

# Transformation of Economic Systems Management under Implementation of the Digital Technologies

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**Abstract** — The article shows that the basis of various transformational processes is the transition from the industrial-market to the information-network management system, which defines the historical meaning of the modern stage of society's development. Taking into consideration the fundamentally different laws of the functioning of these systems, the transition from one system to another is controversial and leads to an increase in uncertainty and instability. Under these conditions, there are appeared new requirements for the management of transformational processes. Information is increasingly becoming an object of management both as a result and as a means of production, and the production of information by using information technologies is gradually becoming a determining process. At the present stage, these technological transformations take the form of digitization, which is in a contradictory relationship with the processes of capitalization and socialization. It has been proved that the processes of digitization, capitalization and socialization in their separateness lead to negative consequences and destabilize of the economy. Therefore, it is necessary to manage these processes in order to harmonize them and subordinate them to the goals of human development. The structure of digital development and the correlation of real and virtual space are revealed on the basis of finding out the patterns of the relationship between cognition and practice. There are determined main trends of digitalization in the technology sectors for 2019-20 years by the synthesis of international expert forecasts. It has been proved that the digitalization of the economy in Ukraine is going on in spite of the lack of existing relevant strategies and programs. There is proposed the criteria for choosing a scenario for the development of the digital economy. Also there are worked out recommendations for government and non-government structures on accelerating the pace of digital technology acquisition in Ukraine.

**Keywords** — *economic systems management, digital technologies, strategy, information, development*

## I. INTRODUCTION

There are many different processes (that differ in their content, forms, orientation, and other characteristics inherent in them) which take place at the same time in the modern world. But among them one can distinguish the core, the fundamental process that causes others. Such a process is the transition from the industrial-market to the information-network system of management, which operate on fundamentally different economic bases.

The industrial-market economy is grounded on the production of goods based on private property, hired labor, an equivalent exchange and distribution of labor productivity by capital and labor costs. Information and network economy is based on the production of information on the basis of social and individual property, free choice of employment and activities, reciprocal exchange and distribution of production results. Information, unlike ordinary goods (the assignment of which one subject excludes assignment to others), can be simultaneously the property of everyone and each individually. Therefore, it corresponds to the social and individual property, which can be manifested in various (including in transitional, modified-private) forms. The free choice of employment and activities is the other side of receiving the basic unconditional income on the basis of reciprocal relations.

Taking into account the fundamentally different laws of functioning of the industrial-market and information-network economy, the transition from one system of management to another will be controversial and conflicting, and uncertainty and instability will increase. Thus, the laws of demand and supply on ordinary and network goods operate in opposite directions. The demand curve for ordinary goods is declining, and the demand curve for network goods is increasing. An example might be a mobile phone as a mixed wealth. On the one hand, it is a common good, and the second phone of one person has less utility than the first one. Accordingly, its price decreases. But as a network benefit, it has completely different characteristics. The more phones have people you can connect with, the more useful your phone and the higher may be it's price. If net wealth becomes more and more, then the aggregate demand curve will consist of a declining demand curve for ordinary goods and a growing curve for net ones, and it will have parameters that are significantly different from those currently used for forecasting. This means that forecasts will become less precise and the uncertainty of development will increase. This characteristic applies to only one law, but the same situation will arise in many cases in the relationship of ownership, exchange, distribution, etc.

Because of such trends will develop not only in national economies but also in the global economy, the growth of uncertainty and instability will have a global character. In such conditions, the problems of managing socio-economic processes are actualized. Effective management involves

knowledge of the laws of development, but in the situation of the new system formation based on other laws, the latter can not be fully understood. This sets a fundamentally new task to management: how to ensure the implementation of strategic goals in terms of strategic uncertainty.

**II. THEORETICAL GROUND, METHODOLOGY AND TOOLS**

The theoretical basis of the study was the research publications of leading international organizations in the field of economic development and digital transformation, in particular Gartner, UNCTAD, World Bank, World Economic Forum, World Trade Organization, which over the past 5-7 years identified the key concepts of digital economy and digital technologies state of digital transformations in the economy of the countries of the world, the indicators of economic development of different countries have been calculated and analyzed, the trends of economic development and so on. We have also relied on monographic studies, for example [1-5], that outline both the separate aspects of digital technologies development and their overall impact on humanity's future.

