

Startup ecosystems within sustainable transformation of universities

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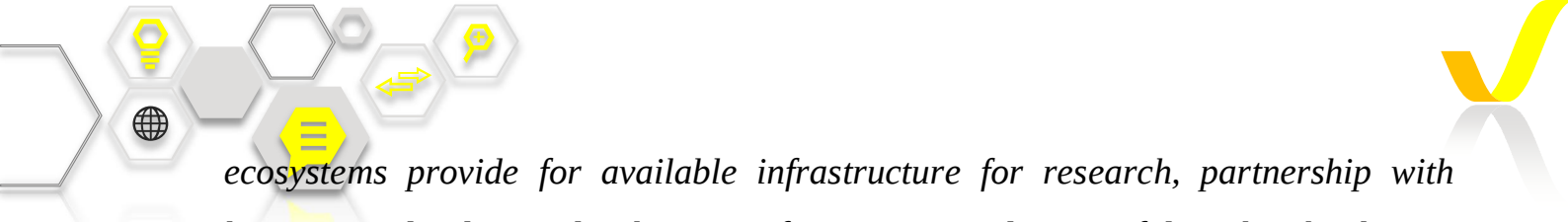
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Abstract. *The article is devoted to study in the study of the role of startup ecosystems in the processes of sustainable transformation of universities. It is studied that, contributing to sustainable transformation of universities, startup*



ecosystems provide for available infrastructure for research, partnership with business and industry, development of science, introduction of digital technologies, development of global cooperation, sustainable development and social responsibility, the multidisciplinary approach, etc.

Objective. *The purpose of the article is to study the role of startup ecosystems in sustainable transformation of universities and analyze current trends in development of Ukrainian startup ecosystems.*

Methods. *The study used general scientific and special methods, in particular: systemic analysis and generalization, statistical and comparative analysis, abstraction and formalization, graphic and abstract-logical.*

Results. *In the article, the main aspects of the impact of the startup ecosystem on transformation of universities are identified, in particular: improving the quality of education and research, formation of innovative thinking, support for entrepreneurship, global cooperation, and promotion of sustainable development. The dynamics of spending on science, technology, and innovation by sectors of implementation in some countries of the world in 2017-2022 (% of GDP) are presented . It was studied that one of first initiatives to create the startup ecosystem was three-year project “Creating a Network of Inter-University Start-Up Centers to Support and Promote Student Innovation Projects” (SUCSID), which was implemented within the framework of the Tempus IV program of the European Union. It was established that in Ukraine there are more than 50 innovation centers and technology parks that actively support startups in various industries, such as information technologies, biotechnology and energy. The largest concentrations of startups are observed in the cities of Kyiv, Lviv and Kharkiv, which is explained by the high scientific and technical potential of these regions. Areas of the activity of the business innovation center “Tech StartUp School” at the National University “Lviv Polytechnic”, the science park of Ivan Franko National University of Lviv “Innovation and Entrepreneurship” , the startup school of Kyiv Polytechnic Institute named after Igor Sikorsky, Startup School of KNEU, Startup Center "Spark" of NTU*



"KhPI", Innovation Hub of Zhytomyr Polytechnic State University and Startup Center of Uzhhorod National University (UzhNU).

Conclusions. *It is argued that due to the support and development of these startup ecosystems, innovation direction continues to develop, taking into account modern market requirements and digital transformation of society, favorable environment is formed for experimental research, development of innovations and support for young scientists on the path to creating competitive products and solutions.*

Keywords: *innovation ecosystem, sustainable development, university, digitalization, digital technologies, digital transformation, business incubators, technology parks, industrial parks, entrepreneurship, business.*

Стартап-екосистеми у процесах сталої трансформації університетів

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Анотація. *Стаття присвячена дослідженню ролі стартап-екосистем у процесах сталої трансформації університетів. Досліджено, що сприяючи сталій трансформації університетів, стартап екосистеми передбачають: наявність інфраструктури для досліджень, партнерство з бізнесом та індустрією, розвиток науки, впровадження цифрових технологій, розвиток глобальної співпраці сталий розвиток та соціальна відповідальність, мультидисциплінарний підхід тощо.*

Метою статті є дослідження ролі стартап-екосистем в процесах сталої трансформації університетів та аналіз сучасних тенденцій розвитку українських стартап-екосистем.

