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TECHNOLOGY TRANSFER IN THE SYSTEM OF INNOVATION DEVELOPMENT: CHALLENGES AND OPPORTUNITIES

The paper is aimed at assessing the processes of technology transfer in the context of innovative economic development and to develop measures to improve them. The article examines the economic essence, importance of technology transfer, and features of its use. It is found that the most problematic issues in the use of technology transfer in Ukraine are insufficient financing of innovation activities, weak inter-connection of scientists and practitioners, lack of interest of researchers in promoting developments, imperfection of state regulation and patent and license support, etc. In order to address these issues, it is proposed to improve funding for researchers at the expense of the state budget, international funds, private capital, investors, grant programs, etc. The attraction of private capital to the implementation of new technologies can also be facilitated by the spread of tax incentives for business entities. This paper presents a new toolkit aimed at enhancing technology transfer in Ukraine. It is focused on building relationships between science and business. Along with solving financial problems, it involves the widespread use of various online and advertising products to ensure the most efficient and rapid information and communication between scientists and representatives of business organizations, and the formation of a modern technology transfer infrastructure. The article outlines the features of effective technology transfer in Ukrainian practice and in developed countries. The proposed approaches to intensifying technology transfer management, unlike the known similar ones, which are mainly characterized by one-sidedness of problem solving, are the most systematic, focused on broad information and communication of participants in the innovation process. The latter can be carried out through the active use of online resources and the latest digital technologies. It is assumed that in the long term, this can provide significant results and create additional opportunities for more effective innovative development of the Ukrainian economy.

Keywords: technology transfer, innovative development, science, business, technology, development, projects, implementation, commercialization, innovators.

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1. Introduction

Among the main directions of Ukraine's strategic development and its post-war recovery, high-tech production is of priority, since it plays a decisive role in the automation, innovation and energy efficiency of various sectors of the national economy, ensures the formation of the material and material basis of all production business structures and, in the context of European integration, is the foundation of effective economic growth. The issue of technology transfer management, as the main object of innovation activity, is one of the most important problems in the development of any country. The state of affairs in the field of technology and innovation, their practical implementation, is assessed by the level of economic success of certain countries and society as a whole. Modern economic processes cannot be imagined without the active development of new technologies, which are based on the principle of accessibility, freedom of use, intellectual property and the principle of transparency of new technological solutions, etc. Recently, the topic of innovative technologies and methods of activating their implementation has acquired both an international and national scale and political and economic significance. Given the acceleration of innovative progress in recent years, the field of technology transfer is of deep interest to both scientists and practitioners from different countries of the world.

In world practice, technology transfer has acquired an extremely broad and accelerated development. At the same time, countries such as the USA, England, Japan, France and Germany are leaders in innovative and technological progress and have already moved to the sixth technological order. The scientific community of foreign countries has formed a clear understanding that the most effective technologies, mainly high, extremely effective and capable of providing a significant increase in production efficiency, are the most competitive positions of business [1–3]. At one time, US computer programs contributed to reducing the duration of launching products into mass production by 30–60 %, improving its quality by 300–600 %, and increasing labor productivity by 40–70 %. Foreign scientists have made a great contribution to the study of the diffusion of innovations, the technology transfer system and the promotion of new products to the market [4]. Effective mathematical models of the distribution of innovative products, mathematical functions are also developed. It is characterized the dynamics of sales of innovations over time [5, 6]. At the current stage of innovative development, researchers' efforts are mainly focused on the commercialization of digital technologies, the use of artificial intelligence, which can contribute to the greatest extent to the efficiency of business development, increasing its competitiveness. Although recently, due to the emergence of certain problems in the practical implementation

of innovations (loss of jobs, weak protection of intellectual products), more and more scientists have begun to pay attention to the issues of protecting the labor rights of employees, ensuring their safety, employment, as well as the protection of intellectual property rights [3]. For Ukraine, the problem of technology transfer is that, unfortunately, it is still not used enough, or not always effectively.

The effective development of Ukraine, its post-war recovery depends significantly on the implementation of innovative projects by business entities in various sectors of the economy. As a result of the post-war devastation and extensive destruction in the country, there is a special need for new technological solutions. This applies to both new methods of defense, drones, deminers of certain territories, and modern means of decentralized electricity generation, new approaches in the development of aviation equipment, the construction of protective structures, transport routes, etc. At the same time, the effectiveness of the implementation of innovations is significantly affected by the process of transferring technologies from the scientific sphere to the production sphere, the so-called technology transfer. The latter involves the fact that a new technology, both mature and in the state of invention, is transferred from its place of origin to the appropriate places of application or business areas.

