



**Kozyk V.,
Danylovych T.,
Mrykhina O.,
Havryliak A.**

RESEARCH OF THE FORMATION AND DEVELOPMENT OF FABLAB AS A FORM OF INTERACTION OF SCIENCE AND MANUFACTURE IN UKRAINE

Об'єктом дослідження є процес взаємодії науки і виробництва на засадах розвитку FabLab в Україні, предметом – теоретичні та прикладні основи становлення і розвитку FabLab. Під час опрацювання проблематики дослідження авторами застосовано методи і підходи: системний підхід, методи групування та узагальнення, метод ретроспекцій, методи аналізу та синтезу. Розглянуто передумови виникнення і поширення FabLab у світі, здійснено ретроспективний аналіз їх розвитку та оцінено сучасний стан. Вивчено засади створення FabLab (вимоги до організаційної структури лабораторій, управлінські підходи, специфічні риси виробничої і навчальної діяльності, комерційну й некомерційну моделі функціонування, правові аспекти, визначення набору інструментів і засобів для винахідництва, особливості FabLab, створених на базі університетів тощо). Проаналізовано проблеми становлення та обґрунтовано перспективи розвитку FabLab в Україні. Зокрема, FabLab розглянуто як важливі елементи інноваційної інфраструктури регіону, покликани давати відповіді на ранніх стадіях інноваційної діяльності. З таких позицій у роботі досліджено можливості, які можуть давати FabLab в Україні. По-перше, сприяти збалансованому вирішенню проблеми створення нових робочих місць в регіоні, створенню нових інноваційних структур. По-друге, організувати простір, де генеруються, втілюються у дослідні взірці та тестуються інноваційні продукти, що стає основою для розвитку бізнесу на інноваційних засадах. По-третє, підвищувати рівень підготовки майбутніх фахівців за допомогою застосування унікальних ресурсів FabLab. По-четверте, сприяти зростанню рівня успішної працевлаштованості студентів, зацікавленню і залученню учнів шкіл до вибору інженерних спеціальностей, стимулюванню молодіжного підприємництва тощо. Ґрунтуючись на результатах аналізування макроекономічних показників, у роботі обґрунтовано роль FabLab в Україні у контексті викликів сучасного технологічного світу щодо перегляду традиційних підходів у виробничій, управлінській та інших сферах діяльності.

Ключові слова: FabLab, дослідження і розробки, інноваційна технологія, цифрова економіка, цифрова лабораторія.

1. Introduction

The spread of the digital economy and the popularization of the concept of open innovation have actualized the problems of finding new forms of realization of creative ideas, the development and transfer of innovative technologies. One of such forms became FabLab (*Fabrication laboratory*) – research workshops, creative spaces where it is possible to make a prototype of a product, test it, economically evaluate it and even bring it to the commercialization stage. FabLab is a modern form of interaction between science and production. It differs from others in the much wider possibilities for translating innovative ideas, since it has unique resources for this. For Ukraine, FabLab is a relatively new phenomenon that is only gaining popularity. The integration of Ukraine into the community of technologically leading countries of the world makes it necessary to pay attention to the prospects for the development of FabLab in domestic spaces, explore the possibilities of such laboratories from the standpoint of improving the efficiency of interaction between regional actors of innovative infrastructures. In recent years, the FabLab issue has become increasingly relevant, as, in particular, works [1–3] show. However, most scientists and

practitioners consider the FabLab problematics only from certain local positions. The study of the place and role of FabLab as subjects of the innovation infrastructure is practically neglected. Despite the fact that all FabLab in the world have a common concept of activity, each country is determined by its own peculiarities of its production. Therefore, foreign experience can be partially used in Ukraine. So, *the object of research* is the process of interaction between science and production based on the development of FabLab in Ukraine. *The aim of this research* is studying the formation and development of FabLab in Ukraine.

2. Methods of research

To achieve this aim it is used:

- method of retrospection – to study the prerequisites for the emergence and spread of FabLab in the world and Ukraine;
- systematic approach – to highlight FabLab as a component in the regional innovation infrastructure system;
- methods of analysis and synthesis – in the study of the basis and features regarding the implementation of innovation activities in Ukraine, the definition of

the role of FabLab for the development of innovation infrastructure;

– methods of grouping and generalization – in terms of forming conclusions on the research results.