Методи. У дослідженні використано загальнонаукові та спеціальні методи, зокрема: системного аналізу та узагальнення, статистичного та порівняльного аналізу, абстрагування та формалізації, графічний та абстрактно-логічний.

Результати. У статті визначено основні аспекти впливу стартап-екосистеми на трансформацію університетів, зокрема: підвищення якості освіти та досліджень, формування інноваційного мислення, підтримка підприємництва, глобальна співпраця, сприяння сталому розвитку. Наведено динаміку витрат на науку, технології та інновації за секторами виконання за деякими країнами світу у 2017-2022 роках (% від ВВП). Досліджено, що однією з перших ініціатив зі створення стартап екосистеми був трирічний проєкт «Створення мережі міжуніверситетських Start-Up центрів для підтримки та просування студентських інноваційних проєктів» (SUCSID), що реалізовувався в межах програми Tempus IV Європейського Союзу. Встановлено, що в Україні функціонує понад 50 інноваційних центрів та технологічних парків, які активно підтримують стартапи в різних галузях, таких як інформаційні технології, біотехнології та енергетика. Найбільші



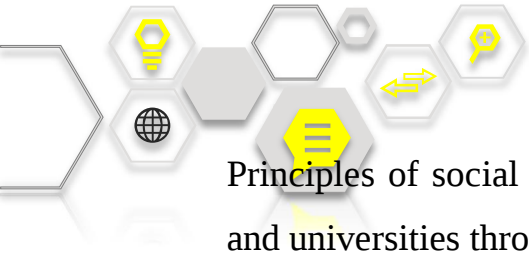
концентрації стартапів спостерігаються у містах Київ, Львів та Харків, що пояснюється високим науково-технічним потенціалом цих регіонів. Проаналізовано напрями діяльності бізнес-інноваційного центру «Tech StartUp School» у Національному університеті «Львівська політехніка», наукового парку Львівського національного університету імені Івана Франка «Інновації та підприємництво», стартап школи КПІ ім. Ігоря Сікорського, Стартап школи КНЕУ, стартап-центру «Спарк» НТУ «ХПІ», інноваційного хабу Державного університету «Житомирська політехніка» та стартап-центру Ужгородського національного університету (УжНУ).

Висновки. Аргументовано, що завдячуючи підтримці та розвитку стартап-екосистем інноваційний напрям досліджень продовжує розвиватись з урахуванням сучасних вимог ринку та цифрової трансформації суспільства. Формується сприятливе середовище для експериментальних досліджень, розвитку інновацій та підтримки молодих науковців на шляху до створення конкурентоспроможних продуктів і рішень.

Ключові слова: інноваційна екосистема, сталий розвиток, університет, цифровізація, цифрові технології, цифрова трансформація, бізнес-інкубатори, технопарки, індустріальні парки, підприємництво, бізнес.

Problem statement. The startup ecosystem plays the key role in transformation of modern universities, providing conditions for development of technologies, scientific research and entrepreneurial initiatives. It allows universities both to adapt to modern challenges, and to actively contribute to sustainable development of society.

Today, universities are increasingly introducing courses and programs related to sustainable development, energy conservation, social justice, environmental responsibility and other global issues, which allows them to maintain competitive advantages. The issue of environmental safety and economical use of resources is of priorities of sustainable development and is supported not only in production, but also in everyday life (using energy-saving technologies, renewable energy sources).



Principles of social responsibility are actively being introduced among businesses and universities through implementation of projects aimed at achieving equality and well-being of the population.

Within the framework of these projects, sustainable transformation requires innovative approaches to education, management and scientific research. Universities become platforms for introduction of new technologies and approaches to solving global problems. That is why sustainable development requires international cooperation. Universities often participate in international scientific and educational programs aimed at solving universal human problems. Technological innovations, in particular development of online education, contribute to increasing accessibility and quality of education, which is an important component of sustainable transformation. Introduction of digital technologies will increase competitiveness of domestic scientists and expand access to platforms for establishing international cooperation and finding investors.