Technology transfer plays a crucial role in the system of innovative development, allows for the dissemination and introduction of advanced technologies, their commercialization. The introduction and commercialization of new technologies and effective technological exchange increase the competitiveness of business, contribute to the development of high-tech imports and exports, general economic development, and the establishment of cooperation between Ukraine and advanced countries of the world.

The difficult situation in Ukraine, which is especially associated with military aggression, requires society to radically change its approaches to the introduction of innovations. The development of relations between the scientific sphere and business can contribute to the technology transfer, their testing, and will make it possible to ensure the innovative development of business structures on an ongoing basis. After all, it is well known that the leaders of the world market today are the owners of the latest technologies, and not only those who managed to introduce something new once. The greatest success is achieved by those who regularly produce new products, provide new services, implement the most modern innovations or improve existing technologies.

Business structures, the scientific community, state and local authorities should synergistically form favorable conditions for technological development, which can strengthen Ukraine's positions both in the external defense of the state and in the rear. Also, obtaining the prospect of joining the EU by Ukraine requires the formation of a qualitatively different innovation policy, which will allow for cardinal changes, despite the state of war and the current economic turmoil.

Given the significant number of scientific developments on this issue and the practical experience gained recently regarding the effective implementation of technology transfer, many tasks arise regarding the use of more modern tools for the implementation of the specified process. A more in-depth consideration of this issue is extremely relevant today and will provide an opportunity to better understand the process of forming the transfer of the latest developments and innovations.

The aim of research is to determine the features of the development of technology transfer, identify its main challenges and opportunities, and develop approaches to intensifying the implementation of innovations based on modern market instruments.

2. Materials and Methods

The object of research is the mechanism of technology transfer in the innovation system.

The issue was resolved using publicly available materials, statistical data, the authors' own research and observations. Well-known scientific

methods were also used, in particular, the system analysis method, to generalize theoretical and methodological approaches to determining the features of the development of technology transfer and managing its development. When assessing various aspects of the development of innovations and their impact on the development of business processes, statistical analysis and generalization methods were used. In the process of identifying the features of technology implementation and their evaluation by specialists, the expert survey method was used. When substantiating measures aimed at accelerating the development of technology transfer in the prospective period, the monographic method was used, and when generalizing and formulating conclusions, the abstract-logical method was used.

3. Results and Discussion

Many scientific works of scientists and researchers are devoted to issues related to innovative development, and in particular, to technology transfer. The main interest of scientists was to determine the essence and general approaches to technology transfer, characterize its types, stages and tasks, identify differences between technology transfer and commercialization. Some attention was paid to the features of public administration and regulation in the field of transfer, to assess the main sources of financial support for innovations, etc.

Thus, in the works of the authors, special attention was paid to the main tools and mechanisms of technology transfer, their features of use in the conditions of Ukraine [7]. The best experience of highly developed countries in the world in the formation of tools for accelerating the development of technology transfer was also analyzed and the importance of these processes in modern conditions was assessed from the point of view of their implementation in Ukraine. The features of the creation and use of a modern information and technological system as a basic platform for technology transfer, as well as the tools of international technology marketing in practice were considered [8]. Scientists have highlighted the concept of technology transfer, including its international experience, analyzed the main forms and methods of technology transfer, identified the main problematic aspects of introducing innovations into production, as well as their impact on the development of agrarian business [9].

A well-known researcher has developed a detailed classification of technology transfer, taking into account the form, purpose, features of transfer, distribution, content of technological achievements, etc. According to the author, technology transfer precedes their commercialization and is based on a certain number of phenomena and processes [10]. From his point of view, the processes of commercialization of scientific developments are aimed at ensuring high profitability and production efficiency. In addition, mastering new technologies contributes to the acquisition of new knowledge, skills and competencies of employees.

At the same time, another author identifies key differences in the definitions of technology transfer and commercialization. Thus, the commercialization of development is accompanied by obtaining profit from its introduction into production and not necessarily with the involvement of third parties. And technology transfer occurs when a new development is transferred to a recipient who organizes its industrial development, although this does not always provide profitability to the parties [11]. In general, some authors are inclined to the fact that both technology transfer and their commercialization can be carried out both sequentially and independently of each other. Therefore, they can be considered as two autonomous processes in the system of innovative activity, which is obviously worth agreeing with.

