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**MELNYK, M. V.** (<https://orcid.org/0000-0001-5731-9088>),  
and **NIKITIN, Yu. O.** (<https://orcid.org/0000-0002-8361-7115>)  
The Institute for Superhard Materials, the NAS Ukraine,  
2, Avtozavodska St., Kyiv, 04074, Ukraine,  
+380 44 468 8632, [alcon@ism.kiev.ua](mailto:alcon@ism.kiev.ua)

## **POSSIBILITIES OF CREATION AND IMPLEMENTATION OF OPEN INNOVATIONS AT R&D ORGANIZATIONS OF THE NAS OF UKRAINE**

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**Introduction.** *The ability of R&D organizations of the NAS of Ukraine to quickly create and implement R&D innovations is crucial for accelerated economic development and is an important factor for raising the competitiveness of Ukraine.*

**Problem Statement.** *R&D innovation may be created and implemented with the use of closed or open innovation approaches. Recently, the negative impact of several factors on the application of the closed innovation approach to the activities of R&D organizations of the NAS of Ukraine has increased.*

**Purpose.** *The purpose is to develop and to test improved theoretical and methodological framework for technological audit of R&D works, assessment of organizational maturity and readiness of R&D organizations of the NAS of Ukraine to use open innovations.*

**Materials and Methods.** *A set of approaches to theoretical generalization, economic analysis and synthesis; mathematical statistics; expert and poll surveys have been used.*

**Results.** *It has been established that a significant share of R&D products of R&D organizations of the NAS of Ukraine has a low readiness for independent and joint commercialization, which means the use of the closed innovation approach. Only a part of R&D organizations of Ukraine has an average level of organizational maturity, while the vast majority have a low and very low level of organizational maturity and readiness to apply open innovations. The application of this concept may contribute to the accelerated innovative development of R&D organizations of the NAS of Ukraine. The theoretical and methodological framework for technological audit of R&D works and assessment of organizational maturity and readiness of R&D organizations of the NAS of Ukraine to the use of open innovation approach has been developed.*

**Conclusions.** *The proposed method allows R&D organizations of the NAS of Ukraine to accelerate the creation and commercialization of R&D innovations.*

*Key words:* open innovations, R&D works, and open innovation approach.

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The ability of R&D organizations to quickly create innovative R&D works and to market them is crucial for accelerating the economic development of the country, and is the most important modern factor for raising its competitiveness. The creation and implementa-

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tion of R&D innovations may be realized with the use of the closed innovation or the open innovation approach.

For many years, R&D organizations of the NAS of Ukraine have been relying on the conventional closed innovation and creating developments internally, i.e. focusing mainly on the use of internal resources to create R&D works and to commercialize them.

Traditionally, the assessment of innovation and organizational capacity of R&D institutes of the NAS of Ukraine is based on the use of general indicators of R&D activities, i.e. the number of publications and patents filed by researchers, which, although useful, but provide R&D organizations only a general view of innovation. This evaluation does not show the current innovative efficiency of research results, which affects the productivity of industrial corporations and economic growth in Ukraine.

Recently, the unfavorable impact of several factors on the application of closed innovation approach to the activities of R&D organizations of the NAS of Ukraine has increased. This results in:

- ◆ uncontrolled release of disruptive R&D results, or their components into the external environment and their use by other companies that gain high profits, while the major costs for the development of innovation are borne by R&D organizations;
- ◆ R&D organizations spend significant resources to solve problems for which there are quite effective solutions that may be available at fairly low prices;
- ◆ most products that have been patented are not used by R&D organization for 100% and are unprofitable;
- ◆ many projects that, in the opinion of R&D organizations, are impracticable, in fact, are quite valuable, but not implemented by R&D organizations, since they do not fit to the existing organizational system.

As a result, the closed innovation approach becomes ever less effective because, on the one hand, R&D organizations have paced down the com-

mercialization of innovation and profit-making, which limits the development of further research and implementation of R&D works, and, on the other hand, third corporations do not invest funds in basic and applied research. Because of increasing negative impact of several external and internal factors, the application of the closed innovation concept fails and puts limitations on ways of implementation of R&D works, which leads to a reduction and loss of innovative growth potential of the NAS of Ukraine.

