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## COMMERCIALIZATION OF UKRAINIAN & SLOVAK SCIENTIFIC RESEARCH: FACETS AND IMPLEMENTATION ALGORITHM\*

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**Abstract.** The article emphasizes the need to develop entrepreneurship in the academic environment to commercialize the scientific research results as one of the possible directions. The problems that prevent Ukrainian and Slovak scientists from commercializing their scientific developments are highlighted, classified, and described in detail, and recommendations are proposed for solving these problems. The commercialization of scientific research is based on transforming scientific developments into profitable commercial products or services that can be successfully introduced to the market. The study examines various aspects of commercialization, including evaluating the commercial potential of scientific research, developing business models, finding investors and partners, intellectual property, marketing innovations, and sales. The elements of innovative ecosystems of different countries and Ukraine are described. Various algorithms for commercializing scientific research are suggested and scrutinized, including specific steps scientists must perform to introduce their developments to the market successfully. The difference in commercialization processes in Ukraine and economically developed countries is demonstrated. A business commercialization algorithm is proposed, which assumes that the first step is to analyse the demand for innovation. It has been proven that projects developed under the market's needs today and in the future are more effective for commercial use. Hence, this approach provides better opportunities for attracting investments, creating strategic alliances with the industrial sector, and increasing effective commercial projects. Recommendations suggested by the authors can help Ukrainian and Slovak scientists commercialize their scientific works more effectively, which will positively impact economic development.

**Keywords:** commercialization of knowledge; technology transfer; entrepreneurial university; commercialization algorithm

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## **1. Introduction**

During the last ten years, the academic environment has significantly changed due to the need to integrate entrepreneurial practices into traditional scientific processes. Entrepreneurship development in science and universities is recognized as an essential factor in stimulating innovation and economic development (Theodoraki et al., 2022; AUTM, 2023). Entrepreneurship in science, which includes the commercialization of scientific research, the creation of innovative companies and cooperation with businesses, is becoming a vital element of the university's innovation ecosystem (Gontareva et al., 2022; Volosheniuk, 2020).

Studying entrepreneurship development in the academic environment becomes an integral part of universities' innovative policy and development strategy to increase their innovative potential, ensure economic growth, and form a competitive scientific environment.

Commercialization of scientific research contributes to transforming scientific ideas into innovative products and services, stimulating the country's economic development. This allows scientific achievements to go beyond laboratories and be introduced into the real sector of goods and services manufacturing, contributing to the creation of new jobs and increasing the competitiveness of the national economy.

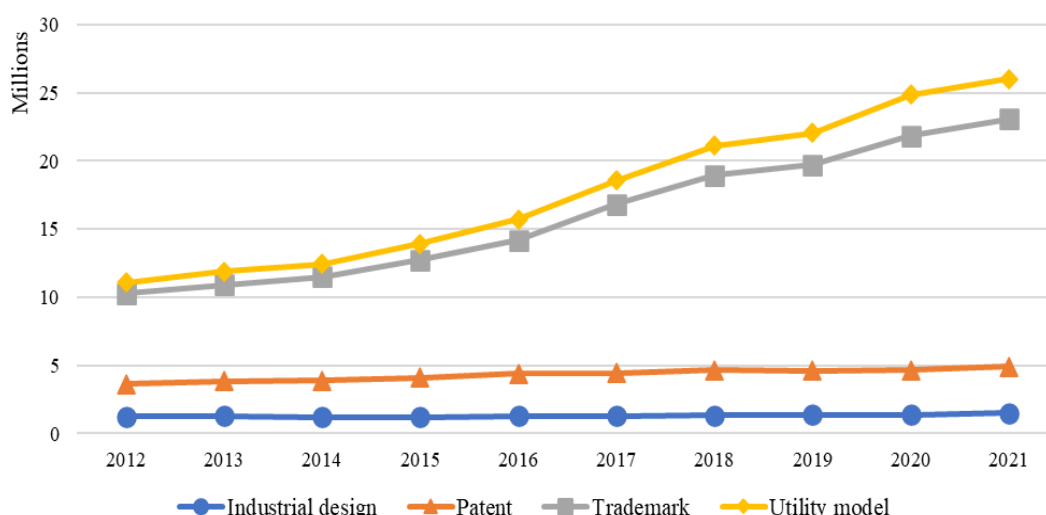
Commercialization of knowledge can provide additional sources of funding for scientific research. In the conditions of a limited budget and science funding in Ukraine, the possibility of attracting investments from the private sector is vital for supporting and developing scientific research.

Stimulation of commercialization processes can contribute to attracting young talents to science, giving them prospects for realizing their ideas and abilities. Young scientists are often looking for opportunities to apply their knowledge in practice, and commercialization in universities can be an effective tool to achieve this (Cabagnols et al., 2022).

Developing mechanisms for commercializing scientific research will help integrate Ukrainian science and scientists into the global scientific and innovative space. This, in turn, will promote the exchange of knowledge, technologies and experience, increasing the quality and efficiency of scientific research. Also, commercialization has a significant social impact, contributing to solving current social problems, improving the population's quality of life, and stimulating social progress. Developing a clear concept and algorithm for commercializing scientific research in Ukraine is essential to creating an effective innovation system that stimulates economic and social development.

## **2. Theoretical background**

The world science generates many inventions that permeate all areas of human activity, including health, engineering, digital technologies, the agricultural sector, and energy. However, only a few of these inventions reach commercial use; many remain in academic laboratories at the patent or testing stage. Commercializing scientific discoveries is a complex process requiring significant investment, time, and specialized knowledge. Although patent registries contain millions of invention descriptions (Figure 1), only a tiny fraction of them transfer into successful commercial products or processes, highlighting the importance of developing strategies to overcome the many challenges on the way to market. The World Intellectual Property Organization (WIPO) provides detailed statistics on patent activity and commercialization, which provides an overview of global trends.