Given the significant number of new developments in the system of innovative activity and technology transfer, many issues still remain beyond the attention of scientists. Not all tools for implementing innovations have yet been considered in detail, there is a lack of a generalizing systemic approach to the specified issues.

In a market economy, specific prerequisites are formed for the development of innovations and their application. At first glance, it seems that society's attitude to innovative proposals should also change radically. That is, entrepreneurs and business entities should actively seek innovative developments in order to provide themselves with better working conditions and material benefits. But in practice, the market mechanism itself does not stimulate this process enough, because any business is oriented towards achieving quick and specific results. And in order to bring innovation to the final result, or rather to sell, commercialize, it is necessary to convince a potential consumer, investor, partner of its advantages. Innovative technologies, in order to be implemented in practice, must meet certain consumer needs, since buyers are not particularly eager to buy unknown ideas. World practice shows that even patented scientific and technical developments are used by 3–5 %. And when moving from idea to implementation into practice, out of 100 existing ideas, only no more than 1 is developed, and out of every 100 innovative products, the market rejects 90 [12]. So, in the innovation system, the most problematic issue is the practical use of new ideas, new knowledge, and the implementation of scientific developments in the production process. This should be ensured on the basis of the transfer of knowledge from science to business, i. e. technology transfer.

In the English-language concept of technology transfer, it is defined as the process of spreading scientific and technical knowledge, a direct transition from fundamental knowledge to technical [13]. That is, technology transfer (or technology transfer) represents the process of transferring technology from a person or organization that has or holds it to another person or organization. These transfers can be carried out between a developer, a business structure, governments, across geopolitical borders, in particular, on official terms, informally, openly, or secretly. Technology transfer plays an extremely important role in the development of innovative activity. It is a productive stage of interaction between research, design and other organizations, scientists, inventors, rationalizers who seek to practically implement existing scientific and technical achievements, new projects both in their country and abroad. With the effective use of the technology transfer mechanism, industrial enterprises can activate the processes of implementation and development of science-intensive technologies in production activities to obtain additional benefits, competitive advantages.

There are many obstacles to solving the above problems in Ukraine, primarily related to weak financing of research activities. This also manifests itself in the imperfection of the state's institutional policy and the system of intellectual property protection, patenting and licensing practices, a mass outflow of scientific personnel, their weak motivation, etc.

In the history of the development of science, there are many cases when quite important discoveries and developments of researchers found a place only on paper and in archives, but were not implemented in practice. After all, they did not receive proper support from management structures, were not provided with the necessary funding for implementation in production, etc. Ukrainian unique inventions, on which scientists and inventors sometimes worked for decades, sometimes did not receive their approval. It happened that they were found in archives and highly appreciated by foreign scientists and even patented for themselves and effectively used. This, in particular, concerns certain studies in the field of agricultural production, the development of livestock breeding, potato growing. One of the most important reasons for the lack of technology transfer, their commercialization, which was primarily emphasized by the scientists themselves, is the lack of funding. This leads to a number of other problems, in particular, the obsolescence of the equipment of scientific and educational institutions, the lack of applied research, the inability to test new technologies, the complexity of patenting, the low level of cooperation between innovative business structures and research institutions, etc.

The lack of financial resources, including for the remuneration of scientists and innovators, is the reason for the outflow of scientific personnel from science to other sectors of the national economy, as well as to other countries. However, there are promising conditions for innovative activity, such as the Horizon program of the European Union, grants from the US National Science Foundation, etc. [14].

Ukraine has received a high assessment among the world community. It is characterized by such characteristics as the level of education (skills) of the population, the level of research activity, the number of patents, the number of publications and the share of high technologies in industry. But it lags behind in the rating in terms of the level of development of ICT infrastructure, ensuring access of private organizations to credit resources [15]. Among the advantages of Ukraine, results in the field of knowledge and technology, human capital, scientific research are often highlighted. Disadvantages also include market conditions, state institutions, infrastructure. It is appropriate to indicate here that Ukraine has low results according to the European Innovation Scoreboard rating [14], the country's positions in this rating are constantly changing, sometimes showing an increase, and sometimes a decrease. In particular, during 2018–2022, Ukraine generally improved its indicators, increasing its rating from 27.8 to 31.0. In the Global Innovation Index 2024, published by WIPO, Ukraine fell five positions compared to last year, taking 60th place, but continues to lead in the number of applications for utility models [15]. According to WIPO, one of the weakest points of the Ukrainian economy is human capital. The shortage of skilled labor due to migration and mobilization processes is a serious challenge for the country's economic development and has a significant impact on the information technology sector [16]. However, despite the deterioration of Ukraine's rating in GII-2024 due to the destruction of infrastructure, population outflow and Russian invasion, which caused a tragic humanitarian crisis, global reconstruction is becoming an important factor in the sustainability and innovative restructuring of the national economy.

