

The world practice has proven that universities can become a source of innovations and the centers of innovative movement. However, there is almost no research into the development of innovative ecosystems of universities under conditions of limited funding and permanent crisis phenomena in the economy. This is a characteristic feature of many countries in the world that are developing or being transformed. The tool for reducing the action of negative factors is to increase the level of organization of innovative ecosystems of universities.

It was found that the consequences of creating an innovative ecosystem of the University are an increase in the degree of commercialization of knowledge of university scientists and students, improvement of human capital, and intensifying cooperation between science, education, business and government agencies in the field of research and innovation. The main actors in the university's innovation ecosystem were separated and their main functional roles were described. In particular, functional roles include education (innovative and entrepreneurial educational programs), basic science (scientific parks, scientific and research laboratories), applied science (startup accelerators, business incubators, startup clubs), and commercialization (centers for knowledge and technology transfer). The experience of creating separate elements of innovative ecosystems of universities of the world was considered and positive results were given. The essence of the concepts of commercialization of knowledge, technology transfer was studied and basic methodological approaches to the creation of the Center for knowledge and technologies transfer on the university base were explored. The purpose, objectives, directions, and functions of the Center for Knowledge and Technology Transfer were highlighted. It was proposed to focus on working at specific requests at any stage of the development of the idea on the principles of the individual approach of targeted assistance, openness to communications, and support throughout all stages of an innovative project

Keywords: *University innovative ecosystem, commercialization of knowledge, technology transfer, startup, innovative activity*

IMPROVEMENT OF THE INNOVATIVE ECOSYSTEM AT UNIVERSITIES

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1. Introduction

The most common conceptual models of technology transfer are the so-called pulling [1], pushing [2], and combined linear models [3]. The driver of the pulling model is the demand in the consumer market; in the pushing model – proposals arising from initiative developments; the combined models integrate both drivers. In the case of a combined model, the organization of the transfer process is complicated, there is a need for an intermediary, consulting, and management services. The growing complexity of innovations not only complicates but also leads to an increase

in the cost of their creation and commercialization, which requires external venture funding. There is a target structure of participants in the innovation process, which, taking into consideration modern innovation and communication technologies, began to be defined as an innovative ecosystem [4, 5]. One of the consequences of the spread of innovative ecosystems was the emergence of a conceptual model of open innovations – the voluntary participation of various entities in the process of collective creation, commercialization, and the use of innovations [6, 7].

Taking into consideration the variety of forms, methods, and conditions for entrepreneurial activity, each particular

ecosystem has its own specific characteristics of technology transfer. However, being an element of the general world and national ecosystems, the specific features always reflect consolidated properties and processes. Due to the revolutionary nature of changes in technologies and/or business models, enterprises are forced to constantly implement innovations in their activities. An important role in this is played by the formation of an innovative environment and the development of an innovative ecosystem that contribute to the rapid implementation of scientific developments in the finished product that is needed by the market. It is generally accepted in the world to actively involve the university community in the processes of innovation creation when forming the mechanisms for the knowledge and technologies transfer [8, 9].

In an interconnected, complementary, and, accordingly, the synergistic ecosystem at the macro level, this is explained by the following. Firstly, the field of activity of universities is the transfer of theoretical knowledge to the practical activities of its graduates. Secondly, there is an objective competitive need for a combination of theory and practice in the training of future specialists. Thirdly, there is a high concentration in universities of the most experienced and motivated employees. Fourthly, there is a variety of scientific disciplines, schools, and approaches that provide a diverse consideration of any innovative object and process. In general, without the transfer of knowledge, skills, and abilities, there are no universities, and technologies transfer is not possible without the knowledge transfer.

Universities integrate efforts with business in order not only to train highly qualified specialists but also to participate in the preparatory, research, and analytical stages of creating innovative products. The innovative ecosystem of the University is understood as an environment that is formed directly by the participants of the innovation process in which there is their interaction, aimed at creating and developing innovations. This environment implies joint agreements, specific economic relations, social contacts, and culture [10, 11]. However, the issue of imbalance between the urgent needs of business and the quality of the internal innovation ecosystem of universities, restrictions on equipment, available human and organizational resources is acute. Therefore, research into the development of the innovative ecosystem of universities is relevant.

2. Literature review and problem statement

In the broadest sense, the term “innovation ecosystem” refers to the environment for finding innovations; that is, a set of conditions that ensure the sustainability of the processes of appearance, transfer, and commercialization of innovations in a mutually conditioned socio-economic system. Article [4] separates three main levels of consideration of the innovative ecosystem:

- business ecosystem – actors (market agents) who receive economic benefits from participation in innovation activities;
- communities – groups of people whose interests, abilities, and capabilities are close in the way of solving scientific and technical problems;
- platforms – software and technical complexes and organizational resources that allow coordinating the joint activities of legally independent actors to meet their various needs.

