of investments. If a company has only one investment, its risk is extremely high. However, if the company has 15-30 investments, it “smoothes” its profits, reducing difference in portfolio returns. Hedging and insurance can provide additional ways to manage risk. In addition, hedging typically involves higher-risk speculative activities, such as short selling or investing in illiquid securities (*Hlushchevskii, 2017*).

Strategy 4. Investment evaluation. Even with the right distribution and diversification of assets, the choice of individual investment should be based on evaluation. Time estimates are a form of market timing for the investor. Valuation terms mean that the company has assets that provide a margin of safety. The required margin of safety will determine the probability of success of the enterprise. The greater the required margin of safety, the more likely it is above the average rate of return. Acquisition of investments without any, or even negative stocks, increases the probability of loss of investment capital. High-quality assets can be risky, and low-quality assets can be safe. It's just a question of the price they paid for them. Businesses should not try to stay ahead of the market and instead focus on buying assets at prices that will greatly increase the chances of a positive outcome for the company (*Boiko, 2017*).

Strategy 5. Investment restrictions. Investment limits can help a company ensure sufficient diversification of its investment portfolio and maintain an acceptable level of risk. Having a credit rating is an important condition of an open financial market and is used internationally: for regulatory purposes; when negotiating with the investor and raising funds and to improve the risk management systems of the investment environment. In determining its policy, the company may either accept the limits set by law or choose more restrictive limits. The recommended approach is to set one set of limits for all broad asset categories and then a separate set of limits for financial instruments (*Chuorina, 2014*).

Investment risks directly depend on changes in the investment climate, ie a set of economic, legal, financial, political and social factors. The investment climate is a complex market tool for optimizing the flow of investment. In order to determine the probability and amount of losses that characterize the magnitude (or degree) of risk, a risk assessment is performed. It is largely subjective and depends on the manager's ability to assess the situation and make decisions.

A step-by-step assessment of investment risks is determined for each stage of investment separately, and then they are summarized. The emphasis of risk assessment of investment activities of the enterprise is on the analysis of risk factors and uncertainty in development process (Table 46).

When assessing the effectiveness of investments, the calculation of the realized return on the portfolio and comparing the result with the selected baseline in this case is quantitative description of the behavior of the selected set of securities or any of the known stock bond indices (Standard & Poo's 500), published by leading consulting companies.

Global bond market indices include the Merrill Lynch Global Bond Index, Barclays Capital Aggregate Bond Index, and WorldBIG (*Holiubov, 2016*). Calculations require the conversion of future flows to the current

Table 46 – Advantages and disadvantages of methods for assessing the risks of investment activities of the enterprise

Risk assessment method	Advantages of the method	Disadvantages of the method
1	*2*	*3*
Expert evaluation	Possible with a lack of information	The views of expert analysts may differ from those of practitioners
SWOT analysis	Simplicity, determination of influencing factors	Lack of dynamics in time, analytical assessment
Method of analogies	Used to assess the risk of re-investment	Difficulties in finding such an investment project
Adjusting the discount rate	Easy to calculate	Do not take into account the probability of deviation from the result

Source: authors' development

period of time, but the calculations do not take into account the probability of deviation from the result, ie the degree of risk (Table 47).

Table 47 – Scientific approaches to risk assessment of investment activities of the enterprise

Approach	Qualitative	Quantitative
1	*2*	*3*
Methods	• building an event tree • construction of a fault tree • identification of hazard indicators • evaluation of points-factors	• decision tree • sensitivity analysis • script-based method • method of statistical approach • Monte Carlo method
Advantage	leads to a quantitative assessment, where the risk is assessed in value terms	simplicity of mathematical calculations
Drawback	complex processes of information processing and analysis	need for a large number of observations

Source: summarized by authors based on (Zaplitna, 2016)

The qualitative approach begins with identifying risks at the planning stage and is based on the need for preliminary research to

gather information before analyzing the actual risks. The essence of a qualitative approach is to study the possible causes of risk and various criteria that contribute to the dynamics of risk. After assessing the expected damage at the last stage of the analysis, measures are prepared to combat the identified risks. A quality approach uses subjective values and is closely linked to investment conditions.

Quantitative approach is a numerical measurement of the impact of changes in factors. Investment risk analysis is based on the application of mathematical statistics, probability theory and other mathematical tools. Quantitative assessment is characterized by the use of unbiased conclusions, requires the proper use of mathematical analytical tools and is based on statistical samples and time series (Table 48).

Table 48 – Quantitative methods for calculating the probability of risks of investment activities of the enterprise

Risk assessment method	Advantages of the method	Disadvantages of the method
1	*2*	*3*
Sensitivity analysis	• quick assessment • modeling of different ways of project development: from negative to positive	• insufficient consideration of the correlation coefficient • only possible scenario • analysis of changes in parameters independently of each other
Script-based method	• accounting for the correlation coefficient • study of possible project implementation options • taking into account the relati-onships between parameters	• inability to predict all possible options and parameters of the external environment • the need to select and process information for multiple forecasts • limited number of variables
Statistical approach	• accurate for a long period	• inaccurate for a long period
Monte Carlo method	• high accuracy, analysis of socially significant projects	• simulation requires software

Source: summarized by authors based on (Tymoshyk, 2019)

Risk assessment of investment activities of the enterprise is an important element of investment policy, regardless of the field of operation, effective implementation of which increases the profitability of

organization and its investment attractiveness and helps to successfully adapt to changes in the environment without significant losses. Telecommunications sector is particularly exposed to risks (Table 49).

Table 49 – Risks of the telecommunications industry of Ukraine

Risk	Impact
1	*2*
Uneven distribution of radio frequency resource between operators	Limiting opportunities for competition in the market
High tax burden	Reduction of net profit of companies
Restriction of subscribers' freedom	The complexity of changing the operator
High levels of concentration and market barriers	Abuse of dominant operators by their own market power

Source: authors' development

Today, market of communications and mobile communications in Ukraine is one of the most competitive and dynamic. By investing in the development of this industry, you can significantly expand not only their capabilities, but also increase the competitiveness of national economy.

The introduction of the 5G service in Ukraine is impossible without investment, so it is necessary to clearly assess the risks of investment activities (Table 50).

The introduction of 5G may require the purchase of a large number of frequencies, the cost of which, due to the low risk of testing mobile capabilities or investments, can pay off in decades. In order for the new technology to successfully focus on the path to consumers, it is necessary to create conditions for improving the country's economy, reducing the tax burden on the industry and its adaptation to European regulatory practices. For this purpose, several areas of investment by telecommunications companies are appropriate:

1. Crown Castle International. In order for all connected devices to work harmoniously, you need to create an infrastructure. Crown Castle International is a REIT that owns, operates and leases cellular towers and other wireless infrastructure. Tower and fiber network operators will be among the first beneficiaries of 5G, as telecommunications operators will improve network coverage and bandwidth. Crown Castle has a 3.5% dividend yield and is traded 22.3 times according to the FFO.

2. Amdocs Limited (DOX). Amdocs is a provider of customer experience solutions for customers in the telecommunications industry. Amdocs won the most innovative 5G strategy at Lighting Leading Lights

Table 50 – Risks of investment activity of the enterprises of telecommunication sphere

Risk	Examples
1	*2*
Economic and legal	– Bureaucratic obstacles in the development of 5G networks – Prohibition to transfer spectrum for use to third parties – Changes in the approach to the definition and regulation of universal services, which include broadband access – Unpredictable changes in the economy and legislation – Suspension of investments from abroad
Socio-political	– Changes in the bill "On electronic communications" – No license to implement 5G mobile communications – Complaints of the population about the quality of services provided
Technological	– Lack of frequencies for the introduction of 5G technology – Lack of technological and technical neutrality – Lack of geographic surveys of networks and data updates once a year – Lack of interaction between business and citizens with the regulator in electronic form
Financial	– Long payback period – Consequences of inflation and stock fluctuations – Occurrence of undesirable events in operational, administrative procedures – Tax increases – Market liquidity risk

Source: authors' development

2019, and the company recently acquired TTS Wireless to further expand its 5G capabilities. Amdocs has zero debt and ROE is about 14%. The share has a 5.4% return on shareholders (dividends + share repurchase) and is traded with 18 times the free cash flow.

3. Xilinx, Inc. (XLNX). Xilinx is a leader in programmable chips that position the company well in key growth areas such as artificial intelligence, cloud computing, autonomous driving and the Internet of Things. In recent years, the company has increased R&D spending to position itself as a stable player in 5G communications. The stock fell more than 30% from its highest time in the spring. Management has issued conservative guidelines for next year, which have lowered expectations and created a better entry point for new investors. Operating margin fluctuates around 30%, and stock trading with 22 times free cash flow with a 5.6% return on shareholders.

4. Qualcomm (QCOM). Qualcomm manufactures digital wireless equipment and is the market leader in wireless chips. Qualcomm should benefit from a richer set of 5G phones and pricing, while most connected devices should lead to increased license sales. In early 2020, the company signed a multi-year agreement to supply chipsets with Apple, confirming Qualcomm's leadership in 5G modems. Qualcomm is highly profitable with an operating margin of 35% and a ROIC of 40%. Shares are traded at 16 times the free cash flow with a 5.0% return on shareholders.

5. Verizon Communications (VZ). Verizon is an integrated telecommunications company that now relies heavily on radio communications (70% of revenue). Verizon is focused primarily on 5G to ensure further growth. Multilevel pricing settings should increase the average revenue per user. Moreover, the potential for wireless connectivity for businesses from the development of industrial use is one of Verizon's greatest 5G capabilities.

Investment risks influence the choice of risk management strategy in order to achieve effective investment activities. The era of 5G is just beginning, so now is a great time to invest in 5G with the least risk and high return, without waiting for further development. Despite the fact that Ukraine does not yet have full coverage, the transition to 5G is inevitable. Even if operators delay 5G investments, they will need to increase infrastructure costs to cope with rising traffic.

Perhaps that is why Ukraine's telecom industry leaders are behaving much more frugally during this first phase of 5G deployment than in 4G. The BIS Research industry intelligence report "Global 5G Infrastructure Market – Analysis and Forecast 2019–2025" (*BISresearch, 2020*) shows that global 5G infrastructure market will grow by more than $ 42 billion by 2025. The market, which is projected to be estimated at $ 2.55 billion in 2020, is expected to grow at a CAGR of 75.09% over the period. Ukraine risks lagging behind other countries in the deployment of 5G mobile services due to strict regulation and weak investment.

Many elements of 5G technology are built in 4G networks, ie mobile operators can use an evolutionary approach to infrastructure investment. Yes, operators can start by upgrading the capacity of an existing 4G macro network by re-equipping part of their 2G and 3G spectrum or purchasing additional spectrum when they exist.

Thus, they can delay investment in 5G by evolving to LTE and LTE-Pro features. Although each technology cycle brings greater opportunities to mobile operators, it also requires greater investment in infrastructure. To get the most out of 5G, they need to understand how the network infrastructure and associated cost base will evolve over the next few years to develop an investment strategy that best meets their unique needs.

In the long run, 5G will be one of key technologies already known as the “Fourth Industrial Revolution”. By 2035, the IHS Markit study shows full global economic impact of 5G: goods and services worth about $ 12.3 trillion, will create about 22 million jobs. The network will add a staggering $ 3 trillion to global GDP. So, as a long-term investment, 5G technology is one of the safest bets you can make.

Investing in new technologies is an opportunity to become a market leader and realize significant benefits. The choice of investment project is a compromise between trying to make a profit and taking into account its risks in conditions of economic uncertainty. Unjustified risk can lead to loss of capital and market position, and in the worst case to bankruptcy.

The investment activity of telecommunication enterprises is focused on the introduction of technological innovations and the development of ICT, which is provided on the basis of continuous research activities. Financial support of investment activities is due to the accumulation of depreciation and net profit, the implementation of capital accumulation policy and the expansion of the reproduction of the resource base for future economic benefits (*Mashlii, 2017*). We propose to consider the risks of investment activities at two levels (Table 51).

Table 51 – Characteristics of risk levels of investment activity

Telecommunication level	Local level
1	***2***
price dumping by main share of participants in the telecommunications market of Ukraine until 2018	the need to simultaneously make significant investments both in increasing capacity and in developing the technical level of the communication network
divergent actions of the authorities in legal field of telecommunications of Ukraine	lack of a clear investment policy for capital investment
impossibility of business planning, due to strong variability of macroeconomic indicators, instability of the hryvnia	the dominance of self-financing policy with small amounts of own sources of financial support for investment activities

Source: authors' development

Depending on the investment risk, you should choose the appropriate management strategy:

1. Risk transfer – assigning responsibility for risk to a third party, such as an insurance company (risk insurance).

2. Risk conservation – the risk still needs to be controlled, but no mitigation measures are in place.

3. Risk reduction – control of risk through actions that reduce the likelihood of risk or minimize its impact before it occurs.

4. Cessation of risk – changes in processes to completely eliminate the risk.

One of the basic problems of investment activity of telecommunication enterprises is the limited financial resources for investment, which is due to low income from service users, main reason for which is low effective demand in Ukraine and fierce price competition, where the tool of survival for a long time was lower prices.

These problems negatively affect the rate of penetration and spread of new generations of ICT in Ukraine compared to developed countries. Ukrainian telecommunications companies are unable to provide sufficient and timely investment. This creates the preconditions for reducing the efficiency of investment activities due to the "failure" effect in the implementation of previously technologically advanced solutions.

The experience of Ukrainian telecommunications companies shows that insufficient investment in the development of operating activities leads to the formation of the so-called technological lag, which threatens very existence of such enterprises in the market. In order to avoid such a scenario, the implementation of investment activities requires the main emphasis on the choice of investment areas.

The directions of investments accepted for realization should be able to provide not only modernization of a telecommunication network, but also to create a basis of its further perspective development taking into account rapidly growing needs in information transfer. It is important to study the international experience of operating and investment activities of telecommunications companies.

Investment projects should not be aimed at supporting their own current activities and solvency, but at large-scale modernization of the communication network and the development of ICT in general. The formation of financial support for investment activities at their own expense provides the least risk. However, such a policy slows down the pace of business development, as the real potential to raise funds in financial market is not used. This limits the broadening of the basis for future economic benefits.

At the same time, raising funds requires timeliness, because in the event of a technological lag, it will be difficult to provide financing for investment activities at the appropriate level, even with active raising funds, because the pace of technological cycles in telecommunications is constantly growing.

The introduction of the latest technologies by Ukrainian telecommunications companies is somewhat delayed compared to foreign ones. The world experience of telecommunication companies in the implementation of innovative technologies (*Verkholiak, 2018*) is the basis that will determine the further directions of development of operational activities and, accordingly, the directions and objects of their investment activities:

1. Development of the network in the direction of formation of technical and technological base for further differentiation of services provided by telecommunications companies and Internet of Things by combining different network standards.

2. Introduction of business models that provide targeted investment in network development to create opportunities for the implementation of range scenarios to meet customer demand, which is constantly changing under the influence of ICT development and expanding geographical presence of the telecommunications company.

The formulated directions will be implemented in the strategies of telecommunication enterprises, the segmentation of which depends on digital maturity of the enterprise. Main components of the strategy of telecommunications companies are the geographical scale, the level of digital ambitions and the contrast of growth priorities, maneuverability, organizational transformations to improve interaction with customers, the formation and regulation of their needs, product simplification.

As the telecommunications sector becomes more complex, it is necessary to balance investment directions. On the one hand, selective business models will allow you to implement targeted strategies and support targeted investments. On the other hand, the preparation of range scenarios in demand with certain levels of service and personalization will be crucial, as customer needs have a strong influence in the digital world.

One of the areas related to solving the problems of efficiency of investment management is the use of new tools for the formation of financial security, which have the availability and ability to determine the economic value of both individual investment decisions and the telecommunications company as a whole.

In addition, there is an urgent need to improve the practice of investment management, which is impossible without further development of the methodological basis for the formation of information and analytical support, organization, analysis, planning and implementation of investment activities, assessing the economic value of investment activities and monitoring.

General structure of investment risk management of telecommunications enterprises should be based on the life cycle of investment projects. Each stage of which is characterized by clear

results, their analysis and decision-making for the next stage. The progress of the investment project requires specific methods of work and adequate principles under a systematic approach.

In order to reduce uncertainty and minimize investment risks, it is necessary to exercise control during the implementation of each stage of the project with the possibility of correlation of management decisions after each stage. At each stage of the investment project implementation, it is necessary to implement such processes as initialization, planning, execution and closure, with the condition of control after each process.

Awareness of risks and an open culture for managing them will strengthen discipline and control, explain the difference between risk avoidance and acceptance, improve risk quantification tools, increase risk management responsibilities and facilitate timely detection of changes in the investment risk profile. Investment risk management can be improved by implementing the following proposals:

1. Focus on the goals and participants of the investment project. Investment risk management as a way to manage the expectations of investment project participants requires the company's management to change attention from assessing the actual results (plan, budget, etc.) to more active management of expectations of all investment project participants. Careful analysis of which should be the first step in the process of investment risk management. The main purpose of all investment risk management measures is to promote the implementation of organizational goals. Investment projects should reflect management's choice of the specific value they want to create for all participants in the investment project. The assessment of investment risks should be aimed at assessing the probability and extent of achieving the objectives.

2. Comprehensive risk assessment. The assessment of investment risks of the enterprise should not be one-sided. The analysis should include issues that may help achieve business goals (opportunities) and those that potentially hinder the achievement of goals (risks). The company's top management must coordinate risk management (events that may occur) and incident management (events that have occurred). Management must be convinced of the need for a proactive, comprehensive approach to both risks and incidents to ensure that business controls are in place.

3. Focus on opportunities. Analysis of investment risks of the enterprise should provide a balanced view of the future. Senior managers should prevent support functions from considering risk mitigation as a critical strategy. It is necessary to move to preventive control and better ways to overcome the risks than just strengthening control. Reviews of investment projects and their plans should be organized to establish the reliability of the existing control system to achieve these goals. Managers

should be encouraged to take advantage of risk management experts and internal auditors. The introduction of new business opportunities should be supported by a discussion of the risks associated with predicting often-promised results.

4. Generalization of risks. The management of a telecommunications company should require a single integrated report, thus expecting that many functions that provide this information will work together. The aim should be to form a common idea of how much the goals of investment activity have been achieved in the previous period and how much they are expected in the next period. Management should insist that those who provide information use modern tools and methods to analyze available business data. They should monitor the effectiveness of the control system and use continuous monitoring to identify irregularities and negative trends in a timely manner and to develop sound measures to minimize investment risks.

5. Detailing of risk management processes. Organizational leaders of the enterprise must insist on the existence of clear rules for the implementation of investment policy, which can actually be implemented in practice. The level of detail of these rules depends on such factors as management philosophy, maturity of business processes, industry practice, legal requirements. The activities of employees at each stage of the investment project must be complementary and clearly coordinated. If the company's management wants the rules to be taken seriously, it must be demonstrated that the violations must be appropriate.

The implementation of these changes will provide a strategic approach to investment risk management of the enterprise by expanding its application to all valuable sources, not just physical and financial. This approach provides effective reduction of investment risk and response to it, emphasizing the reduction of income volatility and minimizing the risk of uncertainty. In compliance with these recommendations, investment activity will be of strategic importance not only for the development of its own economic activity, but also for the development of ICT in Ukraine, its entry into the global information space.

Practical application of these proposals will help raise the management of investment risks of the enterprise to a higher level and will improve the ability to manage them in a business environment and the existing uncertainty. Continuous improvements in investment risk management will enable companies to accelerate their response to investment risks, reduce operating losses, provide integrated responses to interrelated risks, identify risks at their inception stage and improve capital utilization. Moreover, effective investment risk management, consistent with the pace of market changes, protects the reputation and image of enterprises and promotes confidence in the future.