Thus, the scientific, technological and innovative spheres of Ukraine face a number of significant challenges, including insufficient support from the state, weak interest of business structures and educational institutions in investing in these sectors.

In order to identify existing gaps in the system of innovation and technology transfer in general, it is advisable to pay attention to certain points. It can be noted that scientists mostly lack proper information access to the existing needs of entrepreneurs. Researchers often lack information about real production problems and the main needs of business in new developments. The latter is especially exacerbated with the spread of privatization and commercialization of business processes, as the information necessary for scientists becomes increasingly inaccessible and secret. At the same time, a significant part of inventors does not have the opportunity to disseminate information about their potential proposals in order to bring them to practical use, due to the inertia and negative influence of numerous hierarchical management structures. At the same time, business often lacks information about modern achievements of scientists, important advantages and significance of their proposals.

Thus, there is an extraordinary gap between the interests of representatives of science and business. For scientists, a new technology is the result of many years of, sometimes a lifetime of work; they are interested in the smallest technical characteristics of an innovative solution. But at the same time, they do not care enough about its market component – the size of the general available market, or the volume of investments required for implementation, the cost of preparing estimates, patents or grant applications, etc. At the same time, business and government representatives do not particularly care about the technical component of a scientific solution; their interests are more focused on the possibilities of generating income, innovation, and the ability of a new product to scale.

It should be noted that technology transfer offices were created in many higher educational institutions in accordance with the order of the Ministry of Education and Science. However, there is a lack of specialists who would use consolidated data on the most accessible technologies and business needs, as well as be able to competently negotiate with business representatives and conclude technology transfer agreements.

In Ukraine, insufficient attention is paid to the demand for technological innovations and the stimulation of their development, and technology transfer is significantly complicated by the fact that scientific developments in Ukraine are not protected by appropriate legal instruments. Ukraine has adopted the law "On State Regulation of Activities in the Field of Technology Transfer". However, its regulatory function is too narrow and is limited to the development of relevant legislation and the formation of a national policy to promote the development of technologies through state budget expenditures in the field of technology transfer.

Currently, 37 science parks are registered in Ukraine, they are created on the basis of higher educational institutions or research organizations, have a certain potential and are designed to act as catalysts for innovation and the transformation of scientific ideas into production. However, according to experts, only 5 of them carry out innovation activities [17]. The reason for this is a number of barriers, including fiscal pressure, regulatory restrictions on the part of management structures, insufficient attraction of private capital, a complex and long-term procurement process, etc. Even before the war, in the period from 2010 to 2021, innovation spending in Ukraine decreased by 47 %, to 534 million USD. At the same time, in 2016–2017, a "shock" occurred, when innovation spending increased to 909 million USD, and then decreased to 343 USD [14]. Based on the data of the State Statistics Service, it is difficult to understand what caused the sharp increase and the same sharp decrease in innovation spending. Perhaps it is about one or more projects financed by the companies' own funds. Over the past decade, the share of innovatively active enterprises in the total number of industrial enterprises has fluctuated between 13.8 and 18.9 %. At the same time, the share of the total volume of innovative products sold by industrial enterprises is insignificant and does not exceed 2 % over the past five years [17].

There is a problem of the formation of startups, or companies created by one or more entrepreneurs to sell unique or irreplaceable products (services) aimed at the rapid implementation of innovations, generating new ideas. It can be noted that their share or contribution to the real solution of economic challenges in certain production sectors both before the war and at the present time remains extremely low. Over the past 5 years, one of the most important issues has not been the number of startups or developers, or access to new technologies, but ensuring that their customers stimulate demand for development. These are business structures of industry, energy, infrastructure, etc. The country has always had enough developers and various integrators, while there has been a shortage of consumers of innovative products.

It is also noteworthy that the key institutions in Ukraine are the State Agency for the Development of Industry 4.0, as well as a network of independent experts of Industry 4.0, while at present it is necessary to have 5.0 on the horizon. This also includes the Digital Innovation Hub (DIHs) network and the network of innovation clusters.