Based on these studies, we attempted to determine the overall structure of digital development, analyzed the current state of digital transformation in Ukraine, and developed recommendations to accelerate economic development on a digital basis and to look for opportunities to effectively manage economic systems in the digital environment.

The methodological basis of the study was the foundations of institutionalism, the theory of systems and the concept of innovation development. Problematic issues have been considered under synergistic and civilizational approaches. A synergistic approach involves structuring the system under the influence of openness, non-linearity and imbalance. Involvement of synergetics in retrospective institutional analysis overcomes the methodological limitations of the modern neoclassicism, allows us to consider informal institutions as a result of the action of non-equilibrium and heterogeneous dissipative structures. The civilization approach has been used as an integral part of the modern paradigm of postindustrial society.

The methods of generalization, comparison, analysis and synthesis were used to theoretically reproduce the process of digitization of the economy in Ukraine. Methods of structural-logical analysis and factor analysis have been applied in the development of proposals to accelerate the pace of mastery the digital technologies in Ukraine.

**III. ANALYSIS OF DIGITALIZATION PROCESSES IN UKRAINE AND IN THE WORLD**

The global automation market is about \$ 260 billion, and it has a tendency to grow from 8-9% per year. [6] Technologies 4.0 quickly occupy their place at this market. According to reports from various analytical agencies, the global technology market 4.0 was about \$ 60 billion in 2017 and will grow to \$ 220 billion in 2025, which is about 15-20% of annual growth. [7] As we can see, this is much higher than the level of "simple automation", where technologies 3.0 are dominate.

Since Industry 4.0 is largely driven by state programs, countries compete with each other at the level of

performance indicators of government plans. Global players are the United States (44%), China (92%) and the EU (65%). After all, China planned to launch 100 new production at 4.0 technologies in 2018. According to the China 2025 state plan, China should fully switch to smart production by 2025. [8] Therefore, China's leadership is of considerable concern in both the US and the EU.

But far less industrialized countries are showing progress. For example, Kazakhstan 14 industrial facilities under technologies 4.0 with a total cost of \$ 380 million.

Unfortunately, unlike most foreign countries, the Ukrainian government has not approved a strategy or national program for digitization of the economy at the present time that increases of Ukraine's lagging in digitization behind the other countries. Only one (!) document was adopted - The Concept of the Development of the Digital Economy and Society of Ukraine for 2018-2020 [9]. During the last three years, the Ministry of Economy and Trade of Ukraine has developed the Strategy for the development of the industrial complex. The Strategy for the development of the IT industry and the Export strategy are under construction and the work on the Strategy for the development of Artificial Intelligence and the Strategy for the development of the Intellectual Property just began. In the absence of an approved National Strategy or National Program for Digital Development (which have not yet been developed by the government), it is difficult to ensure proper coherence between sectoral strategies, avoid contradictions in the formulation of goals and objectives, since national-level priorities have not been established.

Non-governmental organizations, including APPAU, Federation of Employers of Ukraine, High-Tech Office, Ukrainian Institute of the Future, and others, also take care of the development of strategies, roadmaps, programs, etc. The most important developments in the digital economy are given in Table 1.

TABLE I. INITIATIVES OF NON-GOVERNMENTAL ORGANIZATIONS ON THE DIGITAL DEVELOPMENT OF THE ECONOMY

Organization name	Worked out document	Year of creation
High-tech office	«Digital agenda – 2020» [10]	2017
Employers Federation of Ukraine	Law of Ukraine "On Industrial Policy" [11]	2017
APPAU	Roadmap for digitization of the food and processing industry [12]	2019
Ukrainian Institute for the Future	Economic strategy of Ukraine 2030 [13]	2019

While Ukraine still develop a variety of Strategies and roadmaps for digitalization (that remain projects, are not approved or implemented), other countries, with the approved documents listed above, actively form a "new" digital economy that includes the following main components:

- 1) advanced production, robotics and automation of factories,
- 2) New data sources from mobile and widespread internet connection,

- 3) cloud computing,
- 4) big data analysis,
- 5) artificial intelligence.