Thus, sustainable transformation of the university encompasses various aspects of the institution's activities, from teaching and research to resource management and social responsibility.

Analysis of the latest research and publications. The following leading scientists have devoted their work to the study of formation and development of startup ecosystems and innovative activity at the level of universities in Ukraine: Bazhal Yu.M. [5], Zhilinska O.I. [6], Perminova I.E. [8], Chuprina M.O. [8], Sak T.V. [14], Shostak L.V. [14], Lopatynsky Yu.M. [15], Vodyanka L.D. [15], Granstrada P. [3], Budden H. [4], Murray F. [4] and others.

Highlighting unexplored parts of the general problem. Noting thorough research of scientists, it is appropriate to note that issues of determining the role of startup ecosystems in sustainable transformation of universities and peculiarities of functioning of domestic startup ecosystems require systematization, further study and analysis. The article identifies the main aspects of the startup ecosystem impact on the transformation of universities, and also examines the best domestic practices in the startup ecosystems' development, focusing on their importance and



contribution to the formation of a favorable environment for the development of innovations and support for young scientists on the path to creating competitive products and solutions.

Purpose of the article. The purpose of the article is to study the role of startup ecosystems in sustainable transformation of universities and analyze current trends in development of Ukrainian startup ecosystems.

Presentation of the main material. Features of development of science in universities, as a factor of economic development, are subject of research by many foreign scientists. This is confirmed by the publication of the annual analytical study of the European Commission on the state of innovative development in EU countries (study of the role of research organizations and universities). According to the data of the US National Science Foundation, considerable attention is paid to development of science at universities as foundation for active innovative processes that participate in transformation of ecosystems. In Ukraine, in recent years, changes in legislative regulation of innovation activity have significantly accelerated, which should contribute to active innovative processes at all levels.

Most scientists study development of startup ecosystems from different directions, but they are united by the idea that for successful realization of innovative potential, it is necessary to implement measures for scientific and technological development. Difficult socio-economic situation in Ukraine over past decades has negatively affected innovative capacity both of universities, and of the country as a whole. Low level of financial capacity and imperfect regulatory and legal support of intellectual property rights negatively affect investment attractiveness of domestic startup projects [1-4].

Startup ecosystems contribute to transformation of universities and provide for as follows:

1. Available infrastructure for research, as the startup ecosystem involves successful functioning of science parks, laboratories, technology transfer centers and incubators for startups. These elements create favorable conditions for scientific



research and implementation of innovative projects, ensuring effective knowledge transfer from the university to business and society.

2. Partnerships with business and industry, which allow universities to integrate their own developments into the real economy. This cooperation helps attract necessary investment funds in scientific research and enable developers to gain practical knowledge and experience in real market conditions.

3. Development of science in universities contributes to development of startup projects and business incubators, which are developed by students and teachers. This contributes to development of entrepreneurial thinking, which is the key element of modern university education. Innovative ideas that are born in universities have potential to turn into successful business projects.

4. Introduction of digital technologies, use of various digital platforms for distance learning and data management, and use of artificial intelligence-based technologies allow universities to optimize the educational process and increase work efficiency.

5. Development of global cooperation allows universities to more actively participate in various international scientific research, exchange experience with other institutions and scientists, and participate in global educational and scientific programs. This cooperation contributes to raising the level of educational programs and scientific research that meet modern requirements.

6. Sustainable development and social responsibility. Today, universities are the center of developing solutions to global economic, social and environmental challenges. The innovation ecosystem promotes development of projects focused on sustainable development, environmental efficiency and social responsibility, forming new generation of leaders who can implement these principles in their activities.

7. Multidisciplinary approach. Development of the innovation ecosystem is the tool for transforming universities by establishing interdisciplinary cooperation, which allows developing comprehensive solutions to modern problems. This



research ensures using innovative approaches to solve complex tasks, combine technical, social, economic and environmental aspects.