However, there remained unresolved issues related to the study of the content of platforms for the organization of their functioning within the framework of the innovation ecosystem.

Paper [5] proves the importance of platforms as the organizational basis of innovative ecosystems. According to the researchers [12], platforms create a network effect: the more participants use it, the greater value it has for the organizers, created a community of users, and, in general, for the effectiveness of the innovation process. Work [13] emphasizes that the number of participants in the platform depends on the degree of its openness, software and technical capabilities, rules for connecting and using its resources, the cost of payment for the services provided. The levels of openness of the platform are also determined by the desired level of openness of innovation [14]. Closed innovations (patents, know-how) make it possible to get a monopoly super profit but hamper the creation of infrastructure factors for the development of the sales market. There is a specific innovator dilemma, which is similar to the one described in paper [15].

Participants in various operations on the ecosystem platform form relatively stable groups. First of all, these are owners, organizers of activities, users of various assets, and others [16]. The subject of the study in the article is the innovative ecosystems of universities, so special attention will be paid to the specifics of various groups of university teams that participate in innovation activities.

The university environment should definitely be a systemic source of innovation and have some prerequisites for generating new ideas, creating new products, and transferring knowledge from academic science to the real sector of the economy. Paper [17] explores the place and impact of universities in the world on the development of innovations in the economy. The study of global practices at the level of universities, corporations, and the state on the commercialization of technologies in the early stages of creation was conducted. Article [18] focuses on the relationship between creativity in the field of technology transfer and the economic development of the country. In paper [19], the levels and key factors of knowledge and technology transfer were highlighted. All this proves that universities become centers of innovative clusters through active cooperation between education, science, and business. Universities should act as providers of new knowledge and skills that will enable them to develop students' creativity and readiness for innovations.

The world's leading universities have long been providers of innovation development in their countries. In 1997, the University of Texas introduced a master's program in technology commercialization, which helped launch the spinoff, that is, small enterprises originating from the university. This experience has been widely applied in many countries around the world. This is especially true of polytechnic institutions of higher education, such as Kyiv, Kharkiv, and Lviv Polytechnic Universities. Even the concept of an “entrepreneurial university”, an educational institution that performs a dual function in society, has arisen, it produces new knowledge and carries out activities for knowledge and technologies transfer [21].

In this sense, the issue of formation of an innovative ecosystem in universities, which is a means of activating all human capital, bringing it closer to the needs of the market, and promoting greater innovation and development of society, is important, including the means of outsourcing activities in the IT field [22]. Innovative ecosystems and their management are most often discussed in the context of the business environment, but not always, the special role of creating an innovative ecosystem in the university environment is determined. At the same time, there are several advantages in the formation of such a system on the base of universities:

1) the main task of the innovation ecosystem at a university is not to obtain economic benefits that do not always meet the needs of a particular society. It is rather to gain access to knowledge in order to create and exchange innovations and, ultimately, the development of the economy and society;

2) the existence of collective identity of all participants in the university innovation ecosystem, due to belonging to one institution of higher education, in contrast to the temporary association on the platform of any commercial incubation structure;

3) approximation to the needs of the economy creates the possibility of mutual enrichment of educational, research and innovation-business elements of the university environment, unlike business structures where the unification of these three components of the formation of innovative development is not possible [9].

Thus, the importance and necessity of forming an innovative ecosystem in universities are undeniable, but the problems of establishing stable relations between innovative scientists, university research structures, on the one hand, and business, on the other hand, remain unresolved.

3. The aim and objectives of the study

The aim of this study is to develop a theoretical base for the development of the innovation ecosystem and to study the mechanism of its functioning in universities. This will enable participants of the innovation ecosystem to receive better communication between innovators and customers of innovative products, access to professional advice, the opportunity to attract venture capital. It will be possible to increase the degree of commercialization of knowledge of scientists and students of universities, improving human capital and intensifying cooperation between science, education, business, and government structures in the field of research and innovation.

To achieve the set goal, the following tasks were to be solved:

- to identify participants and components of the innovation ecosystem in universities;
- to consider the main directions, tasks, and functions of the Center for Knowledge and Technology Transfer as a platform for the university's innovation ecosystem;
- to develop the principles and concepts of the mechanism of knowledge and technologies transfer in higher education institutions.

4. The study materials and methods

The object of research is the management of the university's innovation ecosystem to intensify the cooperation of science, education, business, and government structures in the field of research and innovation.

Higher education institutions are the center of researchers who need to be involved in innovation. This requires overcoming a number of social, economic, and organizational barriers. The study proposes to create centers for knowledge and technologies transfer in universities, which would aggregate all the issues of promoting the ideas of scientists in the real sector of the economy and increase the level of organizational support for knowledge and technologies transfer.