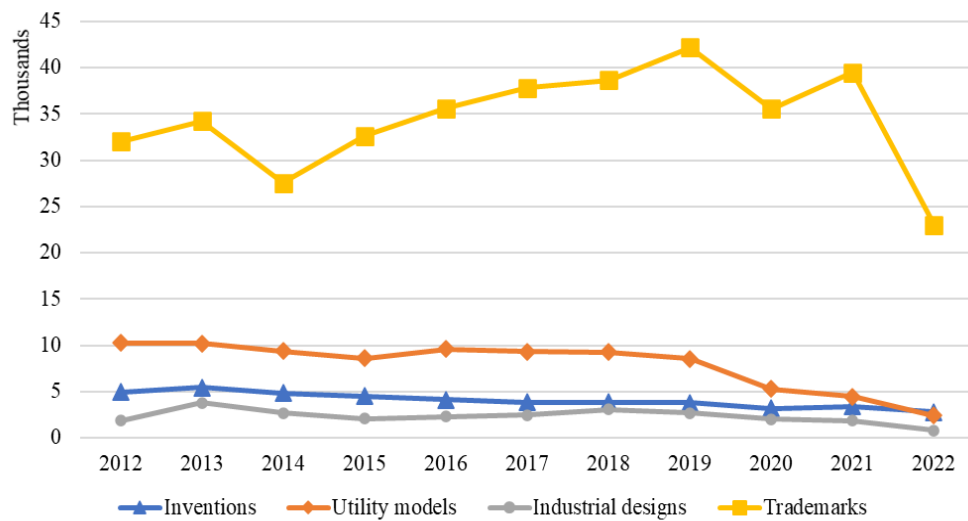


**Figure 1.** The total number of applications in the world, according to the Data Center of the World Intellectual Property Organization  
*Source:* WIPO IP Statistics Data Center

Ukraine is undergoing an institutional reform of the intellectual property sphere and implementation of the relevant legislation. Since November 8, 2022, the State Organization "Ukrainian National Office of Intellectual Property and Innovations" (UNOIP) has performed the functions of the national intellectual property authority, which was formed after the restructuring of the Ukrainian Institute of Intellectual Property, responsible for issuing patents for inventions, utility models, industrial designs, signs for goods and services, copyright and related rights. There are still many unresolved issues in this area, the main one of which is an overly bureaucratic system of intellectual property rights registration, and its protection could be more efficient both in the legal and practical spheres.

Olena Orliuk, the UNOIP head, noted in the Annual Report (2022) that the renewed national intellectual property authority inherited both traditional functions regarding expertise and registration of IP rights, as well as new ones - participation in measures to improve standards of legal protection, development of alternative methods of dispute resolution, raising the level of business culture in this area, promoting creative industries and building the innovative ecosystem of Ukraine.

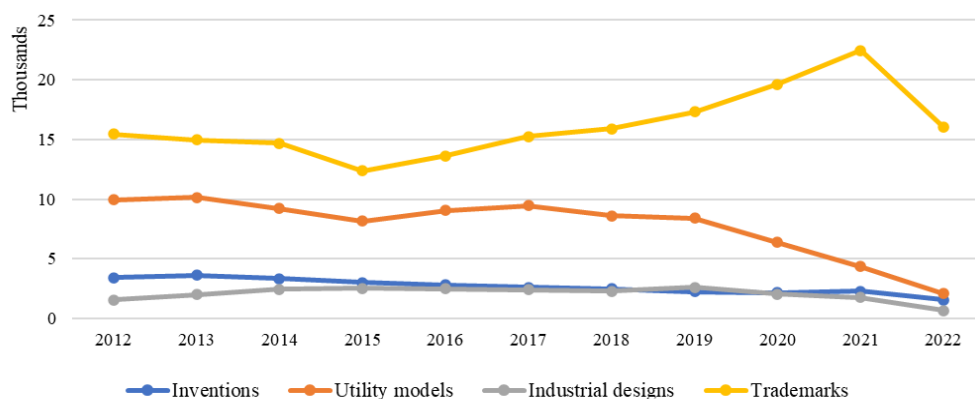
In 2022, 28,971 applications for objects of industrial property were submitted to UNOIP, of which more than 2,760 applications were for inventions, 2,378 – for utility models, 819 – for industrial designs, and 23,014 – for trademarks. Figure 2 represents the dynamics of submitted applications. The war in the country explains the decrease in their number in 2022. And even under these conditions, this reduction is not irretrievable.



**Figure 2.** The total number of applications in Ukraine based on the data of the State Organization "Ukrainian National Office of Intellectual Property and Innovations" (UNOIP)

Source: The reports of the State Organization "Ukrainian National Office of Intellectual Property and Innovations"  
<https://ukrpatent.org/uk/articles/UKRNOIVI-statistics>

According to the UNOIP statistics for 2022, 1,566 inventions, 2,074 utility model patents, 656 industrial samples and 16,028 trademarks were inscribed into the State Register of Patents for Inventions (Figure 3).



**Figure 3.** Number of registered intellectual property objects in Ukraine based on the data of the State Organization "Ukrainian National Office of Intellectual Property and Innovations" (UNOIP)

Source: The reports of the State Organization "Ukrainian National Office of Intellectual Property and Innovations"  
<https://ukrpatent.org/uk/articles/UKRNOIVI-statistics>

The process of technological transfer is crucial to the commercialization of knowledge. It includes the transfer of technologies and knowledge from scientific institutions to the real sector of the economy. Rothaermel and Thursby (2005) examined how universities can improve their capacity for technology transfer and knowledge commercialization. Yermachenko et al. (2015) suggested how governmental bodies can exchange information between relevant state authorities and the commercial sector by installing an integrated e-reporting system comprising the statistical data of travel companies. Sidak et al. (2023) insisted on the responsibility of legal authorities in the provision of regulated development in strategic sectors, pointing to the financial sector's vulnerability if not included in the innovative development process. Tvaronavičienė and Burinskas (2022) analyze the effect of foreign direct investments on the innovative sectors. Klus (2022) added the geopolitical aspect to the technological transfer process. Tvaronavičienė et al. (2021) and Filip et al. (2023) inspected the social influences caused by the comprehensive technology implementation. Technology transfer includes many mechanisms and activities, such as collaborative research, contract research, consulting services,

technology licensing, postgraduate education, training for enterprise personnel, exchange of research personnel, and other forms of information transfer (Hsu et al., 2015).

