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FOREIGN EXPERIENCE IN FORMING INNOVATION ECOSYSTEMS

The article is devoted to the study of foreign experience in the formation of innovative ecosystems in modern conditions. The scientific approaches to defining the essence of the concept of "ecosystem" are analyzed. The definitional content of the concept of "innovative ecosystem" is determined, its main components are identified. The features are outlined development of innovation ecosystems based on the analysis of foreign experience, the types, levels and role of universities in promoting the development of such ecosystems are determined. It is argued that since the modern economy is based on technology, universities must also change at a pace unusual for higher education. While maintaining their main mission - training the next generation and developing new forms of knowledge, universities must also ensure a growing role in stimulating innovation and economic development. The experience of leading countries proves that higher education institutions must actively respond to the challenges of the digital revolution and play an increasingly important role in innovation ecosystems and economies. The best foreign practices in promoting the development of innovation ecosystems are studied.

Keywords: *innovation ecosystem, strategy, industry, enterprise, entrepreneurship, business, innovative technologies, digital technologies, digital transformation, startup projects , university.*
Fig.: 5. References: 22.

Problem statement. The main factors influencing the formation of university innovation ecosystems are mobile Internet, automation of intellectual work, Internet of Things, cloud technologies, advanced robotics, autonomous and near-autonomous vehicles, next-generation genomics , energy storage, 3D printing, advanced materials, deep exploration and production of oil and gas, renewable energy sources. In this context, the issue of forming an innovation ecosystem in universities, which is a means of activating all human capital, bringing it closer to market needs and promoting the activation of innovation and development of society, is gaining particular importance, in particular through the means of outsourcing activities in the IT sphere.

Analysis of recent research and publications. The publication Adner is devoted to the peculiarities of the formation of innovation ecosystems and the analysis of successful foreign practices. R., Gomes A., Granstranda O., Budden P., Murray F., Carneiro from O., Isidro Son D., Criado J., Pererva P., Kuchynskyi V., Cai Y. Ramis, Ferrer B., Luis Martinez Lastra J. et al.

Highlighting unexplored parts of the general problem. The relevance of the chosen research topic is due to the rapid development of technologies, the need to identify the most effective approaches to creating innovation ecosystems and analyzing the possibilities of implementing and adapting successful models of developing best practices to Ukrainian realities in order to increase the competitiveness of both individual participants in the innovation ecosystem and the state as a whole. Despite the significant volume of scientific research on this topic, the study of foreign experience in the formation of innovation ecosystems requires further analysis and the search for useful cases and recommendations for supporting and establishing effective cooperation between participants.

Purpose of the article. The purpose of the article is to study foreign experience in the formation of innovation systems.

Presentation of the main material. The origin of the term "ecosystem" originates from biology, when in the 1930s the British botanist A. Tansley introduced the term "ecosystem", which meant the interaction of a group of organisms with each other and the external environment. In his opinion, organisms should interact with each other, and not just compete with each other for development and cooperation. Fig. 1 presents scientific approaches to the definition of the concept of "ecosystem".