Features of the new digital economy are given by the UNCTAD in [14]:

- new data sources, from smartphones to plant sensors, send a huge amount of data to the cloud, where they are analyzed and after that the new ideas, products and services are generated;
- new business models based on technology and product platforms (platform innovation, platform ownership and platform complimenting) - significantly change the organization of industries and competition in a number of advanced industries and product categories;
- the productivity of hardware and software in ICT has moved to a point where artificial intelligence and machine learning are scaled up.

The new digital economy is capable of expanding organizational and geographical fragmentation of labor into new fields, including previously inseparable and geographically rooted activities that are at the forefront of global value chains, especially R & D, product design, and other knowledge intensive and innovative business functions. The impact on jobs and international competition will entirely depend on the pace of change and the ability of organizations and societies to manage it. [14]

Many well-known international companies have already presented their vision of the prospects for a digital economy for the coming years. The synthesis of their views, as well as the analysis of the presented technologies at the Hanover Messe 2019, allowed us to identify the main trends of digitalisation by technology sectors for 2019-2020 in the following way.

#### 1. Industrial Internet of Things (IIoT)

IIoT is one of the most promising technologies in the Industry 4.0. All world manufacturers today have products and / or solutions from IoT in their portfolio. The most popular are predictive service, predictive quality and digital twins. Digital twins as a technology, including simulation capabilities, has very attractive prospects in the industry, since it allows you to predict more precisely the gaps, optimize service plans, improve quality, and generally improve overall performance of the equipment. According to Gartner, 24% of companies that carry out IIoT today are already using digital twins and another 60% are planning to do so in the coming years [15]. The technology of the twins is well integrated not only with IIoT, but also with artificial intelligence and a virtual and augmented reality. Certainly, the issue of cybersecurity remains a challenge in this area.

#### 2. Immersive technologies - Virtual, augmented and mixed reality

Virtual, augmented and mixed reality technologies can be applied to industry in many areas, such as product design, maintenance, personnel training, teamwork, inventory management, and more. Gartner notes that in 2022 70% of companies will use immersive technologies in B2C, and 25% - for production tasks. [16]

#### 3. Cobots using increases

The industrial robots market is growing fast in the world and currently it is the largest segment among various technologies 4.0. The leaders among industrial robots are, in particular, cobots. Some studies predict the growth of the

Cobot market from \$ 710 million in 2018 to \$ 12.3 billion in 2025 [12]. The main reasons for the popularity of cobots are their functionality (security for people, flexibility, easy and quick adaptation to new tasks, compactness) and affordable price. Cobots have created new great opportunities for industries, especially in the flow-transport and assembling industries.

#### 4. Entry of artificial intelligence (AI) into the industry

With IoT spreading in industry and the corresponding increase in data volumes for processing, there are opportunities for the use of AI. Mainly, AI is used to improve performance and reduce downtime. Machine learning algorithms for production are forming and customizing for specific manufacturing challenges - for example, reducing losses, improving process stability, reducing downtime, etc.

#### 5. Edge computing

As devices connected to the Internet become more and more powerful their quantity is growing, a separate sub-segment, known as edge computing, is separated from the IoT. It's about pre-processing data is precisely at the level of these devices, instead of being immediately transmitted to cloud platforms. Thus not only reduces the cost of cloud, network infrastructure and processing time, but also allows to provide the better cybersecurity.

#### 6. Mobile industry 4.0 - ERP and quality management systems.

The appearance of 5G means more acceleration in the IoT development. 5G was one of the top matters at the Hannover Messe and in 2019 we already see many applications of IIoT in real time on mobile technologies. For example, many ERP systems today integrate with technology 4.0 and increasingly include applications from manufacturing technologies, including MES and quality management systems.

#### 7. Supply chain optimization

Points which used to be just a logistics function in the era of 4.0 acquires the forms of individual business models and the optimization of all horizontal chains. Together with the trend of e-commerce, this trend radically changed customer expectations for individual services, speed, transparency and transaction efficiency. In 2019, this sphere has its own tendencies - it is the digital twins using, mobile applications and forecasting tools, equipped with artificial intelligence. The goal is to make supply chains more accurate, fast and flexible to changes in the environment.

#### 8. Autonomous things

Significant growth will occur in the segment of "autonomous things." There is no difference whether it's about cars, agro or robots, the autonomous things use artificial intelligence algorithms to perform tasks that people have traditionally performed. Today there are 5 types of such things - robots, vehicles, drone, devices and agents. They respectively occupy 4 types of environment - sea, land, air and digital space.