Scientific publications on the commercialization of knowledge focus on the study and description of the mechanisms of cooperation agreements between participants in the transfer process. In their review of the knowledge commercialization literature, Haessler et al. (2023) concluded that a high level of technology variability and a large number of different participants (scientists, management of a scientific institution, manufacturer, service companies, etc.) influence the process of commercialization of technologies. The authors performed a systematic literature review covering 154 articles published in 43 journals over 28 years. They formulated conclusions describing various factors influencing the use of new technologies and identifying fundamentally different mechanisms for creating technological innovations (Labunska et al., 2019).

Knowledge commercialization is a vital element of innovation, which involves transforming ideas, research and knowledge into commercial products or services. This process requires effective interaction between science, industry, and government. Universities generate new knowledge through scientific research and development. Etzkowitz and Leydesdorff (2000) developed a "three-helix" model that describes the interaction between universities, businesses, and government to promote innovation and economic development. Kalantaridis et al. (2017) showed that the participants of this process have common knowledge bases, norms, and cognitive frameworks. Most Ukrainian authors focus on legal issues and problems of intellectual property protection, omitting economic priorities in the case of commercialization (Chugrii, 2017; Pashchenko & Khomenko, 2023).

The government can play an essential role in the commercialization of knowledge by providing funding for research, stimulating cooperation between universities and industry, and establishing a favourable regulatory environment (Brantnell & Baraldi, 2022). Mowery et al. (2005) examined how government can facilitate innovation and the commercialization of knowledge. The regional context also affects the growth of university spin-offs, but with different intensities in different countries (Prencipe et al., 2020).

The development of innovation ecosystems is essential to support the commercialization of knowledge. Moore (1993). described an innovation ecosystem as a network of organizations interacting with each other to promote innovation and new product development. Woodfield et al. (2023) proved that the ecosystem is crucial for commercializing knowledge in traditional low- and medium-tech industries (for example, specific sectors of textile production, agriculture, the metalworking industry, etc.). They have proposed models for commercializing knowledge and various ways of obtaining value in these areas.

Scientists carry out scientific research in universities. At the same time, understanding the attitude of scientists toward entrepreneurship in the university is critical but needs to be studied (Agapito et al., 2022). An analysis of the academic environment in four European countries found that academics in the natural sciences see their faculties as more entrepreneurially oriented than the social sciences (Kalar & Antoncic, 2015). New temporal structures could be used to understand the possibilities of university technology commercialization practices (Kalantaridis & Küttim, 2023).

This study is particularly relevant given the strategic importance of entrepreneurship in universities for sustainable development in a highly competitive global academic environment. Investigating successful world practices and commercialization models of scientific research results allows us to determine the optimal strategies and tools for stimulating and developing entrepreneurship in the Ukraine and Slovak Republic universities (Ponomarenko et al., 2021).

### 3. Aim and methodology

The study aims to determine strategic steps and recommendations for the effective commercialization of scientific developments by Ukrainian and Slovak scientists. To achieve this, the research uses a multifaceted methodological approach, which includes: literature review (critical analysis and synthesis of existing publications on technology transfer and knowledge commercialization to create a fundamental understanding

of the current background), comparative analysis (consideration of different interpretations of the concept of commercialization followed by classification based on precise characteristics to identify best practices and potential gaps), classification analysis (systematization of the facets of commercialization according to criteria, including the type of knowledge, participants and implementation mechanisms), network analysis (study of participants in a network of knowledge transfer and cooperation between organizations to understand the dynamics and relationships that facilitate or hinder commercialization, cross-cultural research (study of commercialization practices in different countries to gain information on global successes and challenges and adapt the results to the Ukrainian and Slovak environment).

#### 4. Results and discussion

Knowledge commercialization is a multifaceted process that transforms scientific discoveries, technologies, and innovations into commercially viable products or services. Different scientists and researchers define this concept, depending on the context and perspective of the study. Below are some examples of definitions of knowledge commercialization from different authors.

Etzkowitz and Leydesdorff (1995) developed the “Triple Helix” theory, which states that the commercialization of knowledge is an interaction between universities, industry, and government to create innovation and economic development. Nelson (1993) defines commercialization as the process by which knowledge and technology generated in scientific research are transformed into new products, processes or services that can be used in the market. Nagel et al. (1991) define commercialization as a process that involves integrating three main components, innovation, entrepreneurship, and capital, to transform knowledge and technology into goods and services that generate economic benefits. Wright (1983) states that the commercialization of knowledge involves the creation, evaluation, protection, and transfer of intellectual property for its further use for commercial purposes. The conducted research made it possible to propose the following classification of the concept of commercialization of knowledge according to the following characteristics: scope, area of application, type of knowledge, process participants, and implementation strategy (Table 1).

**Table 1.** Classification of the concept of commercialization of knowledge

Classification sign	Type	Content
Scope	Broad definition	Covers the entire process from knowledge creation to its commercialization
	Narrow definition	Focuses on a specific step in the process, such as turning discoveries into products.
Area of application	Academic environment	Commercialization in universities and scientific institutions.
	Industry	Implementation of innovations and technologies into the production (manufacturing) process.
Type of knowledge	Technical/technological knowledge	Commercialization of innovative technical developments, materials, technologies.
	Non-technical knowledge	Commercialization of social, economic, managerial innovations.
Process participants	University commercialization	The crucial importance of universities in the process of commercialization
	Corporate commercialization	The main role of the private sector in the process of commercialization
Implementation strategy	Direct commercialization	Selling innovative products or services to end users.
	Indirect commercialization	Technology licensing, transfer of intellectual property rights to other companies.

*Source:* developed by the authors

The understanding of knowledge commercialization varies among academia, depending on their research context and perspective, but its primary purpose remains to create economic benefit. This point presumes that effective commercialization requires coordinated interaction between different sectors of society and fields of knowledge, as well as a strategically thought-out approach to intellectual property management, built taking into account the best global practices and the study of best practices.