CHAPTER FIFTH DIGITAL BACKWATERS OF THE ECONOMY: SOURCES OF NON LINEAR INNOVATION AND DIGITAL POWER

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5.1. The play of economic energies with the digital memory of business: a course on synergistic effects

Given the existing scientific developments in the field of knowledge of network economics, unexplored are the qualitative transformation of network relationships, new conditions for the formation of innovation-digital clusters and cooperation of clusters in virtual reality, in order to obtain a synergistic effect based on innovative changes in activities at all levels of economic aggregation in the direction of the formation of Industry 4.0.

The practical side of universal functions is not fully disclosed, which are inherent in all subjects of cluster formations, namely: regulatory; integrative; broadcasting; communicative (this feature has its own feature – informal communication); consolidation and reproduction of public relations on the basis of virtual-real network interconnections.

The era of network economy, which manifested itself in the transition to third millennium, affected all aspects of economic and social life. Global development of the network economy can be seen as expanding the base of post-industrial society. This allows us to confidently characterize the processes taking place in global economy and world community as a manifestation of a “paradigm shift”.

Modern civilization is characterized by a sharp increase in the dynamism of socio-economic spheres of life and the growth of risks, uncertainty in the development of all aspects of society, the formation of virtual reality. This state of affairs in the world is called the “era of turbulence”.

Institutionally, the complication of the formation of both network and innovation, digital, virtual economies is associated with the emergence of a new method of coordination and harmonization of interests. Thus, in the industrial age (industrial paradigm) the world community was based on two ways of coordination:

• Hierarchical order with a system of vertical subordination and a center of administrative management (rigid model of coordination);

• Market system with price signals, as some deviation from the rigid and clear hierarchy (flexible, but quite atomistic).

The post-industrial paradigm is characterized by a non-hierarchical order or the so-called network coordination mechanism. World economy and all its subsystems are stratified into cluster-network structures with horizontal connections and collaboration mechanism (hybrid model – flexible and integrated at the same time).

In recent decades, the idea of creating clusters based on networking and quality cooperation within this type of entity, has found its application in virtually all countries, including not only the EU, USA, Japan, but also South America, Eastern Europe, Africa. Today, the cluster model, filled with quality network connections, is characterized by a high synergy effect and is one of the most effective forms of achieving competitive advantage.

The concepts of creating clusters are quite diverse. In Canada, Spain, Germany – this is an innovation system; in Austria, Belgium, the Netherlands, Norway, the USA, Switzerland – production and innovation networks and their interaction on the basis of cooperation; in Denmark – resource zones; in Italy, Finland – intersectoral flows of knowledge; in the UK – regional innovation systems.

Creation and consolidation of such development institutions through government programs specific to Argentina, Chile, and Canada. Effective functioning of network platforms is typical of Belgium, France, South Africa, Switzerland (through the interaction of research centers), Colombia, Poland, Portugal, Argentina, Australia, Germany (through public-private partnership), Denmark, Spain (interaction within industries networks). Internationalization based on the program of competitiveness clusters is inherent in the economies of Japan, Ireland, and Austria. The process of knowledge-based clustering is observed in Israel, Great Britain, Germany, Ireland, Finland, Estonia, Spain, the Czech Republic, Austria, Poland (*OECD, 2014; OECD, 2012*).

In Ukraine, economic network cluster formation occurs mainly spontaneously, under the influence of market forces. This influence is quite natural, but its theoretical and methodological and applied aspects are not fully realized. The theory of management of such formations, regulation of the process of their creation and functioning has not been properly developed in the economic science and practice of Ukraine, and unadopted application of foreign experience doesn't provide desired effect in the socio-economic and institutional conditions of the country.

Current institutional structure of Ukraine's economy does not meet new challenges of economic transformation due to significant systemic contradictions caused by low adaptation to modern market realities of institutions, as well as weak ability to actively participate in the reproduction process of institutions generated by transformational change (*Holian, 2006*).

Names of foreign scientists (*Boudeville, 1966; Boshchma, 2005; Richardson, 1973; Richardson, 1974; Porter, 2005; Perroux, 1950, 1967; Spilling, 2006; Winter, 1984*) are connected with the study of general aspects of structural restructuring and complex modernization of the economy in the direction of its regional network and innovative clustering.

Well-known researchers (*Andriichuk, 2010; Androschuk et al., 2009; Britchenko et al., 2019; Deliia, 2011; Dombrovskyi, 2011; Zhdanova, 2008; Karetin, 2009; Kraus et al., 2019[b]; Kraus et al., 2018; Kryvoruchko et al., 2018; Lukianenko, 2008; Napolskikh, 2012; Pishulin, 2020; Odyagailo, 2006; Ratner et al., 2011; Tatarkin, 2011; Togunov, 2009; Tishchenko, 2010; Usov, 2009; Kraus et al., 2021[c]; Fedorov et al., 2010*) have dealt with the formation of virtual reality in the world, innovative modernization, its strategic guidelines and mechanisms for their implementation, structural modeling of the institutional environment of the innovation cluster, self-organization as a new methodology for studying economic systems, economic development of regions (*Zaremskyi, 2010; Ivanov, 2013*), were engaged in the development and implementation of the cluster strategy of innovative development of regions in the context of global economy, clarification of social context of innovative development. But many issues, such as the formation of clusters in virtual reality and the formation of a quality network economy in global digital space, the development of network relationships and cooperation remain insufficiently disclosed.

The work of NAAS academics is devoted to theoretical principles of clustering (*Sabluk et al., 2010*), foreign researchers (*Enright, 1992; Cappellin, 2003; Cappellin, 2007; Cooke, 2006; Cooke et al., 2006; Rallet et al., 2001; Owen-Smith et al., 2004; Lagendijk et al., 2005*). Another researcher proposed a conceptual approach to cluster organization, substantiated the conditions for the formation and effective functioning of clusters (*Kropyvko, 2010*). In a number of scientific papers (*Mazniev, 2015; OESD, 2003; Cooke, 2006; Cooke et al., 2006*) in different periods it was argued that cluster theory in modern conditions is developing not only on the theory of competitive advantage, but also using the achievements of synergetics, logistics, homeostatics and other scientific concepts.

But many issues, such as the formation of clusters in virtual reality and the formation of a quality network economy in general within global digital space, the development of network relationships and cooperation remain insufficiently disclosed. Based on the generalization of literature sources, experience and own research, based on system-synergetic positions and using a logistical approach, we aim to offer the author's vision of achieving in virtual reality to achieve synergy through network interaction in clusters. To present a visualization of the model of creation and effective functioning of innovation clusters.

In order to form an innovative cluster complex on the basis of the cluster approach, it is necessary to first of all consider the existing methodological approaches to cluster identification proposed by foreign and domestic scientists. The most well-known should be considered the methodology for the allocation of clusters (*Porter, 2005*), which includes three stages:

• The composition of the cluster is determined, namely: first, the core of the cluster is detected – a large company or group of similar; secondly, there is a building of vertical links between the core and related companies; third, main horizontal relationships are formed relative to the core of the cluster, for this purpose, the production involved through common channels or those that create by-products or services are identified; and on the basis of determining the use of common factors of production, supply, technology, etc., additional horizontal links are established;

• The composition of organizations within the cluster that provide specialized services, technologies, information, capital, infrastructure is determined;

• Power structures, legislative institutions that have an impact on the activities of the cluster are identified.

Michael Porter also developed the so-called "competitive diamond" or "diamond" to determine national preferences.

We share the conceptual approaches of researches to the basic features of clusters and their typification (*Fedorenko et al., 2008*). These methods contain only a qualitative analysis of the preconditions for the formation of an industrial complex based on a cluster approach. A number of domestic researchers suggest the use of quantitative analysis to determine the directions of cluster formation. One of such directions is the calculation of coefficients of localization and specialization of regions (*Dlugopolskyi, 2003*).

Another analytical approach to cluster identification (*Tarasova, 2007*) is based on the calculation of coefficients that are divided into groups. In particular, the level of specialization of the region's economy, the level of

development of small and medium enterprises, the level of development of investment activities, the level of imports (exports) in the region's economy.

In our opinion, for the formation of networks of innovation clusters it is most appropriate to apply an approach that uses a comprehensive assessment. In addition, at the present stage of development of innovation clusters it is necessary to apply an approach that can not only take into account the sectoral characteristics of operating activities, but also their impact on the formation of market segments of national economy and the interests of all participants.

The representative of the institutional-sociological school in France, economist Fransua Perroux in 1950 proposed the theory of growth poles (*Perroux, 1950; Perroux, 1967*), which is based on the idea of the leading role of the sectoral structure of the economy and, above all, the leading industries that create new goods and services. According to him, all economic entities are unequal at the initial stage of relations, connected by subcontracting relations, which are formed naturally. Once in a polarized space, a networked firm must take into account direct and indirect coercion from the dominant unit, that is, economic units no longer behave as interdependent partners, but as part of a single system, a network.

Jean-Francois Perrault proved that the formation of poles of economic growth occurs in the locations of enterprises of dynamically developing industries. Such industries become the "poles of attraction" of factors of production, which leads to the emergence and growth of industrial centers, the emergence of a synergistic effect of network interconnections. This theory laid the foundations of regional programs in many countries around the world on the basis of network cooperation.

The ideas of Jean-Francois Perrault were developed by the French scientist Jake Budeville (*Boudeville, 1966*). He gave a regional aspect to the economic category of "growth poles", distinguishing three types of economic spaces: homogeneous, polarized, planned. The underdeveloped territory has a homogeneous appearance of space, but during the development of network connections the space inevitably becomes polarized.

For Jake Budeville, not every regional center is a pole of growth, but only one in which propulsive industries have developed. This theory of economic development of the region determines the search for industries that will give impetus to the development of the entire regional system with its network connections. In his research, the scientist showed that the poles of growth can be considered not only a set of leading industries, but also specific areas (settlements), which perform in country's economy as a source of innovation and progress.

Scientific works of English researcher Henri Richardson (*Richardson, 1973; Richardson, 1974*) are devoted to the ideas of the formation of accumulated cities, which become large industrial centers, a kind of poles of growth. This stimulates technical progress and productivity growth, has a significant impact on network processes, the location of enterprises. In addition to the energy effect of the agglomeration and the personal preferences and preferences of investors, key elements of regional growth in the model of Henri Richardson are technical progress and socio-political component.

In essence, Henri Richardson's model realizes the same functional relationships that are characteristic of models of the neoclassical school between the rate of growth and the rate of capital accumulation, increasing labor supply and the speed of technological progress. The functions of the studied model depend on the effect of agglomeration, the advantages of localization, networking and branching of cooperation, the difference in factor prices in the region and in the country as a whole, other features of the regions (*Richardson, 1974*).

American economist Sidney Winter (*Winter, 1984*) in his research identified two technological modes in which an innovative company operates, namely: routine and entrepreneurial. Entrepreneurial regime is characterized by high technological capabilities – investment in innovation can lead to tangible success. At the same time, this success is not guaranteed. The regime is characterized by a significant variety of ideas and a large network of firms operating in it (medium, small), which are based on more applied and hidden knowledge than on the results of research protected by patents. The entrepreneurial regime is characterized by a low level of cumulativeness, main type of evolution is an industry or cluster, and main metaphor is "expansion".

In a routine mode, main actors are large firms. Technological opportunities in it are small, but at the same time there is a high probability of incremental innovations as a result of research. The mode is characterized by high cumulative qualities, due to which the barriers to entry are quite high. Patents that protect the results of scientific developments are an important condition for the assignment of innovative rent. Knowledge in a routine mode is highly specific and less accessible. Main type of cluster (or branch) evolution is "creative accumulation", and main metaphor is "deepening" (*Panyushkin, 2011; Spilling, 2006*). In his work "Open innovations. Creating Profitable Technologies" (*Kraus et al., 2021*[c]). Professor Henry Chesbrough of the University of California proposed a paradigm of closed and open innovation. He calls new approaches to effective innovation "open innovation", understanding that in managing innovation processes,

organizations should not be “closed” in the internal environment, it is necessary to build network relationships and interact. Comparing the features of innovation, which is carried out on the principles of openness and closedness, the scientist demonstrates the contrast of old and new approaches to the development and implementation of innovations.

Along with a comparative description of the old foundations and new, including network, approaches to the implementation of innovations, Henry Chesbrough provides a scheme of open and closed innovations, which has become world famous. Author uses the tunnel to describe the innovation process, the continuous and intermittent boundaries of which clearly demonstrate the essence of yesterday’s and today’s foundations of open networking.

According to the author, today business enters a new stage of innovation, when the sources of innovation potential of companies are outside them, lie in the plane of synergetic effects as a result of network cooperation (*Kraus et al., 2021c; Trifilova, 2008*). Open innovations are a new structure of organization of innovation processes, moving them abroad into an open, free field of high technology transfers through network interactions, new organizational forms of integration of knowledge-intensive commercialized technologies to work in global markets (*Fedorov et al., 2010*).

Exploring the models of open and closed innovations, Henry Chesbrough paid special attention to the following question: How without the help of central laboratories of industrial enterprises (which were key to innovation in the past) is the diffusion of technologies suppliers, consumers, industry consortia? Closing itself in the internal environment, not being a member of network formations, the company spends only its resources, duplicating innovative developments. Hiding the results of research, organizations do not make a profit, unlike those companies that allow other businesses to use their own technology.

Unused innovations lose their appeal and relevance over time. Henry Chesbrough calls the principle extended to the period of closed innovations (when companies preferred to “put” unused technologies on the “shelf”) “naphthalene”. In his opinion, today it is impossible to treat the ideas and people who created them as “warehouse stocks of the company”. The big risk threatens those who postpone the implementation of developments “until better times for business” and is that they can once and for all lose people and innovative ideas that they have developed for the company (*Trifilova, 2008*).

Having studied entropy (from the Greek – “turn”, “transformation”) as a tool for analyzing innovation and considering through the prism of entropy to predict its effectiveness, professor Leonid Usov proposed

his concept (*Usov, 2009*). The entropy of stability of production systems should show main consequences of economic activity. In this sense, Leonid Usov understands changes in the entropy of production systems as main criterion of network efficiency of innovation. He pointed to three qualities of entropy as a tool for analyzing innovation, namely: in closed systems, entropy is constantly increasing; increasing entropy means eliminating differences; the more freedom, the greater the entropy.

These qualities of entropy partially reveal the paradigms of closed and open innovations Henry Chesbrough. According to the concept of Leonid Usov, in an open system, which is filled with network connections, there is, first, its own entropy, which, as in closed systems, always grows. Second, entropy penetrates an open system from the environment (imported entropy). Third, from the open system entropy moves to the external environment, where high-quality inter-corporate relationships are very valuable and bring increased profits (*Usov, 2009*).

Examining genesis of the formation of the theory of innovation, one cannot ignore the emergence of the theory of self-organization and synergetics (*Kraus et al., 2021*[c]). According to the theory of self-organization, innovation-digital activity is provided only under the condition of high flexibility of structure in modern conditions of virtual reality. For this reason, the self-organization of the network economy system begins with the formation of a structure in which each source of external impulses corresponds to an element that generates internal innovation and digital products/services. At the next stage, the system evolves in the direction of a more orderly state, which is achieved under the influence of the struggle for existence. An additional hierarchical level is formed, at which the feedback loop with the external environment is closed (*Deliia, 2011*).

The triple helix model of the professor Henri Etzkowitz's of Stanford University is an example of a harmonious combination of organization and self-organization in innovation processes in network systems. The state, by determining the "rules of the game" of economic entities, supporting institutional transformations, exerts influence on the innovation process. "Business, academic universities and institutes, interacting with each other in the process of generation and commercialization of innovations, show an example of self-organization" (*Erokhina, 2011*).

Institutional transformations form a "critical mass" in public opinion to understand the need for large-scale modernization of social order in the direction of network economy or its important subsystems, and especially innovation (*Tatarkin, 2011*). Modernization is an ongoing process of expanding the opportunities of socio-economic and general social development using new and updated institutions and

forms (relationships) between actors, including network. This type of modernization is called and qualified as institutional (point, local, limited), which is a prerequisite for bringing macroeconomic and other non-modernized institutions and forms in line with needs of a particular stage of social development.

Complex and systemic nature of modernization provides a consistent solution to problems of socio-economic development that hinder the formation of network economy in Ukraine. Modernization of the economy will not be effective and incomplete without changes in political, social and environmental spheres. You can increase and develop innovative developments as much as you want, but if you do not create an innovative network environment, the effect of innovation will be other countries where this environment is formed and operates (*Tatarkin, 2011*).

The resumption of economic growth, which is being pursued in power structures and production circles, now requires active mastery of its national innovative path of development. Ensuring the transition to an innovative type of development is a prerequisite for preserving the economic and political sovereignty of Ukraine. It is generally accepted that an economy characterized by a high level of resource and energy consumption of its products, which is typical for Ukraine, even without the influence of external factors is doomed to gradually deplete the reserves of extensive growth and further increase the threat of economic depression. Therefore, the implementation of the synergetic effect of innovative development, based on network cooperation, becomes for Ukraine only way to reduce technological and economic lag behind developed countries (*Andriichuk, 2010*).

The process of economic agglomeration of interconnected enterprises in a separate territory has been known since the time of handicraft production. Beginning in the 1980's, it received a new impetus in the form of the development of network formations, clusters, as an important factor in the economic growth of the region. It can be stated that regions where clusters are emerging are becoming leaders in economic growth. Such leading regions determine the competitiveness not only of regions but also of national economy. The increase in research in this area suggests that geographical proximity of the relevant economic areas contributes to a higher level of capital use and innovation. Development institutions, which are in direct contact with end users, suppliers, research laboratories, educational institutions, form important factors in the development of regional and national economies (*Karetin, 2009*).

Network economics is a form of information and communication in digital economy. Network Economy is an economy in which activities are

carried out through electronic networks. The basis of network economy – network entities, organizations. However, network economy creates an environment in which any business entity or individual, no matter where he is in the economic system, has been able to communicate easily and at minimal cost with any other company or individual with about working together, exchanging ideas, trade issues, or know-how, or just for fun.

The formation of network society and network economy (mesh economy) lies in the plane of the emergence of new more flexible means of managing companies and communities, complemented by the development of network technologies and spread of solutions based on blockchain technology (chain of transaction blocks). Network company provides for the elimination of various intermediaries in the registration or accounting of property rights to any property, as well as in the conclusion of any agreements with tangible or intangible assets. This leads to colossal changes in the state and corporate bureaucracy, as well as to full-scale democratization of financial sector (*Pishulin, 2020*).

From the point of view of the institutional-network approach, cluster is a new form of organization – heterarchy, which has no pronounced hierarchical features, is only partially market and is characterized by organizational heterogeneity. Such structure is a network that operates on the basis of institutional mechanisms of coordination and cooperation. Its formation presupposes stable connections between participants due to various reasons, including both geographical proximity and the presence of institutions, the interaction with which is not always, and in some cases partially regulated by the market (*Tishchenko, 2010*).

Among key factors that shape the institutional environment of the territory are: improving regional and municipal regulatory framework for innovation policy; investment and economic climate and image of the region; efficiency of the system of regional and local government bodies, competence of the management; mentality of the population, innovative culture of entrepreneurs, traditions and habits of the local scientific community; the level of development of informal development institutions, communication channels and innovative, digital virtual-real platforms for cooperation (*Napolskikh, 2012; Kryvoruchko et al., 2018*).

Clusters were studied in detail by Michael Porter in the 1980's. The approach used by the scientist is called the classical liberal or Anglo-Saxon approach. This approach is based on the self-organization of economic agents within the mechanisms of free market in the absence of direct state intervention. Modern European approach emerged in France in 2008 and is called "pole of competitiveness" and is based on a partnership of business, central and local government. The government is a stakeholder in global competitiveness of the whole country and the

achievement of “pole of competitiveness” of the world level, which is expressed in various forms of state support (*Napolskikh, 2012*).

