IMPACT OF GLOBALIZATION PROCESSES ON CHANGES IN TECHNOLOGICAL DEVELOPMENT IN CONDITIONS OF ECONOMIC DIGITALIZATION

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Abstract: The article aims to determine the impact of globalization processes on technological development to identify further areas of socio-economic development in Ukraine. The method of comparison, systematization, analysis, synthesis, graphical analysis, classification and theoretical substantiation were used in the study. The author states that new relations are being formed between the subjects of economic considerations, including the "New Economy" in the world. Changes in technologies under the influence of globalization challenges are considered. The role of digitalization of public life as a component of the further development of society is determined. The main directions of technological development in the world are systematized. The curve of technological and evolutionary development is constructed on the basis of the S-curve of technological development and the envelope. World trends in technological development are developing according to the model of uneven development of technologies and the envelope curve based on new principles of action. Thus, the technologies of the last five years demonstrate an unmistakable reorientation towards the concept of the super-intelligent "Society 5.0," which allows accumulating information from the physical space and, based on processing by artificial intelligence, returns it to the same physical area with the latest solutions.

Keywords: Digitalization, Innovative technologies, Socio-economic development, Techno-globalism, Technological development.

1 Introduction

Current conditions of globalization dictate their requirements, under which the elements of a new economy are formed based on information technology and the accumulation of a knowledge base. Indeed, new relationships arise between the subjects of economic relations that form the "New Economy" in the world. Restructuring in the methods of doing business, the social life of humanity, ways to meet consumer needs, the relationship of market participants, and the nature of structural and globalization changes are clearly defined.

Modern conditions of economic management under the influence of globalization change form a new technological development paradigm in the world. This paradigm is based on the postulates of Industry 4.0: The Internet of Things, Big Data processing, the use of artificial intelligence, digitalization and robotization, etc. These changes form a new management system characterized by non-linearity and rapid achievement of results [14].

A fundamentally new management system is being formed, which has a characteristic feature – non-linearity and demonstrates a rapid increase in achieving a particular result [27]. The leading global economic forums (World Economic Forum, discussion platforms of the "Group of 20", the Organization for Economic Cooperation and Development) [24] believe that Ukraine is characterized by structural inadequacy of the economy following the Fourth Industrial Revolution.

The purpose of this work is to determine the impact of globalization processes on technological development to identify further areas of the socio-economic development of Ukraine. This goal made it possible to form the following tasks:

- Consider the curves of technology development in the world;
- Follow how the technologies change under the influence of globalization challenges;
- Determine the role of digitalization of public life as a component of the further development of society;
- Systematize the main directions of technological development in the world;
- Build the curve of technological evolutionary development based on the S-curve of technology development and the envelope curve.

Digitalization and globalization of the world economy significantly impact economic cycles, reducing their length, increasing the amplitude of local cycles, and reducing the amplitude of the global revolution. New mechanisms and factors affecting the speed, amplitude, and length of economic cycles, among which advanced digital technologies play a leading role, ensure innovative economic growth [31].

2 Literature Review

Information technology innovations and inventions have made it possible to (a) significantly increase the power of computer technology; (b) increase the speed of information processing and data transmission; (c) reduce the unit cost of their processing, which has led to the active and efficient use of digital information [3].

Let us consider the evolution of scientific approaches to the study of cyclical processes in the economy to identify the cycle-forming factors of the modern economic system. The idea of cycles in the economy was born similarly to this idea in any systematized structure. The first theories of cycles in economic systems associated their presence with external, most often natural, factors. One of the most famous theories of vernal factors was that of Jevons, an English economist who linked the business and solar activity cycles. He considered the cycle duration stable (eleven years) and considered the existence of a relationship through the influence of solar cycles on agriculture [25].

The theory of external factors was most popular at the dawn of the development of the idea of economic cycles [11]; however, the industrial revolution that began led to the development of theories of classical political economy. The most studied are cyclical processes associated with overproduction [7]. The underlying cause of economic cycles at this stage was considered to be the market mechanism itself. Numerous theories have emerged that interpret in their way how cyclic processes of overproduction spread. They can be divided into groups: investment and industrial.