The approach to commercialization of research in different countries of the world varies, depending on cultural, economic, political and scientific factors. For example, the US has a well-developed



commercialization system through technology parks, incubators, and enabling legislation (such as the Bale-Dole Act) that allows universities to own and license intellectual property created with federal funding. The European Union focuses on improving the conditions for commercialization through various financial instruments and programs, such as Horizon Europe, which support innovative projects and cooperation between member countries (Filipová et al., 2019; Piccinetti et al., 2022). China considers the commercialization of research as part of its national development strategy and invests significant resources in supporting innovation and technology transfer. India focuses on strengthening the link between industry and research institutes, introducing startup incentives, and simplifying commercialization procedures. Studying the experiences of different countries and developing effective commercialization models are critically beneficial for creating conditions that would allow scientists to maximize their scientific potential and ensure social and economic benefits from investments in science.

In Ukraine and the Slovak Republic, the approach to the commercialization of scientific research is traditionally based on research institutes and universities, which are the country's leading centres of scientific research. However, the commercialization process in Ukraine can be characterized as transitional and being at the formation stage. In Ukraine, overcoming several barriers, such as insufficient funding of science, bureaucratic obstacles, weak interaction between science and business, and an underdeveloped culture of commercialization in academic circles, is necessary. Overcoming these challenges can significantly strengthen the country's commercialization process of scientific developments. Table 2 shows the main problems scientists face in the commercialization of their research, classified into 4 main groups: organizational resource, legal and social.

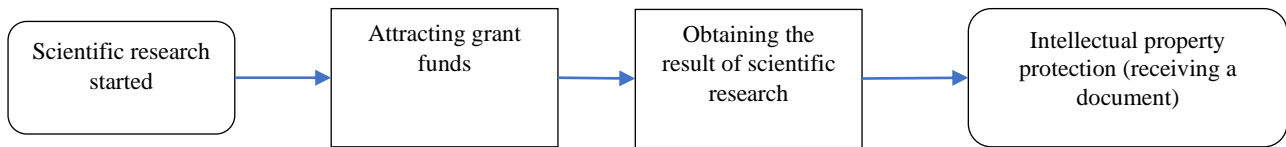
**Table 2.** The main problems of Ukrainian and Slovak scientists in commercialization and recommendations for their overcoming

Group of problems	Problem	Description	Recommendations
Organizational problems	Lack of infrastructure	Lack of specialized incubators, technology parks and other locations to support commercialization	Promote the creation and development of infrastructure facilities and cooperate with existing incubators and technology parks.
	Bureaucratic barriers	High level of bureaucracy and difficulties in navigating the legislative regulations.	Optimize bureaucratic processes to ensure access to legal information and consultations.
	Lack of business connections	The need to improve cooperation between scientific institutions and the business sector.	Establishing ties with the business sector through participation in exhibitions, conferences, and other events.
Resource problems	Insufficient funding	Limited resources for the growth and improvement of scientific developments.	Look for alternative funding sources, such as grants, venture capital investments, and crowdfunding.
	Limited access to investments	Difficulties in attracting investments, especially in the early stages of project development.	Develop pitching skills, improve business planning, and demonstrate the commercialization potential of developments.
Legal problems	Patent tasks	The complexity and duration of the process of obtaining patents.	Creation of a joint structure by several universities with the involvement of legal consultants to speed up and simplify the process of obtaining patents.
	Insufficient protection of intellectual property	The need to strengthen the system of protection of innovators' rights.	Thorough documentation of all development stages, ensuring legal protection of innovations.
Social problems	Cultural factors	The need to create a more entrepreneurial and innovative culture.	Involvement in public discussions on the topic of innovations, conducting educational programs and master classes for the development of entrepreneurial culture.
	Disadvantages in education and training	Lack of specialized programs and courses that prepare scientists for the commercialization of their developments.	Development and implementation of courses and training dedicated to commercialization and business strategies.
	Limited market opportunities	Limitation of the market for some types of innovative products, which complicates their commercialization	Research of international markets, adaptation of products to the needs of different markets, and establishment of partnership relations abroad.

Source: developed by the authors

This table provides an overview of the main problems that Ukrainian and Slovak scientists face when commercializing their developments and offers specific recommendations for solving these problems.

Figure 4 shows the current scientific research process in Ukrainian and Slovak universities.



**Figure 4.** Modern practice of scientific research in universities of Ukraine and the Slovak Republic,

*Source:* developed by the authors

Unfortunately, the result of technology transfer at universities is only obtaining a patent for the outcome of scientific research. In turn, the classic commercialization algorithm is complex and multifaceted, requiring a deep understanding of various aspects and the implementation of a number of actions. Let's consider its components in more detail.

1. Assessment of commercial potential:

- determination of commercial potential – understanding whether the research solves a real problem on the market and whether there is a demand for this solution;
- market analysis - research of potential markets (clients, consumers) for a product or technology and identification of key stakeholders;
- patent search - checking existing patents and determining the possibility of patenting a specific research result.

2. Prototyping and validation:

- prototype development - the creation of a working prototype (or MVP) of a product or technology for demonstration to potential investors or partners;
- testing and validation - testing to confirm the functionality and effectiveness of the solution.

3. Protection of intellectual property:

- patenting – obtaining a patent for innovations to protect intellectual property;
- copyright and trademarks – registration of copyright and trademark, if necessary.

4. Business model development:

- business plan - development of a detailed business plan or Canvas business model, which includes a commercialization strategy, financial forecast and marketing plan;
- revenue model – defining how the product or technology will generate revenue (for example, through sales, licensing, or partnership agreements).

5. Search for funding and partners:

- investments – attraction of investments through venture financing, grants or angel investors;
- partnerships - establishment of partnership relations with industrial companies or other research institutions.

6. Production and sales:

- production - development of a production plan for scaling a product or technology;
- marketing and sales – development and implementation of marketing and sales strategies for each target audience;
- monitoring and optimization– regular assessment and optimization of the commercialization process to increase efficiency and profitability.

7. Scaling:

- expansion into new markets - identification and expansion of presence in new markets;
- constant research and development to improve the product or technology.



These steps may vary depending on the specific situation and research area, but they generally offer a systematic approach to commercializing scientific research. It is important to remember that success in this field requires technical knowledge and an understanding of market processes, strategic planning, and project management skills.

Considering all these aspects and implementing coordinated actions in each can significantly increase the chances of successful commercialization of scientific research.

