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# MECHANISMS OF INTERNATIONAL TECHNOLOGY TRANSFER OF THE EU COUNTRIES IN THE CONTEXT OF GLOBAL DIGITALIZATION: CHALLENGES, TRENDS, PROSPECTS

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The article examines the current aspects of international technology transfer in the countries of the European Union in the context of global digitalization. In the modern world, digital transformations are fundamentally changing the mechanisms of technological exchange between states, companies and research institutions, leading to the need to rethink traditional approaches to innovation management. The article emphasizes that for the European Union, technology transfer is not only a tool for innovative development, but also an important factor in geoeconomic sustainability and the formation of a single digital space. Given the growing complexity and multilevel nature of global economic relations, an effective technology transfer policy requires an interdisciplinary and interinstitutional approach based on the principles of open innovation, cooperation and joint development. European digital initiatives, including the Digital Single Market, Horizon Europe, the European Innovation Council and others, play an important role in this process. They create conditions for the integration of digital solutions into all links of the value chain - from research and development to commercialization. The article highlights the problem of digital inequality both within the EU and globally, where countries with less developed digital infrastructure – Ukraine – risk being on the periphery of technological progress. The article substantiates that increasing the efficiency of international technology transfer is possible only under the conditions of strategic coordination of digital policies, the development of a single regulatory framework, the activation of cross-border cooperation and the formation of inclusive innovation ecosystems. Special attention is paid to the issue of strengthening the role of Ukraine in the European space of technological exchange as a factor of its economic modernization and gradual overcoming of the digital divide. Thus, the approach proposed in the article allows for a comprehensive assessment of current trends in technology transfer in the context of digital transformation, to identify systemic challenges and promising directions for the development of innovation cooperation policy.

**Keywords:** technology transfer, digitalization, European Union, innovation, international cooperation.

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Formulation of the problem. Global digitalization is radically transforming the current environment of international technological exchange, while opening up new opportunities and posing complex challenges. For the European Union countries, technology transfer is becoming a key factor in maintaining innovation competitiveness dynamics, strengthening integration into global value chains. However, this process is accompanied by significant asymmetries between countries in access to digital solutions, uneven development of digital infrastructure, risks of losing technological sovereignty, legal regulation issues, and a growing need for cross-sectoral and international cooperation. In the context of rapid changes caused by the rapid development of artificial intelligence, automation, and digital platforms, there is a need for an in-depth analysis of effective technology transfer mechanisms that take into account both the economic and institutional features of the EU and global trends.

The hypothesis of the study is that increasing the efficiency of international technology transfer within the European Union is possible through the synergy of digital tools, harmonization of regulatory frameworks, development of open innovation ecosystems, and active involvement of new partners, including Ukraine, in the common innovation space. This approach will minimize the risks of digital inequality and contribute to the formation of sustainable, inclusive technological development.

**Analysis of recent research.** The analysis of publications on technology transfer in the context of digitalization demonstrates a number of important areas covering current challenges and opportunities in this area. One of the key aspects is the role of new technologies, such as artificial intelligence, blockchain, and the Internet of Things, in accelerating the process of technology transfer. In particular, Balazyuk and Pylyavets (2022) consider blockchain as a tool for ensuring transparency and efficiency of technology transfer in various sectors of the economy. In addition, Grushko (2024) emphasizes the importance of digital technologies in the development of the educational environment, which is also directly related to the transfer of knowledge and technology between different countries.

Zinchuk (2024) analyzed mechanisms for the transfer of innovative technologies, including the integration of digital platforms for the exchange of information and technology at the international level. These digital platforms are becoming important tools for reducing barriers to technological exchange, creating new opportunities for international cooperation. However, despite significant progress in this area, many aspects of technology transfer remain underresearched, including cybersecurity and intellectual property protection, which are critical in the digital environment. An important topic is the integration of

digital technologies into the development strategies of countries, which is actively studied in the publications of Koval and Lyshak (2024). They emphasize the need to form a single digital market for effective interaction between countries that are actively developing in the face of global challenges. This aspect also emphasizes the importance of cooperation between Ukraine and EU countries in the field of technological exchange. On the other hand, Prudka and Chaika (2021) emphasize the role of technology transfer as an important element for the development of an innovative model of Ukraine's economy, noting that the introduction of modern technologies is a prerequisite for ensuring the competitiveness of the national economy on a global scale. In the context of globalization, the problem of asymmetry of access to innovations and the digital divide between countries is also important, which limits the development opportunities for individual countries, such as Ukraine, in this process.