The emphasis on the development of the innovation ecosystem in universities should be placed on organizational

issues and the introduction of new methods of open communication in the work of relevant departments.

In addition to analyzing and summarizing literary data and provisions on the theory of innovative ecosystems, official data of the State Statistics Service of Ukraine, information and analytical materials of the National Technology Transfer Network, the Institute of Scientific and Technical Information were used as well. To assess empirical data, reports on the scientific and technical activities of universities of Ukraine of the AITM Association, the Ukrainian Startup Fund were applied. Links to the relevant sites were provided in the text of the article. All these data were used as empirical proof and illustration of conceptual provisions developed by the authors of the article.

5. Results of research into the innovation ecosystem and the mechanism of its functioning at universities

5.1. Participants and components of the innovation ecosystem at universities

The theoretical primary sources, as well as practical experience in the development of innovative ecosystems of universities, were analyzed. In particular, the innovative ecosystems of V. N. Karazin Kharkiv National University, Odesa National Economic University, Odesa National Maritime University, and others were explored, and their restrictions were highlighted. Thus, the main constraints of the development of the innovation ecosystem in universities include the following:

1) a high level of competition in the educational space at extremely limited budgetary state funding. This is exacerbated by a decrease in the population especially now when the country's legislation allowed the functioning of branches of foreign universities in the country. That is why one of the main conditions for the survival of universities is an innovative path of development;

2) a low level of communication between science (universities, research institutes, etc.) and the real sector of the economy (production, business), which itself is in a difficult situation. That is why business is not aware of the possibilities of university science, scientific research is carried out without taking into consideration the needs of business, which significantly reduces the degree of commercialization of knowledge and prevents science and business from supporting each other.

The main prerequisite for the development of the innovation ecosystem in universities includes the fact that universities have a high concentration of highly qualified researchers who already are or potentially can become authors of commercially successful developments and ideas. However, the lack of basic knowledge about knowledge commercialization and undeveloped entrepreneurial skills in students and scientists hamper the introduction of many ideas into the finished product.

Formation of the innovative ecosystem at a university will make it possible:

- to unite people with different sets of competencies in one space, which will create a synergistic effect and stimulate innovation;
- to activate the entrepreneurial functions of a higher education institution;
- to create a specific business environment that is favorable for the development and implementation of innovations in the industry and everyday life.

Article [10] separated the key parameters for the development of a successful innovation ecosystem, which include:

resources, management, strategy, leadership, organizational culture, human resources, partners, technologies, and clustering.

Much attention is paid to theoretical issues of knowledge commercialization, but, as some experts note, there is more free money than opportunities to invest in innovation. Firstly, the higher rate of money circulation in exchange transactions; secondly, investments in derivatives are inherently less risky than venture capital; thirdly, the volume of venture capital is declining around the world (Fig. 1).

That is why the main task of the development of the innovation ecosystem in universities and transfer of technologies from the university environment to the real sector of the economy is exactly the popularization of innovation activity among scientists and active youth. This is also a difficult problem to solve around the world because, among all scientists, university teachers appeared to be the least motivated to receive funds from economic activity (Fig. 2).

In order to provide an innovative vector of university development and intensify knowledge transfer from academic science to the real sector of the economy, it is proposed to put universities at the center of the national innovation ecosystem. This ecosystem integrates the following four main components and the environment (Fig. 3).

Consulting agencies are formed under the influence of a request from the main actors. The most popular are engineering and design bureaus, experimental laboratories for prototyping product samples, legal services, organizational and economic support. These structures can also be created by university staff who work at the relevant departments and have the necessary qualifications. Some universities create legal clinics, where law students have the opportunity to gain practical experience while studying. It is necessary to initiate the creation of consulting centers in universities, where students can provide advice on certain issues in their specialty under the supervision and with the help of mentor-teachers. This is one of the ways to involve students in knowledge and technologies transfer in the dual education system, that is, a combination of learning processes and professional activities. According to the dual form of education, knowledge, and technology can become the subject of a tripartite dialogue between universities, students, and enterprises.