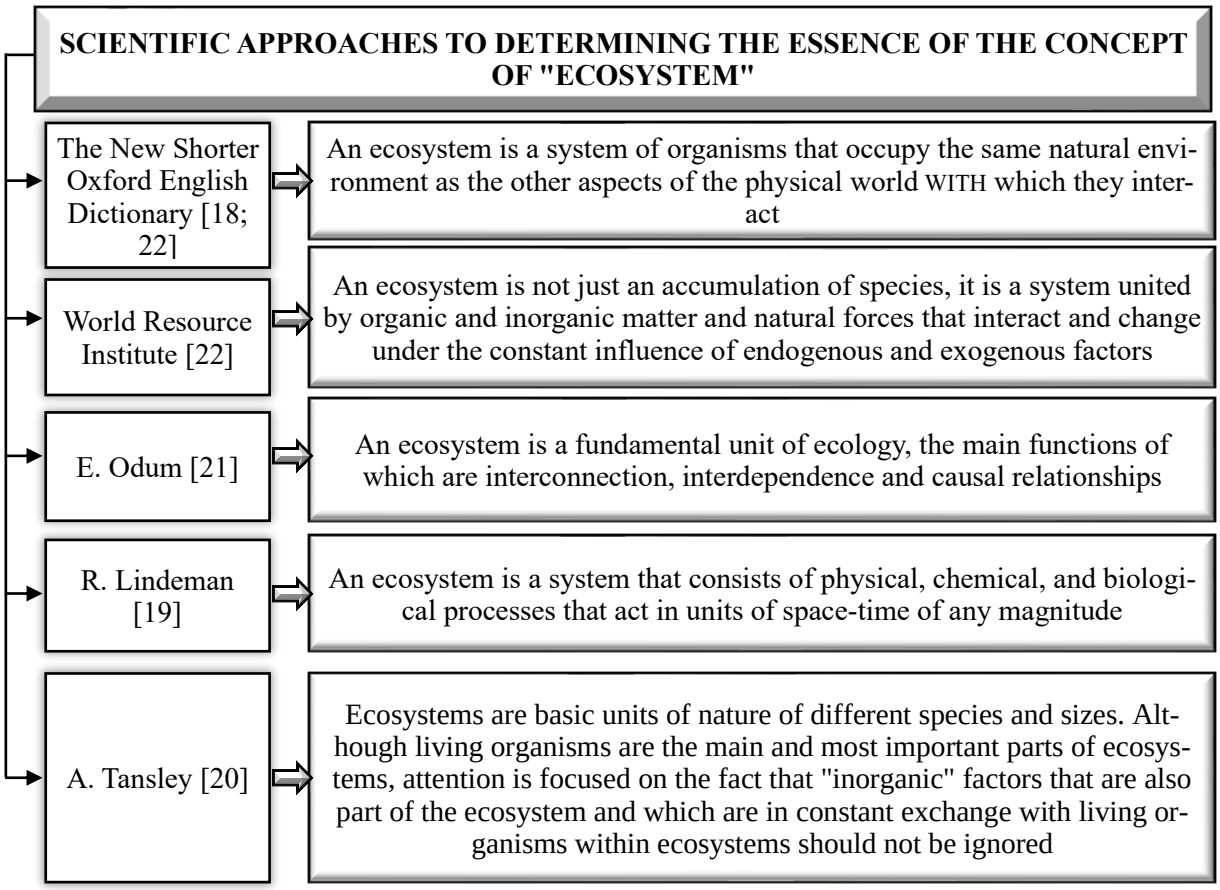

Fig. 1. Scientific approaches to defining the concept of "ecosystem"
Source: systematized by the authors.

An innovation ecosystem is understood as a set of interconnected institutions, organizations, people and processes that create a favorable environment for the development, implementation and dissemination of innovations. The main components of an innovation ecosystem are shown in Fig. 2.