There is a significant gap between academic research in universities and business innovation demands in Ukraine and the Slovak Republic. Scientists often need to pay more attention to assessing the commercial viability of projects, which is critical for further effective commercialization. Unlike basic research, applied research should be accompanied by an evaluation of its commercial potential.

Analysing the commercial potential of scientific research is a crucial step in commercialization, providing a critical role in this process. It combines a series of actions that contribute to assessing innovation opportunities in the market and identifying possible risks and benefits.

Carrying out such an analysis is often beyond the expertise of scientists, as most of them may need to gain the necessary knowledge in the commercial sector. Therefore, entrusting this task to experts who may also be employees of university technology transfer centres specializing in this area is better. The critical stages of assessment and expert specialization are presented in Table 3, which is a guide to defining competencies at each stage. This table provides a structured view of evaluating the commercial potential of scientific research, describing each stage, the relevant steps to be taken, and the experts who can be called in for qualified assistance.

**Table 3.** Contents and recommendations for involving experts in the evaluation of the commercial potential of scientific research

№	Stage	Description	Actions	Experts
1	Market analysis	Research of the market, customers, competitors and trends	Determination of the target segment, analysis of customer needs, analysis of competition, study of market trends	Market analysts
2	Technical assessment	Assessment of the technical readiness of a product or technology	Determination of technical readiness level (TRL), SWOT analysis	Technical experts
3	Financial analysis	Calculation of the cost of development, potential income and profit	Cost analysis, estimation of potential income, determination of product price	Financial analysts
4	Risk assessment	Identification of potential risks and strategies for their minimization	Determination of technical, market, financial and legal risks, development of prevention strategies	Risk management consultants
5	Creating a business model	Development of a profit generation model	Choice of business model (sale, licensing, partnership)	Business consultants
6	Patent analysis	Checking for the presence of existing patents, the possibility of patenting	Searching for patents, determining the possibility of patenting	Intellectual property lawyers

*Source:* developed by the authors

Ukrainian and Slovak scientists can benefit from the experience of other countries and involve professionals in the field of business, marketing, public administration and legal support to ensure the success of their projects. There are many successful examples and best practices in the field of commercialization of scientific research in the world:

1) university technology parks and incubators - Stanford Research Park, USA - one of the world's oldest and most successful university technology parks. It provides infrastructure and resources for startups and large companies based on innovation and technology. It promotes technology transfer and commercialization of scientific research;

2) licensing and cooperation with business - MIT Technology Licensing Office, USA - MIT has one of the most active licensing departments in the world, which promotes the commercialization of technologies developed by the university through licensing and the creation of spin-off companies;

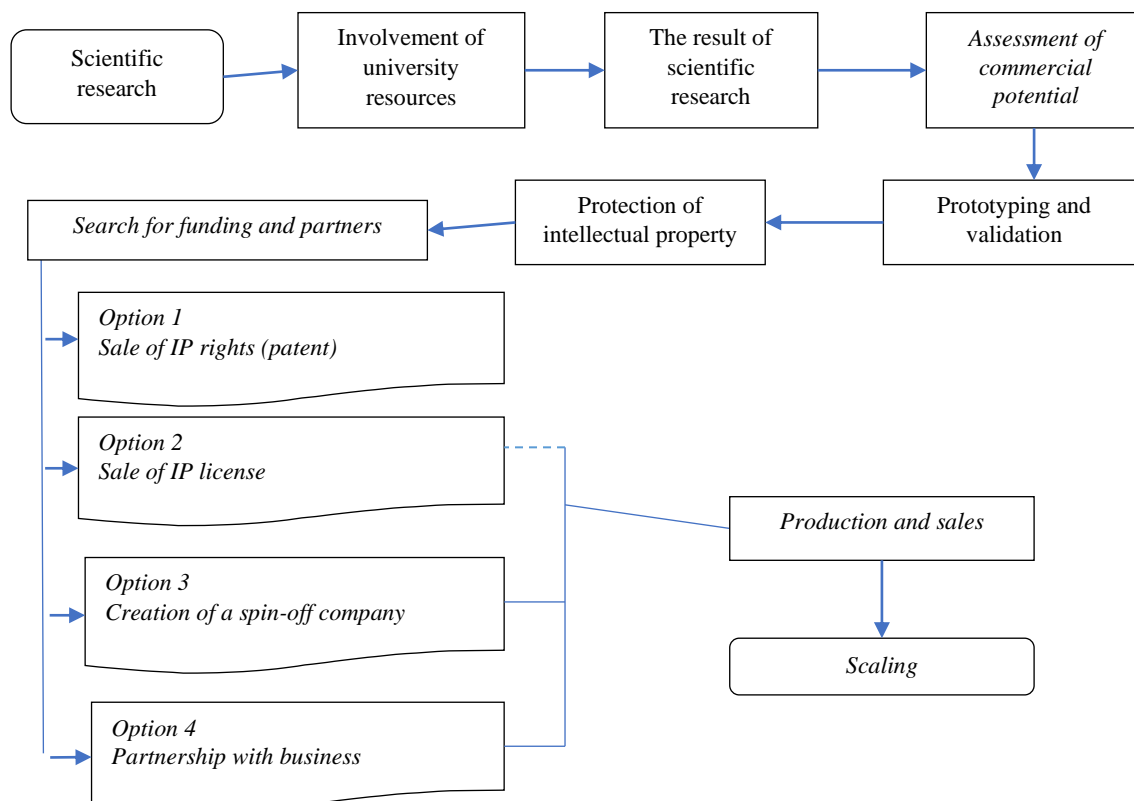
3) early-stage financing funds - Y Combinator, USA - one of the most famous startup accelerators in the world, which offers financing, mentoring and access to a wide network of investors and partners for the development of startups at the early stages;

4) research consortia - Fraunhofer Society, Germany, one of the largest applied research organizations in Europe, which unites several research institutes for cooperation with industry and commercialization of scientific developments.

5) innovation support programs - Horizon Europe, the European Union, is the world's most extensive research and innovation funding program that supports the entire innovation value chain from basic research to bringing products to market.

These practices and organizations have already proven their effectiveness in commercializing scientific research, and their experience can be helpful to Ukrainian and Slovak scientists and innovators. Providing access to resources, networks, and market knowledge are critical elements for successful commercialization.