Thus, although the issue of technology transfer in the digital environment is actively studied in current publications, some aspects, such as cybersecurity, intellectual property protection, and integration of interdisciplinary approaches, require further research. This will allow for a deeper understanding of the mechanisms of effective technology transfer, especially for countries seeking to integrate into the international process of innovation exchange.

The purpose and objectives of the article. The purpose of the article is to study and systematize the mechanisms of international technology transfer of the European Union countries in the context of global digitalization in order to identify effective tools that accelerate innovation exchange, overcome digital inequality and strengthen international technological cooperation.

Research objectives:

- 1. To reveal the essence and structure of technology transfer in the context of digital transformation of the global economy.
- 2. To study the main digital tools (blockchain, AI, cloud services, etc.) that affect the mechanisms of international technology transfer.
- 3. Identify the challenges and barriers that arise in the process of technology transfer in the digital environment.
- 4. Analyze the role of the EU and its institutions (in particular, the Digital Single Market) in shaping an effective technology transfer policy and outline the prospects for its development.

**Summary of the basic research material.** Digital transformation dramatically affects economic processes in all industries, increasing productivity through automation and improvement of business processes [5, c.2].

Technology transfer is an important component of innovation development, which encompasses the transfer of knowledge, technology, intellectual property and research results between different actors - countries, companies, universities, research institutions and other institutions. Technology transfer involves not only the transfer of technology itself, but also the appropriate training of resources, staff development, creation of infrastructure for the implementation of innovations and adaptation to local conditions.

Zinchuk T.O. defines technology transfer (TT) as a sequence of actions in which new knowledge obtained as a result of fundamental and applied research in universities and research institutions is freely disseminated, transferred through the provision of scientific and technical services or purchased by enterprises for implementation as a product or technology [3, c.2].

The main essence of technology transfer is the process of transforming ideas into practical applications, which may include knowledge sharing through patents, licenses, joint ventures, research and educational programs. In the current context of globalization and digitalization, technology transfer is acquiring new aspects, including the growing role of digital platforms and new technologies such as artificial intelligence, blockchain, and the Internet of Things.

Digitalization is changing the foundations of technology transfer mechanisms, adding new opportunities and challenges. First of all, the speed of data and knowledge transfer through online platforms is significantly increasing, allowing for more efficient information exchange between participants in the process, regardless of their geographical location. Platforms such as cloud services allow for instant data transfer and collaboration on innovations [2, c.227]. On the other hand, digitalization also creates new barriers, including cybersecurity, intellectual property protection, and the risks of technological asymmetry between countries and companies. Countries that have limited access to modern digital technologies may be at a disadvantage in terms of effective adoption and implementation of new technologies. Problems with data protection and infringement of intellectual property rights may also slow down the process of technology transfer, as imperfect legal and regulatory systems in some countries may become an obstacle to international cooperation. Digitalization also requires new skills and knowledge in IT, data analytics, programming, and project management, which requires countries to modernize educational and vocational programs to ensure that they have the right skills to effectively implement technology transfer.

International mechanisms and institutions that regulate technology transfer are important elements that ensure the effective and legitimate transfer of technology between countries and companies. One of the main international institutions that facilitates this process is the World Trade Organization (WTO), in particular its Agreement on Trade-Related Aspects

of Intellectual Property Rights (TRIPS) [9], which sets minimum standards for the protection and enforcement of intellectual property in international trade.

In addition, international organizations, such as the United Nations (UN), the World Intellectual Property Organization (WIPO), and the European Commission, play an important role in creating regulations and recommendations related to technology transfer, as well as facilitating international agreements that facilitate technological exchange between states.

One of the important initiatives in this direction is the EU Digital Single Market, which stimulates openness, innovation, and effective access to digital technologies for EU member states [10]. The EU's Digital Single Market is an important component of the Union's technological integration strategy. The purpose of this market is to create conditions for the free exchange of digital products and services between EU countries, which significantly accelerates technological progress and simplifies the transfer of innovations. The Digital Single Market removes the regulatory and legal barriers that previously hindered the effective exchange of technology. The Digital Single Market supports the development of tools such as e-commerce, cloud technologies, data and service exchange platforms that allow businesses and research institutions from different EU countries to interact and collaborate seamlessly in the field of technology. As a result, the EU is becoming not only a domestic but also a global leader in the development and application of digital solutions, which significantly improves the conditions for technology transfer at the international level.