3. Research results and discussion

Popularization in the world of FabLab as a form of interaction between science and research (R&D) and production is confirmed by statistical data, which in recent years indicate a significant increase in the role of such interaction. According to *R&D Trends Forecast* [4], the positions of the integral indicator Expectations for 2018 collaboration efforts relative to 2017, in particular, Participation in R&D alliances increased by 50 %. The contracts/grants position with academia increased by 37 % in the period under review. At the same time, these indicators are the highest values in the framework of the integral index.

The development of the FabLab concept dates back to 2001, when it was first presented in the Massachusetts Institute of Technology's media laboratory (MIT, USA) at the Center for Bits and Atoms (CBA-MIT). Within the framework of cooperation between Grassroots Invention Group and CBA-MIT, with the help of FabLab, they studied the interaction of physics and computer science, the correlation of knowledge and possibilities of implementing innovative ideas, and the like. 2003 The US National Science Foundation began funding a global project to create a production and educational base for digital prototyping. 2009 CBA-MIT established the Fab Foundation, a non-profit organization for facilitating and supporting the development of the international FabLab network.

Now FabLab form an extensive network of high-tech laboratories that provide their participants access to a number of resources (equipment and tools, software, etc.) in order to implement creative ideas. Along with this, within the framework of FabLab, trainings, seminars and other training activities, in particular technological ones, are organized to help FabLab participants master the existing equipment and acquire new knowledge and professionalism. Due to this, FabLab is a space where innovative products are generated, translated into prototypes and tested, which in the future often become the basis for the emergence of a new business.

According to *R&D Trends Forecast* [4], the most promising technologies in the world are now considered:

- big data (the level of perspectivity indicator is more than 60 %);
- Internet of things (about 50 %);
- renewable materials, digital collaboration technologies, virtualization and modeling, 3D printers, robotization, automation (in general, from 30 to 40 %). From this it is obvious that the activities inherent in FabLab correspond to modern market demands and trends.

A significant advantage of FabLab from the standpoint of production is that, due to the specification of technology in the development of the project from idea to prototype, they can help reduce production costs in the implementation of development, respectively, reduce the cost of the final product. With the help of FabLab, it is possible to solve the problem of manufacturing a prototype for presentation to investors, because the inability

to back up idea with a prototype often hampers further financial support for the project.

There are about 1,200 FabLabs in the world, of which more than 500 in the European Region and more than 150 in the USA [5]. FabLab is one of the ways to balance the problem of creating new jobs, because they are aimed at providing enthusiasts and inventors who require an appropriate environment and conditions, and, ultimately, contribute to the creation of new innovative structures. The US Bureau of Labor Statistics predicts that in 2020 the United States will receive about 9.2 million jobs in science and technology [6]. As the analysis of these data shows, there are quite a few categories of society want, but are not represented in these areas for various reasons (insufficient education, age, etc.).

Among the models on the basis of which FabLab can be created, commercial and non-commercial are distinguished [7]. The first provides for prototyping and production of the final product, consulting, training, and the like. The challenge for such FabLabs is finding sources of income based on the services they can provide. The use of the non-commercial model prevails in universities, its main purpose is testing the knowledge gained in theory, interactive learning, and the like in practice. World experience shows that from the standpoint of payback FabLab, a combination of the above models is considered successful. Despite the different financing models, almost all FabLabs in the world have the same basic capabilities, which allow network support for development.

Despite the fact that all FabLabs in the world are based on a common technical and economic basis, each of the laboratories is distinguished by its authenticity. At the same time, an important feature of FabLab is that innovations developed in one country can be used under certain conditions in another within the FabLab network. This allows to apply the developed technology in a new way, adding its added value and opening up new opportunities for innovative development.

A study of the problems of FabLab in Ukraine shows the need to examine the macroeconomic soil regarding the possibility of the development of such forms of interaction between science and production. In terms of the number of scientists, as the main carriers of knowledge capital and engines of scientific and technical activity, Ukraine is among the top ten leaders of the world. However, in recent years, Ukraine's GDP growth rate due to the introduction of new technologies is less than 1 %, whereas in developed countries it is 60–90 % [8].