Michael Porter’s research attention is objectively focused on the phenomenon of “cluster”, as a group of geographically close interconnected companies and connected, through different types of networks, organizations with them, operating in a particular area and characterized by common activities and complementarity. The cluster, as a new model of enterprise integration, allows to obtain competitive advantages from a combination of such factors as: geographical location, interaction, specialization, innovation, networking. According to Michael Porter: “Clusters use important connections, complementarity of industries, dissemination of technologies, experience, information, marketing better than industries… Cluster is not a technology park, not a business incubator, not an industrial park and not a free economic zone – it would not be correct to say that a cluster is a territorial production complex or a research and production association. However, the elements of infrastructure that exist today, or newly created elements of infrastructure, can be part of clusters…” (*Porter, 2005*).

Nowadays, there are many approaches to understanding the essence of cluster. We agree with the opinion of Russian scientist Serhii Karetin, who emphasizes that clusters are concentrated by geographical groups of interconnected companies, specialized service providers, firms in relevant fields, as well as organizations related to their activities (universities, standardization agencies, trade associations) in certain industries that compete but carry out their work (*Karetin, 2009*).

In our opinion, it should be added to the above definition that innovation clusters are vertically integrated structures that are designed to produce competitive innovative products, using the unrealized internal potential of the region, ensuring the connection of production with the spread of new technologies and innovations.

Economic relationships within the cluster create new opportunities for production development, its innovative renewal. Enterprises in the cluster in the process of interaction and “convergence” of interests gradually overcome disunity, inertia and isolation on internal problems, which positively affects the growth of their technical level and competitiveness of products (*Zhdanova, 2008*). This allows the cluster to obtain a potential that exceeds the sum of potentials of individual structural components (economic agents) and allows innovation enterprises to stably carry out digital, investment and innovation activities (*Tishchenko, 2010*).

Modern clusters, uniting a significant number of formally independent enterprises and social institutions, act as a single economic entity. Clusters are an environment for the formation of an innovative approach

to public and corporate governance. The purpose of the state cluster innovation policy should be to increase competitiveness of territorial economic system, and competitiveness factors – components of the so-called "Cluster Complex" – "4C" (by analogy with the "Marketing Complex" – "4P") (*Napolskikh, 2012*).

Foreign scientist Dmytro Napolskykh to the "Cluster Complex" – "4C" refers concentration, competition, cooperation, competitiveness. Another foreign researcher Timur Gareev proposes to consider the cluster complex through its five typical characteristics and accordingly calls it as "5C", namely:

• Concentration (geographical concentration of organizations that form cluster portfolio);

• Competition (competitive basis of general type of economic activity and competition between firms, ie the creation of a dynamic network of domestic markets of suppliers);

• Cooperation of firms horizontally and vertically and the formation of specialized economic and market infrastructure around the cooperative firms;

• Communication (information, including advertising strategy) common with the external environment;

• Competence of human capital in portfolio sphere of the cluster.

Ukrainian scientist Borys Odiagailo points to such institutional bases of cluster relations as: socialization, collectivism, alienation, mediation, measure of usefulness, measure of value, level of networking, measure of trust (*Odyagailo, 2006*).

Based on classic features of the cluster according to Michael Porter, we can talk about the cluster as a group of geographically localized interdependent companies, equipment suppliers, components, specialized services, infrastructure, research institutes, higher education institutions (HEIs) and other organizations that complement each other and strengthen the competitive advantages of individual companies and the cluster as a whole. A cluster is a group of organizations (companies, enterprises, infrastructure facilities, research institutes, free economic zones) related to the relationship of territorial proximity and functional dependence in the field of production and consumption of resources.

The Swedish scientist Ron Boschma pays special attention to the understanding of "territorial (geographical) proximity" in the study of clusters in his research (*Boschma, 2005*). He argues that it is important to distinguish between forms of proximity in the functioning of economic systems. Geographical proximity, in his opinion, is not a specific form. Researcher proved that there are problems of "excessive"

proximity, which are expressed in the form of various blockages and can hinder innovation. Ron Boshchma considers geographical proximity as a complementary factor in the formation of institutional, social, organizational and cognitive proximity (Table 52).

Table 52 – Analysis of forms of "intimacy" by Ron Boschme

Forms of "intimacy"	Dimension	Intimacy insufficiency	Excess intimacy	Workarounds
1	*2*	*3*	*4*	*5*
Institutional	Institute-based trust	Opportunism	Locking and inertia	Institutional audit and balancing
Organizational	Control		Bureaucracy	Systems with "weak" relationships
Social	Social-based trust		Lack of economic justification	Mixing "en-enered" and market relations
Cognitive	"Gap" in knowledge	Misunder-standing	Lack of sources of novelty	Knowledge base with different but complimentary features
Geographical	Distance	No spatial external effects	Lack of geographical openness	Change local and internal links

Source: Boschma, 2005

Scientist, analyzing the role of institutional factors, considers it as a set of social, organizational and directly institutional forms of "intimacy" (*Boschma, 2005*). In addition, we believe that the COVID-19 pandemic has provoked new challenges for business and demonstrated the importance of the ability to work in augmented and virtual reality, to digitize business activities. Thus, we interpret virtual reality as a space between reality and virtuality, between which there is augmented reality (closer to reality) and augmented virtuality (closer to virtuality). We believe that virtual reality of the multiplayer world is based on the exchange of virtual goods within the on-line environment. It creates an opportunity to interact with the artificial world with the help of virtual platforms with the available information funds of the on-line innovation market, the ability to work with cloud technologies. Augmented reality as a component of mixed reality is a combination of virtual and real

spaces through hardware and software, telecommunications, computer networks, and actually shaping digital economy.

We consider innovation-digital cluster as a voluntary informal, institutionalized association of economic entities in terms of their not only territorial proximity, but also virtual-real "proximity", sectoral similarity and cultural-mental unity in order to obtaining a synergetic effect due to complementarity of processes, resources and interconnectedness of financial, information, knowledge, digital, material flows.

Thus, innovation-digital cluster is a highly developed virtual-real institutional infrastructure that forms a certain system of dissemination of new knowledge and technologies, accelerates the transformation of inventions into innovations and innovations into competitive advantages, development of high-quality stable network connections between all participants. The emergence of such clusters is a natural process in the presence of common digital platforms, scientific and production base. Cluster includes institutions-organizations and institutions that both cooperate and compete with each other. It is a knowledge institution that produces innovations and digital products/services. Main characteristics of innovation-digital clusters are:

- Territorial concentration (close location of institutions and organizations creates conditions for rapid economic cooperation, capital exchange);
- The plurality of economic agents (clusters and their activities cover not only the firms in the cluster, but also public organizations, academies, financial intermediaries, institutions that promote cooperation) (*Tishchenko, 2010*);
- Formation of a network of informal and formal relations between economic agents (clusters are a complex system, the elements of which are combined by direct and inverse network connections: material, information and financial flows);
- Long-term perspective of the cluster life cycle on the basis of the triads "business – university – government" and "venture enterprise – supplier – consumer of digital product/service";
- Involvement in the innovation process (venture firms and digital enterprises that are part of the cluster, included in the processes of market/marketing, product, technological, and organizational innovation);
- Common institutional, socio-economic, virtual-real environment, characterized by a high level of trust, norms of cooperation, regional traditions and values in communication, innovative culture;
- Availability of research work in combination with the dynamic process of digitized learning;
- High quality specialization;

• Creation of a special form of innovation – "aggregate innovation and digital products" based on clustering (*Zaremskyi, 2010*).

Thus, in today's virtual reality, cluster is a different form of organization of economic relations based on the principles of digitalization. It is characterized by an internal in-depth flow of innovative ideas, digital knowledge and information. During the formation of network economy in Ukraine, cluster was used to solve a wide range of tasks, in particular to strengthen the competitiveness of the state, region, industry and the development of regional digital development programs; as a basis for stimulating innovation and digital activities and interaction of large and small businesses; as an important mechanism for the implementation of national industrial policy in the direction of the formation of Industry 4.0 (*Dombrovskyi, 2011; Kraus et al., 2018[a]*).

Conditions for the formation of innovation-digital cluster from an institutional point of view, are presented in Table 53.

We agree with the views of Ukrainian researcher Oksana Hryvkivska, who argues that the creation and operation of innovation-digital cluster requires a number of components:

• Innovation, because only new, original, non-standard ideas and know-how can interest the investor;

• Information on the potential of region, its priorities, investment attractiveness and prospects for development through virtual-real interaction;

• Interest, since only the economic benefit from the invested capital is key to the implementation of real investment projects;

• Integration – unification through network interaction of government, business and universities (*Grivkivska et al., 2011*).

The "triple spiral" is more critical for the formation of a mature innovation-digital cluster in the conditions of virtual reality, more precisely – "the collaboration of three types of participants in the innovation game, representing science, business and the state… members of the cluster can complementary assets and competencies in a variety of combinations, which allows you to expand the benefits created, ie increase productivity in its modern sense, typical of the post-industrial economy… Collaboration takes the innovative production culture of the cluster beyond it (through outsourcing, creation of new firms, spillover effects), which leads to the emergence of new network nodes, increasing the competitive strength of the cluster and forming a network environment of virtual reality (*Kraus, 2021[c]*).

The experience of cluster initiatives in post-industrial countries shows the diversity of mechanisms for the formation and stimulation of innovative cluster formations. Thus, if in the United States the "triple

Table 53 – Conditions for the formation of innovation-digital cluster from an institutional point of view

Institute level	Institute type	Characteristics of the environment of formation of innovative clusters
1	2	3
The purpose of the Institute	Collective ideas about the technological level of nation and quality of its resources	Agents believe they themselves, the products they create and the organizations they create can be "best in the world"
	State of empathy in society: stereotypes and installations of agents relative to each other	High levels of empathy that stimulate cooperative behavior
National Formalized Institutes	Legislation on the protection of property rights	Developed law and enforcement practice, judicial protection
National informalized institutes	Distribution of power and property, level of corruption	Corruption at the permissible level within the framework of historical features and evolution of market relations
Local formalized institutions	Specially stimulating legislation and regional state order	Risk of stimulus deformation (may exist in early stages)
Local informalized institutions	Level of trust and exchange of special knowledge	The level of trust is sufficient for the mutual exchange of special knowledge that stimulates innovation
Local institutions	The role of local reputation	Loss of reputation is equivalent to the loss of business (or profession)

Source: Kraus et al., 2021[b]

helix" was formed on the basis of "double helix", namely, "university – business", in European countries with traditional participation of the state. This means a "double spiral" of the "state – business" type. For this reason, in order to implement the vector of modernization of Ukraine's economy on the basis of clustering, there is a need to develop a model of the institutional environment of innovation and digital clusters, which

could be applied within the framework of economic practice and current economic downturn in the country, which is also complemented by the challenges of virtual reality. Cluster methodology is based on the consideration of forms of economic relations and directions of creation of "modern innovative and digital products" as a whole set of elements that are in constant interconnection. Accordingly, the foreign scientist Mykhailo Dombrovsky speaks of the cluster as a complex economic system with its own special network connections (*Dombrovskyi, 2011*).

Cluster, as a dynamic system, consists of specific elements, which have the following main characteristics:

- Form, expressed in the form of specific structure;
- Content hidden in the relationship of cluster elements;
- Spatio-temporal location, which characterizes the relationship of external and internal institutional environment;
- Probable state, which determines the choice of the path of development of cluster system from all possible (*Togunov, 2009*).

The institutional elements and characteristics of cluster structure are interdependent and interrelated. In our opinion, the highest degree of stability of the internal environment of cluster is provided by the construction of cluster, in which the institutional elements that make up and fill it are interdependent.

Such a cluster design is an absolute structure of chiral symmetry (approximate symmetry of strong interaction with respect to transformations and changes). The functional dynamics of the cluster is related to the violation of symmetry. Such a violation is inherent in the very essence of chirality (a property that consists in difference between right and left), as well as the contradictions of respective pairs of institutional elements that "fill" cluster structure. The contradiction of two specific institutional elements of cluster system is resolved through the essence of third element, which is in a certain pattern of relations with these institutional elements.

Cluster systems are highly deterministic institutions. Term "determinism" means that cluster system defines the structure and content, information and energy of this system, the scale of time in it, and therefore its future as a closed or locally closed system is given in specific time and space, despite the possibility of insignificant errors in the real trajectories of the system. That is, the real existence, evolution, vital activity of cluster system is impossible without a specific correspondence with the evolution, development, transformation (in the broad sense of the term – movement and change) of the external environment (*Togunov, 2009*) in new conditions of virtual reality of the 21 century.

Currently, the vast majority of Ukrainian clusters, which according to various estimates reach 50, are in the process of formation. The most popular for their creation are the tourism industry, food and engineering industries, while science-intensive – electronics, alternative energy, nanotechnology and pharmaceuticals – are represented. The leader of clustering in the field of high technologies and existing organizations that perform scientific and technical work is the Kharkiv region and the city of Kyiv (*Bila, 2011*).

The pioneer of clustering in Ukraine is the Khmelnytsk region, where construction and sewing clusters have been operating for over 10 years, and in 2002 the first in Ukraine tourist cluster "Oberig" was launched, designed as a public organization. It included more than 50 representatives of agriculture, farmers, fishermen and craftsmen. In Zaporozhia region the machine-building cluster of LLC "AgroBUM" successfully operates. It unites 20 companies and develops cooperation on the principles of subcontracting. In the Ivano-Frankivsk region there is a well-known Tysmenytsia fur cluster on the basis of OJSC "Tysmenytsia Fur Company". In Rivne region – woodworking cluster "Polissya Rokytnivshchyna", created in 2003.

A promising direction for Ukraine is the creation of cross-border clusters. Given that 19 of the 25 oblasts are border regions, Ukraine has every opportunity to cooperate with foreign companies within cross-border clusters. An example of such cooperation is the Ukrainian-Romanian "First Agrarian Cluster", established in 2009 in Chernivtsi region. Within the framework of the Cross-Border Cooperation Program Poland-Belarus-Ukraine for 2007–2013, a Ukrainian-Polish tourist and recreational cluster was formed (*Bila, 2011*).

Most of the hubs and coworking centers operating in Ukraine are private. Today there are about 200 coworking spaces in Ukraine, some of which have become meeting places for startups. Successful is the Kyiv coworking center "Magazine" on the basis of which business trainings, master classes, educational lectures, conferences, competitions in the field of innovation are held. In 2012, the Cabinet of Ministers approved a resolution on national project "Technopolis", which provides for the construction of innovation parks in Kyiv, Kharkiv, Lviv and Dnipro and the creation of 70-75 thousand jobs for specialists in IT, biotechnology, energy conservation, nanotechnology. Ukrainian Silicon Valley was to be the Bionic Hill Innovation Park, which was planned to be built near Kyiv. However, the project failed due to a lack of adequate government and financial support (*Tarasova, 2007*).

Today, the activity of the Association "Innovative Development of Ukraine" can be considered successful, which promotes the

implementation of promising Ukrainian innovation projects and is working on bills on industrial parks and providing benefits to their members. In 2015, the opening of the California in Ukraine innovation center in Kyiv was announced. In provided for use by the Kyiv administration on the street. Khreshchatyk premises, master classes on implementation of innovative projects, hackathons are held. A network of innovations and entrepreneurship support centers called iHUB is operating effectively in Ukraine. iHUB was initiated by the global network of national non-profit foundations Seed Forum in 2014.

IHUB operates with the support of the Norwegian Ministry of Foreign Affairs and the Embassy of the Kingdom of Norway in Kyiv, with additional funding from the development institutes of Finland, Sweden and England.

From the grant funds, iHUB pays the rent and work of research staff in Kyiv, Chernihiv, Lviv, Vinnytsia, Ivano-Frankivsk, where a number of structural centers operate within the framework of the public-private partnership iHUB.

Already today, more than 50 experts from 20 countries work in structural centers in 40 areas of educational and innovative events. iHUB invests in reconstruction, equipment and project management, assumes all operational and financial risks during the partnership term. According to experts, about 20 thousand people showed interest in this project and became its participants in order to gain knowledge to create startups (*Vlasenko, 2015*).

We believe that in order for innovation hubs to develop, government agencies should provide orders and innovation projects to hub participants on a competitive basis. For example, the automation of urban processes and the introduction of electronic administrative services, which is relevant in light of government-initiated reforms. In addition, from 2016, the Seed Forum plans to launch e-government and E-parliament Electronic Services projects on the basis of iHUB. It is assumed that part of the resources of the innovation center will be used for the development of electronic services of government agencies, payment will be made by a grant from the Norwegian government.

The international innovation cluster “Competitiveness” functions effectively in Ukraine. It is a voluntary association of Ukrainian, foreign educational and scientific institutions and industrial formations of various forms of ownership on the principles of common interests in order to promote effective scientific, educational and organizational and entrepreneurial activities of its founders and participants.

The creation of this cluster is due, firstly, to the need to ensure the innovative breakthrough of individual industries; secondly, traditional

science and education are unable to respond in a timely manner to existing acute problems – society is developing faster than knowledge; thirdly, the need for an innovative economy to be based on the active use of the results of science and best practices and knowledge, which are formed on the basis of continuing education.

Main activity of the cluster "Competitiveness" is to create the foundations – effective research and educational activities to ensure alternative development of priority industries and implementation of projects "Formation of a business incubator and recruitment agency for targeted use of youth potential", "Improving educational level", "Retraining and advanced training of specialists in market specialties (for market needs)" (*OECD, 2012*).

Scientific and educational institutions and industrial formations are involved in the cluster, which actively use innovations in their activities and intend to continue such activities to intensify the process of combining science with production. The participants of the international innovation cluster are:

- Institute of Economics, Technology and Entrepreneurship;
- Ternopil Institute of Agricultural Production of NAASU;
- Khmelnytsk University of Economics;
- Podolsk State Agrarian Technical University;
- University of Economics and Entrepreneurship;
- Ternopil Institute of Social and Information Technologies;
- Bukovynna State Financial Academy;
- King Danylo Halytsky University of Law;
- Panstwowa Wyzsza Szkola Techniczno-Ekonomiczna im. ks. Marki-ewcza in Yaroslavl;
- Agricultural Advisory Service "Agronauka";
- Small enterprises in the field of innovations.

Among the products created by the cluster "Competitiveness" are: remote production (research schools, training and retraining of scientific and professional staff, conducting research and testing in their own research and production journals "Innovative Economy" and "Sustainable Economic Development" and information-consulting newspaper "Consultant", con-ducting scientific and practical Internet conferences, seminars, round tables, implementation of continuous to improve the educational and professional level of the population using competitions of scholars in various fields) and organization in the cluster system of innovation bank, implementation of innovation transfer and diffusion innovative business projects.

Scientific school of the cluster is working on the development of international competitive projects under the cross-border cooperation

program: “Poland-Belarus-Ukraine” and “Romania-Ukraine-Moldova”. The defined conditions of cross-border cooperation program “Poland-Belarus-Ukraine” stipulate that the minimum amount of the tender project is € 100 thousand, the maximum – € 3 million. The cluster has prepared successful tender projects in two priority areas: quality of life”.

Already today, the international innovation cluster “Competitiveness” initiates the implementation of educational, scientific and technological innovation and investment projects in the regions of Ukraine. The implementation of these projects is based on the cooperation of scientific, educational, industrial institutions and local governments in the following areas:

• Formation of competence and employment of the population (innovative-educational project, the activity of which is based on the business personnel incubator “Universal” and the personnel recruitment agency);

• Improving the management and technological structure of production to intensify innovative business activities;

• Creation of an innovative tekhnopark “Agroecological”, the purpose of which is: reproduction and rational use on an ecological basis of the productive potential of rural areas as main means of solving the food and energy problem of the country and increase its global competitiveness (*OECD, 2014*).

Based on the above theoretical and methodological analysis and our own observations, we present in Figure 33 visualizes a slice of network interaction of cluster formations in the conditions of virtual reality.

“The innovative and digital nature of modern clusters is determined not by the actualization of their specialization, but by their unique institutional design. Based on spiral model, they form a striking contrast (difference) with structural formations of other types of territorial-industrial agglomerations”.