According to expert research, a significant part of Ukrainian inventors – 94 % – are graduates of higher educational institutions in the field of engineering, technology and science. At the same time, 28 % of them are women, and 12.7 % are pensioners. The average age of inventors in Ukraine is over 46 years [8]. In addition, Ukrainian schools and higher education institutions do not teach the specifics of innovation and intellectual property. This makes it unlikely that new developments will be successfully implemented and commercialized. The use of new proposals at Ukrainian enterprises and the achievement of certain effects from their commercialization is currently not given sufficient attention.

Another important obstacle to innovation is the peculiarities of patent application examination before granting a patent, the considerable duration of this process, and the lack of regulation of patent fees for authors and developers.

In addition, most patented objects (inventions, utility models, industrial designs) protected by patent documents, despite the fact that they are developed and protected by law, are not used in practice and end their "life" shortly after discovery. All this negatively affects the innovative development of Ukraine.

The situation in the innovation sphere became even more complicated during the war. To some extent, one can agree with the position of some manufacturers that during the war there is no room for innovation, and the current military situation in Ukraine does not contribute to the development of innovations at all. The trend of falling demand for innovative developments was to some extent predictable, because even at the beginning of the war there was a certain drop in demand in most markets, and the very low activity of many cluster participants was also an alarming signal.

Of interest is the information of the Institute of Economic Research and Policy Consultations on the state of innovation among manufacturing enterprises (conducted in 2023 with the involvement of up to 500 enterprises, mainly in the industrial sector). According to this: 18 % of Ukrainian enterprises did not have innovative activity both before the war and during the war; with an increase in the size of the enterprise, the probability of its innovative activity increases. It was also established that innovative activity is developing most actively in the chemical industry, metallurgy and mechanical engineering; the more internationalized the company, the more likely it is to be innovation-oriented [18].

Of course, in wartime, the primary importance among business needs for increased production is not advanced technologies, but completely different factors related to the instability of the situation, a significant drop in demand, a lack of qualified personnel, and an unfavorable regulatory climate in the state. There is a pattern that crisis situations reduce attention to innovation, although a relative exception is observed only during COVID-19.

Referring to the above-mentioned study, about 77 % of respondents indicate that innovation is irrelevant at all, or only in some cases. However, large enterprises, exporters (23 %) show significant interest in innovation, for them it remains relevant, and it is they who mainly try to increase funding for innovation during wartime [14]. The latter especially concerns metallurgists, mechanical engineers and chemists, while in the construction industry there is an absolute cessation of innovative activity.

If to talk about the part of enterprises that increased investments in innovations during the war, although not many of them, about 20 %, they nevertheless represent a very large number in terms of the entire economy, about a thousand enterprises. So, it is worth noting that in Ukraine there is someone and with whom to work in terms of innovation development.

The reduction in innovation spending is primarily due to financial problems, which was noted by 42 % of respondents, the cost of raw materials, logistics also increased, and there was a significant drop in demand for products and services.

The implementation of technology transfer is a very complex process associated with many auxiliary functions – the transfer of supporting documentation, its registration, adjustment and launch, maintenance, participation in production, adaptation to appropriate conditions, a training system and motivation of personnel, etc. Implementation in practice, for the most part, is quite slow. For example, as evidenced by aviation industry workers, when implementing the developments of scientists in the production process, it is often necessary to make changes to the technology and organization of production, equipment, change drawings or documentation.

Due to the fact that innovative products are not in demand in Ukraine, the EIF program and innovation grants were positioned as one of the “survival” tools for innovative SMEs and startups in order to survive on grants at least for a while. State bodies should also respond to any crisis with certain regulatory incentives.

A positive point is the increase in interest in MilTech (military or defense technologies), as well as the launch of relevant startup accelerators (programs that help startups grow and develop). There is also a growing attention of donors to the issue of innovation among SMEs, there are certain shifts in the Ministry of Education and Science, etc. However, without proper coordination at the national level and the implementation of appropriate instruments and institutions, these changes will obviously not have the desired effect.

It should be about changing approaches and improving the interaction and consolidation of representatives of innovation systems, about unifying their priorities and actions. At the same time, the focus is on the appropriate maintenance or growth of demand from end customers of innovative developments, its stimulation through regulatory instruments, and not on startups, as has been the case recently.

Prolonged aggression by Russia has led to significant losses in the industrial sector and investment potential of Ukraine. And the spread of migration processes has led to negative trends in the development of intellectual potential, leading to its reformatting. However, thanks to the financial, economic and financial and technological support to Ukraine by the USA and EU countries, along with certain difficulties in certain sectors of the economy, an unexpected breakthrough in the field of technology transfer is observed. In conditions of war, Ukraine at the state level under state guarantees has almost for the first time received access to the most advanced technologies and developments. This is especially true for such industries as medical, military, defense, and energy. The extraordinary circumstances of the war forced Ukrainians not only to defend themselves, but also to make some innovative progress in the development of the economy. The war provoked many to become even more ambitious – to create new products, take risks in new niches, and enter new markets.