Over time, economists begin to understand that the balance of market and planned systems, which sincerely contain oppositely directed cycles, gives the potential to smooth out the amplitude of cyclical fluctuations that are inevitable for any economic system [11]. However, they are faced with a new challenge – the start of the rapid development of technology and the emerging digital transformation of the financial system as a whole.

As a result, theories are beginning to develop that focus on the technological factor of cyclicality. Some of the most striking are the concept of an actual business cycle and technological structures. The first explains fluctuations in business activity as supply-side shocks, with technological shocks impacting generating cycles more than other parameters. The second argues that the phases of the economic cycle are due to a change in technological structures. However, both have weak predictive properties since they can have random shocks at the output [28].

There has yet to be a consensus in the economic community about what factors and how they influence the length and amplitude of the current global and local economic cycles. However, this topic is of increasing interest, especially in light of the increasingly frequent "financial infections" and cases of synchronization of economic processes at the global and regional levels [4]. Furthermore, the increasing integration of economies into each other leads to such consequences, which are facilitated by the development of technologies and the growing digitalization of the economy and society as a whole – the growth of international commodities and financial turnover around the world.

At present, information is becoming the leading factor of production, and various socioeconomic phenomena, including the cyclical nature of the economy, have an informative character and general information content. In the context of the transition to a digital economy, the scale of digital flows is increasing, the volume of transmitted information is growing, and there is a transfer of information technologies through global networks, affecting most countries of the world [13]. As a result, trade and finance flows have declined markedly, losing their pre-crisis growth momentum. Yet, international trade is projected to increase more than five-fold in the coming decade, driven by digital trade flows, the transfer of information, and an increase in traffic associated with the activities of multinational corporations [23]. The issues of globalization, technological development, and innovation orientation of Ukraine were dealt with by such outstanding domestic scientists Cherniavska, Bila, Kozachenko, Rumiantsev, Akhnovska, Bratslavets, Shkola, Malyshko, Oliinych, Dubei, Reshetilo, Antonyuk, Halchynskii, and Kozak.

The cost of international interactions and transactions is noticeably reduced due to new technologies. In today's world, thanks to international technological tools, even small companies can claim a share of the global market. Facebook, Google, and other high-tech companies have created universal tools for interacting with customers worldwide. According to McKinsey, more than 85% of the tech companies surveyed have some international activity and expect a global presence. In addition, people directly participate in globalization daily, using digital platforms for domestic needs, communication and work. More than 3 billion people use social networks, about 900 million people have international connections in social networks, and 360 million participate in cross-border e-commerce [18].

According to the World Bank, international information, goods, and finance flows have increased world GDP by at least 10% over the past ten years. And although more and more countries are participating in international economic relations, global flows remain concentrated among a small number of leading countries [21]. The gaps between the leaders and the rest of the world are narrowing very slowly, but catch-up growth presents an ample opportunity for countries lagging. Nevertheless, new centers regularly appear where world economic flows are concentrated in one area or another, transforming economic activity.

3 Materials and Methods

The socioeconomic development of countries is directly related to technology development. The latter have their development curve (S-curve of technology development or S-curve of the process of innovative development) (see Figure 1, Figure 2). This curve demonstrates the state and development of the "New Economy" at different stages:

- Gradual increase in the signs of the "New' at the early stage;
- Compliance with growth rates with a specific threshold value;
- A significant drop in rates under the influence of the spread of the "New Economy" (process, phenomenon, technology, system).

Periods during which technological changes occur (technical gaps) form the basis of leadership or lagging. Figures 1 and 2 demonstrate the functional approach that allows determining the system itself (the mode and approach) and the definition of the functions performed by this system.