#### 9. Entrance of blockchain technology to the industry

Blockchain is a network cryptographic technology that allows businesses to track the sequence of transactions or works where multiple counterparts are involved without the necessity to have a single centralized structure. In a context

of low trust or potential conflicts between counterparties in a transaction chain, this significantly reduces friction between them, costs and time to reconcile and pass the service or product with the necessary chain. It is important to note that blockchain is a very stable and safe technology. It is expected that the blockchain market may grow up to \$ 3 trillion by 2030 [17]. Blockchain can significantly improve processes in many industries, and above all, to optimize supply chains.

Digitization of the Ukrainian economy has two distinctive features from other countries - it goes not due to, but in spite of the absence of existing strategies and programs, and it takes place predominantly in the IT industry. So, at this time we have more than 70 companies that develop products and solutions in Industry 4.0 technologies. In March-April 2019 the Association of Industrial Automation Companies conducted a market survey and developed its own version of the Ukrainian Landscape Industry 4.0. [12] This document provides an overview of over 70 companies that are categorized according to Industry 4.0 technology and Application Criteria. In this version, the emphasis is on companies of Ukrainian origin, and the application of Technologies 4.0 for Industry 4.0 is the main criteria for the innovators filtration, which are really a lot in the IT industry and other high-tech sectors. This is done, first of all, for potential Ukrainian customers - requirements and approaches for industrial applications are different - they are more rigid and have a higher entry threshold. Technological Landscape 4.0 includes 76 companies that are divided into 16 segments + 1 from system integration. The last segment is the most significant (21 companies), which is logical - many system integrators and technology companies in Ukraine have long been offering solutions based on new technologies but originating from Western vendors. Among the technological segments is the High Data / Artificial Intelligence / Machine Learning Division - there are 15 companies with their own products and solutions for these technologies for industrial applications. The second place is the segment of IoT devices (12 companies), on the third - Supplemented / Virtual reality (11). Compared to 2017, we record progress in several areas. The total number of companies has grown by half - if in 2017 there were about 50 companies, the current number is over 70. There has been rapid growth in the area of big data, drones, AR / VR, 3D, cyber-security. There are weak or even non-growth segments that are associated with significantly larger investments in hard or full, complex solutions - segments such as the IIoT platform, digital twins, UGV (unmanned ground transport) and robotics. The higher entry threshold, the lack of development strategies in global markets, and weak domestic demand are the main factors behind the gap in these segments. [12]

Application segmentation includes the 14 industry-leading segments in the world. They have the same 70+ companies, but are distributed in the application areas. The most numerous are those segments that typically inherit technology and demand from industry 3.0. Remote monitoring and control - 13 companies, Data-driven analytics - 12, Digital design and simulation - 7. The Predictive maintenance segment - 7 participants. [12] At the same time, the level of their decisions in terms of predictability and reliability is very different.

#### IV. MODEL OF THE DIGITAL DEVELOPMENT STRUCTURE

It should be taken into account that society and the economy are very complex and multilevel systems and distinguish between the fundamental and actual structure of social relations. Fundamental and actual structures include the same elements, but the latter can perform different roles and have different meanings in particular historical social systems or at different stages of their development. Global instability tends to actualize global elements of the social structure. This statement should be taken into account in the management of systems under the terms of global instability.

At the present stage of the information - network economy forming there is a transition from one technosocio-economic structure to another. The basis of such a transition is the interaction of technological, economic and social relations, which shows itself in the form of the relationship of digitalization, capitalization and socialization. Digitization of the economy is a process of introduction the digital technologies into the public production. Capitalization has the meaning of turning any resource into a value capable of producing a new cost. But the socialization of the economy means the direction of economic processes at improving the conditions of activity and human development. The development of digital technologies opens possibilities of significantly improving the efficiency of production, public administration and meeting the needs of the population [6]. The key process in this is the capitalization of digital technologies, that is, investing in digital technology to generate profits.