The startup ecosystem is the core of transformation of universities, contributing to development of innovative and project activities, conducting scientific research, and maximizing involvement of intellectual resources (Fig. 1)

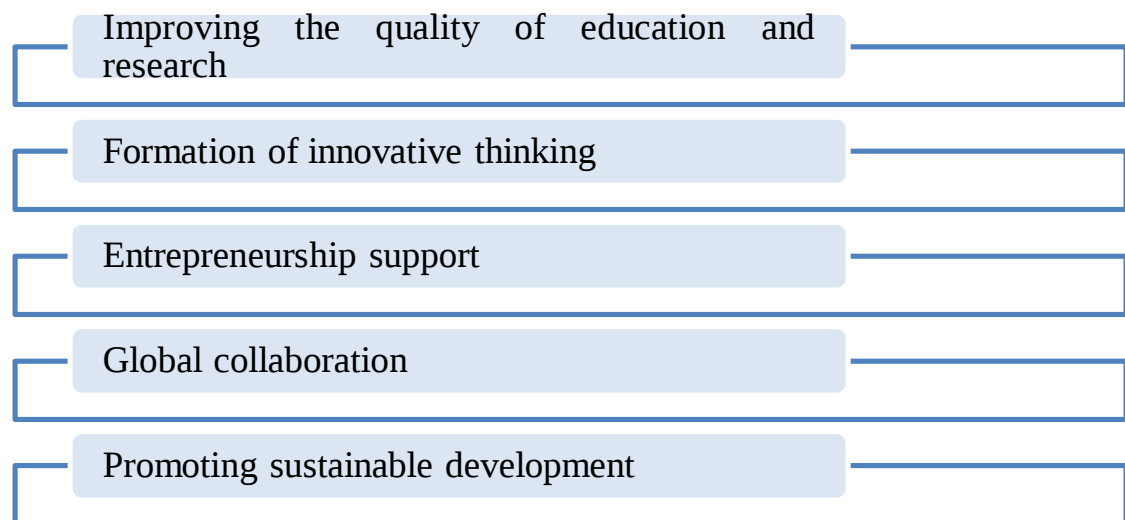


Fig. 1. Main aspects of the impact of the startup ecosystem on transformation of universities
Source: systematized based on [5-8]

Underdevelopment of innovation potential leads to socio-economic consequences and inequality in society, as it affects competitiveness of domestic production. The crisis since 2014, the COVID -19 pandemic, and military aggression of 2022 have negatively affected formation of startup ecosystems in all spheres of public life. Beginning of the pandemic led to the need to introduce new forms of learning and work that would minimize the need for personal presence and communication. Universities were forced to switch to the distance learning format (later, with the weakening of the pandemic, to the blended form), which required introduction of digital technologies and platforms to implement educational process. Starting in 2022, the full-scale invasion affected the change in the format of university work, which also affected scientific and innovative activities.

In these conditions, adaptive capacity of institutions plays important role, allowing them to quickly adapt to new operating conditions. Despite difficulties that



Ukraine and the entire sphere of education and science face, crisis phenomena require non-standard approaches and solutions, which has direct impact on development of innovative methods and approaches.

Creative solutions allow adaptation with the lowest costs and the highest benefits. Despite dynamic development and transformation processes in ecosystems, according to international ratings conducted by Reuters in conjunction with the Scientometric Ratings Agency “Clarivate Analytics”, the study of innovative development at universities shows that the most innovative in Europe and the world are those that support traditional development of science and education [9].

The main criteria indicators in the above rankings are number of citations of patents in other patents and citations of scientific publications in submitted patents. Another important criterion is the number of citations of scientific publications in journals indexed in the international scientometric databases Scopus and Web of Science Core Collection , taking into account the share of citations with scientists from commercial structures, citation indices of scientific articles and patents, part of triad patents (which were simultaneously confirmed in the European, American and Japanese patent offices) [10].

It is believed that these indicators are the main criterion for commercialization of innovative developments of universities. According to authors of the above ratings, these indicators reflect connection between fundamental research at universities and their impact on commercialization of innovative developments. In Europe, among the leaders of innovative universities are institutions with the centuries-old history that have accumulated their educational and scientific potential for decades, due to which they have formed the startup ecosystem.

Foundation of innovative development is accumulation of human capital in relevant ecosystems. That is why in Ukraine, despite the crisis, it is necessary to direct maximum efforts to development of human capital in startup ecosystems. If we compare the cost of human capital in Europe and in Ukraine, we can conclude that remuneration of labor in educational and scientific activities in Ukraine is 5-10 times lower than in Europe.