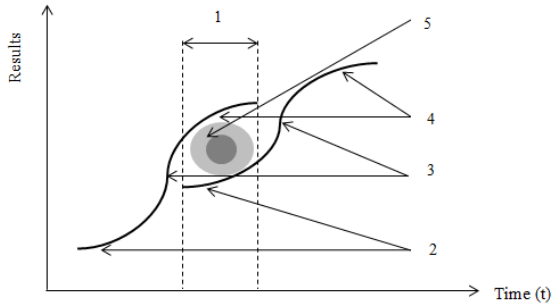

*Figure 1 – Model of uneven (S-shaped) technologies development (systems)**

Transition to the new operating principle, *where*:

1 – technological gaps;
2 – embryonic technologies (genesis);
3 – key (advanced) technologies;
4 – classical technologies;
5 – technology competition zone.
*Compiled by the authors based on the *Algorithm for Solving Inventive Problems* [22].

Getting economic benefits from existing technology may be prioritized over introducing the latest technology, which will lead to a loss in the market. Innovative technologies are designed for long-term success; constant restructuring allows a balance between continuity and change.

Embryonic technologies (2) are not leading to growth and efficiency. Key technologies (3), on the contrary, demonstrate sharp growth; the result is rapidly increasing momentum. Negligible returns characterize classical technologies. After that, situation (1) arises – the period of technological gap, resulting in a transition to a new principle of action – fundamentally new technologies. The end of the previous S-curve collides with the beginning of the new S-curve, and there is fierce competition between existing (old and new) technologies.

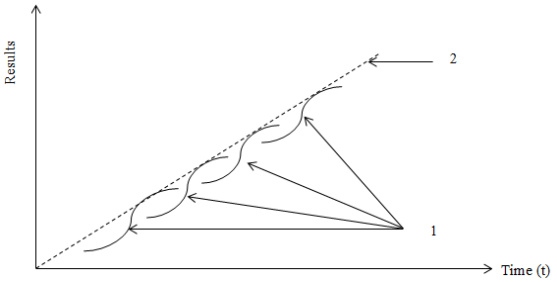

*Figure 2 – The envelope curve**

Where:

1 – S-shaped curves;
2 – envelope curve.
*Compiled by the authors based on the *Algorithm for Solving Inventive Problems* [22].

The envelope curve demonstrates the change in technology, technological patterns, and concepts of the development of society (for example, the evolution of car engines). Consequently, the country's structural shifts process consists of innovative changes, which are the main factor in these shifts and the strategic guideline for changes.

4 Results

As a result, we can come to the following assumptions:

- Limited or lack of resources contributes to the more active development of technologies;
- Planning and implementation of technology takes place using new knowledge with a small number of resources;
- The use of the Law of natural growth in combination with the development of technologies along the S-curve makes it possible to form long-term forecasts of the country's socioeconomic development;
- Many of the latest technologies hold significant transformative potential for international trade.

The Law of natural growth stimulates the reproduction processes of new knowledge and its dissemination, changes in the system and business processes, and increased competitiveness. The Law makes it possible to predict the scale and complexity of systems and knowledge acquisition due to its fractal aspects [26].

Having carried out this study, we consider it necessary to trace how technologies change under the influence of globalization challenges within the framework of the Fourth Industrial Revolution (Table 1).

Table1: The most important innovative technologies of the World according to the World Economic Forum in the context of 2016-2021