Digital development actualizes the problems of the virtual, which arises as a reverse transition from the interiorization of reality in the process of thinking to the exteriorization of the ideal, transforming it into an external process, which in relation to human consciousness acts as reality. The virtual, thus, is inherently the same ideal, but taken beyond the human head and presented as real. Digital development is forming the world of the virtual, which exists alongside and in relation to the real. As a result, the world becomes a hybrid, ie one in which the virtual and the real are closely intertwined.

General logic of the digital economy development is determined by the structure of the relation between the human mind and external reality. All digital technologies emerge as certain forms of exteriorization and technization of the ideal moments of human thinking as a tool for the development of the outside world. In the process of thinking there is a system of information processing and accumulation. It is represented by memory. Information is used in a process of thinking that involves formally-logical and actually reasonable operations. The first one are based on a formal logic. The second one theoretically reflects the inherent contradictions that go beyond formal logic. These three structural elements of human thinking (memory, formal logic, and mind) that commonly exist in the human head, as a result of the use of digital technology, acquire external forms of existence, transform into processes that take place outside the human head, however, in interaction with it (Figure 1)

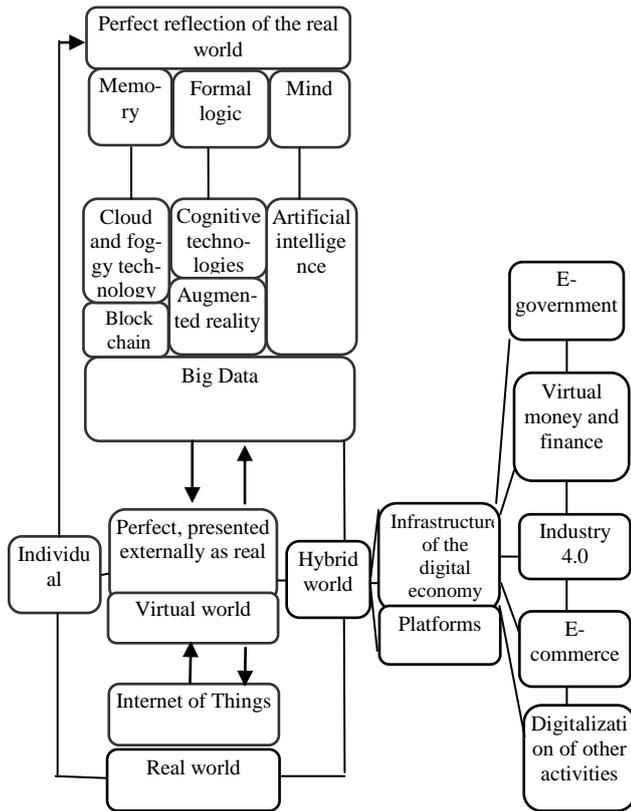


Fig.1. General structure of the digital economy development

Such an element of human thinking, as memory due to exteriorization, is implemented in cloud and foggy technologies and blockchain, formal-logical operations are correlated with cognitive technologies, augmented reality and the Internet of things, and the mind - with artificial intelligence. The combination of digitization and capitalization, together with a significant increase in labor productivity, leads to the dismissal of a large proportion of workers in the manufacturing sector and the rise of unemployment, actualizing social issues. New jobs created in conjunction with the advancement of digital technology in many cases do not require high skills and their social quality is deteriorating. The development of the processes of digitization and capitalization of the economy will have a positive effect on society if these processes would be combined with the processes of the economy socialization. This implies significant changes in the social system, the development of activities related to the sphere of leisure and the formation of new human skills.

V. DEVELOPMENT SCENARIOS AND RECOMMENDATIONS

Taking into account the above trends (which are pointed out in III), we will try to determine the possible impacts of the new digital economy at the Ukrainian economy. Despite the fact that the features of new digital economy can add radical changes, this corresponds to the previous achievements in the field of computerization, which allowed to organize and geographically separate the scope of research and development from production, which leads to the creation of global value chains. The growth in the number of important multinational corporations and successful suppliers of higher-level platforms from developing countries has not changed the global cost chains, which still dominate firms from traditional technological

clusters in industrialized countries. Firms that perform routine assemblies and other simple services in global value chains are less profitable, less paid by their employees, and more vulnerable to business cycles.