In the open market economy, the outlined aspects lead to the outflow of labor abroad, especially among young scientists. Decrease in the number of labor resources leads to reduction in GDP and negative impact on investment potential of the state as a whole. In addition to wages, important role is played by financing of innovative developments, which in the world is correlated as the percentage with the GDP indicator. Thus, dynamics of innovation spending among some countries of the world characterizes uneven distribution of funding within the single country (Fig. 2).

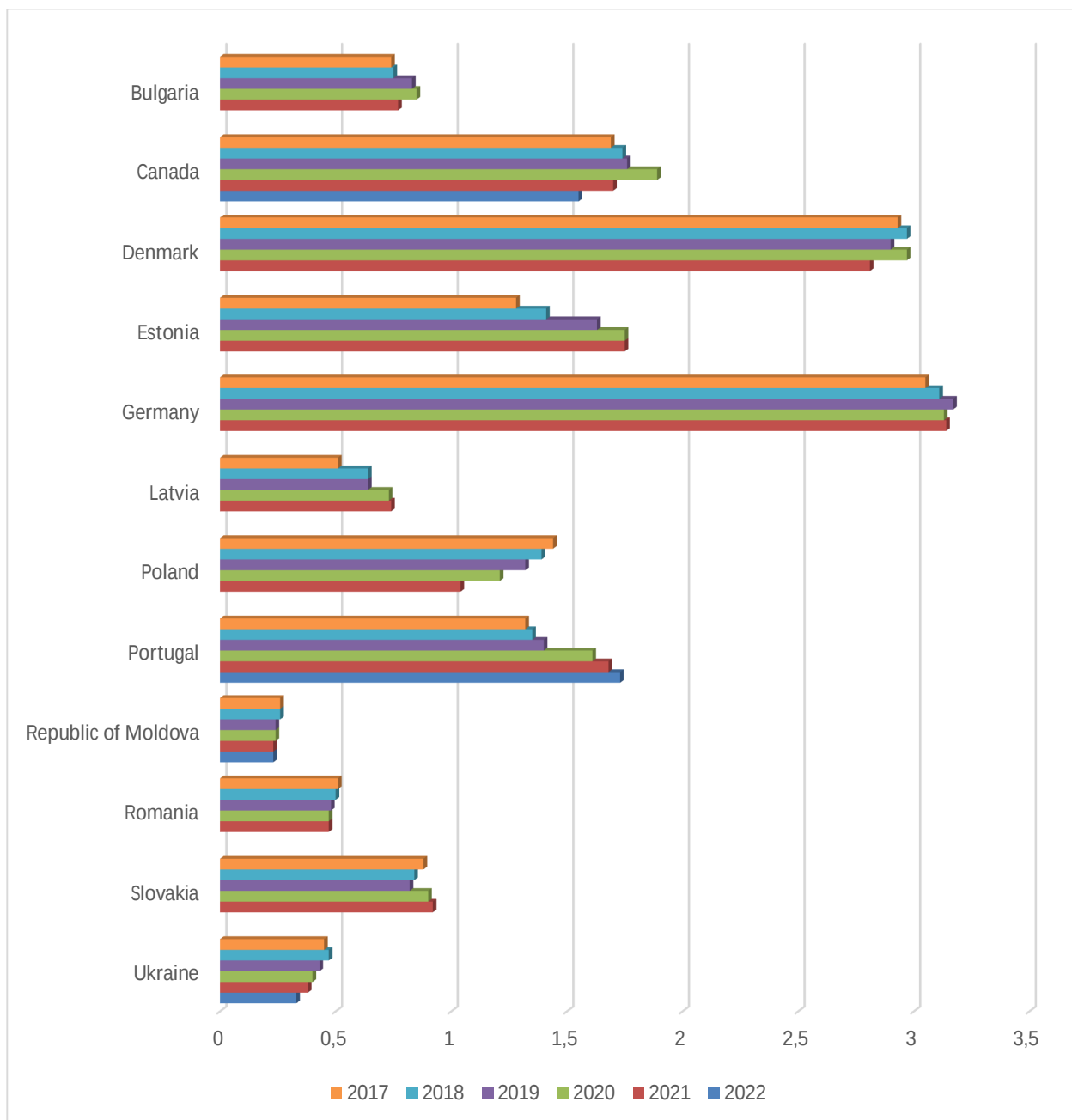
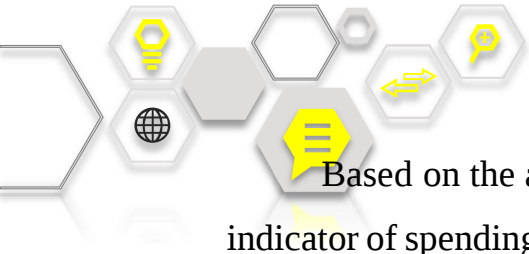