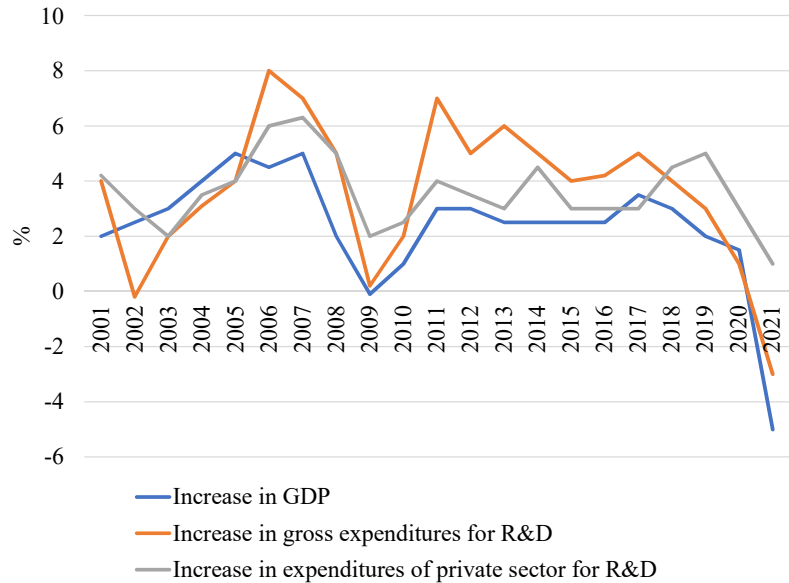


Fig. 1. Covariance of world GDP, public and private investment [23, 24]

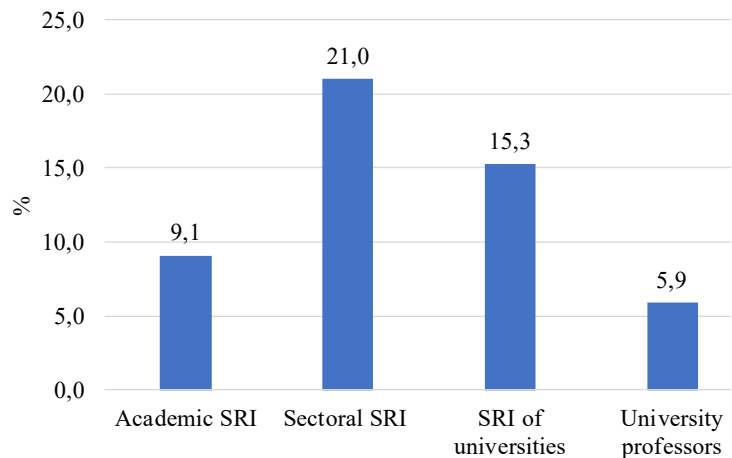


Fig. 2. Motivation of scientists to earn money with the help of scientific research works and research and construction works (adapted from [25])

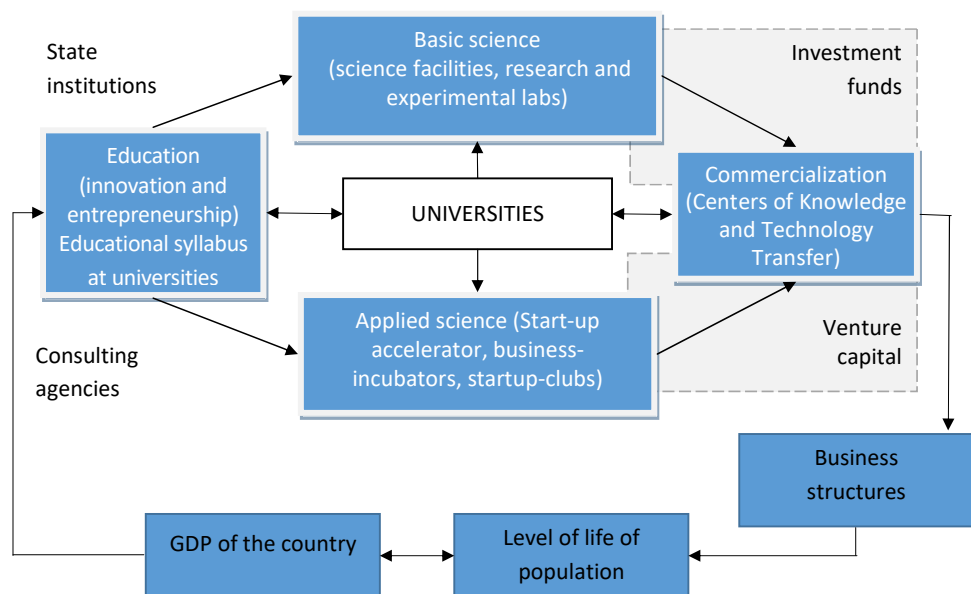


Fig. 3. The main participants and components of the innovative ecosystem of the University

Another important task of the innovative ecosystem of universities should be to create platforms for attracting investment in research developments. Now for a wide range of small investors, there is a dilemma in choosing the direction of investing their own savings and free funds. The banking sector, due to a significant reduction in interest rates, has ceased to be attractive for a capital increase, but only acts as a means of its preserving. That is why so-called crowdfunds are actively beginning to develop, for which the main problem, from the point of view of innovation, is the lack of understanding of promising projects, including innovative research developments that are ready for financing. For example, good results are shown by the Ukrainian Startup Fund, which over the past few years has processed more than 3,000 applications from innovators and financed more than 190 startups worth more than USD 4.8 million [26]. However, financing of more or less innovative startups begins in developed countries with one USD million [27]. So, it is very important to use all resources, including financial ones. Regarding the experience of developing the main participants in the innovation ecosystem in universities and their functional roles, it is advisable to pay special attention to the following:

1. Education. Educational programs of many universities contain the elements of innovative education, but they need systematization and updating. Their goal is to raise awareness of the issues of innovation and the development of entrepreneurial thinking and culture among students, teachers, young scientists, and other representatives of the academic environment. In 2020, at the initiative of the Ministry of Education and Science of Ukraine and the Ministry of Digital Transformation of Ukraine, a pilot project “Entrepreneurial University”, the purpose of which is to develop the ecosystem of entrepreneurship in universities of Ukraine, was launched. According to the results of the 2020–2021 academic year, 76 universities, 170 teachers, and almost 4,500 students from different universities from all over Ukraine joined the project [28]. This project has proved to be very effective. It is developing and new higher education institutions are joining it in the 2021–2022 academic year.

To develop the innovative ecosystem of universities, it is necessary to expand the introduction of individual disciplines and specialized educational programs on innovative entrepreneurship. It is also possible to involve expert practitioners in teaching and focus on the development of students’ teamwork skills. This is a very important feature of the development of innovative projects, where several specialists, most often of different specialties, are needed.

2. Basic science. Almost every university has a structural unit that is responsible for scientific activities. However, the approaches used in these structures do not always meet modern requirements. The activities of scientific departments must be enhanced. In particular, they should focus on the following functions: monitoring the global scientific environment and popularizing scientific activities using modern methods of information dissemination.

Modern science cannot be local. At different universities, scientific research is carried out in the same directions. There is no doubt that combining the efforts of scientists from different higher education institutions, even from different countries, will have a synergistic effect. Therefore, systematic monitoring of innovations in the scientific area of the university will reveal scientific trends and provide up-to-date information to the scientific community.

It should also be noted that there is a significant severance of relations between university and industry (business). However, there are good world examples of how to bridge this gap. In particular, in the United States, the University and Industry Demonstration Partnership (UIDP) was launched for the first time in 2006, and it is now a unique forum for university and industry representatives to find better ways to cooperate. This structure at the early stages was funded by the National Academies of Sciences of the United States and its main goal is to bring together representatives of corporations and universities [17].

The UIDP supports mutually beneficial cooperation between universities and industries by developing and spreading strategies for resolving common issues between the two sectors. It is possible to use their experience to determine intellectual property rights and the mechanism for financing scientific research.

To popularize scientific research, it is necessary to involve young people, including school students, with the help of the results of the Mala Academy of Sciences. Under today’s conditions, the sources and forms of obtaining information of young people are different from those that existed 10 years ago. This must be taken into consideration in order to develop modern content that is perceived by modern youth.

3. Applied science. In the world, the main form of applied innovation is startups, which are provided with significant organizational and intellectual support based on universities around the world. The purpose of creating startup clubs, accelerators, and incubators in universities is to create the necessary conditions for participants to work on innovative projects. Specifically, restrictions on the physical space for meetings with experts, work with mentors and experts, as well as other events. These structures contribute to the development of entrepreneurial abilities, popularization, and implementation of the latest methods of startup acceleration and business incubation. Within these structures, it is supposed to provide consulting, mentoring, and organizational support to university students, external students, innovators, and their teams in the implementation of their projects conducting scientific research, and gaining new knowledge [29].

Based on the needs for economic development around the world, universities are actively developing the startup movement. More than 30 universities in Ukraine have entrepreneurial clubs established with the support of the NGO Innovation Partnership Platform YEP. According to this project, clubs are created at the initiative of the University, and the YEP provides full methodological and organizational support for the work of clubs. In clubs, there are meetings with entrepreneurs, discussion of new ideas and projects, thematic viewings of films and video lectures. Within the club, students can work on their startups.

In 2018, on the base of Odesa National Economic University, a regional center for the development of youth entrepreneurship “Startup University” was created. This is a social platform for the development of business ideas of young people, which is designed to assist in the development and implementation of startup projects in various fields. Over three years, more than 1,500 students took part in this project, 7 mentors worked, 47 experts were involved and as a result, 154 startup projects were developed and presented to experts and investors [30].

Such experience needs to be extended and it is necessary to work towards the commercialization of the results of fundamental and applied research at universities.

4. Commercialization. The growth of commercial importance of technologies and knowledge requires adequate understanding of the essence of commercialization of innovations for the main participants in the innovation ecosystem in universities, the principles of organizing the Center for the Transfer of Knowledge and Technologies, the internal logic of the innovative environment and the mechanism for knowledge and technologies transfer in higher education institutions, the regularities of functioning of the innovative infrastructure.