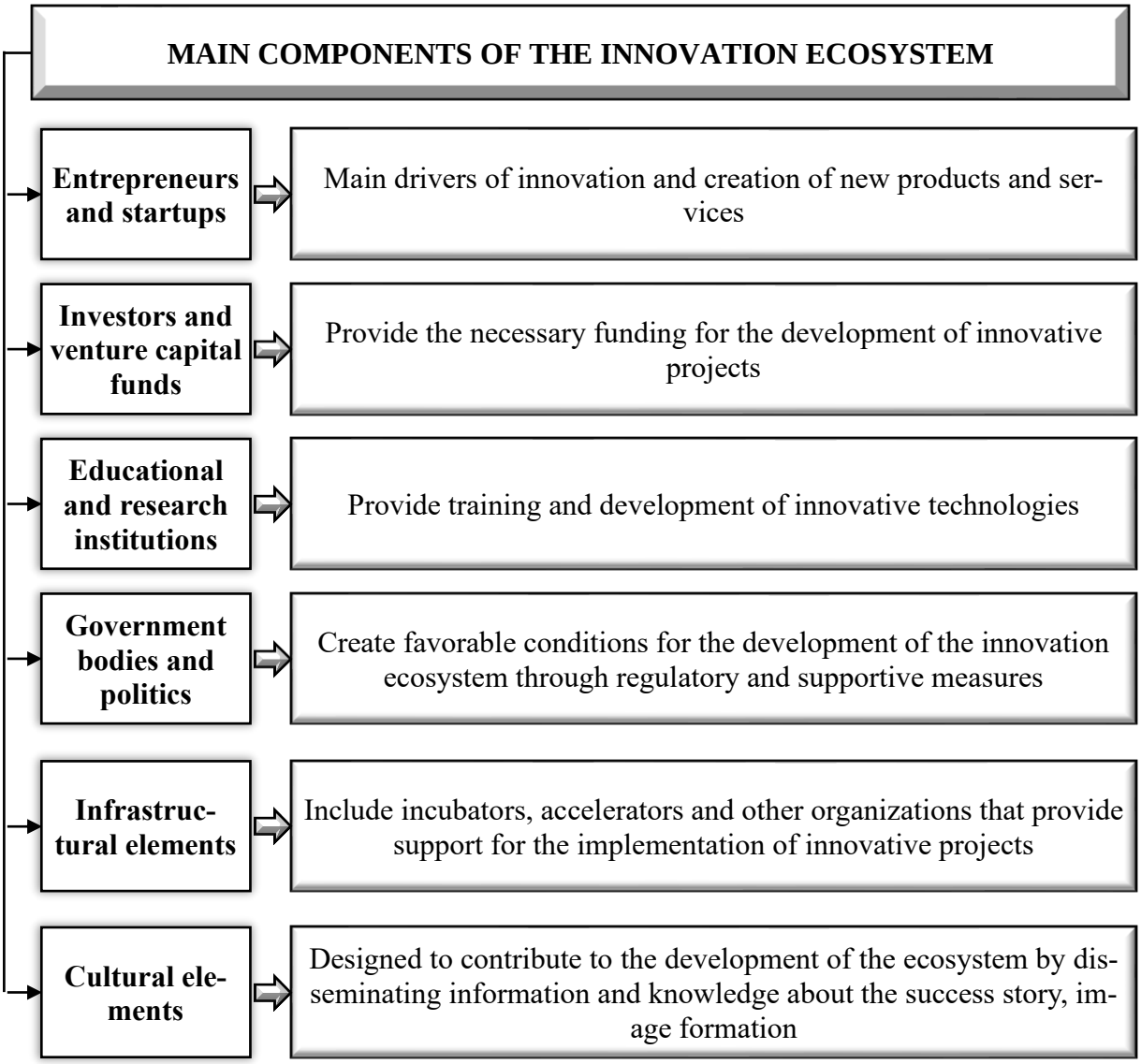

Fig. 2. Main components of the innovation ecosystem

Source: systematized by the authors.

Innovation ecosystems operate at different levels (regional, national, corporate) and in different sectors of the economy (agriculture, industry, education), which significantly affects the characteristics of the participants of the innovation ecosystem. In addition to the usual participants of the innovation ecosystem, private investors (business angels) have been added in recent years, as large corporations have become more interested in the development of business innovations at smaller enterprises. This has introduced the emergence of new educational formats that contribute to the development of entrepreneurship, the emergence of innovative startup projects , and the establishment of new business ties.

Innovation ecosystems and their management are most often discussed in the context of the business environment, but the special role of creating an innovation ecosystem in the university environment is not always determined. At the same time, B. Bittencourt et al. consider the features of the formation of such a system on the basis of universities:

1. The main task of the innovation ecosystem at the university is not to obtain economic benefits , which do not always correspond to the needs of a particular society. It is rather about access to knowledge for the creation and exchange of innovations and, ultimately, the development of the economy and society.

2. The existence of a collective identity of all participants in the university innovation ecosystem, which is determined by belonging to one higher education institution, as opposed to a temporary association on the platform of any commercial incubation structure.

3. Approaching the needs of the economy creates the possibility of mutual enrichment of educational, scientific, and innovative and business elements of the university environment, unlike business structures, where the combination of these three components of the formation of innovative development is impossible [10, 11].

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

As the modern economy is driven by technology, universities must also change at a pace that is unusual for higher education. While maintaining their core mission of educating the next generation and developing new forms of knowledge, universities must also play an increasingly important role in driving innovation and economic development. The experience of leading countries shows that institutions must actively respond to the challenges of the digital revolution and play an increasingly important role in innovation ecosystems and economies by implementing the following key areas (Fig. 3).

1. *Promoting entrepreneurship development* .

As the pace of discovery increases and global competition intensifies, universities are embracing entrepreneurship as part of the academic experience, creating cultures that inspire and support innovative thinking. Regardless of their field of study, students come to university with a desire to contribute to society through startups, social entrepreneurship, and other projects of their own . The same energy and enthusiasm is found among young faculty members who are also exploring new technologies or participating in startups as part of their academic careers.

At a time when societal challenges demand discoveries at the intersection of disciplines, fostering a culture of entrepreneurship is one of the most powerful ways in which universities act as economic catalysts. In fact, data from the US Association of University Technology Managers (AUTM) shows that technology transfer from universities is playing an even more prominent role in economic development.