Fig. 2. Dynamics of spending on science, technology and innovation by sectors of implementation in some countries of the world in 2017-2022 (% of GDP)

Source: systematized by the authors based on [11]



Based on the above data, for 2017-2022, Ukraine has observed decline in the indicator of spending on innovative developments as the percentage of GDP (in 2022 compared to 2017, the decrease of 0.14%). Among the countries studied in 2022, negative dynamics are characteristic of the Republic of Moldova (decrease in 2022 compared to 2017 of 0.03%), Romania (decrease of 0.03%), Denmark (decrease of 0.16%), and Canada (decrease of 0.19%). Leaders among the countries studied in terms of spending on innovative developments are Germany and Denmark [11].

Countries such as Bulgaria, Estonia, Slovakia, Portugal, Poland, Latvia improved their positions in 2022 compared to previous periods. If we compare Ukraine with its close neighbors Poland, Bulgaria and Romania, we can conclude that Ukraine lags significantly behind in financing scientific developments. Therefore, support from the state and authorities at various levels in matters of commercialization of innovations and attracting financial resources to innovative development of universities is one of the priority tasks today.

There are many startup centers, incubators, and accelerators operating in Ukraine that support creation and implementation of innovative ideas and technologies.

At the initial stage of formation of the Ukrainian startup ecosystem, the UVCA – Ukrainian Venture Capital and Private Investment Association, created following the example of the European Association of this profile, served as a kind of coordinator. It acts on behalf of private investors in interaction with the government, contributes to improvement of investment and business climate in the country, helps establish contacts between startups and investors, and also accumulates information about key players in the domestic startup market. Currently, UVCA includes more than 40 participants – leading representatives of the international and Ukrainian investment market, including Almaz Capital, AVentures Capital, Digital Future, Horizon, HP Tech Ventures, KM Core, Intel Capital, EBRD and others. UVCA's activities contributed to popularization of Ukrainian startups abroad and attraction of private investment in the period up to 2019, when state participation in development of the startup ecosystem remained minimal.



One of first initiatives to create the startup ecosystem was the three-year project (2012-2015) “Creating a network of inter-university Start-Up centers to support and promote student innovation projects” [12] (SUCSID) implemented within the framework of the Tempus IV program of the European Union. The project was developed by teachers of the Kharkiv National Economic University and the University of Lyon-2 named after Lumiere (France), and its coordinator is the University of Montpellier 2 (France). The consortium for project implementation included universities from Ukraine, Belarus, Moldova, Sweden, Great Britain, Portugal and Finland. An important advantage of the project was involvement of European business incubators, the Association of IT Companies “Information Technologies of Ukraine” and companies specializing in supporting and promoting innovative solutions. The main objective of the project was to develop innovation and entrepreneurship in partner countries by increasing creativity, competitiveness and employability of university graduates, as well as expanding cooperation between universities, innovation and investment companies for commercialization of knowledge. Participants achieved this by creating a "knowledge triangle": education - research - innovation, which is based on the person-centered approach, innovation and entrepreneurship.

As part of the project, Start-Up centers were opened in Ukraine. The distinctive feature of the initiative is creation of information network for familiarizing with innovative projects and ideas of all participants, as well as creation of the “bank of innovative ideas” for potential investors, partners and other interested parties. During the project, the SUCSID [13] portal (an abbreviation for “Inter-University Start-up Centers for Students' Innovations Development & Promotion”) was created, which provides support to anyone who seeks to implement their business idea and start their own business. This portal is currently operating and developing and represents the Inter-University Start-up Center as key result of the Tempus SUCSID project, which is funded by the European Commission's Lifelong Learning Support Program. University Start-Up Centers were opened with the aim to create favorable business environment. Their activities are focused on



stimulating creativity and innovation, as well as supporting students in transforming their own business ideas into real projects, and subsequently into sustainable and successful businesses.