It should be noted that in addition to solving their specific problems, each subject of the institutional environment of the innovation-digital cluster (Figure 39) performs universal functions that are inherent in all institutions of cluster formations. Among these functions: regulatory; integrative; broadcasting; communicative (this feature has its own feature – informal communication); consolidation and reproduction of social relations.

The central circle, which is superimposed on other circles and formed a so-called “spiral”, illustrates the effect of synergy of joint interactive network interactions. These actions are aimed at achieving in the innovation-digital cluster “the effect of digital development and innovative growth, which are based on dynamism of constant renewal and continuous growth of digital production”.

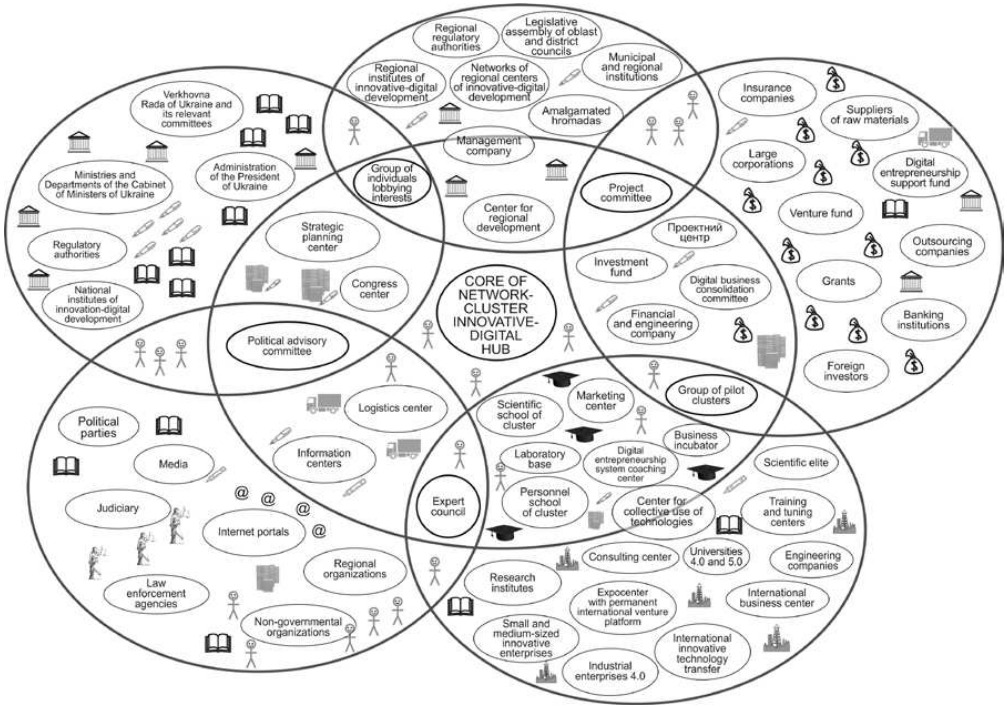

Figure 39 – Visualization of n etwork interaction of cluster formations in the conditions of virtual reality (compiled by authors on the basis of sources

Source: Togunov, 2009; Napolskikh, 2012; Kraus, 2014; Kraus et al., 2019[d]; Britchenko et al., 2019; author's development

At the intersection of the inner circle of the innovation-digital cluster (which demonstrates its internal environment) with five other circles (circles that conditionally demonstrate the external institutional environment), there are informal and formal institutions-institutions of cluster (*Napolskikh, 2012*) with their virtually real relationships.

We agree with Dmytro Napolskykh that "the institutional environment of innovation and digital clusters, including the system of social institutions, organizations and their relationships, is a key part of the institutional environment of the territory that is developing most dynamically". Scholar emphasizes that the institutional environment of territories necessarily consists of formal and informal institutions. To the formal he refers: only hierarchically-built regulatory framework, public authorities and local governments, budget, commercial and public organizations. Dmytro Napolskykh defines informal institutions as "forms of social interactions that have developed on the territory as a result of a long process of social evolution" (*Napolskikh, 2012*). Among such forms he names: religious, moral and ethical, economic.

It is worth noting that full-fledged clusters, which are designed for innovation-digital type of growth, received an impetus for development only in the post-industrial era. Their competitive advantages are associated not only and not so much with territorial proximity of participants, but with their functional interdependence and complementarity.

Cluster systems are characterized by following features:

– The existence of a corporate management system, control over business process, collective economic monitoring;

– The presence of a leading enterprise that determines long-term economic, innovative and digital strategy of regional economic system;

– Territorial localization of the bulk of business entities-members of cluster system;

– Stability of strategic economic ties within cluster system, including its regional, interregional, domestic and international relations;

– Creation by members of cluster of a non-profit association, voluntary membership, the presence of a coordinating organization;

– Long-term coordination of interaction of participants of cluster system within its national and intraregional programs of digital development, investment projects, network processes (*Dombrovskyi, 2011*).

Cluster systems can bring together large, small and medium-sized enterprises. Basis for the success of such associations is synergetic effect of geographical proximity to each other and to consumers. They can be formed by industry profile, ie sectoral. Economic agents of cluster systems have every chance to become:

– Research institutes and educational organizations;

– Organization of innovation infrastructure and infrastructure to support small and medium enterprises (business incubators, special economic zones, technology parks, venture funds, knowledge transfer centers);

• Firms specializing in specialized, usually competitive digital activities;

• Firms-suppliers of raw materials, goods or services for profile enterprises;

• Non-profit and public organizations, associations of entrepreneurs, chambers of commerce and industry;

• Enterprises that provide access to information, engineering, transport, energy and other infrastructure (*Orev, 2011*).

Synergetic approach used in the formation and development of innovation-digital clusters is considered through the prism of the relationship "subject – the subjective relationship of innovation-active organizations and digital enterprises" (*Andriichuk, 2010*). In addition, in our case, this effect lies in the plane of restructuring "old" development institutions in "new" under the influence of the relevant institutional and legal basis, systemic and comprehensive modernization and diversification of all sectors of production, improvement of the innovation and investment situation, construction of an effective innovation and digital virtual-real infrastructure of the European standard, implementation of clustering of the economy using the opportunities of network cooperation.

It is the theory of finite sets, studying the rules: how, knowing the number of elements of some sets, gives the answer – how to calculate the number of elements of other sets, composed of the first with some operations. Basic space of a self-organized socio-economic system on the way to building an innovation system can be qualified as a kind of network set. This network set is based on:

• Formation by institutes-organizations of innovative development of network structures based on relations of trust and system of interaction, first of all, horizontal;

• Complicating the functioning of modern socio-economic systems in the context of globalization and the formation of digital economy.

We made an attempt to conditionally represent network economic space, which implies the presence of many "new" institutions of innovation and digital development, which determine new rules for the formation of network interaction. From the standpoint of set theory, the peculiarity of innovation-network structures is that they allow you to create a variety of mechanisms of interaction. Under these mechanisms, institutions-

organizations of innovation and digital development, which are part of network structure, retain the status of legal entities. It should be noted that in innovation-network structures there is not just cooperation of different institutions-institutions and institutes-organizations, but their coherent interaction when they function as a whole, increasing their economic and institutional capabilities and forming a synergetic effect or synergism (synergism is the result of a complex interaction of measures that provide additional efficiency of digital enterprise more than the simple arithmetic sum of the effects of individual measures/methods. This concept is also called the synergetic effect "2 + 2 = 5" (*Redina et al., 2009*).

As a result of such interaction, a "new" institutional structure in the innovation sphere is constantly emerging, which provides for the presence of digital enterprises that carry out their risky activities both within existing development institutions and within the framework of "new" institutes of innovation and digital development created by them in the conditions of virtual reality. These institutes will make the internal organization of innovation and network structure (cluster structure, technical and technological zone, technopolis, technopark, innotech).

During digital economic development, in the conditions of institutional uncertainty, the enterprises of the sphere of innovation can make collective decisions concerning new rules of network interaction and produce their own institutions. These institutions are "born" and founded to:

- Structuring of new directions of collective interactions;
- Creating opportunities to find new rules and norms of these interactions;
- Development of effective compromise solutions, the adoption of which leads to the benefit of all participants in the innovation-digital process.

Based on this, we can safely say that having made its choice in favor of European vector of development, national economy of Ukraine has become transitional, as it joins the conditions of forming contours of global network-digital economic system. That is, it is characterized by transitional institutional states. This opinion is shared by Ukrainian scientist Dmytro Lukianenko (*Lukianenko, 2008*).

The high degree of interaction between universities and business and the state, shown in Figure 1, is based on new organizational principles – network structures that unite once isolated innovation centers in universities, industrial firms and government agencies. These networks can consolidate the intellectual, material and financial resources of several universities, public research centers and innovation

structures of private firms located in the same region or in different regions of the country. Moreover, they can, on a virtual-real basis, unite research, educational and commercial organizations in different countries (*Ivanov, 2013*).

Qualitatively new nature of organizational forms of interaction of innovation-digital structures creates an incubation effect – universities and research organizations of the state and business are transformed into incubators of new innovation firms, digital enterprises and research organizations. Prerequisites for this are:

- Selection of the most promising ideas in the field of technology;
- Sufficient funding in the form of grants and interest-free loans;
- Outsourcing;
- Training of staff of future companies during practical work;
- Inclusion of firms with professionally trained staff in common network with potential partners and investors (*Ivanov, 2013*).

The basis of the architecture of network economy is formed by innovation-digital organizations and industry clusters – groups of closely related enterprises on the production principle, localized territorially and jointly promoting innovative products, digital services to the innovation market. Factors such as mutual trust, partnership, use of a common information field, joint scientific and technical centers, marketing structures and sources of funding, support of local chambers of commerce and regional administration are of key importance. Ensuring such a high level of cooperation is impossible without clear legal norms governing the behavior of all subjects of the joint innovation and digital network and their relations with external business structures and authorities (*Ratner et al., 2011*).

The activity of innovation-digital structures operating in the conditions of virtual reality is based on four principles:

- Maximum convergence of science, production, commerce;
- Creation of the most favorable conditions for the development of science-intensive production, innovative business, digital entrepreneurship;
- Associations of firms that develop and provide commercial sales of various types of science-intensive products and promote accelerated processes of exchange of scientific and technical information;
- Formation of scientific conditions for the incubation period of formation of small innovative firms, carrying out the first, most scientific stage of scientific and technical developments (*Androschuk et al., 2009*).

Global experience has already shown that the conditions for successful partnership in the internal environment of the cluster in virtual reality based on network interaction are openness, transparency and

high professionalism of partners. Speaking about the professionalism of partners, it should be noted that in the implementation of socio-economic programs and investment projects, their performers are dealing with living people, nature or the law. Unprofessionalism, low ethical standards can harm target groups to which the beneficial effects of programs or projects are directed. The issue of implementing ethical norms and professional standards within the partnership should be taken into account by all partners. Effective partnership is impossible without a special intellectual and cultural environment (in innovative business and digital entrepreneurship it is called corporate culture), that is, a collective system of business principles, norms of behavior, traditions, symbols, rituals and beliefs, which would be perceived by most economic agents (*Khomenko, 2007*).

Cluster systems based on network cooperation are formed on the basis of three principles, depending on the structure, size and type of activity:

- Concentration – location convenient for regular contacts;
- Common interests of potential participants – the same, or interdependent areas of activity, common market or area of activity;
- Interaction – relationships, interdependence with a large variety of formal and informal relationships (*Dombrovskyi, 2011*).

As a result, it should be noted that at mesoeconomic level we already see how financial-industrial groups of enterprises, research and production networks, cluster structures, interregional complexes, technology parks, megacities, free economic zones, business incubators, venture enterprises interact. If we consider transformation of the economic complex of the region to combine all intermediate formations within one middle level and leave regional economic complex on the basis of innovation-digital cluster formation as an independent, we obtain following sequence: megaeconomics – macroeconomics – mesoeconomics – microeconomics – minieconomics – nanoeconomics (*Kolodinskyi, 2008*). The meso-level, in contrast to others, is less stable and is under the influence of adaptive transformation and strategic changes within the regional innovation market.

One of the main elements of the infrastructure that determines the development of a portfolio of innovation and digital strategic alternatives of the economic cluster at the meso level is the institutional component. This is due to the fact that market infrastructure acts as an institutionalized transaction (agreement that is accompanied by mutual actions and deeds) (*Tolstykh et al., 2009*).

Summing up our study, it should be noted that network economy in the 21 century like no other economy (innovative, informational,

knowledgeable, blue, green, circular, row, digital) highlights the organic relationship of technological (virtual-real networks) and institutional specifics of a constantly updated way of life (networked social environment).

It is network economy that demonstrates new forms of qualitative accumulation and augmentation of new knowledge that occurs through their network replication (division), and innovative growth is the result of the formation in the economy and society of a new, network model of coordination, networking of new quality, which is constantly adjusted by digital tools. We can also state that it is obvious that the transition to network economy is not enough to create the latest production infrastructure (digital platforms, business incubators, innovation hubs, industrial parks, technology platforms, coworking centers, technology parks, ventures funds, etc.). Why? And because in the absence of the necessary density of social cooperation, in the case of a shortage of democratic institutions and a low level of public confidence, such an infrastructure will work idle.

The managerial consequences of our research are the formation of new quality of cluster solutions, designed to create appropriate conditions and ensure the essential changes needed for innovative-digital development institutions, to direct the potential of all stakeholders in the development of national and international innovation clusters. in the conditions of virtual reality, to create potential for development of economy of all state. An example of such an initiative is the cluster service, main purpose of which is to create conditions that will ensure self-organized formation of clusters by the mechanism “top-down” in the future, and the role will be revealed through the organic unification of separate interests of government, science and business representatives on a fair, equal, parity basis due to the presence of their own interest, which does not contradict, but complements the interests of all stakeholders, forms synergy effects. The prototype of the cluster service at the current stage can be considered a project of educational and scientific diplomacy initiated by the National Center “Small Academy of Sciences of Ukraine”.

The synergistic effect of networking creates a new phenomenon of growing marginal utility and growing marginal productivity from innovative glocalization and digital globalization. The greater the scale of innovation and digital activities in the conditions of virtual reality, the greater the efficiency of the use of additional resources. The effect of scale is especially pronounced within the network, which uses the standards produced and tested by it. Network structure helps to increase digital competence of members of all, without exception, economic agents of clusters. Standards in network economy are becoming a major factor in competitiveness at all levels of aggregation.

Thus, the formation of a new quality of networking and cooperation is a new approach to solving the problem of competition in virtual reality and in digital market of goods/services. This trend is a consequence of rapid digital development and spread of high-tech products and integrated solutions in modern economy, the processes of accelerated improvement of digital technologies and high levels of risk in new markets.

Despite the scale of existing scientific achievements, it is still important in the future to conduct research aimed at understanding the ideology of digital economy, in order to form a new virtual reality. There is a need to develop high-quality institutions that would accelerate digital development in terms of augmented reality, as well as to focus on the work of tools in terms of effective legislative and institutional capacity for digitalization of national economies. Research is needed to find answers to following questions: How is virtual reality different from digital, augmented, augmented, augmented, augmented, and mixed realities? How to work in digital ecosystem with an innovation ecosystem? How can digital entrepreneurship, start-up and the state “in the smartphone” influence the development of innovations and derive economic benefits from it?

5.2. Digital opportunities Industry 5.0 in the gig economy

The issue of accelerated formation and development of Industry 5.0 is an important world-class problem, the relevance of which is growing in the context of new digital solutions, the growth of virtual mobility and global socialization. In the context of rapid institutional change and technological structure, developments of only digital experience with clients or the digitization of business operating model is no longer sufficient. It is necessary to be prepared to disrupt the established business model, change the market, and rethink product lines and service models. It is Industry 5.0 that provides not only the introduction of innovations, but also the change in business processes, the creation of a modern IT infrastructure, the development of corporate culture aimed at encouraging employee participation in generating new ideas for the development of innovative business and increasing the level of customer service efficiency.

We share the opinion of Jack Ma Yun, a co-founder of Alibaba Group, claiming that the key to future business success lies in:

- Making society, customers and employees happy;
- Investing in people working for the company because they believe in its success;

• Investing in small businesses and the private sector, develop and protect entrepreneurs;

• Being not afraid of artificial intelligence, because robots will never replace humans as they do not have a heart and self-confidence. It is creativity, innovation and critical thinking that makes human beings different from machines;

• A teacher should believe that his student will succeed and devote more time to him unleashing his potential. It is worth appreciating good teachers and becoming even better for our future learners;

• Learning from real business, from mistakes done in it, which forms high-quality knowledge that needs to be applied;

• Thinking about how communications and advertising of the future will help their clients;

• Working in various industries and constantly learn.

The digital space, constant and accelerated changes and the pace of development of innovations lead to constant systemic and complex modernization. Instruments, mechanisms and theories that worked qualitatively in such a relatively stable world cannot be combined with new development institutions, and their behavior is unpredictable. This creates a need to study the traditional concept of competition that has dominated business research for the past decade. But times have changed and old theories do not always work in practice, as entrepreneurship has become digital, commerce has become electronic.

M. Porter's world-famous model of the five forces of competition that used to dominate in the world of strategic thinking for a long time, but the digital transformation of business has changed the situation. According to this model, the strategic position of a particular business is influenced by the following threats: the threat of appearance on the market of substitute products; the threat of the emergence of new market players; the threat of market power of consumers; the threat of market power of suppliers; the level of competition in the industry.

The goal of the strategy itself is to put under control these five threats and thus keep the business secure. However, this model does not work in the digital space. Let's take as example platforms as one of the common business models for the digital economy. The main players in digital platforms are consumers, manufacturers and business partners. On these platforms, high-quality and effective interaction has the greatest value for consumers and manufacturers. The digital platform itself is designed to maximize this value and reduce risks. In practice, expectations come true in terms of the threat of the emergence of new players and market power of consumers in M. Porter's model, which can fail and cause devastating damage to the digital platform.

Digital platforms, as they develop, form an innovative ecosystem around them, which promotes the platform and is responsible for its revenue side. But in practice, it is not economically profitable when development partners outgrow the development company and "bypass" it, so it is worth strengthening the quality of management. If such a threat exists, then it is worth immediately taking countermeasures such as the buyback of a block of shares in support of the developers. Therefore, this situation testifies to how the first two conditions are fulfilled in M. Porter's model. In terms of the level of competition as the fifth component in this model, then through the prism of the digital economy it is dynamic and three-dimensional. This is due to the fact that the following enter into competition: platforms among themselves, trying to make the transition and interaction more expensive; platform with partners, in order to prevent them from growing the volume of the platform; partners with each other for market share (*Davtyan, 2019*[c]).

In the digital economy, one more feature can be traced, namely, that competition allows you to significantly increase profits and increase the share of digital business. In the context of the digitalization of the economy and the existing hypercompetition, the proliferation of technological progress, the establishment of the institution of ownership of infrastructure and the uniqueness of resources no longer provide adequate permanent competitive advantages. However, for a platform economy operating on the basis of digitalization, there are such resources available and this is valuable interaction and information. Therefore, such unpredictability in the digital space suggests that as a result of using M. Porter's model for digital business, the outcome can turn both positive and negative.

The number of scientific researches and publications devoted to this problem in the world is growing explosively. Innovative countries are currently developing key signs of the emergence of Industry 5.0. They are manifested in the transformation of existing business processes under the influence of new technologies and the formation of smart assets, e-services for digital business and e-government, the formation of Education 5.0 and Society 5.0, launching a quality educational and research process in University 5.0.

It is digital entrepreneurship in terms of virtual mobility contributes to the rapid development of the concept of Industry 5.0 in terms of creating qualitatively new business models, logistics, e-commerce, smart manufacturing in gigonomics. This study is performed in the interests of national security of Ukraine, as evidenced by the provisions of paragraph 51 of the National Security Strategy of Ukraine (Decree of the President of Ukraine from 14.09.2020 № 392) and paragraph 18 of the Economic

Security Strategy of Ukraine (corresponding decree from 11.08.2021 № 347): “guaranteeing national economic independence and the ability to protect national economic interests, in particular in high-tech sphere”.