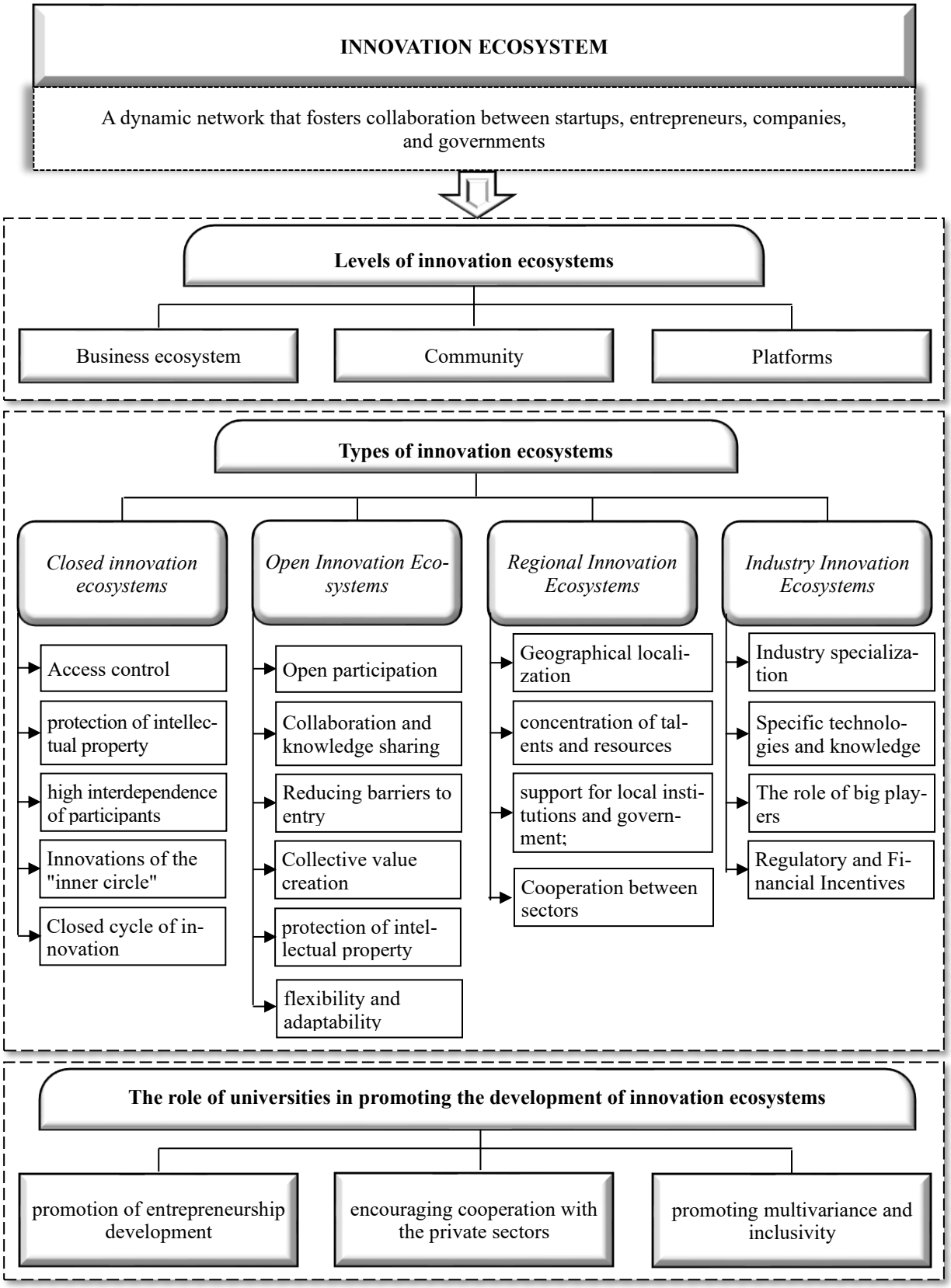

Fig. 3. Features of the development of innovative ecosystems based on the analysis of foreign experience

Source: systematized by the authors.

The transfer of academic technologies for the benefit of society and the economy in 2022 is: $ 91.8 billion in research spending; 24,140 invention disclosures; 6,801 operating startups as of 2022; 998 new startups created; 850 new products created; 9,884 licenses and options executed; 16,857 new patent applications filed; 7,739 patents issued [12].

2. *Encouraging cooperation with the private sector* .

In today's competitive environment, universities must also develop new partnerships with leading companies, foundations, and other research institutions. These partnerships do more than just transfer knowledge from the lab to the field. They provide critical funding for talented faculty and students engaged in basic research, allow students and faculty to exchange ideas with the best minds both inside and outside academia, and, perhaps most importantly, help prepare students for life in a rapidly changing world.

Corporations recognize the high value and benefits of such cooperation.

NSF is an independent federal agency that supports science and technology in all 50 states and territories of the United States. NSF was established in 1950 by Congress to: promote the advancement of science; promote the national health, prosperity, and welfare; and provide for the national defense.

NSF accomplishes its mission primarily through grantmaking. NSF investments account for about 25 percent of federal support for basic research at U.S. colleges and universities. NSF also supports solution-oriented research that has the potential to make a difference to American society.

According to data collected by the US National Science Foundation (NSF), industry funding of university research and development has been growing at an average of more than 5.5% per year over the past 10 years [13]. The US Consolidated Appropriations Act provides for funding for the NSF annually (Figure 4).