Digitalization is significantly changing not only the economic structure, but also the mechanisms of technology transfer and exchange between countries and companies. Thanks to the rapid development of digital technologies such as blockchain, artificial intelligence, and the Internet of Things, technology transfer has become much faster, more efficient, and less costly [4].

Blockchain, as one of the most revolutionary digital technologies, is changing approaches to technology transfer and data storage. Due to its ability to ensure transparency, security, and the impossibility of changing information without the knowledge of all participants in the process, blockchain can become a powerful tool for preserving intellectual property rights and ensuring legality in technology exchange. It can provide efficient and reliable registration of technology transfer agreements, preventing fraud or breach of contract [1].

Artificial intelligence (AI) also has a significant impact on technology transfer. AI algorithms can be used to analyze large amounts of data, which can optimize the process of selecting the best-fit technologies for specific conditions and automate numerous stages of the transfer. They can help identify the most promising technologies for investment, provide predictive

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outcomes from their implementation, and improve intellectual property management processes, which is important for international technology transfer.

Digital platforms have become important tools for international technology exchange, as they enable the rapid transfer of data and technological knowledge on a global scale. Through platforms such as online technology marketplaces, collaborative research platforms, cloud services, and specialized portals for scientific and technical cooperation, businesses can interact directly with innovation providers and gain access to the latest developments and expertise.

Digital platforms help minimize the time and financial costs of finding and implementing new technologies, and reduce barriers for countries with limited resources or access to advanced technologies. They create an environment for a more open, transparent and efficient exchange of technologies between countries, which accelerates innovation and economic development.

Such platforms can also become tools for cooperation between small and medium-sized enterprises, helping them to access new technologies and research results that were previously available only to large corporations. Integration with global markets and resources allows small businesses to actively innovate, thereby increasing their competitiveness.

The process of technology transfer in the European Union faces a number of challenges and barriers (asymmetry of access to innovation, cybersecurity and intellectual property protection issues, and a lack of qualified personnel) that can slow down or complicate the effective exchange of innovations.

One of the biggest challenges to technology transfer in the EU is the asymmetry of access to innovation between countries, which is part of the overall digital divide. Differences in the level of development between Western and Eastern European countries, as well as between large and small economies, can lead to the fact that technologies that are developing in some countries may not be available to others. Countries with developed digital infrastructures, such as Germany or France, are better placed to adapt and commercialize new technologies, while other Member States, especially in Eastern Europe, may face difficulties in providing the necessary infrastructure for technology transfer.

The second major barrier to technology transfer in the EU is cybersecurity and intellectual property protection. In the context of globalization and high levels of digitalization, the risk of cyber threats such as infrastructure attacks, data theft, or criminal activities related to the illegal use of intellectual property is growing. The EU is actively working on implementing cybersecurity regulations, such as the GDPR, which regulates the protection of personal data, but there are some difficulties in standardizing security mechanisms internationally. Different countries may have different levels of preparation for protection against cyber threats,

which leads to uneven application of technologies and complicates their transfer between countries, especially for small and medium-sized enterprises that do not have sufficient resources to ensure an adequate level of cybersecurity [6, p.15].

The last important barrier to technology transfer is the lack of qualified personnel, particularly in countries with less developed economies. Successful implementation of new technologies requires highly qualified specialists who are able to work with advanced innovations, develop new solutions and adapt them to specific conditions. In some EU countries, there is an urgent need for education and training that meets the requirements of the digital economy. The gap in the level of education between EU countries creates obstacles to the rapid adaptation of technologies and the introduction of innovative solutions at the level of the entire Union. For effective technology transfer, the EU needs to.

The European Union is one of the world's leading models in the field of international technological exchange due to the integration of states and the creation of a single legal and economic platform for interaction in the field of technology and innovation. The process of technological exchange between EU member states is multilevel and includes both institutional mechanisms and strategic initiatives that promote innovation and technology at the European and international levels.

Ukraine has a significant scientific and technological potential, but lacks the resources and experience to commercialize its developments and implement new technologies. International technology transfer can help Ukraine overcome these limitations and integrate into the global innovation system [11, p.2].