The course of integration of Ukraine into the community of innovatively leading countries stimulates the strengthening of the integral interaction of education, science, business structures and authorities, as evidenced by current legislation. Now it encourages universities to consider new forms of interaction with the business and actualizes the creation of FabLab.

During 2017, 963 organizations (59.392 scientists) carried out scientific and technical works in Ukraine, 15.2 % of which belonged to the higher education sector, 45.8 % to the public sector, 39.0 % to the entrepreneurial [9]. In 2017–2018 in Ukraine, there were 661 higher education institutions (HEI) I–IV level of accreditation [10], of which more than half have the right to carry out research and development work (R&D). This indicates significant scientific, technical and scientific and technological

potentials of the domestic sector of higher education and science, and consequently, the ability to carry out research and development, to produce technologies and transfer them to business. At the same time, the number of transferred new technologies (technical achievements) in Ukraine (cumulatively, for all business entities) in 2017 was 59 units, and the number of transferred technologies outside Ukraine – 2 units. The acquisition of new technologies in the same year significantly exceeded their transfer, and a total of 832 units were acquired [10]. The analysis shows that the majority of university developments remains at the level of research works and does not reach the prototype stage.

According to the results of economic development in 2018, voiced during the World Economic Forum in Davos (Switzerland), Ukraine was in the list of countries whose economic level is slowly declining. Now Ukraine is on the 83rd line of 140 countries – between the Dominican Republic and Macedonia [11].

According to the Global Innovation Index (GII), in 2018 Ukraine took 43rd place among 126 countries of the world against 50th place in 2017 in the component «Knowledge & technology outputs», in 2018 Ukraine belonged to 27th place [12]. According to the components of the Global Competitiveness Index (GCI), in Ukraine there are compared diametric positions. In particular, it belongs to the 131st place in the sub-indexes «Macroeconomic stability» and the 110th in the «Institutions», the 46th place in the sub-indexes «Skills» and the 47th place in the «Market size» [11]. Since Ukrainians traditionally attach great importance to higher education and the development of intelligence, this indicates openness and attractiveness of the Ukrainian market internationally. For «Innovation capability», Ukraine is ranked 58th, and according to «ICT adoption» – 77th place in the ranking [11]. Thus, the indicators characterizing the innovation potential show a number of activity and indicate prospects in the field of scientific, technical and technological development of Ukraine.

In Ukraine, FabLab presents:

- Laboratory of digital production IZOLAB (Kyiv);
- FabLab CREATORS (European University, Kyiv);
- FabLab at the I. Puluji University (Ternopil);
- MiRONAFT – FabLab at the Odesa National Academy of Food Technologies;
- FabLab Fabricator, created on the basis of UNIT. City Technopark (Kyiv);
- FabLab in Kuznets Kharkiv National University;
- preparations are underway for the creation of FabLab on the basis of the National University «Lviv Polytechnic».

However, with the existing scientific and technical potential of Ukraine, FabLab could be more. FabLabs show a correlation between the development of innovation infrastructure entities, therefore their number in the country is an important indicator for comparison (in France there are currently 154 such laboratories).

In general, statistics on the development of R&D laboratories in regions of the world show that their globalization continues. The number of R&D laboratories is increasing in the world. Currently, their largest number is in Western Europe – 139, North and Central America – 118, East and Southeast Asia – 97 [4]. This situation is a response to the challenges of the modern technological

world in revising traditional approaches in the production, management and other areas of activity. Taking into account this trend in Ukraine may become a promising direction for stimulating innovative development of the country, in particular, in modern conditions of overcoming the economic crisis.

4. Conclusions

The research results prove the importance and development prospects of FabLab, as elements of the innovation infrastructure of the regions of Ukraine. This allows to justify and take into account the value of FabLab in the development of the strategy of innovative development of Ukraine. It is shown that the use of FabLab resources is of particular importance in the early stages of innovation. FabLab features such as: testing innovative ideas, conducting expertise of prototypes, successful prototyping, testing innovative development, etc. reduce the level of risk in the further mass production. Gradually, the development of a project goes beyond FabLab, filling the niches of the innovation infrastructure, both in the resource sense and in the understanding of the project team. It has been substantiated that at the present stage of development of the Ukrainian economy, raising the level of training of future specialists through the use of FabLab resources will help to increase the level of successful employment of students. FabLab will stimulate interest and attract school students to the choice of engineering specialties, the development of youth entrepreneurship and the like. The study of the identified problems shows the bottom of the challenges for the modern economy. On the one hand, FabLab is the position of modern producers of high technologies in the world, which stimulate access to modern means of innovative development. On the other hand, it is predicted that the global challenge for FabLab is addressing an issue that may be maturing in the coming years – what will be the development of innovative products, when there will be unlimited access to this.