Today, with the participation of international partners and countries, the issues of creating new modern production facilities and joint ventures, repairing and improving equipment and technology, as well as using defense technologies in civilian life are being resolved. An important aspect is access to the latest medical technologies, in particular, in ophthalmology, orthopedics, reconstructive and rehabilitation medicine.

It is possible to note a certain focus on technology transfer and contract manufacturing of pharmaceutical enterprises – in Ukraine, the production of new medicines increased during the war. There is a well-known practice when large international companies transferred technologies for manufacturing new medicines to Ukrainian pharmaceutical enterprises under partnership terms.

So, despite the existing difficulties in the extreme conditions of war, innovative development is in some way activated, as is also evidenced by the practice of accelerated development of innovation during the Great Patriotic War. After all, all the aspirations of researchers and innovators are aimed at solving both complex business issues and ensuring the country's technical defense in the optimal terms, which seemed unrealistic.

Thus, despite martial law in Ukraine, in 2022–2023, researchers at Khmelnytskyi State University received 210 copyright certificates and 16 patents for utility models, filed 26 applications for utility models and 2 applications for industrial models. This was also stated by the team of developers of the system for detecting malfunctions and emergencies in energy networks of the Central University of Science and Technology of Ukraine. It won first place at the YEP Hardware Engineering Hackathon, an ecosystem of innovative startups and a forum for innovators where they present their painstaking developments.

It is especially worth noting the inventor from Kropyvnytskyi, who proposed a device to facilitate the work of electricians. Among the innovative technological developments of Ukroboronprom enterprises is a Ukrainian innovation called the Berest multiple launch rocket system (MLRS).

It is possible to believe that the main market mechanism for technology transfer should be Internet tools (Table 1).

Table 1

Main tools for technology transfer

Name	Characteristics
1	2
Proper financing of innovation developers	Improving the financing of innovators of scientific institutions, educational institutions, business structures through state programs, international funds, private capital, investments, expanding the use of tax incentives, grants, etc.
Websites	Promotional websites of scientific developments, websites of development organizations, scientific institutions and partners
Social networks	Information web pages, events in certain social networks
Partner newsletters	Thematic web bulletins, scientific author newsletters, articles
Internet advertising	Contextual (advertising focused on specific user requests, based on keyword search) and contextual-media advertising Google, a large network of partner resources on which it is possible to place contextual blocks; banner advertising (a type of digital advertising where the main focus is on images, a complex of graphics and a text call to action, rather than text; advertising in social networks, viral advertising (content that spreads quickly on social networks, evokes emotions)
Online conferences, webinars and virtual exhibitions	These are events that take place online, rather than in a physical location, when participants can join in unlimited numbers from offices, homes, etc
Open innovation platform	It allows business leaders, innovation teams, startup projects to learn and create new ways to digitally develop their business, the platform helps startups and companies develop and commercialize advanced technologies and developments, its tools and approaches can manage and support all participants in the commercialization process – from research, idea, launch – to project popularization. The platform's work is aimed at increasing the efficiency of technology commercialization, promoting innovations to the international market, and forming elements of the information and communication technology infrastructure
Extensive technology transfer infrastructure	It covers regional centers for working with clients, sellers, buyers of new technologies, information systems for exchanging technological requests and proposals, provide an opportunity to consolidate various information resources (departmental, state structures, specialized companies)
Technopolises and technology parks	They are created at universities, contribute to the formation of a knowledge-intensive sector in the field of high-tech industry, create a scientific and technical core of the world economy, their development can become the most important tool for the effective development of the state, the creation of sustainable development programs
Technology transfer centers	They are aimed at the active introduction of innovations into the industrial sphere, their functions are the prompt provision of information; analysis of the conclusion of contracts for the implementation of scientific research; conducting negotiations; promotion of technological developments; development of the intellectual property institute, etc. Promote the creation of new small and medium-sized enterprises in the commercialization of technologies, increasing the number of high-paying jobs for qualified specialists