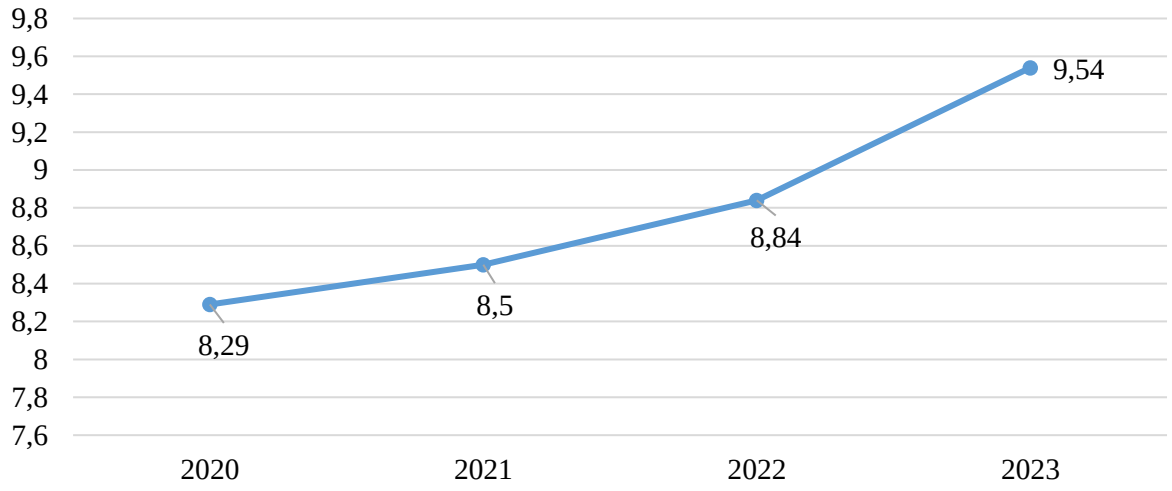

Fig. 4. Dynamics of federal funding for NSF research and development for 2020–2023, billion dollars

Source: [13].

The Consolidated Appropriations Act of 2023 provides:

- $ 7.18 billion for research and related activities (RRA) ;
- $ 1.17 billion for STEM education (Science , Technology , Engineering and Mathematics);
- $ 234.0 million for the construction of major research equipment and facilities (MREFC);
- $ 448.0 million to the Agency Operations and Awards Management (AOAM) account;
- $ 24.41 million to the Office of the Inspector General (OIG) ;
- $ 5.09 million to the account of the Office of the National Science Board (NSB) [13].

This trend is not limited to the United States. The European Commission is also strengthening partnerships between universities and industry through the creation of the European Institute of Innovation and Technology (EIT). Through its Knowledge and Innovation Communities, the EIT fosters collaboration between academia, research and business in more than 30 collaborative centers in 15 Member States [14].

The EIT Knowledge and Innovation Communities are pan-European networks focused on tackling specific societal challenges, such as health or climate change. They involve partnerships between:

1. Higher education institutions.
2. Research centers.
3. Businesses and investors.
4. Public and non-profit organizations.

The main areas of investment are:

1. Climate change – accelerating the transition to a zero-carbon economy, developing innovative technologies that contribute to climate protection; forming a new generation of climate leaders who help create a climate-resilient Europe. To date, more than 250 global partners have joined, investing more than €92 million in startup investments, and €688 million in EIT funding.
2. Cultural and creative sectors and industries – creativity without borders, innovation without limits; developing an inclusive and sustainable vision by Europe's creative community. To date, more than 50 global partners have joined, investing about 1 million euros in investments attracted to startups, and 6 million euros have been allocated for EIT funding.
3. Digitization is the driver of Europe's digital transformation; a community committed to using digital technologies for a sustainable, inclusive and just society. To date, more than 270 global partners have joined, investing about €105 million in investments attracted to startups, and €610 million has been allocated for EIT funding.
4. The Future of Food – Building a food system that meets the demands of the future, producing healthy food for all; changing society’s relationship with food and agriculture. To date, over 310 global partners have joined, investing over €406 million in startup investments, and €354 million in EIT funding.

5. Healthcare Innovation – developing technology that helps people access healthy lifestyles and healthy aging. To date, over 540 global partners have joined, with over €480 million in investments raised in startups, and €480 million in EIT funding.

6. Sustainable Energy – Achieving a sustainable energy future for Europe, a leading driver of a new European economy based on renewable energy. To date, over 590 global partners have joined, investing over €679 million in startup investments, and €709 million in EIT funding.

7. Value-added manufacturing – strengthening and increasing the competitiveness of European industry; creating the workforce of tomorrow. To date, over 250 global partners have joined, investing over €3 million in startup investments, and €169 million in EIT funding.