5. 2. Basic directions, tasks, and functions of the Center for Knowledge and Technology Transfer

In works [31–33], a thorough study of the concept of “technology transfer” was carried out, and definitions given by different authors in different years in different countries of the world were presented. It is advisable to dwell only on certain aspects of this concept. We propose to dwell on the definition of the Association of University Technology Managers [31]. It is proposed to imply by technology transfer the formal transfer of new knowledge or innovations obtained as a result of research work in universities and research organizations to the commercial sector for public benefit, the so-called open innovations.

Commercialization of knowledge in universities can be carried out by creating knowledge and technology transfer centers [32, 33]. The first centers of technology transfer in their modern sense emerged in Europe and the United States in the 1940s and 1950s. The purpose of such centers is to ensure the commercialization of military technologies and dual-use technologies by creating on their basis a considerable range of civilian products. The wide development of this organizational form took place in the 1980-1990s. with the adoption in a number of countries of laws that gave universities the right to develop, created at the expense of state funding.

There are the following kinds of transfer:

- commercial, which involves the transfer of results of scientific research to the economic sector to obtain a commercial benefit;
- non-commercial, which does not imply commercial benefit and is usually used to transfer results of fundamental research. This transfer in economically developed countries takes place with the participation of the state that can compensate for the costs of scientific research.

Examples of non-profit technology transfer include scientists' publications in specialized journals, providing access to databases, internships for scientists, participating in exhibitions and conferences, patenting, consulting, etc.

According to the “Information and Analytical Notes on the Impact of Technology Transfer Activities” on the website of the Ministry of Education and Science in Ukraine in 2020, only 127 organizations carried out activities in the field of technology transfer, and 17 of them were higher education institutions. In comparison, in 2019, the number of these organizations was 52, including 21 universities, that is, almost 2.5 times less, but revenues under technology transfer contracts were 3 times higher – USD 14.3 million in 2019 against USD 3.7 million in 2020 [34]. Such results indicate an urgent need to improve technology transfer mechanisms in Ukraine.

The classic scheme of technology transfer in the innovation process is the one, which is supposed to provide a

technological request from production for the development of the necessary innovative product, or research. In the opposite direction, scientific institutions offer a technological proposal (development), which provides the main characteristics of an innovative product. In theory, this scheme looks reasonable, but in practice, it works differently.

According to the results of the study, the success of commercialization of scientific development is much higher if it is performed by request of production. There is an explanation for this: when a business is in dire need of new technology, it very quickly introduces it into production. The problem is that businesses can't always formulate their needs clearly. And in the context of a lengthy economic crisis, scientific research issues face the need to solve current economic issues.

That is why the goal of the Center for knowledge and technology transfer at the University (Center) is to create favorable conditions for the development of an innovative environment in the region.

The following general tasks, functions, and directions of the Center's work are offered:

- infrastructure: promoting the creation of comfortable conditions for innovators during their work on projects (equipment, premises, communications);
 - consulting: organization of advisory support for innovators when working on projects on the issues of expertise, evaluation, economics, finance, management, law, etc. (including the issue of protection of intellectual property). Legal support, economic calculations, patent research, innovation marketing, project design and preparation for presentation to investors;
 - commercialization: assistance to innovators in the process of commercialization of the results of their scientific research. attracting an investor, providing feedback to promote the growth of the effectiveness of the innovation process;
 - cooperation: establishing mutually beneficial cooperation with external and internal stakeholders (researchers, businessmen, government agencies, other educational institutions, etc.);
 - training: organization of lectures, master classes, workshops, training and other meetings of innovators and teams with representatives of the Ukrainian and world innovation ecosystem, generation of ideas, development of a business model, ideas' validation, Customer Development, etc.;
 - informing: popularization of innovative activities in the media, informing all stakeholders about the work of the Center, involving gifted researchers in innovative activities. Media and PR information support in the project promotion.
- The Center can act as a link between innovators and other stakeholders.

5. 3. Principles and concepts of the mechanism of knowledge and technologies transfer at higher education institutions

Further development of the transfer mechanism involves strengthening the impact of market needs on the choice of problematic issues for research. The result was a different approach to technology transfer, which involved parallel work of innovators and research into market needs.

When constructing a technology transfer mechanism, it is necessary to take as a basis the principles of startups based on the Customer Development methodology proposed by Steve Blank in the 1990s. It involves 100 percent customer orientation and thrift, that is, spending all types of resources (time, abilities,

work, finance) on the development of only the innovations needed by consumers. The difference between the technology transfer mechanism and the startup scheme will be:

- a wider range of consumers (customers, first of all, will be business/production, that is, the emphasis on the B2B segment);
- a lower level of innovation of the proposed technologies (scientists can fulfill orders to improve existing technologies or optimize business resources);
- smaller production volumes (not mandatory expansion of business, which is a necessary element of a startup).