Ukraine's integration into the international technology transfer process is an important strategic step to stimulate its technological development and digital transformation.

During 2014-2023, 26395 technology transfer agreements were concluded for a total of UAH 1246.38 million. The largest number of agreements was concluded in 2014, but the largest amount of funds under the concluded agreements was received in 2020 - UAH 218.74 million [7].

The highest average value of one technology transfer agreement was achieved in 2020 and amounted to UAH 118.17 thousand, which is 1.7 times higher compared to the value of the agreement in 2019. The lowest average value was recorded in 2014 - UAH 12.20 thousand (Fig. 2).

Over ten years, from 2014 to 2023, UAH 1233.73 million was received under technology transfer agreements, the dynamics of which and the volume of their use in the studied years are shown in Fig. 3. The largest amount under technology transfer agreements was received in 2020 and 2021 - UAH 218.74 million and UAH 187.95 million, respectively, and the smallest

in 2014 - UAH 64.90 million. The largest amount of funds received under technology transfer agreements was used in 2019 and 2021 - UAH 118.99 million and UAH 121.70 million, respectively.

Given the existing potential and significant opportunities for cooperation with EU countries, Ukraine has a chance to become an important player in the global technology market. However, in order to realize this potential, a number of barriers need to be removed, including legal regulation, infrastructure, and education. Cooperation with EU countries is one

of the main opportunities to accelerate Ukraine's technological development [8, p.15]. The EU has many years of experience in managing technology transfer processes and actively supports neighboring countries seeking to integrate into the European economic area. Joint projects with EU countries in areas such as green energy, digital technologies, robotics, and artificial intelligence can ensure the transfer of advanced technologies that will allow Ukraine not only to develop but also to become competitive in the global market. Such projects will also contribute to strengthening

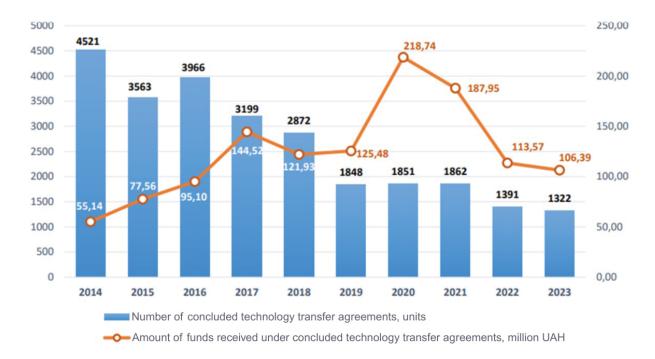


Fig. 1. Number of technology transfer agreements and amount of funds received in 2014-2023 [7]

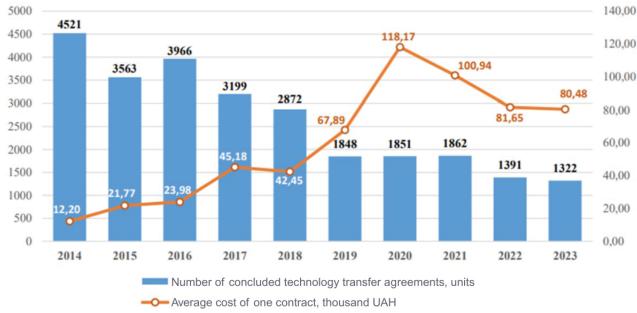


Fig. 2 Number of concluded agreements and average cost of one agreement in 2014-2023 [7]

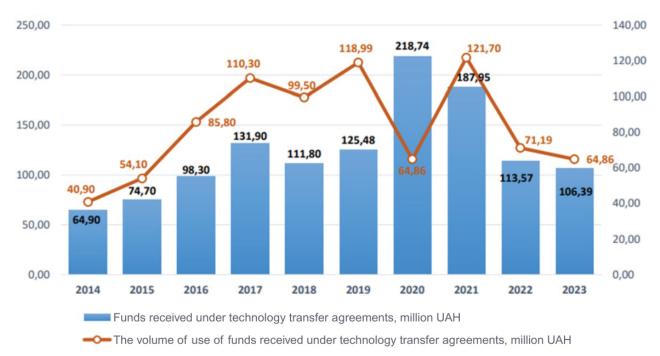


Fig. 3. Funds received under technology transfer agreements and their use in 2014-2023 [7]

international relations and developing the technological ecosystem in Ukraine.