8. Raw materials – making raw materials a major European power; the goal is to make Europe self-sufficient and environmentally sustainable by rethinking the resource value chain. To date, over 570 global partners have joined, investing over €119 million in startups, and €466 million in EIT funding.

9. Urban mobility – smart, green and integrated transport; European cities should be laboratories for innovation that decarbonises mobility and puts people back at the centre of urban planning. To date, over 270 global partners have joined, investing over €4 million in startups, and €189 million in EIT funding [14].

The EIT is therefore the largest innovation network in Europe, strengthening innovation since 2008. The model is based on partnerships between sectors, i.e. it brings together organisations involved in business, education and research. The aim of these partnerships is to find and commercialise solutions to pressing global problems. To address these global challenges, this community of partners offers a wide range of training courses, business creation and acceleration services and innovation-oriented research projects .

3. *Promoting diversity and inclusion* .

Successful university startups and corporate partnerships do not tell the whole story. As economic transformation accelerates, it is important that universities continue to focus on incorporating diverse perspectives into their operations.

Opportunities for various startups are expanding in the US, especially in STEM fields. *STEM* This is not only the right thing to do, but also necessary to meet the economic demand arising from a technology-driven economy. The US Bureau of Labor Statistics projects that STEM jobs will grow by 8.9%, compared to 6.4% growth in non-STEM fields [15].

To address this important issue, the University of Maryland , Baltimore (UMBC) launched the Meyerhoff Scholars Program back in 1989 to expand opportunities for individuals from racially , socioeconomically, and geographically diverse communities who aspire to pursue degrees in STEM fields.

These efforts have paid off. Today, UMBC is among the top ten undergraduate institutions in producing African-American students who go on to earn Ph.D. degrees in the sciences and engineering. Other universities are following suit, committing to increasing the number of women and underrepresented minorities in their programs.

Universities have a key role to play in ensuring that economic gains are spread across the economy, not just among those pursuing higher education in technology fields. For example, in Philadelphia, Pennsylvania , Drexel University and the University of Pennsylvania have joined forces with the public, private, and civic sectors to create the West Philadelphia Skills Initiative (West Philadelphia Skills Initiative). Philadelphia Skills Initiative) is a workforce development organization in the United States [16]. It offers training, support, and non-baccalaureate job opportunities to residents of the West Philadelphia area. The organization's success is driven by the strategic leadership of its parent organization, the University City District, long-term investment of funds, a commitment to continuous improvement, and the support of an extensive network of partners.

West Philadelphia Skills Initiative offers educational programs in the following areas:

1. Individual training programs. A skills development initiative targets specific positions that employers need to fill and uses a team-based learning model to recruit, assess, and train candidates on behalf of the new employer. The employer can then interview and select the best candidates for the open positions. Historically, employers who use a training program have seen significant increases in employee retention within the first 12 months of the program.

From 2011 to 2024, a professional development program has employed over 1,898 people, many of whom are members of historically discriminated communities, in significant positions in leading institutions around the world, the total salary of participants after completing the program is $ 122 million , the increase in the average hourly wage of participants after completing the program is an average of $ 3.31 , about 90% of all program participants keep their jobs for 12+ months [17].

2. Recruitment and Retention Consulting. The Skills Initiative has over a decade of experience in recruiting, onboarding, and coaching entry-level employees. Through quantitative and qualitative data analysis, it identifies the root causes of employee turnover and offers solutions to increase employee retention and reduce costs.

3. Training for managers and permanent employees. The initiative creates individualized training programs for permanent employees, managers. Workshops such as social identity, awareness, upward management, and development orientation can be conducted as separate sessions or as part of an overall talent management strategy.

4. Accelerated Placement Model: The Skills Development Initiative has developed an accelerated placement model – WorkWithWPSI – aimed at rapidly placing graduates in available positions with leading employers that do not fall under the traditional training model.

When The Skills The Initiative has demonstrated its ability to successfully employ local residents and create value for employers by reducing employee turnover, and the list of employer partners has expanded to include local

employers such as SEPTA , Penn Medicine and the Philadelphia Fire Department. This expansion has allowed the Skills Initiative to offer exciting new opportunities to West Philadelphia residents. Supported by the JPMorgan Foundation Chase Skills Initiative built on this success and began to collaborate with new partners in other areas, including Temple University in North Philadelphia and PIDC at the Navy Yard in South Philadelphia.

4. *Research into the relationship between technology and society* .

Of course, there is no guarantee that technology will automatically benefit humanity. This is where higher education institutions have the greatest responsibility in the digital revolution: to educate ethicists , artists, and philosophers who can point the way; policy experts and economists who can chart the course; and cognitive scientists and sociologists who can help ensure that the future is built for people, not just machines. Universities have a responsibility to ensure that academics work side by side with applied researchers and technologists who lead the revolution and foster innovation ecosystems (Fig. 5).