Visually, the classical algorithm for commercializing scientific research in universities, considering the entrepreneurial component (highlighted in *italics*), can be presented as follows (Figure 5). It should be noted that each stage enables pivoting or refusing to continue working on the project.



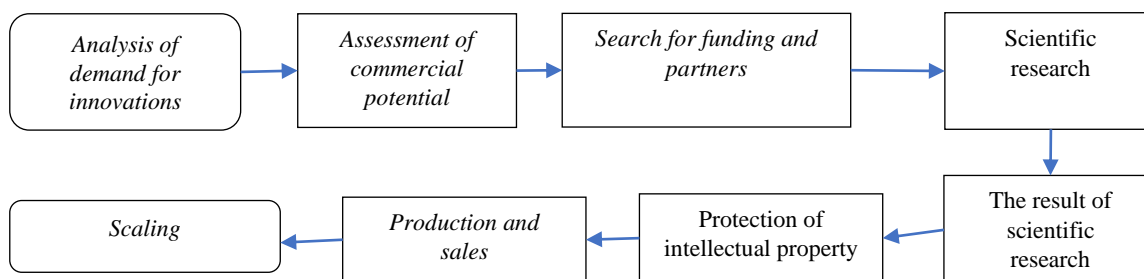
**Figure 5.** The classic algorithm for the commercialization of scientific research in the world universities

Source: developed by the authors

Universities play a crucial role in developing innovations that lead to the creation of new products, processes, and services. Research results can be commercialized through licensing, spin-off and startup companies, and direct industry partnerships (Etzkowitz & Leydesdorff, 2000; Shane, 2004). However, not all scientific discoveries achieve commercial success, and market orientation can be a determining factor in this process (Markman et al., 2005).

Market orientation requires universities to understand market needs and develop research that meets these needs. According to Siegel et al. (2003), universities that actively interact with the industrial sector and identify commercial applications of their research are more likely to succeed in commercialization. The enterprise's activities in the field of innovation should include interrelated research, technical and commercial processes that cover the adoption and implementation of decisions necessary for the effective transfer of a new product or service from the idea stage to market entry (Kosenko et al., 2019).

It is necessary to put the business interests of the university first in the algorithm of commercialization of applied scientific research. Therefore, the following business algorithm for commercializing scientific research in universities is proposed and submitted for discussion (Figure 6).



**Figure 6.** The business model of the algorithm of commercialization of scientific research in universities

*Source:* developed by the authors

The level of effective commercialization in universities that conduct research oriented to market needs is higher because such research has more excellent commercial value and is more quickly applied to business (Wright et al., 2008). Universities must develop strategies promoting close engagement with industry and creating products that meet market needs.

Research developed with specific market demands is more likely to find rapid adoption because it meets the actual needs of businesses and consumers (Lockett et al., 2003). The involvement of external investors and partners in the early stages of research can provide a better understanding of market requirements and priorities.

Collaboration with industry increases the chances of successful commercialization as it facilitates the sharing knowledge and resources. Universities can use business connections in relevant sectors to establish contacts with potential buyers and consumers of technology.

Market orientation allows universities to focus on creating innovative products that can be commercially successful. Products that solve specific consumer problems or significantly improve existing technologies are more likely to receive funding and enter the market.

Also, universities can sell and license their inventions to companies that have the resources for their further development and commercialization. The creation of spin-off companies based on university research can be an effective route to commercialization, especially when experienced entrepreneurs and investors back these companies.

Universities that provide support in the form of incubators, accelerators, and advisory and financial services can significantly increase the chances of success for their researchers. Educational institutions can also aid in

patenting inventions and protecting intellectual property. Establishing clear metrics for evaluating the commercialization process can help universities identify successful strategies and areas for improvement.

## 5. Conclusions

Analyzing the commercialization of scientific research in universities as a systemic phenomenon allows us to determine effective mechanisms for integrating entrepreneurial culture into the scientific environment and identify barriers and incentives for entrepreneurship development among scientists and students.

Commercialization knowledge, which ranges from Etzkowitz and Leydesdorff's "Triple Spiral" theory to Wright's classification, is a multidimensional process covering the creation, evaluation, protection, and transfer of intellectual property, including different scopes, fields of application, types of knowledge, stakeholders in the process and implementation strategies which reflects the diversity of approaches of scientists and researchers to this concept.

The commercialization of scientific research in universities reflects a variety of approaches. It is determined by the context in which scientists work, but its goal - creating economic benefit - remains unchanged. Effective commercialization requires coordination between different sectors of society and thoughtful management of intellectual property that considers the global and local dimensions of innovative activity.

Ukrainian scientists face multi-layered challenges in commercializing research, which include organizational and resource constraints, legal complexities, and social barriers. Solving these problems requires creating an infrastructure for innovation, reducing bureaucracy, attracting investment, and improving education. Effective strategies like university collaboration to facilitate patenting, develop educational programs, and boost international trade can enhance commercialization and promote economic growth.

As for the importance of market orientation for effective commercialization of scientific research in universities, our analysis confirms that university research based on the current and future market demands has more excellent commercial value and effectiveness in implementation. It was proved that such an orientation contributes to attracting external funding, the development of partnership relations with industry, and increasing the number of successful commercial initiatives.

The results obtained during the study indicate that universities should actively work on improving the interaction mechanisms with the market to ensure that their research is relevant to market needs. This may include developing specialized programs that support innovative research with high potential for commercialization and creating effective platforms for exchanging knowledge between universities and industry.

Universities must also implement systematic approaches to evaluating and monitoring commercialization processes to identify successful strategies and areas for further development. Given the growing role of universities in the global innovation ecosystem, further research in this area is urgently needed to understand how academic resources can best be used to drive economic growth and development.

In the future, it is planned to describe in detail the commercialization algorithm in Ukrainian universities and to consider and describe its various options, considering the attraction of investments from different sources at different stages.