No	Advanced technologies 2016		Advanced technologies 2021	
	Technologies	Technology specification	Technologies	Technology specification
1.	Nanosensors and the Internet of Things	Connecting many devices to the Internet, transferring medicine, energy efficiency mechanisms, and other sectors to a new, high-quality level.	Decarburization	Consists of the latest carbon reduction technologies, including emission-free air conditioning, renewable energy sources, and meat-free protein production. Use of hydrogen fuel cells.
2.	Energy sources (accumulators, batteries)	Non-traditional types of energy (solar, wind, sea waves, etc.). Batteries made without harmful substances and metals will support the lives of villages, cities, and enterprises.	Self-fertilizing crops	Thanks to the latest engineering approaches, crops produce their fertilizers, which allows for creating a symbiosis between roots and soil bacteria.
3.	Block chain	Conducting transactions and creating a ledger using cryptographic methods.	Respiratory sensors for disease diagnosis	The latest equipment recognizes the connection when the patient breathes and determines the disease of prejudice.
4.	2D materials	They consist of one layer of atoms - grapheme, germaneness, furrows, which gives the uniqueness of the materials (flexibility, lightness, strength, and optics).	Production of drugs (drugs) on demand	Pharmacology technologies allow you to determine the composition and dosage of a particular drug for a specific person.
5.	Autonomous hybrid cars (without driver)	Equipped with autopilot, navigation, cameras, radars, and devices for receiving information from the outside based on cyber-physical systems.	Power transmission by wireless signals	Charging low-power devices (intelligent times, pacemaker, hemodialysis) via Wi-Fi signals or other wireless networks.
6.	Elements functioning on electronic chips	Nanoelectronic carriers are attached to the corresponding element, which transmits information about the "behavior" of the organ under the influence of faces, the environment, and physiological processes.	Aging engineering	Identifying the mechanisms of aging, preventing morbidity and summer troubles, and ensuring healthy human aging.
7.	Perovskite components for solar energy	Reduce the cost of solar energy production (the panels' size and weight are reduced, respectively), making it more environmentally friendly.	Green ammonia	Production of ammonia fertilizers from more purified hydrogen sources.
8.	Open ecosystems	Transition to "contextual" intelligence. Simplifies the management of a person's affairs through special software (financial transactions, online medicine).	Wireless biomarker devices	Portable, wireless, wearable devices track human biological markers (blood tests) to prevent disease.
9.	Ontogenetic	New methods of treating nervous and mental diseases by directing light to identify altered neurons.	Houses from improvised (local) materials	Construction of houses using 3D printers from local materials (clay, green palm branches, algae).
10.	System metabolic engineering	Reproduction of microorganisms to change the traditional raw materials for chemical production and pharmacology. It will allow these microorganisms to replace natural plants or animal organs to produce medicines.	Space Internet of Things	Distribution of devices for connecting to the Internet through the use of light Nanosatellites orbiting the globe.

*Compiled by the author based on the *World Economic Forum's Meta-Council on Emerging Technologies* and *Top 10 Emerging Technologies of 2021* [15, 17].

This Table clearly shows the change in society's development values. In recent years, innovations have clearly defined ways of solving social problems, including improving the planet's climate. This identifies the development of the concept of Society 5.0.

The concept super-intellectual concept of "Society 5.0" is designed based on the idea of the information society "Industry 4.0" to solve such global problems of humankind as reducing the working-age population and prolonging its healthy life (healthy aging), medical and biotechnologies, maintaining the planet's climate (global warming) problems (reduction of emissions, hydrogen, etc.), natural and artificial disasters, alternative energy sources, lack of natural resources and food, comprehensive communications (information and communication support in any corner of the earth). Therefore, the philosophy of the "Society 5.0" concept is the use of Internet of Things technologies, which allows accumulating information arrays in the physical space – extensive data that are processed by artificial intelligence, and new decisions are made by sending them to the exact physical measurement [16].

Of course, public life digitalization is an integral part of society's further development. Polanyi believes that digital transformation dictates the need to find methods to adapt to new challenges and situations [20]. We agree with this statement and think that this transformation is possible due to the emergence of a new digital generation of workers [14], who, thanks to their competencies, will be able to interact virtually in cyberspace as soon as possible.

Let us carry out a comparative description of the achievements of the Fourth Industrial Revolution; the Concept of Society 4.0 and the Concept of Society 5.0 (see Table 2).

Table 2: Comparative characteristics of the achievements of the Fourth Industrial Revolution, the Concept of Society 4.0 and the Concept of Society 5.0 (author's development)

4 Industrial Revolution	The concept of Society 4.0	The concept of Society 5.0
Intelligent sensors	Population reduction. Decreased industry competitiveness.	Intellectual society. Population reduction.
Internet of Things, Cloud Services, Mobile Devices	Individual optimization through the use of information and communication technologies.	General society optimization with the help of cyber-physical space.
Production automation. Management of all processes and sub-processes in real time under the influence of external factors	The world is associated with restrictions (temporal, spatial).	World free from any restrictions.