The application of the open innovation concept may contribute to the accelerated innovative development of R&D organizations of the NAS of Ukraine with increasing their influence in the international scientific environment.

The open innovation is the use of compatible (internal and external) knowledge and resources to create and to implement innovative R&D works that can be used to address existing and future socio-economic needs of society [1, 2].

The use of open innovation by organizations and companies helps identify the factors of the two-way flow of knowledge and decide on the inclusion of external sources at all or some stages of the innovation process [3]. It has been proved that the open innovation approach has a favorable effect on enhancing knowledge and investment in organizations and companies, giving them three main benefits: sharing knowledge, reducing risks, and accelerating development [4]. The allocation of resources and risks between two or more organizations /companies is one way to reduce the costs of developing open innovation [5] and to respond quickly to market needs [6].

However, the open innovation may not be successfully realized, unless there is sufficient organizational readiness of all parties involved in creating and implementing open innovation [7]. Organizations and companies need to find ways to work more closely with external partners, even competitors, without losing competitive advantage and shall have strategies that allow them to integrate their joint efforts [8]. The effectiveness of open innovation increases due to systemic organi-

zation and implementation of indicators of the innovative approach of open innovation [9]. Especially effective is the use of quantitative indicators to evaluate the implementation of open innovation [10]. The groups of evaluation indicators for measuring open innovation include: search and flows of external knowledge and information (breadth and depth of external knowledge and information); dependence of innovation process on knowledge inflow and outflow; level of R&D cooperation with external partners (breadth and depth of cooperation), including R&D outsourcing; indicators that measure the internal innovation capacity of the organization, the R&D intensity, efficiency of R&D cooperation, the degree of openness, HR and internal R&D research group factors [11].

The substantiation of the need to monitor the process of open innovation application [12] has allowed establishing factors and indicators of influence on improving the efficiency of the innovation process of organizations and companies, which use the open innovation approach [13]. However, despite the existing understanding of the need and importance of open innovation, in practice, organizations and companies have been applying an open innovation approach through trials and errors [14].

In Ukraine, one of the main sources of the creation and implementation of R&D projects/innovations is the NAS that carries out 2717 applied research and 2454 fundamental research works financed from various funds (general fund and special fund of the state budget); the number of implemented R&D works (innovations) is 1011 units (based on data for 2017) [18].

Prospects and obstacles to the use of the open innovation approach in R&D organizations of the NAS of Ukraine are closely related to the general situation of the legislative and infrastructural framework in Ukraine [15–16].

The purpose of this research is to develop and test improved theoretical and methodological framework for technological audit of R&D works and assessment of organizational maturity and rea-

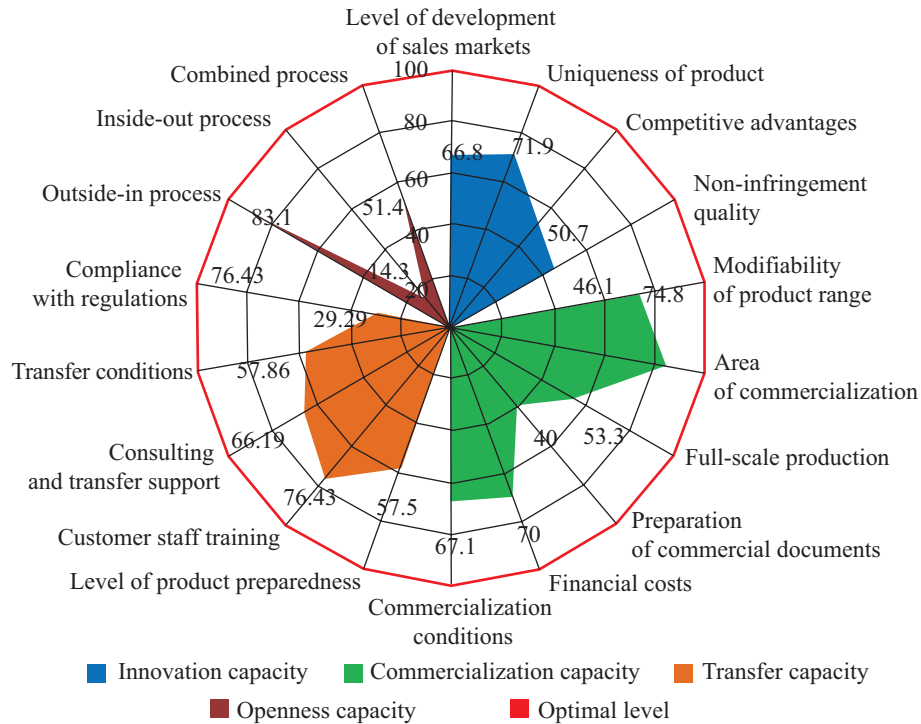
diness of R&D organizations of the NAS of Ukraine to implement open innovations.