## References

Agapito, J. J., Jala, L. L., Cruz-Español, R., & Esguerra, A. G. (2022). Predictors of entrepreneurial attitude among administrators of selected community colleges and universities in Leyte. *Insights into Regional Development*, 4(4), 36-51. [https://doi.org/10.9770/IRD.2022.4.4\(3\)](https://doi.org/10.9770/IRD.2022.4.4(3))

Annual report of the National Intellectual Property Authority (2022). 96 c. Available at: <https://ukrpatent.org/uk/articles/UKRNOIVI-statistics>

Association of University Technology Managers (AUTM) Available at: <https://autm.net/surveys>

Cabagnols, A., Maâlej, A., Mauchand, P., & Kammoun, O. (2022). The determinants of entrepreneurial intention of scientist PhD students: analytical vs emotional formation of the intention. *Insights into Regional Development*, 4(4), 63-82. [https://doi.org/10.9770/IRD.2022.4.4\(5\)](https://doi.org/10.9770/IRD.2022.4.4(5))

Chuhrii, N. (2017). Commercialization intellectual property as a necessary condition for the innovative development of the enterprise [Komercializatsiia intelektualnoi vlasnosti yak neobkhidna umova innovatsiinoho rozvytku pidpriemstva]. *Prychornomorski ekonomichni studii*, 17, 137-141. Available at: [http://nbuv.gov.ua/UJRN/bses\\_2017\\_17\\_28](http://nbuv.gov.ua/UJRN/bses_2017_17_28)

Brantnell, A., & Baraldi, E. (2022). Understanding the roles and involvement of technology transfer offices in the commercialization of university research. *Technovation*, 115, Article Number 102525. <http://doi.org/10.1016/j.technovation.2022.102525>

Etzkowitz, H., & Leydesdorff, L. (1995). The Triple Helix: University-Industry-Government Relations: A Laboratory for Knowledge-Based Economic Development. *EASST Review*, 14, 14-19. [https://www.researchgate.net/publication/241858820\\_The\\_Triple\\_Helix\\_-\\_University-Industry-Government\\_Relations\\_A\\_Laboratory\\_for\\_Knowledge\\_Based\\_Economic\\_Development](https://www.researchgate.net/publication/241858820_The_Triple_Helix_-_University-Industry-Government_Relations_A_Laboratory_for_Knowledge_Based_Economic_Development)

Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university-industry-government relations. *Research Policy*, 29(2), 109-123. [https://doi.org/10.1016/S0048-7333\(99\)00055-4](https://doi.org/10.1016/S0048-7333(99)00055-4)

Filip, S, et. al. (2023). Organizational financing of healthcare in the Slovak Republic and selected European countries / Filip Stanislav, Dubrovina Nadija, Sidak Mikuláš. In: Developments in Information and Knowledge Management Systems for Business Applications.- Švajčiarsko: Springer, Basel, ISBN 978-80-223-5525-4.

Filipová, L., Filip, & Stehlíková, B. (2019) *Cross Boarder Collaboration in Tourism Development in Slovak Republic*. Wolters Kluwer. ISBN 978-80-571-0014-0. <https://www.martinus.sk/?uItem=589527>

Gontareva, I., Litvinov, O., Hrebennyk, N., Nebaba, N., Litvinova, V., & Chimshir, A. (2022). Improvement of the innovative ecosystem at universities. *Eastern-European Journal of Enterprise Technologies*, 1(13(115)), 59–68. <https://doi.org/10.15587/1729-4061.2022.251799>

Haessler, P., Giones, F., & Brem, A. (2023). The who and how of commercializing emerging technologies: A technology-focused review. *Technovation*, 121, 102637. <https://doi.org/10.1016/j.technovation.2022.102637>

Hsu, D. W. L., Shen, Y.-C., Yuan, B. J. C., & Chou, C. J. (2015). Toward successful commercialization of university technology: Performance drivers of university technology transfer in Taiwan. *Technological Forecasting and Social Change*, 92, 25-39. <https://doi.org/10.1016/j.techfore.2014.11.002>

Kalantaridis, C., Küttim, M., Govind, M., & Sousa, C. (2017). How to commercialize university-generated knowledge internationally? A comparative analysis of contingent institutional conditions. *Technological Forecasting and Social Change*, 123, 35-44. <https://doi.org/10.1016/j.techfore.2017.06.013>

Kalar, B., & Antoncic, B. (2015). The entrepreneurial university, academic activities and technology and knowledge transfer in four European countries. *Technovation*, 36–37, 1-11. <https://doi.org/10.1016/j.technovation.2014.11.002>

Klus, M. (2022). La principale méthode de travail de l'UE consiste à trouver des compromis et à construire une compréhension mutuelle afin de maintenir l'unité. *Revue Hermès*. 90(2), 67-69.

Kosenko O., Cherepanova V., Dolyna I., Matrosova V., Kolotiuk O. (2019). Evaluation of innovative technology market potential on the basis of technology audit. *Innovative Marketing*, 15 (2), 30–41. [https://doi.org/10.21511/im.15\(2\).2019.03](https://doi.org/10.21511/im.15(2).2019.03)

Kalantaridis, C., & Küttim, M. (2023). Multidimensional time and university technology commercialization as opportunity praxis: A realist synthesis of the accumulated literature. *Technovation*, 122, Article 102685. <https://doi.org/10.1016/j.technovation.2022.102685>

Labunska, S., Gavkalova, N., Pylypenko, A., & Prokopishyna, O. (2019). Cognitive Instruments Of Public Management Accountability For Development Of National Innovation System. *Public Policy And Administration*, 18(3), 114-124. <https://doi.org/10.5755/j01.ppaa.18.3.24727>

Lockett A., Wright M., & Franklin S. (2003). Technology transfer and universities' spin-out strategies. *Small Business Economics*, 20(2), 185-200. <https://doi.org/10.1023/A:1022220216972>

Markman G. D., Phan P. H., Balkin D. B., & Gianiodis P. T. (2005). Entrepreneurship and university-based technology transfer. *Journal of Business Venturing*, 20(2), 241-263. <https://doi.org/10.1016/j.jbusvent.2003.12.003>

Moore, J. F. (1993). Predators and prey: a new ecology of competition. *Harvard Business Review*, 71(3), 75-86. Available at: [https://www.researchgate.net/publication/13172133\\_Predators\\_and\\_Prey\\_A\\_New\\_Ecology\\_of\\_Competition](https://www.researchgate.net/publication/13172133_Predators_and_Prey_A_New_Ecology_of_Competition)