References

1. Zozyk V. V., Mrykhina O. B. Aktualizatsiia roli transferu tekhnolohii u systemi «Univertsytet – Vlada – Biznes» v Ukraini // Visnyk Kyivskoho natsionalnoho universytetu tekhnolohii ta dizainu «Ekonomichni nauky». 2017. Issue 2 (109). P. 29–35.
2. Guerra A. G., de Gómez L. S. From a FabLab towards a Social Entrepreneurship and Business Lab // Journal of Cases on Information Technology. 2016. Vol. 18, Issue 4. P. 1–21. doi: <http://doi.org/10.4018/jcit.2016100101>
3. Kohtala C. Making «Making» Critical: How Sustainability is Constituted in Fab Lab Ideology // The Design Journal. 2016. Vol. 20, Issue 3. P. 375–394. doi: <http://doi.org/10.1080/14606925.2016.1261504>
4. Results from the Innovation Research Interchange's Annual Survey. R & D Trends Forecast // Research-Technology Management Journal. 2016. Vol. 61, Issue 1. P. 23–34. doi: <http://doi.org/10.1080/08956308.2018.1399021>
5. Fab Labs list. URL: <https://www.fablabs.io/labs/map>
6. Gershenfeld N. How to Make Almost Anything. The Digital Fabrication Revolution // Foreign Affairs. 2012. Vol. 91, Issue 6. P. 43–57.
7. Directory for the Fab Lab ecosystem. URL: <http://fablab.org/>
8. Nauka, tekhnolohii ta innovatsii. Obstezhennia innovatsiinoi diialnosti v ekonomitsi Ukrainy (za mizhnarodnoiu metodolohiieiu) // Derzhavna sluzhba statystyky Ukrainy. URL: http://www.ukrstat.gov.ua/druk/publicat/kat_u/publnauka_u.htm

9. Vysychi navchalni zaklady // Derzhavna sluzhba statystyky Ukrainy. URL: http://www.ukrstat.gov.ua/operativ/operativ2005/osv_rik/osv_u/vuz_u.html
10. Stvorennia ta vykorystannia peredovykh tekhnolohii ta ob'ektiv prava intelektualnoi vlasnosti na pidpriemstvakh Ukrainy // Derzhavna sluzhba statystyky Ukrainy. URL: https://ukrstat.org/uk/metaopus/2014/0115003_2014.htm
11. Global Competitiveness Report 2018: report / ed. by Schwab K. Geneva: World Economic Forum, 2018. 671 p.
12. Global Innovation Index. URL: <https://www.globalinnovationindex.org>

Kozyk Vasyl, PhD, Professor, Head of Department of Economics of Enterprises and Investments, Lviv Polytechnic National University, Ukraine, ORCID: <http://orcid.org/0000-0003-4204-6026>, e-mail: vasyl.v.kozyk@gmail.com

Danylovykh Taras, PhD, Associate Professor, Department of Economics of Enterprises and Investments, Lviv Polytechnic National University, Ukraine, ORCID: <http://orcid.org/0000-0003-3316-4856>, e-mail: taras.b.danylovykh@lpnu.ua

Mrykhina Oleksandra, Doctor of Economical Sciences, Associate Professor, Department of Economics of Enterprises and Investments, Lviv Polytechnic National University, Ukraine, ORCID: <http://orcid.org/0000-0002-0567-2995>, e-mail: oleksandramrykhina@gmail.com

Havryliak Anatolii, PhD, Associate Professor, Department of Economics of Enterprises and Investments, Lviv Polytechnic National University, Ukraine, ORCID: <http://orcid.org/0000-0003-1389-2784>, e-mail: anatolii.s.havryliak@lpnu.ua