CHAPTER FIFTH DIGITAL BACKWATERS OF THE ECONOMY: SOURCES OF NON LINEAR INNOVATION AND DIGITAL POWER

DOI: https://doi.org/10.30525/978-9934-26-287-6-5

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., 2021[c]; 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”.

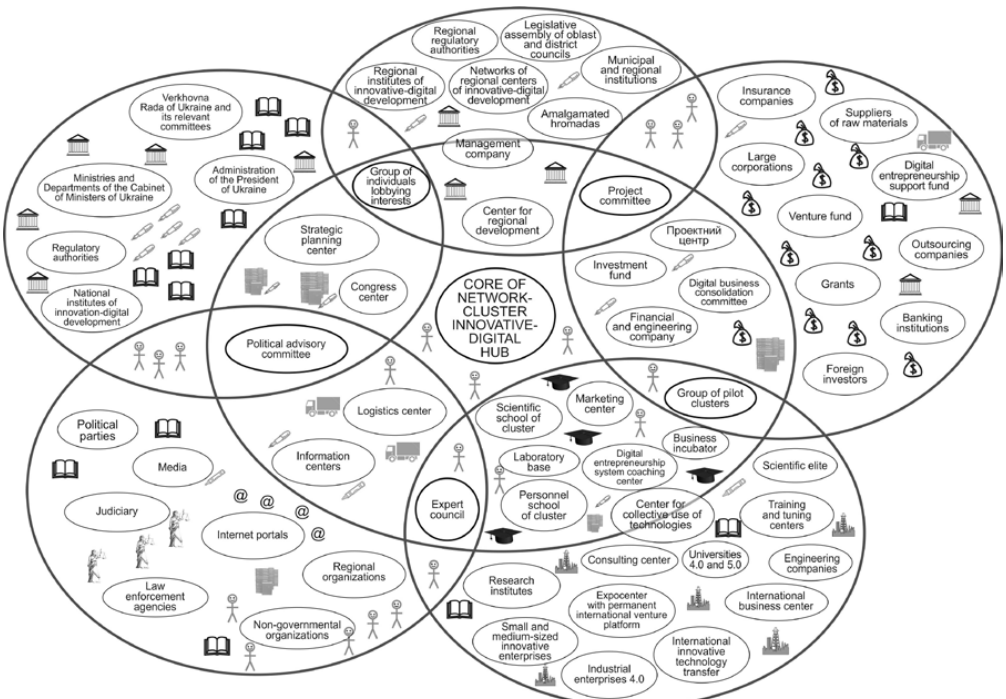

Figure 39 – Visualization of n etwork interaction of cluster formations in the conditions of virtual reality (compiled by authors on the basis of sources

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

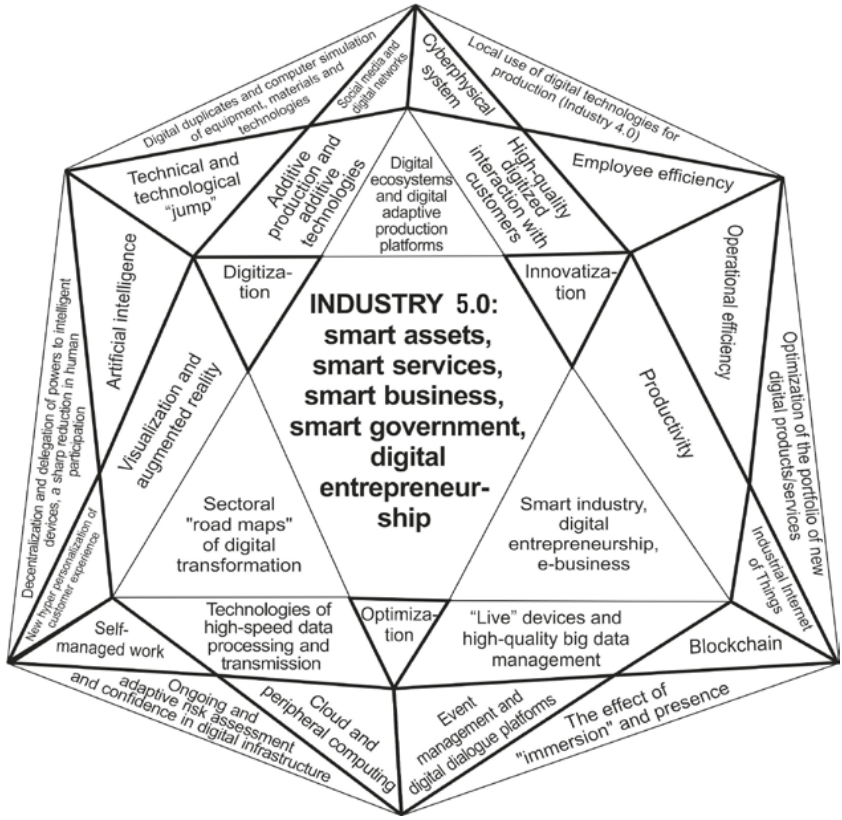

Figure 40 – Visual section of the structural elements of the concept of Industry 5.0

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

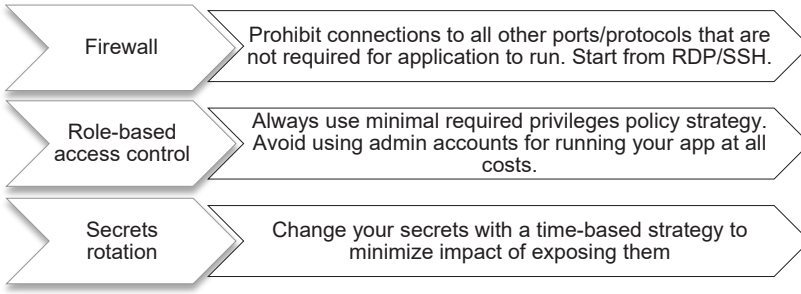

Figure 42 – Ways to ensure cyber security

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.