Mowery, D. C., Nelson, R. R., Sampat, B. N., & Ziedonis, A. A. (2005). The Bayh-Dole Act of 1980 and University--Industry Technology Transfer: A Model for Other OECD Governments? *The Journal of Technology Transfer*, 30(2\_2), 115-127. <https://doi.org/10.1007/s10961-004-4361-z>

Nagel, R. N., Dove, R., & Preiss, K. (1991). 21st century manufacturing enterprise strategy: An industry-led view. Iacocca Institute, Lehigh University. 58 p <https://doi.org/10.21236/ADA257032>

Nelson, R. R. (1993). National innovation systems: A comparative analysis. Oxford University Press. 560 p <https://ssrn.com/abstract=1496195>

Pashchenko, V., & Khomenko, O. (2023). Basic principles and methods of commercialization of intellectual property [Osnovni pryncypy i metody komertsializatsii intelektualnoi vlasnosti]. Available at: <http://cpdcipr.kpi.ua/article/view/278812>

Piccinetti, L., Santoro, D., & Rezk, M. R. (2023). The Karolinska Institute innovation ecosystem for cancer startups: lessons learned and best practices. *Insights into Regional Development*, 5(2), 10-23. [https://doi.org/10.9770/IRD.2023.5.2\(1\)](https://doi.org/10.9770/IRD.2023.5.2(1))

Ponomarenko, V., Rayevnyeva, O., Yermachenko, V., Aksonova I., Brovko, O. (2021). Digitalization as a development factor of innovative-active university. *Problems and Perspectives in Management*, 19(4), 213-231. [http://doi:10.21511/ppm.19\(4\).2021.18](http://doi:10.21511/ppm.19(4).2021.18)

Prencipe, A., Corsi, C., Rodríguez-Gulías, M. J., Fernández-López, S., & Rodeiro-Pazos, D. (2020). Influence of the regional entrepreneurial ecosystem and its knowledge spillovers in developing successful university spin-offs. *Socio-Economic Planning Sciences*, 72. <https://doi.org/10.1016/j.seps.2020.100814>

Reports of the State Organization "Ukrainian National Office of Intellectual Property and Innovation". Available at: <https://ukrpatent.org/uk/articles/UKRNOIVI-statistics>

Rothaermel, F. T., & Thursby, M. (2005). University-industry collaboration in inventor. *Management Science*, 51(5), 755-769. <https://doi.org/10.1287/mnsc.1040.0354>

Shane, S. (2004). Academic entrepreneurship: University spin-offs and wealth creation. Edward Elgar Publishing. <https://doi.org/10.4337/9781843769828>

Sidak, M., et al. (2023). Legislation on the redistribution of financial services in selected EU member states and innovative way of financial intermediation in the Slovak Republic / Sidak Mikuláš, Andrea Slezáková, Filip Stanislav. In: *Developments in Information and Knowledge Management Systems for Bussiness Applications - Švajčiarsko: Springer, Basel, 2023.- ISBN 978-3-031-27505-0.- S. 277-300.* [https://doi.org/10.1007/978-3-031-27506-7\\_11](https://doi.org/10.1007/978-3-031-27506-7_11)

Siegel, D. S., Waldman, D. A., Atwater, L. E., & Link, A. N. (2003). Commercial knowledge transfers from universities to firms: improving the effectiveness of university-industry collaboration. *The Journal of High Technology Management Research*, 14(1), 111-133. [https://doi.org/10.1016/S1047-8310\(03\)00007-5](https://doi.org/10.1016/S1047-8310(03)00007-5)

Theodoraki, C., Dana, L.-P., & Caputo, A. (2022). Building sustainable entrepreneurial ecosystems: A holistic approach. *Journal of Business Research*, 140, 346-360. <https://doi.org/10.1016/j.jbusres.2021.11.005>

Tvaronavičienė, M., Mazur, N., Mishchuk, H., & Bilan, Y. (2021). Quality of life of the youth: assessment methodology development and empirical study in human capital management. *Economic Research-Ekonomska Istraživanja*, 35(1), 1088-1105. <https://doi.org/10.1080/1331677X.2021.1956361>

Tvaronavičienė, M., & Burinskas, A. (2022). Review of studies on FDI: The case of Baltic States / M. Tvaronavičienė, A. Burinskas. In: *Journal of International Studies*, 210-225. <https://doi.org/10.14254/2071-8330.2022/15-2/14>

Volosheniuk, L., Gornostay, N., & Mikhalkchenkova, O. (2020). Innovative ecosystem: concepts, functions, levels of innovative development, examples [Innovatsiina ekosystema: poniattia, funktsii, rivni innovatsiinoho rozvytku, pryklady]. *Nauka, Tekhnolohii, Innovatsii*, 1(13). 3-9. <http://doi.org/10.35668/2520-6524-2020-1-01>

WIPO IP Statistics Data Center Available at: <https://www3.wipo.int/ipstats/key-search/search-result?type=KEY&key=201>

Woodfield, P. J., Ooi, Y. M., & Husted, K. (2023). Commercialization patterns of scientific knowledge in traditional low- and medium-tech industries. *Technological Forecasting and Social Change*, 189, 122349. <https://doi.org/10.1016/j.techfore.2023.122349>



Wright, B. D. (1983). The economics of invention incentives: Patents, prizes, and research contracts. *The American Economic Review*, 73(4), 691-707. <http://links.jstor.org/sici?sici=0002-8282%28198309%2973%3A4%3C691%3ATEOIP%3E2.0.CO%3B2-2>

Wright, M., Clarysse, B., Lockett, A., & Knockaert, M. (2008). Mid-range universities' linkages with industry: Knowledge types and the role of intermediaries. *Research Policy*, 37(8), 1205-1223. <https://doi.org/10.1016/j.respol.2008.04.021>

Yermachenko, V., Dekhtyar, N., & Znakhur, S. (2015). Improving the system of raw data as one of the objectives in planning the strategic development of tourism industry in Ukraine. *Aktual'ni Problemy Ekonomiky = Actual Problems in Economics*, 165, 401-414.

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