Continuation of Table 1

1	2
Information and communication tools:	Electronic platforms, regular newsletters, broker congresses, technological missions
Accelerators	Organizations that help startups grow quickly and become successful
Business incubator	Structures specializing in providing favorable conditions for the effective work of innovative firms that promote original scientific and technical projects, by providing these firms with material, information, consulting and other resources and services
SME retraining programs	Grant programs for SMEs and entrepreneurship development companies (EDCs) for the implementation of measures aimed at improving the human resources, innovation, and export potential of Ukrainian business
Meetings with developers in the format of technological and innovation days, events, etc.	Traditionally, they have a certain informational and cultural content, event activities are implemented through the organization of various types and forms of events (meetings, concerts, show programs, etc.), using artistic means and theatrical techniques, broadcasting a certain important experience, help to aesthetically perceive reality, influence people's preferences and priorities

Note: * – compiled by the authors based on data [12, 19]

All of the above tools are available to many companies that produce cutting-edge technologies and other participants in the innovation infrastructure. Completed innovation projects are considered ready-to-implement technologies that can increase the efficiency of any business in practice.

Also, of certain scientific interest are the studies of UkrISTEI, conducted since 2004, aimed at forming a systematic approach to the development of basic tools and mechanisms for technology transfer. At the same time, a universal automated information system was created.

As the main technology transfer tools that were introduced into operation at UkrISTEI, it is appropriate to identify the following: the universal ASFIMIR system, an automated system for the formation of integrated interstate information resources. With its help, functions related to the promotion and transfer of technologies are implemented; an open innovation platform based on ASFIMIR; an interregional technology transfer network [20].

Based on the research results, an automated program for the formation of integrated interstate information resources (ASFIMIR) has been developed, which has been operating in UkrISTEI since 2007.

The automated system for the transfer of new technologies is based on several main links, namely:

- the main purpose of this system is to create and distribute integrated information resources that come from those countries and organizations with which scientific and technical agreements have been concluded and it is planned to maintain cooperation in the coming years;
- to ensure the prompt exchange of necessary information between users of other countries, the system includes two powerful functional blocks, this is a block of local databases located on the UkrISTEI server and an Internet block;
- certain blocks have been created in this system to ensure coordination of the format of information presentation, main areas of cooperation and database structure for different countries;
- to use the information exchange mode, the system has a block of external links that contain the necessary directories;
- information can be received and transmitted in an automated mode, either as an Internet link with an agreed delivery field, if the user's country has such an automated system, or as a file in WORD format, if the user does not have such a system;
- to use the information exchange mode between the integrated resource and the user's country, the Internet part has a unified form designed for users to provide resources to the system and transmit additional information about the development of technology and specific investment projects, abstracts of reports are available on the UkrISTEI website, and full information is provided in the local database;
- the system is designed to best help users promote their developments, technologies or projects on the innovation market.

The system also includes a local database, access to which can be obtained only upon request by filling out an online form.

Thus, the program is based on a systemic approach and involves the accumulation and rapid exchange of information between developers and consumers of innovative developments.

Taking into account the above approaches, the following systemic market toolkit can be proposed, aimed at activating the development of technology transfer (Fig. 1).

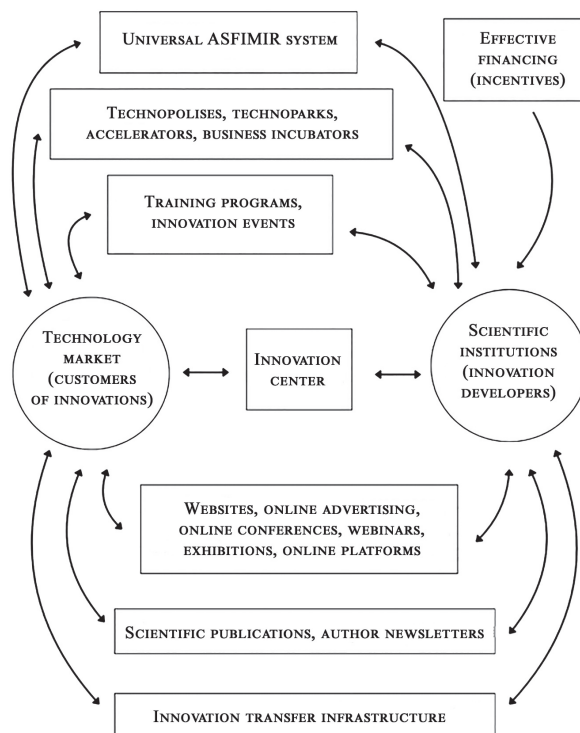


Fig. 1. Proposed tools for activating technology transfer

The issue of reforming technology transfer is a complex and long-term matter. However, new technologies in the fields of defense, energy, prosthetics can already appear on the market today, provided that scientists and businesses cooperate closely.