Complex information systems	Rapid aging society. Need for more participation of women in social development.	Society in whose development all segments of the population and all age groups take an active part.
Digital ecosystems	Natural and artificial disasters. Outdated infrastructure. Environmental problems. Efficient use of natural resources and water.	Society security in cyber-physical space. The society maintains an optimal balance between economic development and the state of the environment. Use of new resources (data).
Robotization	Finding solutions to individual problems. Improving the efficiency of particular industries and sectors of the economy.	Solving complex social problems. Ensuring the standard of living people and their well-being.
Big data analytics	Uneven regional development. Population concentration in big cities.	Society in which there is a high quality of life, regardless of location in the territory.

Table 2 demonstrates the main directions of the world's technological development. It allows for forming development priorities based on the current trends and implementation measures of socioeconomic development in the context of global challenges.

According to Table 2 and the studies carried out, construct a technological evolutionary development curve based on the S-curve of technology development and the envelope curve (Figure 3).

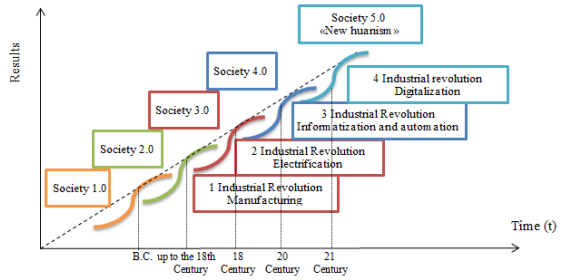

*Figure 3 – Curve of technological and evolutionary development based on the S-curve of technological development and the envelope curve**

*Compiled by the authors based on Figure 1 and Figure 2.

According to this Figure 3, there are clearly defined stages of social development as follows:

- Stage 1 – Society 1.0 (characterized by the production of agricultural and agricultural products as a result of human activities);
- Stage 2 – Society 2.0 (farming and agricultural products become the exchange subject);
- Stage 3 – Society 3.0 (industrial production is developing, motors and devices are appearing, and production is being electrified);
- Stage 4 – Society 4.0 (informatization of society, computerization, new technologies, innovations, Industry 4.0);
- Stage 5 – Society 5.0 (characterized by expanding the concept of "Industry 4.0" to "Industry X.0", cyberspace, solving immediate social programs, sustainable economic development, digitalization, reproduction of the relevant infrastructure in virtual reality).

5 Discussion

An important factor in international competitiveness and a guarantee of the future success of the economy of any state and its regions is technological development, which is at the transition stage from the fifth technical order to the sixth. The changing world is turning into "the world of subtle technologies that begin to control the world of machines" [12, p. 2]. The economy, under the influence of the above changes, has the features indicated below [2, p. 15–19].

Globalization is characterized by the fact that the components of the economy: capital, production, management, markets, labor, information, and technology are organized in such a way that there is closer cooperation between countries and regions at a great distance, intellectual formations and innovation clusters arise.

The knowledge economy is an economy that is a catalyst for innovation and the development of science and technology. It is based on knowledge concentrated in human capital. The progress of knowledge erodes the integrity of the property. Also, it undermines the conditions for the functioning of the free market [8, p. 37].

Intellectual capital is intangible assets that form the knowledge and competencies of personnel to create tangible and intangible assets in intellectual work, making it possible to develop competitive advantages [19].

Digital transformation is changing all areas of society by revising digital strategies, models, operations, marketing approaches, tasks, and goals by introducing digital technologies to accelerate and increase results [29].

Handling intangible benefits, information, and relationships creates opportunities for their use, subject to the involvement of highly qualified personnel.

The interaction of individual segments of the new economy is forming digital platforms to unite the interests of all participants in the market system.

Such a change leads to transformations in such areas as:

- Dominant technological solutions;
- The new organizational practice of entrepreneurship.