The following names of such scientists as R. Azum (*Azuma, 1997*), W. Isaacson (*Isaacson, 2017*), D. Lichtblau (*Lichtblau, 2014*), T. Stock and G. Seliger (*Stoct et al., 2016*), E. Schaeffer (*Schaeffer, 2017*) are associated with the study of the general aspects of transformational changes and the comprehensive modernization of the economy in the direction of its innovative and digital development. In the course of writing, it was the book by Eric Schaeffer, a researcher, “Industry X.0: Realizing Digital Value in Industrial Sectors” (*Schaeffer, 2017*), which really attracted our scientific attention having become a bestseller in the scientific world. In addition, it clearly demonstrates the powerful impact of the Industrial Internet of Things on manufacturing and explains in detail how to realize the possibilities of technology to increase competitiveness, profits and further the development of business digitization.

Well-known researchers and economists, including H. Androshchuk (*Novikova et al., 2018*), Yu. Bazhal and V. Vyshnevskyi (*Vyshnevskyi et al., 2018*), V. Vitlinskyi (*Vitlinskyi et al., 2018*), G. Davtyan (*Davtyan, 2019[a]; Davtyan, 2019[b]; Davtyan, 2020*), Ya. Zhalilo, N. Yehorov, S. Koliadenko, O. Kryvoruchko (*Kryvoruchko et al., 2017*), P. Leonenko (*Leonenko et al., 2016*), V. Liashenko (*Liashenko, 2018*), O. Manzhura (*Manzhura et al., 2020*), V. Nekrasov (*Nekrasov, 2020*), I. Novikova and V. Osetskyi (*Novikova et al., 2018*), B. Paton (*Paton, 2016*), M. Slabko (*Vitlinskyi et al., 2018*), S. Shchegliuk (*Shchegliuk, 2019*), O. Yurchak (*Yurchak, 2020*) were involved in the formation of digital platforms in the world, the disclosure of the institutional content of their work and the formation of Industry 4.0 on the scale of the global system, the innovation of the Ukrainian economy, the possibility of its breakthrough development and the study of the prospects, directions and mechanisms for the development of the smart industry in the era of digitalization.

S. Bespalov, H. Holotsukov, V. Ivlichev, S. Ivanov, M. Pustovoit, I. Malchevskyi, D. Nikolenko, V. Kirsanov, O. Khimich and I. Shchetynin (*Khimich et al., 2018*) were engaged in the development and implementation of distributed information technologies related to the processing of documents accompanying the opening, execution, control, accounting, closing of research and development works. But a significant number of problems, such as the formation of digital platforms and in general the formation of a quality Industry 5.0 in terms of innovation and digitalization of economic relations in the gig-economy remain insufficiently disclosed.

Kenneth S. Laudon and Jane P. Lodon are scientists and practitioners in the field of information systems, who managed to present systems through a sociotechnical view in the organizational changes of their textbook for teaching information systems management. This view states that "optimal organizational efficiency is achieved by joint optimization of both social and technical systems used in production" (*Laudon et al., 2014*). Thus, they argue that system performance is optimized when both technology and organization mutually adapt to each other until a satisfactory match is obtained.

Some aspects of the implementation and operation of smart innovations, the main components of digital infrastructure (applications, data centers, information and communication networks, information collection systems), mastering the technology of Industry 5.0 and analysis of their potential application are revealed in the works of scientists such as P. Maddikunta, Q. Pham, B. Prabadevi, N. Deepa, K. Dev, T. Gadekallu, M. Liyanage (*Maddikunta et al., 2021*), M. Javaid and A. Haleem (reveal new digital technologies and critical components of Industry 5.0, point out changes brought by Industry 5.0 for the economy, determine the factors for successful implementation in the field of production) (*Javaid et al., 2020*). Completed scientific and practical work, which examines the practical measures, tools and methods of accelerating the emergence of Industry 5.0 in terms of defining new role of workers, safe and inclusive work environment, attracting and retaining talents that shape Society 5.0 is the work of M. Breque, L. De Nul, A. Petridis (*Breque et al., 2021*).

The use of artificial intelligence and innovation in the age of Internet of Things and Industry 5.0, the work of digital twins, the efficient use of renewable energy sources is revealed in the works of F. Aslam, W. Aimin, M. Li and K. Rehman (*Aslam et al., 2020*), J. Müller (*Müller, 2020*). The problems of transformation of Industry 4.0 into Industry 5.0, which go from digital production to Society 5.0, as well as the security of critical infrastructure are revealed in the scientific work of P. Skobelev and S. Borovik (*Skobelev et al., 2017*). Role of soft skills in improving the efficiency of companies during modern digital revolution has been thoroughly revealed by F. Caputo, V. Cillo, E. Candelo and Y. Liu (*Caputo et al., 2019*).

Given the existing developments, authors consider it necessary to continue work on some vectors of the research aimed at solving the urgent problem of developing new approaches to the formation of Industry 5.0 on the basis of digitalization of economic relations in virtual mobility and in the context of global socialization. results of COVID-19 and economic convergence, congruence and collaboration with the countries of the European Union, in order to ensure national economic

security. In the rating of innovative economies 2020 by the Bloomberg agency, Ukraine lost 3 positions and took 56th place out of 60 possible. For the ranking, Bloomberg analyzes 60 economies of countries, among which are mainly representatives of Europe, North America and Asia. The rating was topped by Germany (88.21 points), which moved South Korea for the first time during 6 years. South Korea and Singapore are in second and third places respectively. Switzerland and Sweden are closing Top-5. Top-10 includes Israel, Finland, Denmark, the USA and France. Japan lost 3 positions and took 12th place. China is in 15th place (+1 position). The Russian Federation in the ranking of 2020 is in 26th place (adding one position), Poland – 25 (-3 positions) (*Economic truth, 2020*).

The rating of innovative economies is calculated on the basis of information on the intensity of research and development, the production of innovative services and goods, labor productivity, patent activity and other indicators. The index also takes into account the quality of education and the concentration of high-tech companies in the country (*Marchenko et al., 2021*[a]). The result of Ukraine in 2019 worsened due to the low level of education efficiency and the number of scientists, and in addition, there is a low level of use of high technologies and the number of registered patents.

The Deloitte's study, "Forecasting the Development of High-Tech, Media and Telecommunications" has identified five key technologies that could dramatically change people's lives already in 2020. A brief summary of them has been presented in Table 54.

In a digital environment, one of the main strategic advantages is technology, so a company can be successful or even a monopoly until another company creates a new technology that is superior to it. And most importantly, collaborative interaction with all participants in the digital environment, based on the institution of trust. For these reasons, the participants of the digital platform, if they see the technology, they are interested on the market, then willingly cooperate with the companies that own it. Main participants in digital platforms are: the platform itself, manufacturers, users, terminals. The platforms are entrusted with the right to establish rules and ensure transactions between manufacturers and the users who are connected to the platform through terminals (smartphones, computers, etc.). The goal of the digital platform is to create value for all parties and maximize profitability.

A striking example demonstrating the work of a digital platform is the experience of Huawei: entering the Huawei market, it did not create a new mobile platform, there was no need, it was the experience of Microsoft. Therefore, Huawei as a terminal has connected to the Android platform,

Table 54 – Latest Technologies Defining a New Quality of Life for People

Latest technology/ product/ service	Characteristic content features, new opportunities that open up as a result of the application of technology, obtaining service, use of a product
1	*2*
Autonomous artificial intelligence (AI) in a smartphone	"Neural processor" (edge AI) is a chip designed to process information using AI directly on the device, without a "cloud" connection. Nowadays, in every smartphone, i-pad, TV, smartwatch, fitness tracker, wireless headphones, AI will work without an Internet connection. That is, we are talking about autonomous AI. Face recognition on the smartphone screen while taking a photo, biometric access to the gadget, image filters, voice recognition, language translation, voice assistance, virtual reality, applying 3D effects, hiding wrinkles, incredible photos in low light conditions – all this works on the basis of machine learning technology. These technologies operate on the power of a conventional processor or in the "cloud" using an Internet connection. However, when they run an AI neural processor, they will run faster and use less power, increasing battery life. It is better to store and process the user's personal information on devices in terms of privacy and security. Personal information that is always on the phone cannot be intercepted or used improperly. When the phone has an AI chip, it can do all these things without connection to the network.
Professional robot assistants	Unlike industrial robots, professional robots are used outside of production. They usually help people, not replace them. Professional robots are most popular in retail, hotel business, healthcare and logistics. Some of them are used in space and defense, agriculture and construction. There is also a class of robots for end-user. They are designed for home cleaning, lawn maintenance and window cleaning. The price, power and flexibility of robots are driven by the advancement of 5G and AI chips. An archetypal industrial robot is a mechanical arm with varying levels of freeness and flexibility found in factories around the world. The largest users of industrial robots are automobile manufacturers, electrical and electronic products, metal, plastics, chemicals, food products and drinks.
Available satellite Internet	Satellite broadband can provide high-speed Internet for people outside the reach of cell towers or high-speed lines. World is expected to receive social and economic dividends that benefit entrepreneurs, hospitals, schools and governments.

(End of Table 54)

1	*2*
The rise of audiobooks and podcasts	Podcasting is an audio or video broadcast on the Internet in the style of radio and television programs on a specific topic and with a specific broadcast frequency. Market growth of audiobooks and podcasts shows that they are characterized by crisp sound.
Cycling technology revolution	As a result of the growth in cycling, a number of technological innovations are also increasing, such as: predictive analytics, mobile applications, wireless communications, digital urban planning tools, 3D printing, electrification. These innovations make the bicycle safer, faster, more comfortable and provide accurate speed and route information. The bike becomes more attractive to use. The growing use of city bicycles can bring significant positive social changes: reducing traffic, reducing nature pollution, reducing load of public transport systems, health improvement. Due to improvements in lithium-ion battery technology, lower prices and increasing production capacity the electric bike market is growing rapidly. More than 130 million of them are expected to be sold during 2020–2023.

Source: compiled by authors based on (Nekrasov, 2020; Kraus et al., 2018; HITECH office, 2016)

playing by the rules of the digital environment. But the US sanctions and Google's actions have violated one of the main pillars of cooperation, namely, trust. And this left an imprint not only on Huawei, but on the available other terminals (for example, Samsung, Xiaomi, etc.). The solution to the problem and the preservation of Huawei's strategic superiority lies in the creation of its Harmony OS operating system. Therefore, if Huawei manages to turn it into a full-fledged platform, comprehensively enforce the rules of cooperation and, at the same time, provide protection from local laws in order not to "fall into the trap" like Google, the company will take possession of a significant share of the smartphone user market (*Davtyan, 2020*).

We are convinced that digitalization and innovation of the economy can be realized only through the development and implementation of innovative digital technologies on an ongoing basis, the formation of high-quality legal, organizational, socio-economic and other conditions for the transformation of society and the reincarnation of the traditional economy to a new level of development, namely, the formation of gig-economy (*Osetskyi et al., 2021*[c]). The gig-economy is a new form of relationship between employer and employee based on the development

of technologies and the emergence of new types of economic activity, when the employer does not own the means of production, but becomes the acquirer of intellectual property, due to which service providers are not protected by any mechanisms in front of the owner of the digital platforms and consumers of services (*Shchegliuk, 2019*).

The emergence of the gig-economy is causing revolutionary changes in literally all spheres of life. We are talking about the creation of qualitatively new models of business, logistics, trade, production. Transformational changes are not bypassed by the education system, health care, and public administration. It can be affirmatively stated that the concept of the gig-economy today defines a new paradigm for the development of the economy, society and the state. We share the scientific views of the Ukrainian professor V. Vitlinskyi, who is convinced that the basic core of the gig-economy is mobile services that allow workers to interact in the economic field without intermediaries, such as state institutions, institution of power, etc. (*Vitlinskyi et al., 2018*).

If we consider gig economy from the standpoint of socio-technical systems, it will mean that technology, in terms of its content, should not be a governing factor in the implementation of new operating systems. Therefore, in order to be classified as "socio-technical", equal attention should be paid to providing a high-quality and pleasant working environment for employees. Work System Theory (WST) and the Work System Method (WSM) simplify the conceptualization of traditional complex socio-technical system (STS) approach. Expanding previous STS studies that separate social and technical aspects; WST combines two perspectives in the work system and outlines the structure of WSM, which considers the work system as a system of interest and offers appropriate solutions (*Alter, 2015*).

Gig economy statistics show a free market system where organizations and independent workers engage in short-term work arrangements. BLS data suggest that in 2017 the US gig economy had 55 million participants. It's estimated that 36% of US workers take part in the gig economy and 33% of companies extensively use gig workers. The word "gig" refers to the transient nature of the job itself. Gig economy definition encompasses all sorts of contingent work arrangements, for example: Freelancers; Consultants; Independent contractors and professionals; Temps (temporary contract workers).

Gig economy is not a new phenomenon-freelancers have been around for a while. So have consultants, temps, and so on. The reason why gig economy has been under scrutiny for the past couple of years is that technology has lowered barriers to entry so much that "gigs" have become easily accessible to an unprecedented number of people

(*Cambridge dictionary, 2022*). What was perceived as a side hustle only a couple of years ago, turned into a trillion-dollar industry with millions of participants. Because of the very technology that made all this possible, it became increasingly hard to clearly classify what counts as part of gig economy and what doesn't.

What's more, studies vary so much in terms of their design that many arrive at conflicting conclusions. Just like in the case of the Contingent Worker Supplement from the BLS and the study conducted by Alan Krueger of Princeton University and Larry Katz of Harvard University – with the latter saying that the gig economy is rapidly growing and the former that it's slowly shrinking. Let's get in sync on the definitions first. Say gig economy and people will think of: Uber/Lyft drivers; TaskRabbit workers; Airbnb landlords; Online marketplace sellers; Volunteers; Artists. But the list should also include: On-call workers; Multiple job holders; Contingent and part-time workers; Highly skilled contractors; Seasonal workers; Consultants; And many others. Gig economy participants sometimes treat their gigs as their main source of income, and sometimes as a secondary one. Some of them are highly skilled and this mode of work is their choice, some are unskilled and have no alternatives (*Duszynski, 2022*).

We believe that a deep understanding of the opportunities and threats of the implementation of the concepts of Industry 4.0 and Industry 5.0 in Ukraine can become a decisive step in the implementation of the digital economic development strategy of the country. Within the framework of the study, we consider it necessary to note the difference between these Industries (Table 55, Table 56). Industry 4.0 is an updated concept of "smart factory", identified with the Fourth Industrial Revolution and the emergence of cybersystems, it is one of the phases of digitalization and demonstrates full automation and robotization of production, development of information and communication technologies (*Manzhura et al., 2021[a]; Shtepa et al., 2021[c]*).

"Industry 4.0" is one of the higher phases of digitalization (functionality exclusively within the 6th technological mode), compared to "smart factories", where such technologies as big data analytics (Big Data), machine learning, m2m-communications, artificial intelligence, a new generation of robots (*HITECH office, 2016*). "Smart factories" (from the English – smart factory, "smart production") – the concept of "digitalization" of industrial production in order to improve their operational activities and business efficiency, work within the 5th and 6th technological way. "Smart factories" appeal to such technologies as "cloud" computing, wireless communications, remote control and maintenance, cybersecurity, integration of control systems, integration and better cooperation in the value chain, 3D printing (*HITECH office, 2016*).

So, Industry 1.0 is about Mechanization, Industry 2.0 is about Electrification, Industry 3.0 is about Automation, Industry 4.0 is about Digitalization, and Industry 5.0 is about Personalization and about the interdependence of man and machine using cognitive computing and human intelligence. Mass customization and personalization for humans. The Fifth Industrial Revolution, or Industry 5.0 will be focused on the co-operation between man and machine, as human intelligence works in harmony with cognitive computing. By putting humans back into Industrial production with collaborative robots, workers will be upskilled to provide value-added tasks in production, leading to mass customization and personalization for customers. Industry 5.0 can be considered as a new quality collaboration, customization, personalization, human intelligence, cognitive computing, optimal balance of efficiency and productivity. Industry 5.0 is a new production model where the focus lies on the interaction between humans and machines (*Breque et al., 2021; Müller, 2020*).

Table 55 – General characteristics of Industry 4.0 and Industry 5.0

Industry 4.0	Industry 5.0
1	2
Focus on equipment connectivity	Focus Customer Experience
Mass personalization	Hyper-Customization
Smart Supply Chain	Responsive & Distributed Supply Chain
Smart Products	Interactive Products (Experience-Activated)
Remote workforce	On-site Workforce

Source: author's development

The previous tier, Industry 4.0, emerged with the arrival of automation technologies, IoT and the smart factory (characterizes the content of the 6th technological way). Industry 5.0 takes the next step, which involves leveraging the collaboration between increasingly powerful and accurate machinery and the unique creative potential of the human being (characterizes the 7th technological structure). Industry 5.0 provides a vison of industry that aims beyond efficiency and productivity as the sole goals, and reinforces the role and the contribution of industry to society. It places the wellbeing of the worker at the center of the production process and uses new technologies to provide prosperity beyond jobs and growth while respecting the production limits of the planet. It complements the existing "Industry 4.0" approach by specifically putting research and innovation at the service of the transition to a sustainable, human-centric and resilient European industry.

Table 56 – Characteristics and Differences between Industry 4.0 and Industry 5.0

Type	Industry 4.0	Industry 5.0
1	*2*	*3*
The type of economy in which the corresponding Industry is being implemented	Lays foundations for the formation of the digital economy. Acquires the characteristics of the network economy.	The development of the digital economy, at the same time, the formation of the gig-economy can be traced, the economy functions in conditions of virtual and augmented reality.
Features inherent in the production of Industry	Automation of production, its standardization, harmonization of initiatives and development programs. The emergence of cyber production, cyber systems, cyber machines that exist and are not yet integrated into one network at all levels of economic aggregation.	"Living" devices, smart services, smart assets, smart business. Cyber-physical systems, united into one network, interact in real time, self-adjusting, self-learning. Virtual secretaries, smart advisors, virtual assistants.
Technological mode that is the core of industry	6th technical and technological mode	7th technical and technological mode
Possible implementation options	Submarine superliners, string transport, electric vehicles, aerospace transport systems. Waste-free and closed technological "chains". Nanotechnology, amorphous metals, materials with memory, high-temperature superconductivity, torsion technologies for processing materials. Water purification, seawater desalination, modified agriculture, disease treatment, cloning. Bioenergy, optics, quantum vacuum computers, artificial intelligence, torsion communication systems.	Technologies of "thermonuclear fusion", psi-technologies (achievements in modern psychology, including new means of managing people), bioenergy, technologies related to morality and responsibility. The 7th mode is implemented on the basis of the formation of Industry 5.0 with the help of: • hyperintelligence, • hyperknowledge, • hyperinformation, • hypercommunication, • "Games with the subconscious and mind". The presence of 5 cognitive technologies is predicted:

(Continuation of Table 56)

1	*2*	*3*
Possible implementation options	Hydrogen energy, synthetic fuel, solar energy converters, closed-cycle nuclear power plants, fast reactors, vortex heat generators.	• neuroimaging, • cognotropic drugs • cognitive assistants, • Brain-Machine interfaces, • artificial sense organs.
The main factor of production	novation and innovation	creative intelligence
Type of enterprise	Innovative enterprise prevails. Innovative enterprise – enterprise (association of enterprises), develops, produces and sells innovative products and (or) products or services, the volume of which in monetary terms exceeds 70 percent of its total volume of products and (or) services (*zakon.rada.gov.ua*, 2012).	Digital entrepreneurship and e-business are represented in small, medium and large businesses. Digital entrepreneurship – entrepreneurship that is fully digitalized as a result of the use of digital business technologies based on digital platforms with ERP, CRM, SaaS systems, etc., digital specialists who develop, produce and implement a digital product / service, at the same time, is accelerator of the socio-economic life of Society 5.0 in virtual reality and is able to increase quickly the GDP of any country.
Electronic commerce model that prevails	Business-to-consumer model (B2C) – the subject (producer of goods / services) is the business, and the object (consumer of goods / services) is the consumer. The model is consumer oriented.	Business-to-business model (Business-to-business: B2B) – the subject (producer of goods and services) is business and the object (consumer of goods / services) is business. Priority and concentration of efforts on the development and implementation of the so-called industrial orientation of Internet, which provides for the application of high technologies in industry. Limitless B2B market will be created

(End of Table 56)

1	*2*	*3*
Electronic commerce model that prevails		for digital companies, the development of new areas and development factors will be stimulated, where the leading role will be given to production innovations solely based on “green” and low-carbon technologies.
General characteristics, presentation of the content of the Industry	Develops industry taking into account the trends of the new industrial era. This is about the transition to fully automated digital production, controlled by intelligent systems in real time in constant interaction with the external environment, going beyond the boundaries of one enterprise, with the prospect of their network interconnection on a global scale.	This is the highest stage of digitalization and represents the concept of innovative digital production, which includes sufficient assets, smart services, smart business and smart government. The ecosystem of Industry 5.0 is a dynamic, adaptive “organism” that is aimed at the technological development of the country according to the 7th technological mode and not only because of territorial cooperation, the participants of which, by combining their resources, pursue the goal of joint achieving innovative results on mutually beneficial principles, but also full use of the potential of virtual and augmented reality that opens up from the use of public digital platforms (public economy / sharing economy).