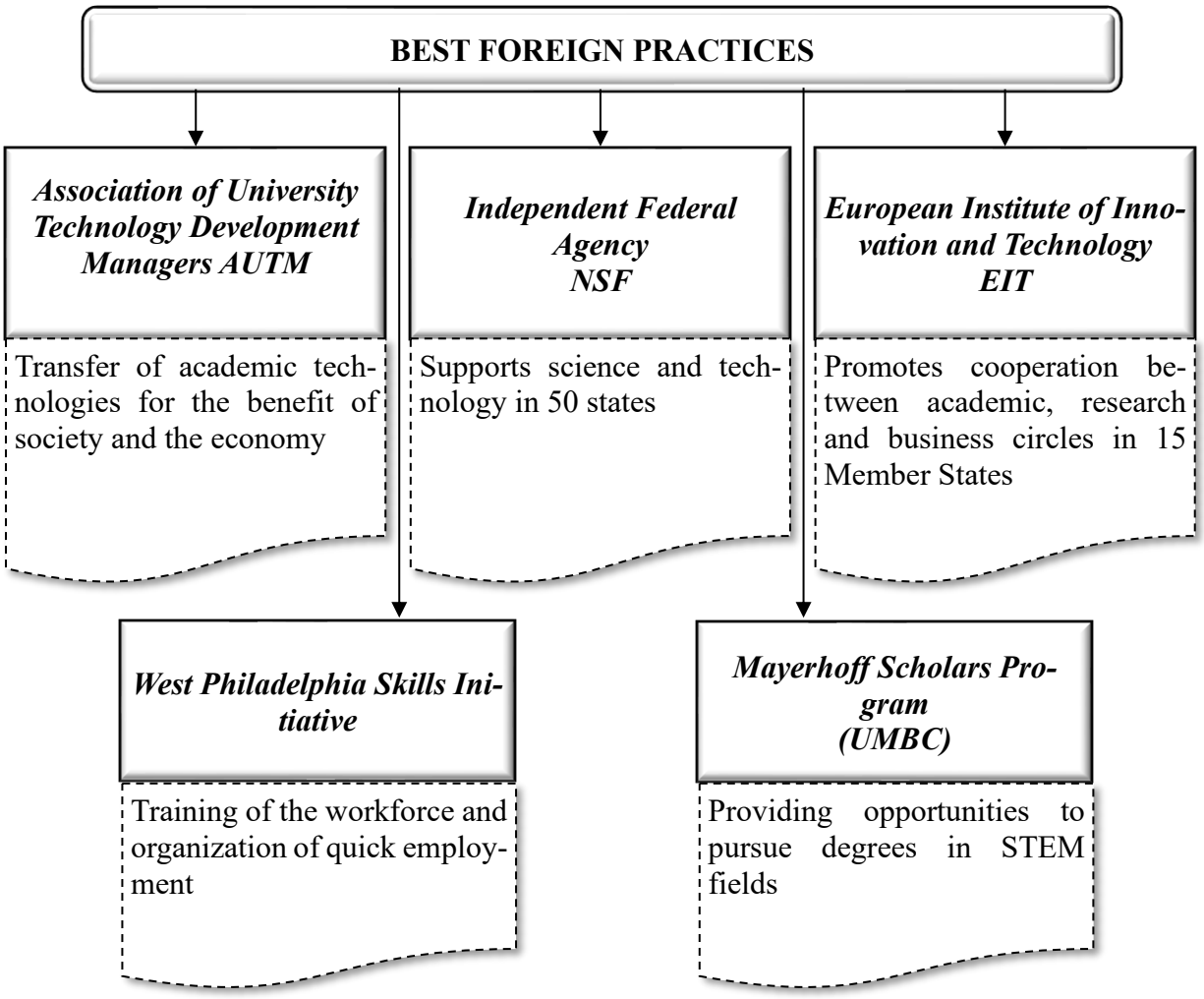

Fig. 5. Best foreign practices in promoting the development of innovation ecosystems

The U.S. labor market has demonstrated an impressive ability to absorb dramatic changes in technology—but not without a worrying increase in inequality among its citizens. Wage trends over time are strongly correlated with educational attainment, with the wage gap between the most and least educated steadily widening [17]. Less educated citizens have seen their real incomes decline since the early 1970s. Economists predict that the next wave of innovation will further exacerbate this inequality.

Conclusion. Innovation ecosystems are key elements of the modern economy, as they create favorable conditions for the development of new technologies, products and services. They bring together a variety of participants – companies, scientific institutions, government bodies, investors and startups – to create new ideas and implement them. Types of innovation ecosystems, namely closed, open, regional and sectoral, have different approaches to interaction between participants, which allows adapting these models to specific needs and development conditions.