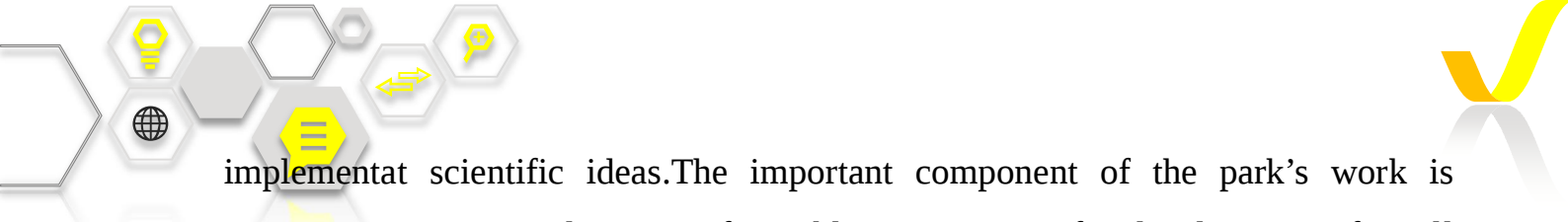
Today, there are over 50 innovation centers and technology parks operating in Ukraine, which actively support startups in various industries, including information technology, biotechnology, and energy [14].

The largest concentrations of startups are observed in the cities of Kyiv, Lviv, and Kharkiv, which is explained by high scientific and technological potential of these regions [15].

In October 2017, official opening of the ***Business Innovation Center “Tech StartUp School”*** [16] took place ***at the National University “Lviv Polytechnic”***. The mission of Tech StartUp School is to create comfortable innovation environment where creative ideas turn into successful startups. Here, innovators, under the guidance of experienced business coaches and mentors, go through entire journey from the birth of the idea to the business model formation, finding investments and commercializing their projects. This space offers incubation, pre-acceleration and acceleration programs designed for inventors and innovators who seek to develop their own technological and creative solutions. Cooperation with state institutions in innovation and invention support allows us to involve experienced coaches and mentors in the educational process, providing high-quality technical equipment and tools.

The main mechanisms for development of startups implemented by the School are pre-acceleration programs, crowdfunding platforms, technology laboratories, and unique collaborations with government institutions and organizations aimed at developing innovations.

Another innovation center is successfully operating and developing in Lviv – ***the Science Park of the Ivan Franko National University of Lviv “Innovation and Entrepreneurship”*** [17], which acts as the platform for combining education, science and business. Its activities are aimed at developing and implementing innovative technologies, their entry into the market and attracting investments to



implementat scientific ideas. The important component of the park's work is supporting startups and creating favorable environment for development of small innovative businesses. Special attention is paid here to involving students and teachers in implementation of applied projects. They can cooperate with experienced mentors and experts, working on their own ideas.

The park offers specialized training programs and advanced training courses that meet current market needs. Practitioners are involved in teaching, helping participants acquire applied skills and effectively solve professional tasks.

One of the leading projects of the park is Lviv Startup Fest - the competition for startups, which enables students present their innovative ideas and attract resources for their implementation. This competition contributes to formation of high-tech production, creation of new jobs and economic growth of the region. Thanks to its activities, the science park plays the key role in building the innovation ecosystem of the Lviv region and Ukraine as a whole, uniting efforts of science, education and business for the sake of sustainable development.

Startup School of Igor Sikorsky Kyiv Polytechnic Institute [18] is the platform for learning, developing innovative ideas and supporting entrepreneurial initiatives. It is aimed at students, postgraduates, scientists and inventors who seek to implement their ideas in the form of startups or join technological projects as co-founders. Within the framework of its activities, the Startup School attracts and selects creative people who wish to be engaged in innovative entrepreneurship. Participants include inventors, scientists, postgraduates and students of KPI, other universities and research institutes, as well as business representatives.