The improved scientific and methodological approach to the technological audit of R&D works includes evaluating the four capacities: innovation, commercialization, transfer, and the ability to openness. This includes a varied number of parameters and characteristics, which are evaluated by a scoring system and describe the profile of R&D work: *the innovation capacity* that characterizes the uniqueness of development, competitive advantage, non-infringement quality, and sales markets; *the commercialization capacity* that describes the area of commercialization, the modifiability of the product range, the possibility of industrial production, financial costs and conditions of commercialization; *the transfer capacity* that characterizes the readiness of the product and personnel for the transfer, the conditions of transfer of R&D product, compliance with regulatory documentation; and *the openness capacity* that shows the possibility of applying the open innovative approach at the stages of the commercialization and the application of outside-in knowledge and information flows, the independent inside-out promotion of R&D product. As a result, the technological audit of profiles of R&D works has not only a qualitative assessment, but also a quantitative evaluation of potentials: innovation, transfer, commercialization, and openness.

The developed scientific and methodological approach has been tested for technological audit of 70 promising R&D works carried out by R&D organizations of the NAS of Ukraine in the field of structural and functional materials technology, which have rich experience in materials science [17].

The distribution of these R&D works by *Eurostat* types of innovations has shown that 28 (40%) R&D works are process innovations and 42 (60%) ones are product innovations.

The results of technological audit of R&D works and comparative assessment of four capacities have shown that most R&D works have a high potential: innovation capacity from 46% to 72%, com-



**Fig. 1.** Comparative evaluation of innovation, commercialization, transfer, and openness capacity of R&D works of R&D organizations of the NAS of Ukraine, which carry out promising R&D works in the field of structural and functional materials technology  
 Source: developed by the authors.

mercialization capacity from 40% to 85%, and transfer capacity from 30% up to 76% (Fig. 1).

The evaluation of the openness capacity by indicators:

- ♦ outside-in process (adsorption of external knowledge): 53 developments have a high level (from 75% to 100%) and 14 developments have a medium level (from 45% to 70%);
- ♦ inside-out process (integration or transfer of internal knowledge outside): 45 developments are absolutely unprepared; 21 developments have a low readiness (up to 40%);
- ♦ combined process (combination of adsorption and integration processes): 43 R&D works have a low level (up to 40%) and 16 R&D works have a medium level (from 45% to 70%).