Taking into consideration the differences highlighted above, we propose an improved technology transfer mechanism, which is shown in Fig. 4. The staff of higher education institutions, scientific institutions, institutes, laboratories, individual scientists and scientific teams, students, etc. can act as innovators-developers. Business and government agencies can order innovative products. The mechanism considers all stages and forms of communication between innovators and businesses, which should be provided by the Center of knowledge and technology transfer of the University.

In the context of digitalization, everyone can get a lot of information on each issue at various thematic courses, webinars, seminars, conferences online or offline. The problem lies in the versatility of most of these proposals, which can be solved by individualizing consultation and training. Each specific innovative project or idea requires specific consultants. This is what we need to pay attention to while working with innovators.

It is necessary to focus on working by specific requests with specific people, teams. It doesn't matter at what stage of development the idea is. Perhaps only at the stage of formulation of the hypothesis. The project can be considered by experts in terms of its prospects. The priority should be given to the projects that are carried out at the request of business.

As an example, we can consider the work of the Odesa Center for Knowledge and Technology Transfer, which was created within the framework of the project “Development of the interregional network of technology transfer”, implemented jointly by the State Institution “Ukrainian Institute of Scientific and Technical Expertise and Information” and Odesa National Economic University. A distinctive feature of the Center for Transfer of Knowledge and Technologies is that it includes the Advisory Council on Scientific and Technical Creativity, headed by the Vice-Rector for Scientific Work of the University. The Advisory Council contains specialist deputy deans and representatives: student society, a union of entrepreneurs of Odessa region, Chamber of Commerce and Industry, and scientific and technical experts of the Institute.

The principles of the Center for knowledge and technology transfer are shown in Fig. 5.

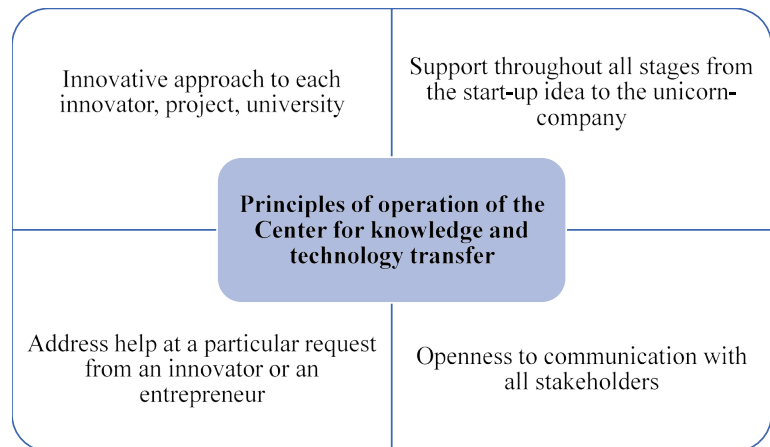


Fig. 5. Principles of operation of the Center for knowledge and technology transfer at universities

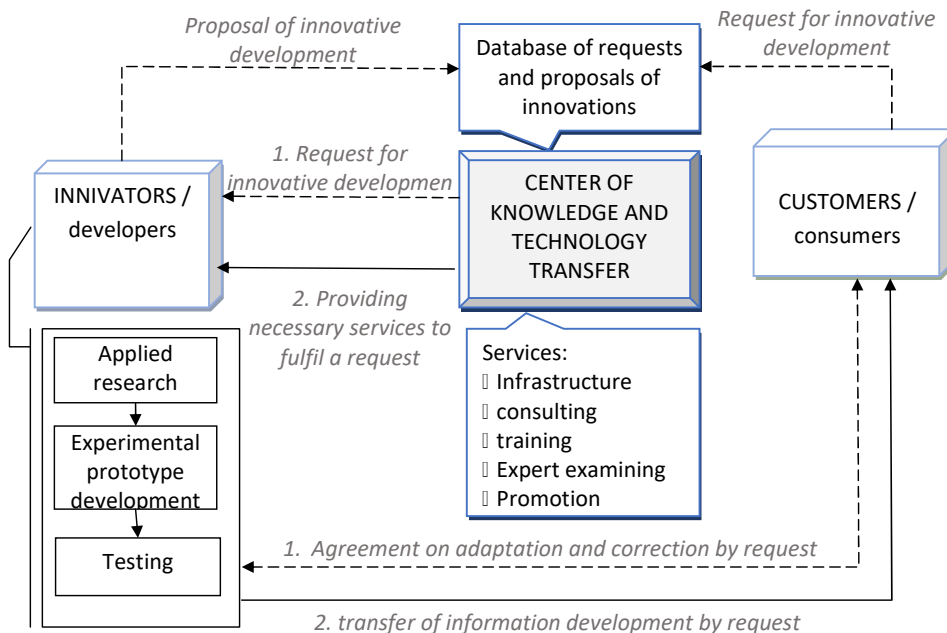


Fig. 4. Improved mechanism for the knowledge and technologies transfer at universities