There is a change in the relative structure of costs under the influence of new technology of a particular factor of production, which becomes relatively cheap and is not exhausted in the foreseeable future. It can increase profits by reducing the cost of capital and labor. Consequently, an appropriate organizational business practice is formed. The widespread use of innovative technologies creates new market conditions and principles of organization of activities corresponding to them, surpassing the previous ones and becoming part of the new efficiency theory. The essence of this theory is that the supply curve has a negative slope. Marginal costs tend to zero at significant intervals, and the demand curve has a positive slope. Marginal utility increases as the number of participants in the consumption of goods grow [6]:

- Management of economic activity;
- Social institutions;
- People's behavior.

The above has caused the emergence of such a phenomenon of the global economy as techno-globalism. A process of globalization that extends to the sphere of innovative technologies and research and development work. It reflects the cyclical nature of the configurations of technological modes both in the territorial and temporal dimensions. It is understood that new products and technical systems developed by the world's leading countries fall on the periphery of the world economy and can be used in economically backward countries. Techno-globalism has acquired the features of a system and has become an imperative of the economic policy of all the world's leading states [1, p. 168].

In developed countries, we are already discussing building an intellectual society (a super-smart society or Society 5.0) [6, p. 13–15]. Science and technological innovations will ensure balanced economic development and solve social problems. Its top link will be the "smart industry" (English Smart industry)

[5]. A prerequisite for its creation is cooperation between industry, academia, and government [6, p. 14].

New opportunities will favor countries that create infrastructure, institutions, and business environments in which their companies and citizens feel empowered to reach their fullest potential [32]. Among the factors that directly affect the channels of the spread of crisis phenomena and the synchronization of cycles, we can distinguish:

- The growth in the speed of information transfer allows not only for reducing operating costs, as well as infrastructure and marketing costs but also to make decisions faster, based on more analytical data;
- Increased interaction with the end user due to omnichannel leads to an acceleration in the growth of loyalty, therefore, to an acceleration of the life cycle of products, which accordingly affects the acceleration of the life cycle of production/development of new products (the agile methodology is being implemented on ever larger structures);
- Transfer pricing allows multinational companies to smooth out internal costs through the interaction between individual international divisions (however, it often leads to tax speculation);
- An increase in the number of types of assets leads to the diversification of foreign investments, which reduces their riskiness for investors and increases the attractiveness of this type of investment; however, the growth in the volume of foreign investments itself leads to an increase in the risk of states' dependence on external financial sources.

Based on these factors, the following can be drawn:

- The length of cycles and, accordingly, the intervals between recessions and crises are reduced, similar to the shortening of the life cycle of most high-tech products;
- The risks of financial infections (contagious crises) increase due to the growth of unregulated, accelerating, and increasing volume financial flows between countries;
- The amplitude of local cycles increases due to the rise in the speed of the reaction of agents to economic downturns and the rapid withdrawal of funds from inefficient assets, as well as facilitating the possibility of international migration (in times of crisis, the outflow of the able-bodied population slows down the speed of economic recovery);
- The amplitude of the global cycle is smoothed out due to the growth in the number of participants in international relationships leading to the possibility of a quick change of counterparties and preventing the impact of negative factors in one country's economy on the economy of others.

International financial and economic organizations see technology as the main driver and condition for the survival of companies and countries [5].

6 Conclusion

Further technological development is formed based on the Concept of Society 5.0, which allows, thanks to the Internet of Things technology, to accumulate large amounts of information in physical space, which is analyzed by artificial intelligence and stored in cyberspace. In processing and collecting data, new decisions are made to solve social problems and implement safe and environmentally friendly innovations, which are returned to the physical dimension. The critical fact is the capitalization of results from introducing innovative technologies.

Thus, further development's main priority is replacing human labor with the latest knowledge, which is a source of value in technological development.

Based on the research, it is essential to form a conceptual vision of the resource provision of the country and its regions. Thanks to the provision of resources, a large number of issues related to the economic and social well-being of the population are resolved, which is a priority issue for the countries of the world.

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Primary Paper Section: A

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