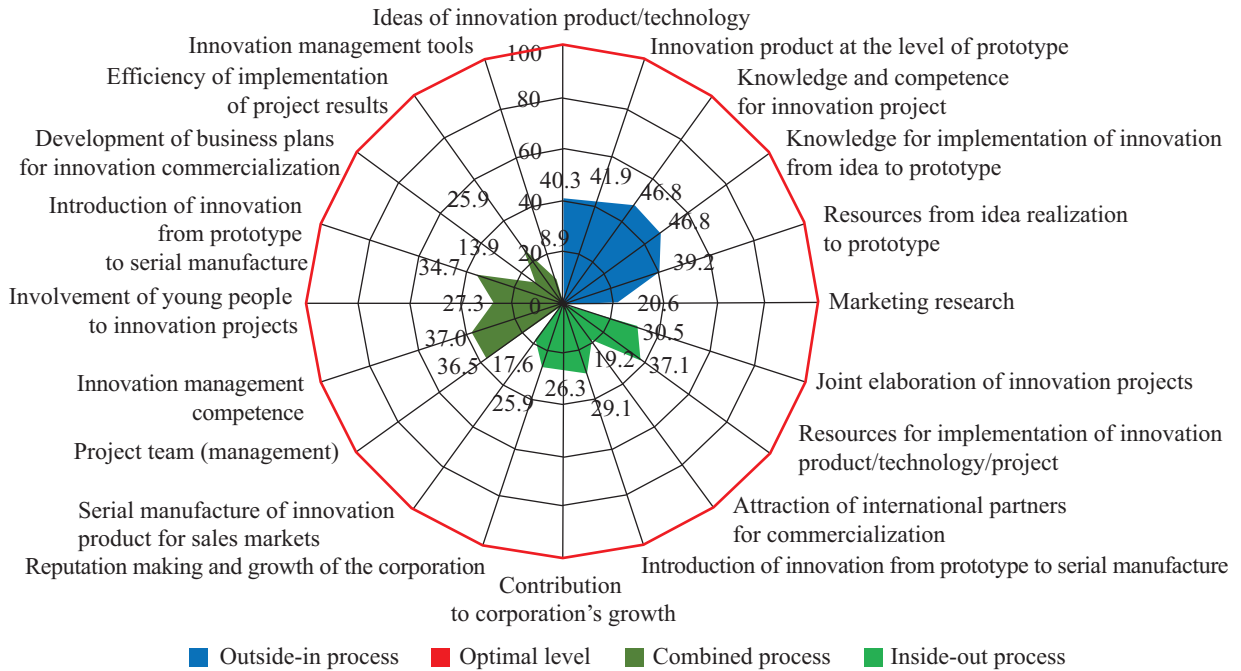
Only 4 R&D works have a medium level (from 45% to 70%) of readiness for independent inside-out promotion of R&D products and 11 ones ha-

ve a high level (from 75% to 100%) of readiness for joint promotion of R&D products.

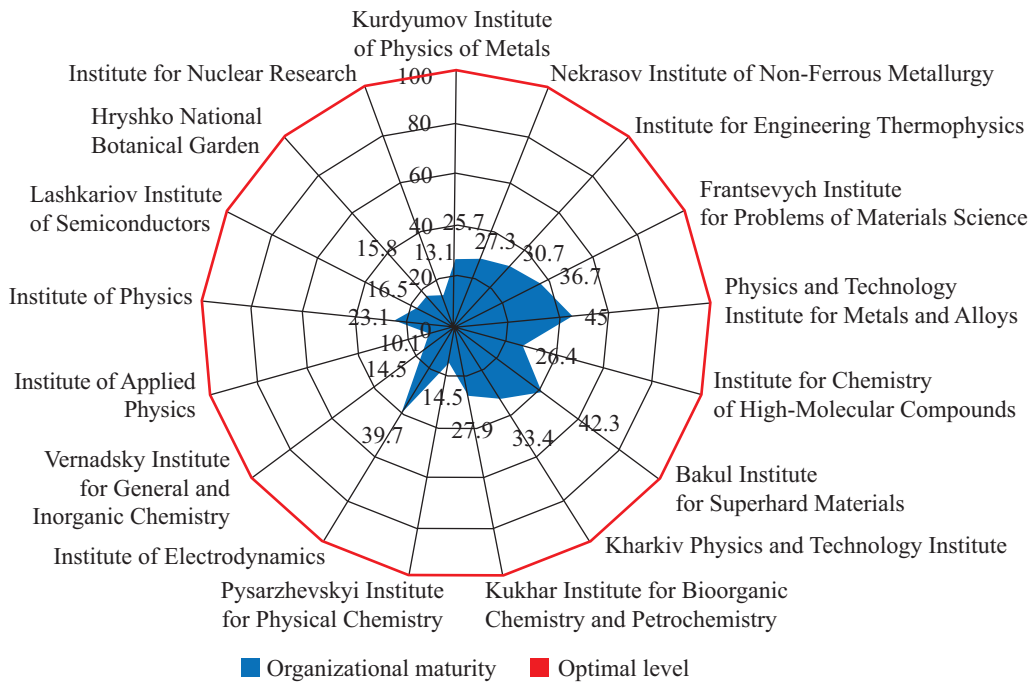
It has been established that the majority of the R&D works of R&D organizations of the NAS of Ukraine is not ready enough for independent or joint promotion of R&D works, which is a result of the widespread use of the traditional closed innovation approach in most R&D organizations of the NAS of Ukraine.