One of the main tasks of the Center at the first stage is to establish communication between innovators and businesses. To do this, it is necessary to place special forms on the site of the Center:

1) for innovators – a form of innovative proposal, that is, innovators can place information about their innovative proposal at any stage of work for the general public. It should be noted that in this case, we are not talking about ready-made projects, but only about the initiative of researchers who are ready to work. Here they can demonstrate their scientific interests and introduce themselves;

2) for business – a form of innovative request, that is, a form from businessmen, in which they indicate to innovators and scientists a request for the development of a scientific, research, or innovative product.

The obtained results on the principles and concept of the mechanism of transfer of knowledge and technologies make it possible to create an innovative ecosystem based on higher education institutions in order to provide opportunities for establishing a connection between innovators, universities, and entrepreneurs. As an organizational element of the innovation ecosystem, it is proposed to create knowledge and technology transfer centers at universities.

6. Discussion of results of the research into the possibility of developing an innovative ecosystem at the university

In Fig. 3, universities are placed in the center of the national ecosystem. This corresponds to the practice of developed countries such as the United States, Germany, etc. In these countries, national innovation ecosystems operate under conditions of stable market relations and added value, which is sufficient for extended reproduction. That is why the main form of commercialization of technologies for universities is economic contracts with state and market structures. For developing countries that have a raw material structure of the economy, the demand for innovation (especially breakthroughs) is limited. This, on the one hand, reduces the economic efficiency of innovative activities of universities. On the other hand, it increases its socio-educational significance. That is why in Fig. 3 educational function is leading, and Fig. 4 emphasizes the need for additional services. These include consulting, expert examination, and infrastructure for supporting innovation in the business environment. As an element of the organizational framework for the platform of the innovative ecosystem of the University, a permanent advisory council consisting of representatives of all participants in the regional innovation ecosystem was used. In turn, this requires changes in the principles of the Transfer Center through the use of open innovations, including on a networked digital platform on the Internet.

The provided recommendations (Fig. 3–5) on the development of the innovative ecosystem of universities are explained by the fact that functional organization is a component of ensuring the effectiveness of the activities of any socio-economic system. Based on the functional organization, more economical use of material and financial resources is possible. In contrast to the existing recommendations [32], the focus is on the principles of openness of communications and attracting students to knowledge and technologies transfer to business. The main limitation of the study is the fact that the paper does not consider the regulatory and institutional support of the process of organizing an innovative ecosystem in higher education institutions of Ukraine.

The research should be practically used by universities and the Ministry of Education and Science to intensify innovation activity and knowledge and technologies transfer. The theoretical value of the study lies in the development of a theoretical basis and a mechanism for knowledge and technologies transfer at higher education institutions.

In the future, it is planned to develop proposals for the regulatory and institutional support of the innovation ecosystem at the university using the experience of the world's leading higher education institutions.

7. Conclusions

1. We established the following main participants and components of the university's innovation ecosystem: education, basic science, applied science, and commercialization of knowledge. Much more attention is paid to the educational component in the structure of the innovation ecosystem: universities within various educational programs provide the necessary knowledge of innovation activity and develop entrepreneurial skills. Scientific parks function on the base of many universities and modern research laboratories are created with the help of business. The emphasis on the development of basic science in universities should be made on organizational issues and the introduction of new methods of work of the relevant departments. We supplied practical examples of the development of the startup movement in universities, which contributes to the popularization of innovation activities and provides the necessary knowledge and resources to university students to create and expand their startup projects.

2. The most weakly-developed component or the area of activity in the innovative ecosystem of higher education institutions is the issue of commercialization of knowledge. The study proposes to create centers for knowledge and technologies transfer at universities that would aggregate all the issues of promoting the ideas of scientists in the real sector of the economy, creating a bridge from innovators to business. The main directions, tasks, and functions of the Center for Knowledge and Technologies Transfer, as well as the principles of work that meet the goal of developing an innovative ecosystem in universities, were outlined.

3. The theoretical basis of the mechanism of knowledge and technologies transfer in higher education institutions was developed. The staff of higher education institutions, scientific institutions, individual scientists and scientific teams, students, etc. act as innovators-developers. Businesses or the state can order innovative products. All stages and forms of open communication between innovators and businesses, which should be provided by the Center of knowledge and technology transfer, were explored in the mechanism.

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