Innovation ecosystems have numerous advantages, including the ability to rapidly introduce innovations, increase the competitiveness of industries and regions, and stimulate economic growth through cooperation and competition between participants. At the same time, they face certain challenges, such as dependence on economic cycles of certain industries, regulatory constraints, and the need for constant updating of resources and technologies.

Among the promising areas for implementing innovative ecosystems, it should be noted:

1. Expanding access to financing through public, private or combined investments, which will allow startups and small businesses to implement new ideas faster.

2. Increasing the level of cooperation between sectors, involving not only enterprises, but also scientific institutions, universities and the state in the ecosystem development process, which will contribute to more effective generation and implementation of innovations, especially in high-tech and socially significant areas.

3. The development of regional and industry ecosystems, the creation of regional innovation hubs and industry clusters will contribute to the development of local economies and support the unique needs of various industries, such as technology, healthcare, or green energy.

4. Training and education – education and training systems focused on innovation ecosystems will contribute to the development of qualified personnel capable of implementing and supporting innovative projects.

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ЗАКОРДОННИЙ ДОСВІД ФОРМУВАННЯ ІННОВАЦІЙНИХ ЕКОСИСТЕМ

Стаття присвячена дослідженню закордонного досвіду формування інноваційних екосистем у сучасних умовах. Проаналізовано наукові підходи до визначення сутності поняття «екосистема». Визначено дефініційний зміст поняття «інноваційна екосистема», визначено основні її компоненти. Окреслено особливості розвитку інноваційних екосистем на основі аналізу закордонного досвіду, визначено типи, рівні та роль університетів у сприянні розвитку таких екосистем. Аргументовано, що оскільки сучасна економіка заснована на технологіях, університети також повинні змінюватися темпами, незвичними для вищої освіти. Зберігаючи основну місію – навчання наступного покоління та розвиток нових форм знань, університети повинні також забезпечити зростаючу роль у стимулюванні інновацій і економічного розвитку. Досвід провідних країн доводить, що заклади вищої освіти повинні активно відповідати на виклики цифрової революції та відігравати все важливішу роль в інноваційних екосистемах і економіках. Досліджено кращі закордонні практики сприяння розвитку інноваційних екосистем, серед яких: Асоціація менеджерів з технологічного розвитку університетів AUTM, Незалежне федеративне агентство NSF, Європейський інститут інновацій і технологій EIT, Ініціатива навичок Західної Філадельфії (West Philadelphia Skills Initiative), Програма стипендіатів Майєрхоффа (UMBC). Доведено, що інноваційні екосистеми є ключовими елементами сучасної економіки, оскільки вони створюють сприятливі умови для розвитку нових технологій, продуктів і послуг, об'єднуючи різних учасників – представників бізнесу, наукові установи, державні органи, інвесторів та стартапи – з метою створення нових ідей і їхнього впровадження. Проаналізовано типи інноваційних екосистем, а саме закриті, відкриті, регіональні та галузеві, мають різні підходи до взаємодії між учасниками, що дозволяє адаптувати ці моделі до специфічних потреб і умов розвитку. Аргументовано, що інноваційні екосистеми мають численні переваги, зокрема, можливість швидкого впровадження інновацій, підвищення конкурентоспроможності галузей та регіонів, а також стимулювання економічного зростання через кооперацію та конкуренцію між учасниками. Водночас акцентується увага на тому, що вони стикаються з певними викликами, серед яких залежність від економічних циклів певних галузей, регуляторні обмеження та потреба у постійному оновленні ресурсів і технологій. Визначено перспективні напрями впровадження інноваційних екосистем: розширення доступу до фінансування через державні, приватні або комбіновані інвестиції, що дозволить стартапам і малим підприємствам швидше впроваджувати нові ідеї; підвищення рівня співпраці між секторами, залучення не лише підприємств, але й наукових установ, університетів та держави до процесу розвитку екосистеми, що сприятиме ефективнішій генерації та впровадженню інновацій, особливо у високотехнологічних і соціально значущих сферах; розвиток регіональних та галузевих екосистем, створення регіональних інноваційних хабів та галузевих кластерів сприятиме розвитку локальних економік та підтримці унікальних потреб різних галузей, таких як технології, охорона здоров'я чи зелена енергетика; підготовка кадрів та освіта – системи навчання та підготовки фахівців, орієнтовані на інноваційні екосистеми, сприятимуть розвитку кваліфікованих кадрів, здатних реалізувати та підтримувати інноваційні проєкти.

Ключові слова: *інноваційна екосистема; стратегія; промисловість; підприємство; підприємництво; бізнес; інноваційні технології; цифрові технології; цифрова трансформація; стартап проєкти; університет.*

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