Systematic implementation of an open innovative approach to accelerate the creation and implementation of innovative R&D works at R&D organizations of the NAS of Ukraine requires organizational maturity and readiness of R&D organizations of the NAS of Ukraine to apply the open innovation model.

The advanced scientific and methodological approach to assessing the organizational maturity and readiness of R&D organizations to use open



**Fig. 2.** Evaluation of the indicators that describe organizational maturity and readiness to use open innovations for 24 R&D organizations of the NAS of Ukraine  
 Source: developed by the authors.



**Fig. 3.** Comparative evaluation of organizational maturity and readiness of the focus group of some R&D organizations of the NAS of Ukraine to apply open innovations  
 Source: developed by the authors.

innovations includes the assessment of 20 indicators of the three processes of the open innovative approach to the creation and implementation of innovations. This scientific and methodological framework has been used to assess organizational maturity and readiness to use open innovations for 24 R&D organizations of the NAS of Ukraine, which carry out promising R&D works in the field of structural and functional materials technology [17].

The results of the assessment of 24 R&D organizations of the NAS of Ukraine have shown that: the average level of indicators that characterize the adsorption capacity for the application of external knowledge and information is 30.16% (the outside-in process); the average level of indica-

tors that describe the ability to independently create and promote the results of R&D activities outside the R&D organization is 25.45% (the inside-out process); and the average level of indicators characterizing the organizational readiness to jointly create and promote innovations is 28.93% (the combined process) (Fig. 2).

The assessment of organizational maturity and readiness to apply open innovations in relation to specific R&D organizations of the NAS of Ukraine has shown that: 7 (29% of the studied) research organizations of the NAS of Ukraine) have a medium level of organizational readiness (from 40% to 50%); 4 (16%) R&D organizations of the NAS of Ukraine have lower than medium level of organizational readiness (30–40%); 6 (25%) R&D

#### Evaluation of Organizational Maturity and Readiness of R&D Institutes of the NAS of Ukraine, Which Do Research in the Field of Structural and Functional Materials Technology to the Application of the Open Innovation Approach

| Institute of the NAS of Ukraine                              | Outside-in process, % | Inside-out process, % | Combined process, % | Average, % |
|--|-----------------------|-----------------------|---------------------|------------|
| Kurdyumov Institute of Physics of Metals                     | 45                    | 18                    | 14                  | 25.7       |
| Nekrasov Institute of Non-Ferrous Metallurgy                 | 28                    | 20                    | 34                  | 27.3       |
| Institute for Engineering Thermophysics                      | 40                    | 16                    | 36                  | 30.7       |
| Frantsevych Institute for Problems of Materials Science      | 38                    | 36                    | 36                  | 36.7       |
| Physics and Technology Institute for Metals and Alloys       | 45                    | 48                    | 42                  | 45         |
| Institute for Chemistry of High-Molecular Compounds          | 31.7                  | 22.2                  | 25.3                | 26.4       |
| Bakul Institute for Superhard Materials                      | 30                    | 53                    | 44                  | 42.3       |
| Kharkiv Physics and Technology Institute                     | 30.9                  | 36.7                  | 32.6                | 33.4       |
| Kukhar Institute for Bioorganic Chemistry and Petrochemistry | 42.8                  | 20.4                  | 20.4                | 27.9       |
| Pysarzhevskiy Institute for Physical Chemistry               | 1.9                   | 0.81                  | 1.63                | 14.5       |
| Institute of Electrodynamics                                 | 3.33                  | 4.08                  | 4.49                | 39.7       |
| Vernadsky Institute for General and Inorganic Chemistry      | 19                    | 8.1                   | 16.3                | 14.5       |
| Institute of Applied Physics                                 | 14.2                  | 4                     | 12.2                | 10.1       |
| Institute of Physics   | 28.5                  | 24.4                  | 16.3                | 23.1       |
| Lashkariov Institute of Semiconductors                       | 19                    | 14.2                  | 16.3                | 16.5       |
| Hryshko National Botanical Garden                            | 19                    | 12.2                  | 16.3                | 15.8       |
| Institute for Nuclear Research                               | 19                    | 8.1                   | 12.2                | 13.1       |
| Bohatskyi Physics and Chemistry Institute                    | 14.2                  | 8.1                   | 0                   | 7.4        |
| Institute of Single Crystals                                 | 40.4                  | 44.8                  | 36.6                | 40.6       |
| Galkin Donetsk Physico-Technical Institute                   | 35.7                  | 14.2                  | 18.3                | 22.7       |
| Karpenko Physico-Mechanical Institute                        | 45.2                  | 51                    | 40.8                | 45.7       |
| Institute of Gas   | 42.8                  | 44.8                  | 38.7                | 42.1       |
| Paton Electric Welding Institute                             | 40.4                  | 59.1                  | 44.8                | 48.1       |
| R&D Institute for Microdevices                               | 50                    | 42.8                  | 42.8                | 45.2       |