Source: author’s development

Technological structure is a set of related industries that have a single technical level and develop synchronously. The change of technological devices dominating in the economy causes an uneven course of

scientific and technological progress. The 7th technical-technological structure is a combination of "fusion" technology and psi-technology, which are synchronously evolving with bioenergy, cognitive technologies (such as neuroimaging, cognotropic drugs, cognitive assistants, brain-machine interfaces), artificial organs, technologies and organs related to morality and responsibility. This technological way of life is realized with the help of hyperintelligence, hyperknowledge, hyperinformation, hypercommunication.

Analyzing the content of Table 56 through the prism of the concept of socio-technical systems in contrast to theories of technological determinism, which argued the unilateral effect of technology on man in the process of labor operations, we conclude that Industry 5.0 is also based on human-machine interaction. We are convinced that the design of technical and social conditions should be carried out in such a way that technological efficiency and humanitarian aspects do not contradict each other. The formation of Industry 5.0 lies in the plane of interaction of subsystems of the socio-technical system. Namely:

• We develop a technical subsystem through devices, tools and technologies that convert input into output and in a way that improves the economic efficiency of the organization;

• We strengthen the social subsystem with knowledge, skills, mood, values, attitudes to the functions performed, the system of incentives, quality management structure of industrial development institutions 5.0;

• Considering the connections of organizations with the environment, we have the opportunity to develop a new quality of the subsystem of Industry 5.0 environment, through social values, state and social institutions with which the organizations of Industry 5.0 interact.

Achieving high efficiency of Industry 5.0 organization is possible only when its subsystems, their interaction and their harmonized work are optimized.

Industry 5.0 is currently the highest stage of digitalization and at the same time is a concept of innovative digital production, which consists of smart assets, smart services, smart business and smart government. The visual components that in our understanding reveal the content of the concept of Industry 5.0 are presented in Figure 40. However, it should be noted that we tried to present the concept of Industry 5.0 for the reason that the concept differs significantly from the theory not only in its incompleteness, but also insufficient verification (confirmation). We consider the concept as a system of views on the understanding of Industry 5.0 and its institutionalization, or as a single idea that defines some preliminary, incomplete, and our assumptions for current and future research on understanding the content of

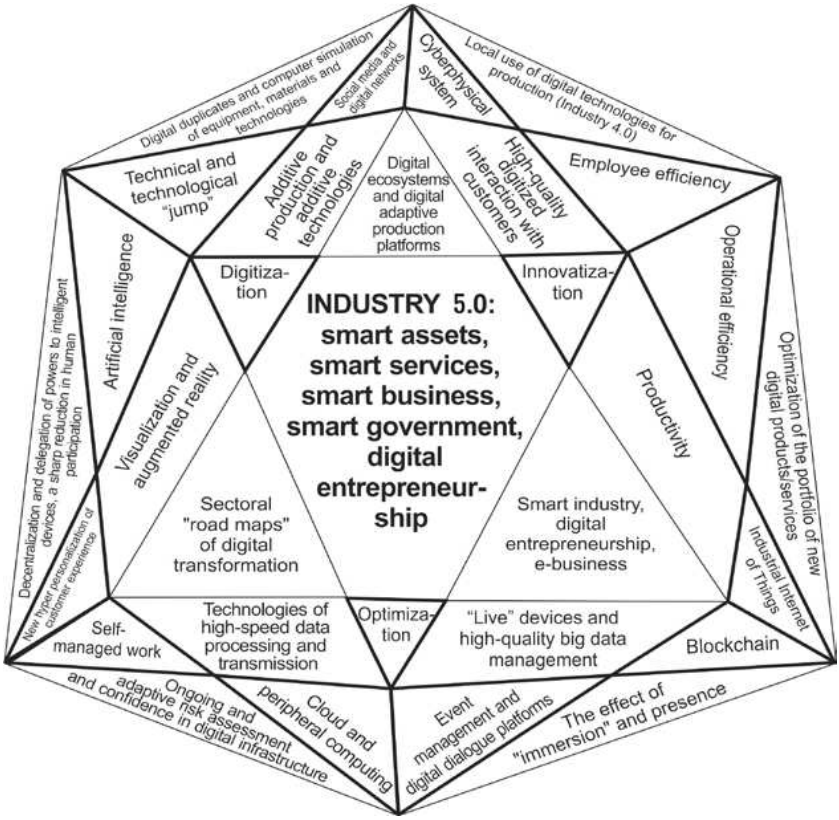

Figure 40 – Visual section of the structural elements of the concept of Industry 5.0

Source: author's development

Industry 5.0 through the prism of its structural elements in the conditions of virtual reality and functioning of the given Industry exclusively within the limits of the 7th technological way (*Marchenko et al., 2021[b]; Kraus et al., 2021[a]*).

In our opinion, the characteristic features of Industry 5.0 are:

1. Full automation of the production process, the management of which is carried out in real time, taking into account constant dynamic changes, can be traced in the external environment.

2. Decentralized decision-making that control physical processes and create virtual copies of objects of the physical world of exclusively cyber-physical systems.

3. High communication maintained between staff and machine, provided by Internet technologies.

4. Cyber-physical systems, being united into one network, interact in real time, self-adjusting, self-learning.

5. Production of goods within the limits of the needs and requirements of an individual order, optimizing the production cost.

6. Production within the needs and requirements of the individual order, optimizing the cost of production. The concept of Industry 5.0, presented visually in Figure 40, is understood by us as a synergy of innovation-digital and business environment with the use of research (*Kraus et al., 2021*[c]), organizational-managerial, institutional, financial-economic and educational resources, which is provided by high-quality work of mechanisms and tools of knowledge transfer, for the purpose of production of the newest products / services by all subjects of an ecosystem of Industry 5.0, through network interrelations of various formal and informal institutes which form public interaction in the course of creation of idea and its commercialization (*Kraus et al., 2021*[b]). The ecosystem of Industry 5.0 is a kind of dynamic, adaptive "organism" aimed at the technological development of the country in the 7th technological way and not only through territorial cooperation, whose participants, combining their resources, pursue the goal of jointly achieving innovative results on mutually beneficial principles but also the full use of the potential of virtual and augmented reality, which opens up from the use of digital sharing platforms (sharing economy / line economy).

Gig-economy and those economic relations that are inherent in it, is a modern form of existence of the information economy on the technological and ideological basis of the Fourth Industrial Revolution (*Manzhura et al., 2020*[b]*; Kraus et al., 2018*). In our opinion, the philosophical meaning of Industry 5.0 is extremely important, which is that its potential, results and impact are reduced to people and their values. Inadequate awareness of business entities about the effectiveness of the implementation of Industry 5.0 concept, the dignity and complexity of its implementation and the novelty of technologies fill it, become an obstacle to the rapid formation of the digital economy. In addition, there are no appropriate institutional conditions for creating a favorable investment climate for the introduction of digital technologies. There is no full funding for the development of the infrastructure of the platform economy and the

preparation of appropriate human resources for the implementation of the digitalization process itself.

Among the obstacles on the way to the accelerated formation of Industry 5.0, the following ones should be named: problems with the general positioning of Ukraine in the field of world Industry 4.0 and 5.0; vague or no positioning of Ukrainian developers in terms of individual segments; there is no consolidated, export program of action with the support of the government. Digital transformation is not only about technology, but also about the business strategy towards the formation of Industry 5.0. The transition to Industry 4.0 and the gradual transition to Industry 5.0 (Industry 5.0 is the next stage of development of the "start" factory / "smart industry", i.e. it follows Industry 4.0) is a complete change of the existing business model, and hence what products, to which customers, through which sales channels and at what price the company will make an offer. Ukrainian companies need to reconsider their approaches to what markets they operate in, what customer problems they want to solve, and what roles they play in the value chain formation.

The secret of business success through e-commerce lies in the constant work on logistics, payment systems and Internet quality. Today, the signs of Industry 4.0 available in the Ukrainian industry can be traced in various sectors of the economy. Successful examples have been presented in Table 57.

To organize and efficiently manage a business, both in the real and digital world, you need metrics. For traditional businesses, there are a number of proven metrics and KPIs that can help you understand how successful your business is. But the virtual-real space has not yet developed such a large number of necessary protocol options for high-quality organization and effective management of digital business, platform economy. This is how traditional business creates values that consumers receive along the chain, conveyor belt at the end.

In this type of conveyor business, products are produced with the lowest cost of resources, then delivered to consumers through well-organized logistics systems, marketing policy, advertising. Having received income, the business covers its costs, and at the expense of profits pays rewards to investors and supports future growth, expands production. The system of indicators of the conveyor business is designed to assess the efficiency with which the flow of values moves through this traditional conveyor. In simplified form, these are key indicators such as cash flow, inventory turnover, net profit, gross profit, overhead and profit aimed at business expansion, and so on. These indicators allow managers to identify problems, obstacles and breakdowns in this chain,

Table 57 – Ukrainian Companies which Have Signs of Industry 4.0, as of March 1, 2020

Name of a company	City, region	General characteristics of the content of the company's work, its product or service
1	*2*	*3*
Distributed Data Systems	Dnipro	the leader of the Ukrainian segment of manufacturers of human-machine interface tools, known for its WebHMI product successfully exported to the EU.
eLaks	Kharkiv	one of the leaders in industrial automation and power engineering in Ukraine. Offers innovative technical solutions for control systems of technological and production processes, as well as electric drives in Ukraine and for export.
Infocom Ltd	Zaporizhzhia	the company with the largest portfolio of industrial high-tech, innovator in the field of solar energy, electric transport and robotics technology, automated transport technologies.
IT-Enterprise	Kyiv	leader in the category of Ukrainian IT developers for Industry 4.0. Development of R&D services (CableDesigner), personnel and equipment integration (Industrial IoT), optimal production planning (AI, APS, MES), predictive maintenance of equipment (RCM).
QRSmarty	Zaporizhzhia	development of accounting system of inventory items in production using laser marking methods.
Lemberg Solutions	Lviv	a service company that helps companies in the EU, the USA and Ukraine create innovative solutions based on the Industrial IoT and Machine Learning.
Oueedo Robotics	Odesa	a startup specializing in the implementation of solutions for collaborative robots (cobots). It is a representative of the 4.0 Centers network in Ukraine, based on the country's leading technical universities.
RWA	Kharkiv	the leader in the automation of railway transport in Ukraine, which specializes in a number of modern solutions for the automation of railway traffic, which is of interest to international partners, including proposals in the Mobility 4.0 segment.

(End of Table 57)

1	*2*	*3*
Virgil Security Inc.	Kyiv	a company specializing in cyber security, including for industry, namely in data protection solutions in complex infrastructure facilities of the energy and industrial sectors.
S-engineering	Odesa	one of the leaders in industrial automation in Ukraine and the production of electrical equipment. Offers patented innovative solutions for transport production lines. EPC contractor in the field of automation and electric power supply.
SMARTICO	Dnipro	one of the leaders of Ukrainian market in the segment of telemetry and industrial IoT. Complete automation solutions based on SMARTICO cloud technologies are implemented today in the segments of industry, energy, as well as in urban infrastructure.

Source: grouped by authors on the basis of (Yurchak, 2020)

increasing the efficiency of the process, which, in turn, provides a rapid passage of more profitable flow of values.

But today's realities of digital space require the development of a new logic of platform business. This is triggered by a number of factors:

– Digital platforms create value due to the impact of network effects, and platform management should focus on the positive network effects and actions of the digital platform that generate them. An indicator of the level of success of interactions that create value and the factors that affect it is a key measure of the functioning of the platform. Therefore, it is important to maintain constant repetition to create the value of interaction. The end result of the analysis should be positive network effects and value creation for all participants, including users of the platform, its sponsors, and managers;

– In the platform business, companies pursue a goal in terms of creating, sharing and delivering value within the ecosystem, and part of this activity takes place on the platform, and part – outside. The goal of the platform business is to create value for all users;

– A number of indicators used in traditional business do not apply to digital business, which operates on an innovative basis, sometimes some of them can be dangerous if they are used in the wrong life cycle of digital business. Innovative business that is implemented on digital

platforms goes through several stages, such as launch or startup, growth and maturity. Each stage has its own system of indicators and protocol for their application. For example, it can be a user base, active producers and consumers, the critical point of the size and volume of the platform, liquidity of the platform, conversion of active users, solvent customers, depth of involvement of users and producers, user-to-manufacturer conversion rate and vice versa (*Davtyan, 2019[a]*).

It is worth noting that Industry 4.0 is essentially designed to digitize and integrate processes vertically throughout the organization through all functions, from product development / acquisition through production, DIEM logistics and after-sales service capabilities. It is vertical integration that defines intelligent integration and digitization at different hierarchical levels of the value chain. This makes it possible to use order digitization processes and products, taking into account customer characteristics, when automatic data transmission in integrated planning and production systems can be guaranteed. It is within the framework of vertical integration that flexible and reconfigurable production structures become possible, which can be adaptable to each specific customer order and market changes. These functions are the main tools for manufacturers to remain competitive in the markets (*Stoct et al., 2016*).

Digitization of the horizontal value chain integrates and optimizes the flow of information and the flow of goods from the customer throughout the corporation to the level of the supplier and vice versa. Within this approach, all internal mechanisms (for example, procurement, logistics, production) will be interconnected with all external partners (*PricewaterhouseCoopers, 2014*). In horizontal integration, the concept of Industry 4.0 will allow all businesses to adapt to new circumstances at all times (to the volume of orders or availability of materials). Under such conditions, automatic optimization of production processes becomes possible due to the integration of customers and suppliers into the value chain (*Lichtblau, 2014*). The content of the step-by-step protocol of formation of Industry 5.0 through the prism of innovations, technologies in the management of the industry and business has been revealed in Table 58.

In the context of the formation and development of Industry 5.0, it should be considered as a high-tech and medium-tech industry. They are considered to be the driving force, the engine of economic growth of innovatively developed countries. The focus should be on the practical implementation of the following steps:

• Focus on industrial high-tech, where the key advantage for the national economy is a talented and cheap labor force, which determines an efficient engine of industrial production. In addition, industrial high-

Table 58 – Protocol of Industry 5.0 formation through the prism of Innovations, Technologies in Industry and Business Management

Name of the stage	General characteristics of the stage	Step-by-step content of the stage and its possible sub-stages
1	*2*	*3*
Defining the innovation basis of a "technological breakthrough" in a particular industry, forming Industry 5.0	Not every innovation will become a great thing in the future and not every new technology will redefine the rules of the game. Disruptive innovation depends on sector and in fact can only work effectively for individual enterprises. Companies must constantly scan the horizon for potential game changers, that is, events or changes that fundamentally change the situation.	Potential industry trends. Studying industry trends can reveal potential investments by competitive or adjacent participants in the value chain, as well as threats to sector convergence. In addition, it can help to predict potential areas for future changes in the industry. By critically examining the value chain, one can identify problem areas that a disruptive innovation initiator can try to eliminate or losses that can be prevented by a new or different approach. Evaluating changes, one can determine where there are likely reputational issues or potential loss of trust. This is where new competitors can "play" to gain market share.
		Disruptive technologies. Latest technologies provide opportunities that can significantly change the business environment. Every potentially disruptive technology must be examined for its possible application in a particular sector. To assess the situation, it is most important to review the activities of startups in the field. It is also necessary to analyze the use cases of recognized disruptive technologies from other sectors and assess which of these technologies or their combinations may be key in the further development of activities.
		Strategic technologies. Analyzing and assessing disruptive changes, it is worth paying attention to the value of disruptive technologies. An analysis of the values of revolutionary technologies will allow to determine priority technologies for further study and a clear delineation of investments.

(Continuation of Table 58)

1	2	3
Threat Assessments	Assessment of the impact of disruptive innovation, changes on business. It is important to understand that ongoing disruptive innovation can have different implications for different enterprises, even within same sector, that is, a differentiated approach must be applied. To assess the impact of the most promising disruptive changes, one should study business models, operations and financial performance of enterprises. Studying the above areas of the enterprise's work in a complex will create a holistic picture, determine where the impact will be felt in the first place and what are its cascading consequences.	*Business model.* Each element of the business model must be considered to identify potential weaknesses that could be used by a disruptive change initiator. Market participants must explore new opportunities to tailor unique value propositions to customer needs, increase costs and improve coverage. New market entrants can disrupt value chain, take it to a qualitatively new level or change markets, affecting the area and challenging the fundamental principles of its development. Disruptive innovators can play the game to get rid of intermediaries and "take over the customer".
		Financial model. This model covers income, expenses, profits, investment models and taxation. The influence on financial model can be carried out in several directions, namely: new models for generating income; increased volatility and the emergence of new competitors can reduce investment; profitability may be jeopardized by declining revenues, customers, price pressures and increased costs; threats to the long-term competitiveness of a business can directly affect the ability to raise capital. The potential impact of the initiators of the technological breakthrough on the financial model can be assessed by developing and running scenarios that involve stress testing the main assumptions in the model, checking its robustness and identifying vulnerabilities.
		Operating model. Development in technology accelerates changes in operating models. For example, "artificial intelligence" and "machine learning" allow you to consider certain cases of payment of insurance compensation in a matter of seconds, instantly destroys the traditional model of considering an issue, assessing and making decisions by a person.

(Continuation of Table 58)

1	2	3
Determination of a course for further development and route plan. *The four main approaches organizations can take are: defense, innovation adoption, disruptive innovation initiation, retreat*	A widescale technological breakthrough can radically change the main components of an organization's current strategy and cause the need for its revision. Therefore, it remains important to assess the relevance of the existing portfolio of strategic initiatives. Significant sources of value should be identified, assessment criteria agreed, priorities reconsidered and investment areas redefined. It is advisable to consider important disruptive changes and determine where the innovator gains advantage, where the defensive play is required, and where it is more profitable to copy quickly the innovation of others.	*Defense*. Sometimes, potential disruptive innovation can be countered by creating barriers or other similar defensive actions. However, this becomes, as a rule, a short-term strategy.
		Innovation adoption. Attempt to integrate disruptive technologies into a company's business or operating model
		Retreat. Admission of failure and trying to keep the maximum profit, focusing on the development of other areas of activity
		Disruptive innovation initiation. Companies can decide to innovate and disrupt the market. Such a move inevitably leads to total dominance of the current business model, but can also provide an invaluable advantage for the innovator.
Implementation of structural changes at the level of the organization's DNA	Change of culture, as the successful choice of an approach to technological breakthrough depends on it. Employees of the organization must become open to change and be encouraged and stimulate innovation in every possible way in order to break stereotypes.	Culture change must start from the "top". The organization's management should consider disruptive innovation as a priority. This issue should be regularly discussed by senior management and it should form the main part of the current strategy. To move beyond modernization and develop a truly innovative approach to disruptive change, organizations must find solutions to incubate innovative ideas and effective ways to integrate innovation from startups back into the business. Classic linear approaches of phased planning and 2–3-year implementation programs should be replaced by adaptive approaches and traditions of constant experimentation and quick decision-making that break stereotypes.