When implementing measures to implement innovations, special attention should be paid to tax incentives that will help attract private capital to the development of new technologies. Thanks to the above initiatives, it is possible to reduce research costs and accelerate the introduction of new technologies to the market.

In matters of technology transfer, foreign experience should be taken into account with the aim of implementing it in Ukrainian practice. Thus, in foreign practice, powerful national technology transfer systems have long been operating. Here, the most effective national system is the US, which annually receives significant profits from this (more than 100 billion USD) [6]. In the USA, for example, patent rights, worth 30 dollars, have been unchanged for 70 years, which allowed a large number of citizens to participate in technological changes. As experts note, "cheap patent laws of the United States" are the secret of the country's extraordinary success in innovation. The international technology transfer of Japan, Israel and other countries, where the most favorable conditions have been created for this, is quite powerful. Thus, in the USA, more than 30 legislative acts have been adopted in the technology transfer system and the intellectual property market, which is quite positively reflected in the commercialization of the results of intellectual activity. In American practice, 8 times more innovations are introduced each year compared to other Western European countries, and their researchers receive more patents than all the scientists in the world.

It is interesting that among American innovators the prevailing view is that if a new technology is not commercialized, it was not created.

In the field of development and dissemination of innovations, the issues of sources of financing and intellectual property in Ukraine require special dialogue and resolution. If financial support, due to military operations, is extremely difficult (although even under such conditions there are opportunities), then it is worth developing a new legislative system, more focused on supporting innovations, now. It is possible to believe that at the current stage these issues require the greatest attention from state and regional authorities and entrepreneurs. The proposed tools for managing the transfer of new technologies, unlike traditional ones, are based on more general, systemic approaches. They are aimed at the widespread use of Internet technologies, effective communication of science and business, accelerated implementation of scientific developments in practice, and better development of Ukrainian science.

It is worth noting that it may be difficult for business representatives to simultaneously use all the proposed measures for innovation management, but they can choose for themselves those that best meet their financial capabilities or preferences. Prospects for further exploration of this issue may be in the area of a more in-depth study of the issue of intellectual property and the features of the use of electronic methods of information exchange in the technology transfer management system.

4. Conclusions

Technology transfer is a complex process that involves the movement, transfer and implementation of scientific and technical developments from the scientific sphere to a specific consumer, business structure, with the aim of introducing them into production, acts as a certain type of communication, stimulates the creation of new consumer values. Based on the analysis, in Ukraine, in the system of innovation development and technology transfer, a generally not very favorable situation is observed. This is explained by certain problems and challenges – insufficient funding for innovations and their implementation, deterioration of the scientific staff, weak communication between scientists and practitioners, weakened state regulation of intellectual property issues, etc. And although all these gaps were observed before, they became even more acute during martial law.

As studies show, along with this, breakthrough trends in the system of transfer of new technologies are observed in certain sectors of the economy, especially in the production of military equipment, drones, energy, medical services, pharmaceuticals. This is primarily due to military actions, assistance for the development of innovations from international partners and donors. Ukraine, despite the war, along with certain setbacks in the innovation sphere, also has corresponding advantages and opportunities for the further development of innovative projects and technologies.

Achieving success in the innovation sphere, in particular, can be achieved on the basis of establishing closer ties between the scientific sphere and business. The acceleration of technology transfer and commercialization of scientific knowledge can be facilitated by the implementation of the above-mentioned most modern market methods and tools. The proposed new market tools, in contrast to traditional methods of stimulating the development of innovations, provide for the possibility of ensuring the closest relationship, informational, communicative and beneficial cooperation and combining the interests of representatives of the scientific sphere (innovation developers) and their potential customers (business structures). It is based on the widest use of the main advantages of digitalization, online tools for implementing new methods of communication and information exchange, and the formation of new motives and incentives in the modern innovation market.

New approaches to activating the dissemination of innovations also include improving the system of financial incentives for scientists, regulating tax legislation, improving the system of training and communication, taking into account the principles of transparency, consistency, etc. The implementation of positive foreign and domestic experience in the innovation development system will also be of great importance.

Prospects for further exploration of this issue may include research into world practices in managing the commercialization of intellectual property objects in research universities in foreign countries, methods of training and acquiring practical skills in the innovation implementation system.

Conflict of interest

The authors declare that they have no conflict of interest regarding this research, including financial, personal, authorship or other, that could influence the research and its results presented in this article.

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Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies in creating the presented work.

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