According to the UNCTAD [14], there are three broad scenarios for developing countries in the new digital economy. First, ordinary business functions such as production, software coding and back office services, which served as the basis for rapid development, may be the first to be re-protected or even eliminated by advanced production and automation. This can lead to a break with the global cost chains and huge social defects at the developers, where the export-oriented factories now employ dozens and even hundreds of thousands of workers in very concentrated production clusters. Under the second scenario, new digital economy tools could enable developing companies to move up the value chain, become less dependent on the innovative and coordinating functions of leading firms in global value chains, and independently produce competitive and global products. An example of such a scenario can be 3D printing, which shows the possible alignment of the value chain curve. Such a scenario, according to the authors, is most suitable for Ukraine, as this has the necessary potential for it. The third scenario means that "innovation here" / "production there" is the geographical distribution of labor remains relatively stable, since the new digital economy changes products and processes at existing technological and production clusters. The balance between centripetal and centrifugal effects on the geography of industries, as well as the changes in the complexity and fluidity of the models of the global value chains that are observed today, undoubtedly, constitute the main research questions for scientists regarding global value chains in the coming decades. The following recommendations for government and non-governmental organizations may be useful in accelerating the pace of digital capture in Ukraine:

- implementing powerful, massive education and education campaigns in the domestic market (to stimulate demand) and the foreign market (for attracting investment) using case studies of digital technology developers and successful stories of Ukrainian enterprises that mastered these technologies;
- development and adoption of strategies, programs, roadmaps for the digitization of industries and the national economy as a whole;
- stimulation of the transfer of finished technologies from research institutes to the final customers through the use of modern marketing tools;
- integration into the Digital Innovation Hubs Network (I4MS / Horizon2020 Fund), which for some years has been offering on-demand solutions to industry 4.0 for big data, robotics, IoT and other segments;
- creation of proper conditions for the development of innovative ecosystems in industry;
- accelerating work on the harmonization of technical standards (relating to Industry 4.0) and integration into the EU digital environment.

## VI. CONCLUSIONS

In contrast to the existing scientific studies in which digitization, capitalization and socialization are mainly regarded as independent phenomena, it is shown that these processes are in a complex interaction, which at the present stage is contradictory and disturbs the process of development synchronization of different types of production and entrepreneurship on the basis of the approval of a new technological structure. As a result the overall form of socio-economic dynamics has changes. The contradictory interaction of the digitization, capitalization and socialization processes creates problems and challenges for the society, which are global and of fundamental importance:

- Digitization, together with the creation of new technological development potential and increased productivity, greatly enhances the network characteristics of the economic system functioning, contributing to the increasing possibilities of fragmentation, disintegration and disintegration of the economy, society and man, thus creating challenges to the very existence of humanity;
- Capitalization of digital technologies increases the unevenness of the economic development, the financing of economic processes, changes the nature of economic dynamics, in which abrupt development and crisis dynamics become complementary characteristics of the reproduction process in different parts of the world economic space, and economic fluctuations become different parameters;
- Digitization and capitalization in their unity lead to significant changes in a person's role in the production process, the content and nature of a person's activity, the correlation between his need and freedom, which raises a number of fundamentally new social problems.

The structure of digital development is determined by the processes of exteriorization and technization of the basic components of human thinking, resulting in the formation of a system of technologies that combine real and virtual space and create fundamentally new opportunities for bio-techno-social development. Ukraine's lagging behind the rest of the world to move towards digitization of the economy continues to grow. While Ukraine is developing various strategies and road maps for digitalization that remain projects, they are not approved and implemented, other countries are actively forming a "new" digital economy with advanced production, robotics, new data sources from mobile and widespread Internet connection, artificial intelligence. The most promising technologies for the 2019-2020 years are the industrial Internet of things, artificial intelligence, complemented by analytics, immersive technologies, blockchain, smart spaces, quantum computing. A feasible and acceptable scenario for the development of new digital economy in Ukraine is the one in which the new digital economy tools could enable developing companies to move up the value chain, become less dependent on the innovative and coordinating functions of leading firms in global value chains, and independently produce competitive and global products. The acceleration of digital assimilation in Ukraine depends on joint coordinated actions of

governmental and non-governmental structures. The main efforts should be directed towards the development and adoption of strategic digitalization initiatives, the creation of appropriate conditions for the development of innovative ecosystems, the harmonization of technical standards and integration into the digital environment of the EU.

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