Source: author's development

tech traces the presence of cross-sectoral, technological areas, including artificial intelligence, cyber security;

• High-quality transmission through the chain of "segmentation-targeting-positioning" type, which allows achieving effective geographic segmentation, entering attractive markets and as a result of the desired positioning in new countries;

• Design (mechanical, electronic, electrical, technological, construction);

• Working out of startup projects in close cooperation with integrators and big brands;

• Development of real support of state stakeholders in the organization of target companies for industrial high-tech, adherence to coordination, integration, improvement of communication between all stakeholders during the implementation of the national innovation strategy;

• Development of easy scaling of successful startup projects to global markets through the implementation of not only the B2C model (business for consumers), but also B2B (business for business);

• Building up in terms of industrial automation and integrated engineering (including the commissioning of complex industrial facilities);

• Creation of real sectoral and regional innovation ecosystems, the participants of which must be IT companies and their customers, state and commercial institutions (including educational institutions, office lessors), IT entrepreneurs and full-time employees, suppliers of computer equipment. Since all actors in the innovation ecosystem influence each other, they must be flexible in order to develop the market quickly and compete with the global market;

• Collaboration with associations and innovation clusters, cooperation with leading industry and profile experts, marketing agencies, venture studios, creation and quality work of the site-marketplace;

• Establishment and effective development at all stages of venture studios performance: 1) *search for and verification of the idea* (the idea may belong to a startup or studio: market and target audience definition); 2) *creation of prototypes* (definition of the main feature, creation of design); 3) *hypothesis testing* (site, usability tests, funnel testing, change of project development direction); 4) *packaging* (creation of the final product model, design, presentation); 5) *project analysis* (determining success, creating reports, allocating resources).

European institutions have identified along with the formation and development of digital business with the characteristics of both Industry 4.0 and Industry 5.0. The procedure involves the following steps:

1. When you set up a website for your business, you should decide if you'll be opening an online shop in addition to your general information website. If your idea is to set up an online shop, you can either: do it

yourself with your own resources, engage an online shop provider and develop it externally. In either case, there are specific things to keep in mind to offer your customers a transparent and user-friendly experience.

2. Setting up a business website (if you choose to use a third-party platform, which is any software developed externally to you or your core website provider, there are certain additional elements to consider).

3. Selling online using a third-party platform (if you choose to set up an online shop yourself, make sure that is compliant with rules and regulations).

4. Setting up your online shop (in all cases, be prepared to secure your website against any threats that could ultimately impact your business, such as data theft).

5. Securing your website (once you have completed a sale online, remember to also consider your obligations related to deliveries, fulfilment, and any type of customer service).

6. Deliveries and fulfilment for online sales.

7. Customer service for online businesses (promoting your business online is another important part of digitalization. Remember to adhere to specific rules related to business practices online to keep your promotional efforts fair and transparent to your customers).

8. Promoting a business online (*Your Europe, 2021*).

Pursuing the goal of using all the power of existing information technologies, it is obvious that it would be worthwhile to abandon the old processes, rethink the content of work, radically restructure the processes and give businesses a new format of cooperation. These circumstances determine the need to ensure the variability, dynamism and adaptability of economic development processes, based on the digital context and innovation. The development of production processes in terms of their digitalization and innovation of the economy can be divided into the following stages: standardization, adaptability, and prediction. In the early 20 century, automation laid the foundation for standardization, during which there was an improvement in efficiency, consistency and productivity. As the standardization progressed, the processes became automated, and this made it possible to reduce costs, increase speed and improve quality. Today, positive shifts can be expected for business by changing the content of the work itself. To achieve this, owners of all types of businesses need to attract investments in information technology as quickly and in such large volumes as possible but not in the automation of the traditional methods of work.

Top management and time management should realize that it is impossible to obtain a positive effect by applying the methods of the past in the context of the digitalization of the economy. The reason for this is that many existing procedures, job descriptions, a number of work processes,

control mechanisms and organizational structures are not compatible with the latest information technologies available. To use modern information and communication technologies to their full potential, it is necessary to abandon old processes, rethink the content of work, radically restructure the process and give businesses a new format of work, both with the external environment and within the organization.

As a result, organizations will have new opportunities to ensure variability (dynamism) and adaptability of processes based on the context. That is, constantly assimilating and processing new information taking into account the current business context is a chance for businesses to adapt processes during their implementation. This very stage is quite complicated and it completely new methods of doing business are used on it. Transformation of processes enables companies to become more flexible and faster. In addition, at any time, it is easy to adapt to behavior, take into account the tastes and needs of customers and employees. This ability to adapt is based on BigData and an algorithm for enhanced digitization of processes.

New processes open up new opportunities for companies to adapt to the changing environment and the "digital landscape". They meet the following requirements of digital time, namely: "innovation", "speed", "service", "individuality" and "quality". But there's a period coming when for business work in the system of "real-time changes", as they say "changes along the way", will be lagging behind. This is what will lead to the emergence of the next stage of development of processes – their prediction, both existing and new ones. An organization will need to identify information, make decisions, and proactively adapt its processes based on what may occur. With the development of algorithms, digitization and implementation of IoT, it will be possible to "extract" reality from big data, as a result of compiling a complete psychography and behavioral map of any person (*Davtyan, 2019*[b]).

The ways and tools that will accelerate the formation of Industry 5.0 are as follows:

• Developing of a roadmap for the implementation of special conditions for accelerated development and attraction of investments for all medium and high-tech sectors;

• Approval of new innovative and industrial strategies and their harmonization or, if necessary, transparent and direct correlation;

• Accelerated clustering based on innovation hubs in the 5.0 and 4.0 area at all levels of economic aggregation, internationalization and integration into the global innovation space 5.0;

• Implementation of sectoral strategies within the framework of the Export Strategy of Ukraine. So, if to take the IT sphere as an example,

we realize that in the global space they have been talking for a long about specific digital sectors that have industry links – as FinTech (digital finance), MarTech (marketing), MilTech (defense), CleanTech (green technology) and alternative energy), AgriTech (precision agriculture), Industry 4.0 (production processes in industry, energy, infrastructure). In the Ukrainian Digital Agenda, which was presented in 2018 by the Cabinet of Ministers, all these issues are presented quite reasonably, namely:

• Launching of a digital platform, which is designed to facilitate the integration of the national startup ecosystem into the global space;

• Institutionalization of the development of industrial high-tech at all levels of economic aggregation, that is, complete synchronization of industrial, innovation and 5.0 strategies;

• Profiling and engaging in cooperation in government programs of both governmental and non-governmental institutions.

Digital technologies are needed to increase the efficiency of Ukrainian industry, and in some sectors, they are becoming the basis for product and production strategies. Their transformative power is changing traditional business models, value chains and driving new products and innovations. Digitalization for Ukraine is positive because it is focused on improving the quality of social welfare infrastructure and social services, organizing transparency and targeting social assistance, and thus reducing costs (*HITECH office, 2016*).

Main characteristics that determine the formation of the smart industry, smart business, and smart services include:

• A comprehensive focus on services, where it is expected that not only the interaction between devices and systems will be traced, but also there will be deep coherence in terms of cooperation between ecosystem participants and individuals;

• Virtual reality, which in Industry 5.0 creates virtual copies of intelligent physical objects (scaling from a small device to a factory or factory);

• Launch and effective operation of various mechanisms of simulation, economic modeling, digital expert assessment of the real state of the economy;

• Decentralization, which in Industry 5.0 allows in some cyberphysical systems to make their own decisions and interact qualitatively with another more optimal way;

• Interoperability, which allows individuals to effectively connect cyberphysical systems and smart lines of plants / factories;

• Modularity, which allows flexible adaptation of smart factories to external institutional changes through easily changeable individual modules of the management system;

• Temporal reality, as all data and their analysis can be obtained in real time.

Summing up the conducted study, it is worth noting that a focus on industrial innovation and investment, a special focus on digitalization and sustainable development, building global value chains, inclusiveness and prioritizing investment should, in our opinion, become key topics for further research. In addition, in practice, a broad coalition should be created with educators, officials, analysts, high-tech, economists, industrialists, scientists who will fully join the formation of Industry 5.0 based on digitalization and innovation. In the course of our research, we came to the conclusion that Industry 5.0 represents a new approach to organizing production in a virtual reality environment, which is based on highly intelligent integrated newest products and digital ecosystems that form a completely innovative digital value chain, adding new competence and implement deep cultural changes in the direction of the formation of a new virtual reality. “Living” devices, smart assets, smart services, data management are the foundation of Industry 5.0 concept.

We are convinced that the digital transformation opens fundamentally new horizons and opportunities for the formation of added value in virtually all areas of the economy. The digital transformation is not only about technology, but also about the business strategy towards the formation of Industry 4.0 and 5.0. It is possible to accelerate the formation of Industry 5.0 in the context of innovation and digitalization of economic relations in the gig-economy if the following mechanisms are implemented in practice and tools are applied, including: the formation of a list of public-private partnership projects for investments in digital infrastructure (among the priority areas should be energy, digital technologies, infrastructure); starting work in venture capital studios as platforms that provide startups with the necessary expertise and infrastructure for the purpose of innovative digital development, testing the viability of projects, attracting investments and creating “greenhouse” conditions that are best suited for turning a startup into an independent digital business.

The updated approach to the concept of Industry 5.0, taking into account the digitalization of economic relations in various modifications, will be used in all sectors of the national economy and will transform the economic system, modernize production and digitize entrepreneurship, and thus have a positive effect on strategic socio-economic development and financial systems, achieving a high level of national security and financial independence of Ukraine. The presented ways and tools to accelerate the emergence of Industry 5.0 in virtual reality can be used

in the military sphere, in particular to identify gaps in the functioning and development of strategic facilities. This, in turn, will avoid the loss of economic potential and lay the foundations for financial stabilization in the future. The research results will be of practical significance for critical infrastructure, industry, medicine, agriculture, education, IT sector, financial system.

Given that Industry 5.0 is a digital rethinking of all manufacturing, in which businesses use new digital technologies to digitally transform their core processes and functions, interact with customers and employees, and ultimately their business models, so it makes sense new systems and products, new approaches to processes, the ability to obtain data from sensors and sensors that are now everywhere, and innovative technologies such as artificial intelligence allow us to achieve new levels of efficiency in R&D, engineering, manufacturing and back office functions, thus requiring additional costs, research and proper scientific attention. In addition, hyperpersonalization, augmented reality and virtual mobility are fundamentally changing the way businesses interact with their customers and even their own employees. Smart products, services and entire production lines based on the new Industry 5.0 ecosystems open up previously unavailable business models and sources of profit through the quality of digital entrepreneurship.

As a result of the research conducted, we came to the conclusion that design of technical and social conditions should be carried out so that technological efficiency and humanitarian aspects do not contradict each other. This fact is evidenced by the existing scientific approach Sociotechnical systems (STS). After all, we are talking about the study of the interaction of infrastructural elements of society and the infrastructure of Industry 5.0 and Industry 4.0, the substantive realizations of society, on the one hand, and human behavior – on the other hand. In addition, the socio-technical system is formed by such subsystems as: technical subsystem includes devices, tools and technologies that convert input into output, a way to improve the economic efficiency of the organization and a social subsystem that includes employees (knowledge, skills, mood, values, settings, attitudes to the functions performed), management structure, system of incentives.

We are convinced that in the near future Ukraine will become high-tech and post-industrial and will be integrated into global technological value chains, producing unique engineering services and high-quality products in them. Further research and development are necessary to direct to find the ways to implement the operational objectives and strategic goals of the Government of Ukraine and, accordingly, the nature and content of socio-economic policy in the digital economy.

5.3. Cyber security and digital armor of business players

Pursuing the goal of effective functioning in today's conditions, business is forced to quickly repel cyber-attacks and a number of existing cyber threats. Today, in the first place are the problems associated with the formation and development of cybersecurity of digital entrepreneurship, using modern information and communication technologies for economic development at the micro and macro levels and stabilization of social development in general.

Modern technological trends such as e-commerce, blockchain, Internet of Things, computer engineering, modern wireless technology, the spread of new business models in the use of advanced digital technologies, cloud computing, big data analysis create all opportunities for new quality doing business. At the same time, along with innovation, there is some complexity and acceleration in digital environment, which causes the problem of digital security.

Digital economy is an economic activity in which the key factors of production are data in digital form or activities for the creation, dissemination and use of digital technologies and related products and services. Digital economy is, in essence, an innovative superstructure of the real economy, which, at the same time, cannot exist in isolation from material production.

The potential benefits of these digital technologies are certainly enormous, but their implementation poses threats to the security of members' personal information in society, and the slightest outflow of data undermines faith in innovation and the economy as a whole.

In addition, the rapid growth of cybersecurity violations in digitalization of the economy, which is observed today, is closely related to the constant complexity and growth of digital technologies, which, moreover, are constantly improving (*Kraus et al., 2018*). For these reasons, it is important to take advantage of all available opportunities provided by modern cybersecurity tools to maintain market competitiveness.

Changing world presented today: Use of data growing exponentially, same for the collected PII; Adversarial machine learning and AI; Evolving ramsomware; Use of cloud platforms; Mass collection of marketing data; Collection of data from children. The marketplace is full of fragmented point solutions: infrastructure security, threat solutions, compliance tools, identity solutions, end-point security, IOT security, security management, datacenter security, information solutions. We are convinced that in the conditions of digitalization of the economy there is an urgent need for a part Integrate security into your platform, services, and productivity tools (Figure 41).

Intelligent security

- *Identity & access management.* Protect users' identities and control access to valuable resources.
- *Information protection.* Ensure documents and emails are seen only by authorized people.
- *Threat protection.* Protect against advanced threats and recover quickly when attacked.
- *Security management.* Gain visibility and control over security tools.

Figure 41 – Intelligent security in terms of digitalization of business

To get started with intelligent security:

• Begin with a customized Value Discovery Workshop;

• Calculate the expected ROI of digital transformation with our Value Calculator;

• Chat with an account specialist to design your strategic approach.

The security criteria of modern digital entrepreneurship include the following mandatory facts:

1. Data must always be encrypted during storage and transmission.
2. Encryption should take place at the client level.
3. Only the client should have access to the encryption keys.
4. Actual data shall not be transmitted through open mail channels.
5. The company must control the storage of encrypted information and access keys to it.
6. The decision must comply with the law (e.g. GDPR).

The information security policy of the enterprise should consist of following sections:

• The purpose of the document, main tasks of information security of business entity;

• Scope of application of Company's Information Security Policy;

• Role and responsibility for information security;

• The purpose of information security at the enterprise;

• Principles (rules, requirements) of information security of the enterprise;

• List of interrelated documents, including legislative and other normative legal acts of Ukraine, international, national standards on information security and protection against cyber threats;

• Revision of Information Security Policy of the enterprise (which subdivision, service, officials review the Policy, who is responsible for the changes to the Policy, who is responsible for the support of the Policy);

• History of changes in the document.

Main threats to the cybersecurity of digital economy today are encryption viruses, such as encrypting viruses, which penetrates not only personal computers but also networks of strategic facilities, nuclear power plants, airports, defense companies, large factories – viruses that can cause man-made disasters.

The losses from such intrusions are estimated at hundreds of millions of dollars. Most relevant for businesses cyber threats include phishing (22%), cyberattacks (to disrupt activities) (13%), cyberattacks (to steal money) (12%), fraud (10%), cyberattacks (to steal money) intellectual property) (8%), spam (6%), attacks from within the enterprise (5%), natural disasters (2%), espionage (2%) (*SIDCON, 2019*).

Statistics confirm that 96% of cyberattacks and data leaks start with e-mail. Email is protected just like a postcard, because emails "pass" through vulnerable and potentially dangerous mail servers. However, SSL/TSL does not guarantee security. Today, data interception and hacking are possible for only $ 200, and network implants for traffic interception cost only $ 60. Not surprisingly, browsers are usually vulnerable to hacking. The e-mail infrastructure does not verify the sender. The company's perimeter security features do not protect e-mail after sending emails.

From these facts it is clear that the underestimation of cybersecurity by the company leads to great losses and losses, to breach of confidentiality and outflow of data, disclosure of trade secrets, opportunities for industrial espionage, unforeseen problems of business processes, intellectual piracy, reduced quality of products and services.

Entrepreneurial practice has shown that Ramsomware is the most common threat in the implementation of business processes. Ramsomware can be divided into two main types – encryptors (cryptocurrencies – "cryptoransomware") and blockers (blockers – "blockers"). Encryptors, when they get to main computer of the enterprise, encode valuable files: documents, photos, databases, etc. For decryption, the creators of ciphers demand a ransom – an average of about $ 300.

Types of ramsomware are as follows:

1. Screen lock (shows a threatening window and indicates that the user's computer is locked; you can usually resolve the issue without adverse effects).

2. File encryption (encrypts user files, displaying a window with a threatening caption; usually not decrypted, because only cybercriminals have a decryption key).

3. Boot ramsomware (overwrites the MBR (master boot record), encrypts the hard drive, shows a threat message when the system is booted; usually not decrypted, because only cybercriminals have a decryption key).

The threats to Ramsomware through business impact are as follows, namely:

• Temporary data loss can completely disrupt extremely important business processes (lost sales, reduced productivity, significant costs for system recovery, loss of reputation);

• Constant data losses lead to a decline in the company's competitiveness, reduction of sales revenue in the long run, disruption of continuous access to data.

Main problems faced by cryptographers include:

• Ransom payment (this is expensive, it also encourages criminals to create new cryptographers);

• According to statistics, 20% of those who still paid the ransom to criminals and did not get their files back.

From the above, it is clear that in this publication it is appropriate to find out the reasons for the increase in the number of crimes. Such a large number of different gadgets has led to the fact that users are completely unprepared people. It is not uncommon for 3-4-year-old children to go online.

Main problem today is the extremely low computer literacy of the population. Software developers are concerned about the rapid entry of the product into the market. They are not interested in the security problem of the user who bought the product. Cyber threats are closer and more real than you might think. Even protests are already moving into cyberspace.

A cyberattack can be carried out on any resource or digital service available 24 hours a day, 365 days a year, just as freely, and most importantly – you can buy anonymously with cyber weapons or order a turnkey attack. This fact certainly contributes to the development of the shadow, illegal and criminal market in cyberspace, because it already has significant technical capabilities for "ideal" crime.

What caused such a rapid decline in computer literacy? Statistics show that the number of personal digital devices in families is constantly growing. The level of knowledge about cyber threats and ways to protect against them among some Internet users is absent as such, and in others – is significantly reduced. According to research, users increasingly prefer mobile devices: 59% of respondents today access the Internet mainly from a smartphone, and in 2012 this figure was only 36%. However, it is in this segment that the neglect of protection is most noticeable.

Threats when using smartphones are as follows:

1. Interception and listening to subscribers' conversations.

2. Falsification of subscribers' conversations for the purpose of compromising.

3. Remote activation of microphone and camera of the phone and further unauthorized listening to conversations, photo and video shooting.

4. Sending SMS and MMS messages that contain viruses and “steal” information.

5. Unauthorized access to a mobile phone.

6. Malicious software capable of executing unauthorized remote commands.

7. False authentication and authorization lead to unauthorized access to information, including by forging a unique subscriber ID.

8. False base station, so-called IMSI trap, which lowers the standard level of encryption and makes it easier to intercept and listen to mobile phone data.