The school provides training in innovative entrepreneurship, helping participants to form their technological and business ideas. They are provided with comprehensive support in developing projects and creating prototypes of business products. The important aspect of the school's work is motivation of participants to develop their own ideas and prepare startups that meet requirements of interested investors. The startup school helps to find investors, business angels for promising



projects, and also organizes selecting the best startups with participation of trainers, experts, funds and investors.

The Startup School of Igor Sikorsky Kyiv Polytechnic Institute is the important element in development of Ukraine's innovation ecosystem, contributing to formation of new generation of entrepreneurs capable of creating world-class products.

Startup School KNEU [19] is the innovative platform created to develop entrepreneurial ideas and form a startup culture among pupils, students, postgraduates and young entrepreneurs. The initiative of the Vadym Hetman Kyiv National Economic University is aimed at supporting innovative entrepreneurship, providing practical knowledge and skills, as well as creating conditions for successful implementation of business ideas. The school offers unique opportunities to gain experience in the startup industry, including theoretical consultations, practical classes and mentoring support.

The training program covers the entire cycle of creating a startup - from developing the idea to preparing presentations for investors. Participants gain knowledge in key aspects as follows: product development, innovative project management, marketing, branding, raising funding, team building, and growth strategies. Particular attention is paid to practical component: participants test their ideas on real clients, create financial models, product prototypes, and also prepare for pitches before a jury and investors.

Startup Center "Spark" NTU "KhPI" [20] is the unique platform for supporting innovative entrepreneurship and developing the startup ecosystem in Ukraine. The main goal of the center is to create favorable conditions for implementation of innovative ideas of students, schoolchildren and scientists. The center actively supports young startups, providing opportunities for training, mentoring, team building and finding investors.

The center's activities include organizing events such as the All-Ukrainian Innovation Festival, Students' startup competitions, and Thematic conferences. In particular, within the framework of the StartUP-school project, innovative



environment is created for schoolchildren and college students, which stimulates development of entrepreneurial skills and helps to implement promising ideas. Participants are enabled to gain knowledge in business modeling, marketing, legal support, attracting investments, and presenting their projects.

The Innovation Hub of the Zhytomyr Polytechnic State University [21] acts as modern ecosystem for development of innovative projects, commercialization of scientific developments and support of entrepreneurial initiatives of teachers, students and postgraduates. It offers a wide range of services and competencies - from prototyping and testing to mechanical, electrical engineering, software development, robotics and IoT. Modern laboratories and equipment, such as 3D printers, laser machines, equipment for metal and woodworking, electronic laboratories and VR studios, allow the implementation of the most daring innovative ideas.

The Innovation Hub also includes the Technology and Innovation Support Center (TISC), which is part of the national network of TISCs. The Center provides users with access to patent and non-patent information, advises on its use, organizes distance learning under the programs of the WIPO Academy, and offers other services aimed at developing and supporting innovation activities.

Startup Center of Uzhhorod National University (UzhNU) [22] was created to support scientific developments of students, postgraduates and young scientists. Its activities are aimed at forming creative generation of young scientists, promoting creation of research groups to solve urgent scientific issues and developing innovative environment at the university.

The Center creates favorable environment for experimental research, supports access to educational materials and software, and contributes to formation of innovative ecosystem through cooperation with scientific and methodological centers and other organizations.

Conclusions. Today, the role of the startup ecosystem in sustainable transformation of universities is one of the key ones. Development of science and innovation in universities requires significant support and change, as market



demands are constantly increasing. In all spheres of public life, achieving sustainable development goals based on principles of environmental friendliness, energy efficiency, and social security is relevant. Commercialization of innovative developments plays important role in increasing competitiveness of universities. To support and develop science in universities, it is advisable to change regulatory and legal framework to protect intellectual property rights, which will also contribute to improving investment climate in the state and attracting financial resources.

Startup ecosystems are formed based on of leading classical universities, which are the foundation of scientific initiatives. Thanks to support and development of intellectual potential in these institutions, appropriate scientific schools are formed, which continue to develop innovation taking into account modern market requirements and digital transformation of society, contributing to formation of favorable environment for experimental research, development of innovations and supporting young scientists on the path to creating competitive products and solutions.

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