organizations of the NAS of Ukraine have a low level of organizational readiness (20–30%); and 7 (30%) R&D organizations have a very low level of organizational readiness to use open innovations (10–20%) (Table).

It has been found that a smaller part (46%) R&D organizations of the NAS of Ukraine have a medium and low medium level of organizational readiness for open innovations, while the majority (54%) has a low and very low level of organizational readiness for application of the open innovation approach.

The comparative evaluation of organizational maturity and readiness of the focus group of some

R&D organizations of the NAS of Ukraine to apply open innovations in different areas is shown in Fig. 3.

The research has shown that many R&D organizations of the NAS of Ukraine of those studied prefer the traditional closed innovation approach based on their clear desire to preserve the value of innovation and ideas using only internal resources. One of the ways to increase the ability of R&D organizations of the NAS of Ukraine to speed up the creation of innovative R&D works and to quickly market them is the open innovative approach to the creation and implementation of innovations.

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*М.В. Мельник* (<https://orcid.org/0000-0001-5731-9088>),

*Ю.О. Нікітін* (<https://orcid.org/0000-0002-8361-7115>)

Інститут надтвердих матеріалів ім. В.М. Бакуля НАН України,  
вул. Автозаводська, 2, Київ, 04074, Україна,  
+380 44 468 8632, [alcon@ism.kiev.ua](mailto:alcon@ism.kiev.ua)

## МОЖЛИВОСТІ СТВОРЕННЯ ТА ВПРОВАДЖЕННЯ ВІДКРИТИХ ІННОВАЦІЙ НАУКОВИМИ ОРГАНІЗАЦІЯМИ НАН УКРАЇНИ

**Вступ.** Здатність наукових організацій НАН України швидко створювати й впроваджувати інноваційні науково-технічні розробки має вирішальне значення для прискореного економічного розвитку та є важливим фактором підвищення конкурентоспроможності України.

**Проблематика.** Створення та впровадження інноваційних науково-технологічних розробок може здійснюватися шляхом використання концепції закритих чи відкритих інновацій. Останнім часом посилюється негативний вплив низки чинників використання концепції закритих інновацій в діяльності наукових організацій НАН України.

**Мета.** Розробка та апробація удосконалених теоретико-методологічних засад технологічного аудиту науково-технологічних розробок, оцінки організаційної зрілості та готовності наукових організацій НАН України до застосування відкритих інновацій.

**Матеріали й методи.** Використано підходи теоретичного узагальнення; економічного аналізу та синтезу, математичної статистики, експертного та анкетного дослідження.

**Результати.** Встановлено, що значна частка науково-технологічних розробок наукових організацій НАН України має низьку готовність до самостійної та спільної комерціалізації, що характеризує застосування концепції закритих інновацій. Лише частина наукових організацій України має середній рівень організаційної зрілості, а переважна більшість має низький та дуже низький рівень організаційної зрілості та готовності до застосування відкритих інновацій. Натомість застосування зазначеної концепції може сприяти прискореному інноваційному розвитку наукових організацій НАН України. Розроблено теоретико-методологічний підхід технологічного аудиту науково-технологічних розробок та оцінки організаційної зрілості та готовності наукових організацій НАН України до застосування відкритих інновацій.

**Висновки.** Запропонований метод дозволить науковим організаціям НАН України пришвидшити виведення їх на ринки інноваційних науково-технічних розробок.

*Ключові слова:* відкриті інновації, науково-технологічні розробки, відкритий інноваційний підхід.