9. Loss of data from lost and stolen mobile phones.

10. Breakdown of protection of short-range wireless high-frequency communication modules Near Field Communication (NFC) built into mobile phones.

Known attacks on confidential information and personal data include: Dentons correspondence published on Internet; sale of personal correspondence of statesmen in Ukraine.

As for the theft of company employees’ accounts, it happens regularly. So, for example, VAL.UA:

2 533 total number of attacked company records;

OSCHDBANK.UA: 33 total number of attacked company records;

PRIVATBANK.UA: 24 338 total number of company records attacked;

NAFTOGAZ.COM: 114 total number of company records attacked;

ZAPORIZHSTAL.COM: 293 total number of company records attacked;

UZ.GOV.UA: 1 381 total number of attacked company records.

The world experience of cyberattacks also deserves attention. Thus, the broken MOSSACK FONSECA mail server resulted in personal data of shareholders and directors of 214 000+ companies in 200 countries in 21 offshore zones becoming available; the property of 140 politicians and civil servants became known; “Leakage” of documents under agreements worth $ 2 trillion.

The experience of the hacked Delloite mail server made confidential information available to US Department of State, US Secretary of Energy, Homeland Security and Defense; data of 350 clients became known, including 30 leading companies, 4 international banks and 3 airlines; there is no two-factor authentication.

In the light of such criminal cyberattacks, of course, it is logical to develop various types of protection in order to protect data from their

interception. This protection must be invisible to the naked eye; have a secure mail channel; E-mail certificate; E-mail safe; E-mail shredder; cyber security center; encryption of letters and attachments; protected view Table 59.

Risk – clear text secret. Workstation → Source control → Deploy tool/Config tool → Host.

Table 59 – Managing secrets

	Workstation	Source control	Deploy tool/ Config tool	Host
1	2	3	4	5
Plain text secrets	-	-	-	-
Private branch for secrets	secret	-	-	-
Rewrite secrets during deploy	secret	secret	+	secret
Environment variables for secrets	secret	secret	+	secret
Managed identity	secret	secret	secret	secret

Creating a high-quality, reliable, with a high degree of protection of cloud infrastructure from cyberattacks, we will try to summarize below (Figure 42).

Security 101: Authentication – the process of showing something to be true or valid. Authorization – the process of giving someone permission to do or have something.

Main tasks of enterprises in terms of cybersecurity should be: identification of potential threats to cybersecurity of enterprises and

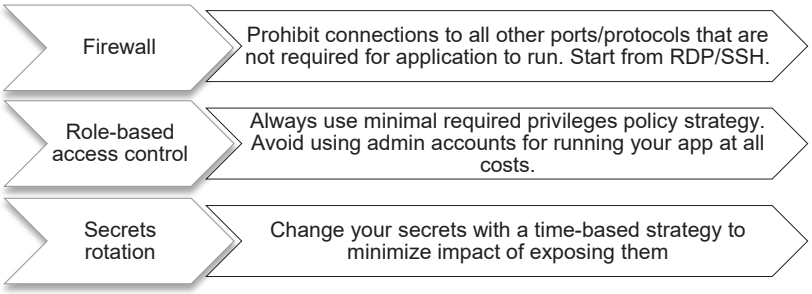

Figure 42 – Ways to ensure cyber security

vulnerabilities; cyber incident prevention; neutralization or minimization of threats to information security of the enterprise (Table 60).

Cybersecurity of enterprises should be achieved by:

• Organizing the collection of information about the internal and external environment of the enterprise;

• Conducting information-analytical research of clients, business partners and competitors, information audit and information monitoring at the enterprise, analytical information processing;

• Organization of the system of information support of decisions of management and owners of the enterprise;

• Definition of categories of the information processed by the enterprise and working off of corresponding measures for its protection;

• Compliance with the relevant modes of activity of the company;

• Observance by all employees of the enterprise of norms and rules of work with the information with limited access;

• Timely detection of possible channels of information outflow with limited access (*SIDCON, 2019*).

Table 60 – Managing access

	Firewal	Role-based access control	Secrets rotation
1	2	3	4
Plain text secrets	+	-	-
Private branch for secrets	+	-	+
Rewrite secrets during deploy	secret	secret	+
Environment variables for secrets	secret	secret	+
Managed identity	secret	secret	secret

We strongly believe that industry standards for cybersecurity should be developed and approved at the state level. It is important to create conditions for effective cooperation between the state and other economic entities in order to establish reliable data collection on cybersecurity incidents at the level of large and medium-sized enterprises. Today, both individuals and businesses are not always able to say with certainty that they are dealing with information leakage or other cybersecurity violations.

The following instructions regarding the procedural management of cyber incidents must be implemented in enterprises. Namely:

1. Develop procedures for handling various types of cyber incidents, including: failure of information system; malicious code; error as a result

of incomplete or inaccurate business data; breach of confidentiality and integrity; abuse of information systems.

2. In addition to the usual contingency plans, include following procedures: analysis and identification of the causes of cyber incidents; localization; planning and implementation of corrective actions to prevent relapses (if necessary); liaison with those affected by the incident or involved in recovery; reporting on actions to those who have the appropriate authority.

3. Audit journals and similar evidence should be collected and, if necessary, defended for internal analysis of the problem, presented as court evidence of a potential breach of contract or regulatory requirements, or in the case of a civil or criminal lawsuit; negotiating compensation from software and service providers.

4. Recovery activities after breaches of security and failures in the correct operation of the system should be closely monitored with official registration. Procedures should ensure that only clearly identified and automated personnel are allowed access to existing systems and operational data; all emergency actions taken were clearly documented; emergency actions were reported to management and systematically reviewed; the integrity of business systems and security measures were confirmed with minimal delay (*SIDCON, 2019*).

Public institutions should develop general policy principles in digital economy that affect all sectors of the economy and aim to achieve sustainable economic growth, as well as analyze the problems arising from digital transformation, risks and effects of digitalization of the economy, including those that related to providing citizens with the skills and knowledge needed in digital economy (*Deloitte, 2016*).

Government of Ukraine needs a new level of knowledge of the population to transfer the economy to the rails of cyberspace and social networks are losing the signs of entertainment. Social networks are becoming a working tool for teaching society the necessary skills and abilities, a possible “bridge of communication” with government agencies. It is also worth noting that the global trend in the development of theory and practice of cybersecurity is that the cybersecurity units formed in different countries should not become a superstructure over public administration or business processes in enterprises. Cybersecurity units should become an organic part of a single mechanism, so to speak, “fit” into the overall development strategy of the state at both the macro and meso and micro levels.

In pursuit of the goal of cybersecurity of business entity in the context of digitalization of the economy, in our opinion, to digitize the quality management processes requires full automation of production and business

processes of technological laboratories. Not all businesses properly assess the importance and need to attract investment in the implementation of laboratory information management systems (LIMS), although they solve a number of important problems for the company, including:

• Access to world markets, which requires the organization of a quality management system in accordance with international standards, ie with the mandatory use of LIMS;

• Quality data are not taken into account in the process of prompt decision-making by production services, which inevitably leads to losses and reduced efficiency;

• Without LIMS there is no possibility of storing data on quality, ensuring the information loop and transparency of the production process, collecting data on the genealogy of products for further analysis;

• Unjustifiably high time for staff to enter data and generate source documentation, instead of doing analysis to improve production efficiency;

• Insufficient reliability of quality data due to human factor in data transmission and calculations;

• Disordered methodological base of technological laboratories.

But we are convinced that the most important reason for the implementation of such a tool as LIMS is a prudent decision to move to a policy of continuous improvement of product quality management processes throughout its life cycle. This is stated in the international quality standards ISO 14001 (Environmental Management System), ISO 9001 (Quality Management System) and ISO / IEC 17025 (General requirements for the competence of testing and calibration laboratories).

International quality standards do not directly set the quality standards of individual specific goods or services, but determine the effectiveness of the organization of production and management, on which the quality of products actually depends, ie provide for the use of LIMS.

For example, Indasoft-Ukraine has extensive experience in implementing various digital tools that ensure their activities in oil and gas, chemical, metallurgical industries and this experience clearly shows the most effective way to implement and LIMS as part of a single information management system. This kind of single digital control system aims to increase production efficiency and reduce losses by improving the transparency of processes. It is always based on a single resource of all-important production information, namely a real-time data server.

As part of a comprehensive production management system, LIMS is a source of data on qualitative and quantitative test results and characteristics of control objects, provides real-time opportunities to integrate data into control systems and enterprise resource planning (ERP) systems.

In the framework of cybersecurity in the course of digitization of activities, the basic and priority tasks are mainly new quality of production processes of technological laboratories in terms of:

• Planning of works (planning of sampling at implementation of the schedule of analytical control (GAK) according to requirements of branch standards, instructions and best practices.) Realization of registration having arrived to laboratory of unscheduled samples through assignment to them of unique identification numbers. Registration of applications for testing in order to follow the procedure for conducting additional research and interaction of stakeholders);

• Preparation for measurement (calculation of calibrated characteristics with construction of calibration graphs. Construction and approval of calibrated characteristics (GC). Automatic control over the validity of GC. Carrying out calculated values of the significant component by the value of the analytical signal. Checking the stability of GC);

• Sampling (implementation of the process of entering information about samples into the system by assigning it a defined identifier. During registration, the following sample parameters are preserved: identification (reference to the object of analysis, process line point, sampling point, research indicators); on sampling (date, time, sampling method, equipment used), registration parameters (input time, performer, unique identifier), if necessary, entering other registration attributes of samples Labeling and bar coding of samples: label form development, label printing, label sample identification, search for samples by barcode);

• Carrying out measurements (implementation of sample management: introduction of primary measurements; mathematical data processing, calculation of results through the algorithm of processing of results of measurements according to a test technique);

• Calculation of results (assessment of continuity of measurement results, determination of average value and meridian, adherence to the algorithm of research, automated evaluation of research results and metrological characteristics. Distribution of powers to decide on approval, adjustment or rejection of results. Approval of measurement results: release of samples; authorization of results, after authorization of actual results take part in formation of accompanying and reporting documents);

• Registration of results (formation of test reports: setting up forms, forming review and approval of test report; export of list of protocols. Formation of reporting on results: creation of various source documents according to the established form of regulatory bodies; saving reports in various formats Presentation of data on the results in the form of tables and graphs to assess the effectiveness of business processes of laboratories).

The expansion and subsequent implementation tasks of LIMS should include the automation of business processes, namely digitization centers, in order to strengthen the cybersecurity of the business entity through:

• New quality of personnel management (ie from tracking all data on personnel (education, certification, advanced training), formation of all reporting on personnel);

• Equipment management (identification of laboratory equipment, control of the state of the park with equipment, metrological verification processes);

• Management of reagents, materials and standard samples (including accounting of materials, control of their receipt, storage and planning of purchases);

• Accounting of regulatory documentation (including maintaining registers of regulatory documents, from tracking the history of changes in documents, their versions, control over their validity);

• Intra-laboratory control (implements main types of intra-laboratory quality control by operational control, stability control using control charts based on control samples and control procedures, between laboratory comparative tests);

• Development of functionality in accordance with customer requirements.

Practical example of Digital Lab licensing by businesses to enhance cybersecurity is presented in Table 61.

As a result, it should be noted that all businesses, without exception, should adhere to the principles of cybersecurity in accordance with Article 7 of the Law of Ukraine “On Basic Principles of Cybersecurity of Ukraine” (*Zakon.rada, 2020*), including:

• Openness, accessibility, stability and security of cyberspace, development of the Internet and responsible actions in cyberspace;

• Public-private cooperation, broad cooperation with civil society in the field of cybersecurity and cybersecurity, in particular by exchanging information on cybersecurity incidents, implementation of joint research and development projects, training and retraining of personnel in this field;

• Proportionality and adequacy of cyber defense measures to real and potential risks, realization of the inalienable right of the state to self-defense in accordance with the norms of international law in case of aggressive actions in cyberspace;

• Priority of precautionary measures;

• International cooperation in order to strengthen mutual trust in the field of cybersecurity and develop joint approaches to counter cyber threats, consolidate efforts in the investigation and prevention

Table 61 – Licensing Digital Lab by businesses to enhance cybersecurity

Name	Composition	Expansion capabilities
1	*2*	*3*
Digital Lab-Light Package	Server data processing module. Server license up to 5 concurrent connections of APM engineer clients and APM laboratory assistant. APM Engineer – 1 pc. APM laboratory assistant – 1 pc.	APM Engineer APM laboratory assistant APM preview
Digital Lab-Express package	Server data processing module. Server license up to 10 concurrent connections of APM engineer clients and APM laboratory assistant. APM Engineer – 2 pcs. APM laboratory assistant – 3 pcs.	Server module for collecting data from hardware. The server expansion package was functioning to manage the lab's activities. Server package of functionality extensions to control the quality of research results. The server extension package was functioning for statistical control. Server module integration with adjacent AC class ERP/MES/MDM. Server package of functionality extensions for managing the passportization of commodity products. APM Engineer APM laboratory assistant APM preview APM browsing over the Web
Digital Lab-Standart package	Server data processing module. Server package of functionality extensions for laboratory management. Server license up to 20 concurrent connections of APM engineer clients and APM laboratory assistant. APM Engineer – 4 pcs. APM laboratory assistant – 6 pcs.	Server module for collecting data from hardware. The server extension package functioned to control the quality of research results. The server extension package was functioning for statistical control. Server module integration with adjacent AC class ERP/MES/MDM. Server package of functionality extensions for managing the passportization of commodity products. APM Engineer APM laboratory assistant APM preview APM browsing over the Web
Digital Lab-PRO package		All components can be included, with any number of customers.

of cybercrime, prevent the use of cyberspace for terrorist, military and other illegal purposes.

As a result, we note that the leading fight against cybercrime is:

- Investigations, forensics, and analytics;
- Machine learning, AI, and data visualization;
- Public and private partnership;
- Creative legal standings.

Main tasks to prevent cyber threats, in our opinion, should be: protection of personal data (intensive exchange and use of large data streams reduces the degree of confidentiality of information used, which creates digital threats); security of commercial information systems; security of information systems of state structures; protection of the working environment, technologies and tools.

Methods and means of protection still remain passwords to files; PGP encryption; server encryption. Digital way of life, the introduction of new information programs and digital technologies, problems of big data analysis, the changing technological age, the emergence of blockchain technology, Internet of Things force companies to treat their own human resources, knowledge assets characterized by their own specifics.

In today's development of digital technologies, cyber threats should be considered comprehensively. After all, the loss of funds and information leakage is only one scenario for a cyber-attack. The country's critical infrastructure facilities, such as the energy sector and the transport system, may also be at risk. For these reasons, preventing and addressing the threats to the digital economy is the foundation of competitiveness of both business and the state as a whole.

Today, no one doubts that digital transformation of the industry and the consideration of cybersecurity in the course of this change is the most advanced way to increase production, improve quality and reduce production costs in a safe way, as well as to improve investment efficiency and improve market competitiveness ratings.

The transition to principles of Fourth Industrial Revolution on the basis of cybersecurity means the transition to digital format of all-important production and business processes of the entity, formation of a single information space with free data exchange between levels of government in real time.

The quality management system based on cybersecurity is one of main components of any modern production, especially in areas where the basic parameters of raw materials, semi-finished products and finished products cannot be automatically measured, and process control is carried out by laboratory analysis.

CONCLUSIONS

During the preparation of this scientific publication, the authors aimed to objectively highlight the nature of digital transformation, to present the patterns of formation, formation and functioning of digital entrepreneurship within the framework of the digital ecosystem of Industry 5.0, as well as to reveal the connections and present the interdependencies between economic agents in the digital state and synergistic effects from their interaction.

One of the key directions of the state's development is the digital transformation of the economy. The effective operation of the digital ecosystem today depends to a great extent on the latest technologies that speed up the digital transformation of the country's "infrastructural fabric". At the same time, digital infrastructure is capable of qualitatively changing the ecosystem of the national economy, forming new mechanisms, management methods, establishing instant cooperation through network services, and developing further innovative directions for its development.

The synergistic potential of social, mobile, cloud technologies, data analysis technologies, and the Internet of Things, individually and collectively, can lead to transformational changes in public administration and make the public sector efficient and valuable. The authors note that the formation of digital infrastructure, the process is widespread, complex and gradual, but opens up great opportunities for the development of market entities of all spheres of the economy when using information technologies, which are the basis for transformations in society, taking into account material and social values.

The authors present the key problems that arise in the course of digitalization of business processes at enterprises, among which are named: the historical orientation of production on mass, "running" standard sizes and large batches; large-scale loading of production; the complexity of cooperation and logic between production sites. It was determined that the following should be included among the high-quality and effective tools of innovative digital transformation in virtual reality: a single online order management system for all enterprises (application registration – technical expertise – planning – execution control – shipment); Smart Factory, Predictive Maintenance, IIoT, CRM, SCM.

The dangers and threats arising from the digitization of the infrastructure include: cybercrime (quite often, even individual states are involved in the work of anonymous hacker groups and data theft); digital inequality and discrimination; lack of guarantee of digital rights. The monograph mentions socio-economic benefits and benefits from the functioning of digital infrastructure, including: implementation of

electronic document management; a more open and accessible market; increasing the level of production; simplifying financial transactions, increasing the role of electronic and digital money; development of remote work opportunities; reduction of the cost of goods and services; reducing the level of bureaucracy; enables the integral interaction of virtual and physical, i.e. creates a cyber-physical space.

Summarizing the results of the research, the team of authors put forward the thesis that the accelerated formation of Industry X.0 will declare a new quality of economic relations due to innovations. The key characteristics of X.0 Industry include: full automation of the production process; high communication between personnel and the machine through Internet technologies; cyber-physical systems that, by combining into one network, interact in real time, self-adjust, self-learn.

By analogy with the construction of the well-known Rubik's cube, the authors of the study made an attempt to prove that the formation of an effectively working digital economy is possible under the conditions of achieving harmonious relationships "science-business-government-education", as a result of which an environment is formed – a digital cubic space of a new economic augmented reality, some digital matrix. The difference between FinTech 1.0, FinTech 2.0, FinTech 3.0, FinTech 3.5 is defined. The author's understanding of the content of the digital economy and the interpretation of the category "digital cubic space" are offered. The difference between virtual, augmented, extended, improved and enriched realities is indicated.

This, in turn, allowed the authors to reveal the stages, the protocol, the ways of the formation of Industry 5.0 through the prism of innovations, technologies in the management of the industry and business and the presentation of characteristics that determine the new quality of work of smart industry, smart business, smart services, including modularity, interoperability, virtual reality. Based on this, the scientists presented the structural elements of the concept of Industry 5.0, which defined effective digital economic relations that form the gig economy, as a result of the step-by-step content of the stages of the formation of smart business, assets, and digital platforms. The tools and mechanisms that will allow to accelerate the formation of Industry 5.0 have been identified. The concept of "Industry 5.0" was revealed. In the monograph, the reader can get acquainted with the proposed practical measures aimed at the in-depth development of high-tech industries and the expansion of a new quality of life for people. The main characteristics determining the formation of smart industry, smart services, digital infrastructure, digital entrepreneurship, and smart cities are indicated.

The team of authors is of the position that in the course of digital transformation, an effective policy of digitization, which contributes to the accumulation of digital resources to meet public needs, becomes of great importance. This policy is determined by the degree of influence of the digital state on the digitization of socio-economic processes and changes under the influence of the latest trends in the world economy. Under these conditions, the digital development of Ukraine today, taking into account our proposed proposals, will become more flexible, adapted to economic changes, needs and conditions for ensuring effective activity, activation of investment and innovation activities of market entities. At the same time, the systematic and comprehensive modernization of Ukraine's economy within the framework of digital transformation will contribute to post-war recovery processes in terms of stable filling of the country's budget and rational use of funds, which will force digital enterprises to focus on the priorities of financial stabilization and economic growth of Ukraine.

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