O. Shvydanenko notes that despite the challenges of a full-scale war, thanks to a balanced state policy, support from the international community and the hard work of Ukrainian scientists, engineers and entrepreneurs, Ukraine can become one of the leaders in the global technology market [12, p.6].

To integrate into international technology chains, Ukraine needs to identify several key strategic directions. First, it is to improve the legal framework to ensure the protection of intellectual property and create favorable conditions for investment in high technologies. Second, it is important to actively involve young scientists and specialists in the field of research and development, creating conditions for their professional development and support for startups. Third, it is necessary to increase integration into global digital platforms that ensure the exchange of technologies, data and services between different countries.

The findings of this study. The main forms and models of international technology transfer used in EU countries are analyzed, in particular, licensing, joint ventures, research partnerships and digital platforms. Key digital tools that transform technology

transfer mechanisms are identified: cloud computing, blockchain, artificial intelligence, big data analytics. The main challenges that hinder effective technology transfer are identified: legal fragmentation, cyber risks, lack of common standards for data exchange and digital interoperability. The EU policy in the field of digitalization and technology transfer is analyzed, in particular the Digital Single Market and Horizon Europe initiatives, and the prospects for the development of these mechanisms until 2030 are determined.

Technology transfer mechanisms in EU countries are actively adapting to the conditions of digitalization, taking on new forms due to digital platforms and innovative tools. Effective technology transfer requires harmonization of the regulatory environment within the EU and active stimulation of digital ecosystems to support innovative enterprises. The most promising areas for the development of international technology transfer are the creation of open digital infrastructures, the use of blockchain solutions to protect intellectual property rights, and support for transnational innovation clusters. Successful implementation of the digital technology transfer strategy will contribute to increasing the competitiveness of the EU economy and strengthening its position in the global innovation environment.

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# МЕХАНІЗМИ МІЖНАРОДНОГО ТРАНСФЕРУ ТЕХНОЛОГІЙ КРАЇН ЄС В УМОВАХ ГЛОБАЛЬНОЇ ЦИФРОВІЗАЦІЇ: ВИКЛИКИ, ТЕНДЕНЦІЇ, ПЕРСПЕКТИВИ

У статті розглядаються актуальні аспекти міжнародного трансферу технологій у країнах Європейського Союзу в умовах глобальної цифровізації. У сучасному світі цифрові трансформації докорінно змінюють механізми технологічного обміну між державами, компаніями та дослідницькими установами, зумовлюючи потребу в переосмисленні традиційних підходів до управління інноваціями. У статті підкреслюється, що для Європейського Союзу трансфер технологій є не лише інструментом інноваційного розвитку, а й важливим чинником геоекономічної стійкості та формування єдиного цифрового простору. Враховуючи зростаючу складність та багаторівневість глобальних економічних зв'язків, ефективна політика трансферу технологій потребує міждисциплінарного та міжінституційного підходу, що базується на принципах відкритих інновацій, кооперації та спільної розробки. Важливу роль у цьому процесі

відіграють європейські цифрові ініціативи, серед яких Єдиний цифровий ринок, Horizon Europe, European Innovation Council та інші. Вони створюють умови для інтеграції цифрових рішень у всі ланки ланцюга створення доданої вартості — від досліджень і розробок до комерціалізації. В статті актуалізується проблема цифрової нерівності як усередині ЄС, так і в глобальному вимірі, де країни з менш розвиненою цифровою інфраструктурою, зокрема, Україна ризикують опинитися на периферії технологічного прогресу. У статті обґрунтовано, що підвищення ефективності міжнародного трансферу технологій можливе лише за умов стратегічного узгодження цифрових політик, розвитку єдиної нормативної бази, активізації транскордонної співпраці та формування інклюзивних екосистем інновацій. Окрема увага приділена питанню посилення ролі України в європейському просторі технологічного обміну як чинника її економічної модернізації та поступового подолання цифрового розриву. Таким чином, запропонований у статті підхід дозволяє комплексно оцінити сучасні тенденції трансферу технологій в умовах цифрової трансформації, визначити системні виклики та перспективні напрями розвитку політики інноваційної кооперації.

Ключові слова: трансфер технологій, цифровізація, Європейський Союз, інновації, міжнародна співпраця.

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