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HELIX MODELS AS A METHODOLOGICAL BASIS FOR ORGANISATIONAL AND ECONOMIC SUPPORT OF INNOVATIVE ENTREPRENEURSHIP

ГЕЛІКСНІ МОДЕЛІ ЯК МЕТОДОЛОГІЧНА ОСНОВА ОРГАНІЗАЦІЙНО-ЕКОНОМІЧНОГО ЗАБЕЗПЕЧЕННЯ ІННОВАЦІЙНОГО ПІДПРИЄМНИЦТВА

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The article substantiates the feasibility of utilising helical models (Triple, Quadruple, Quintuple Helix) as a methodological basis for innovative entrepreneurship's organisational and economic support. The text under discussion highlights the evolution of models from the triple interaction of universities, business, and the state to expanded forms involving civil society and the natural environment. The practical implementation of these strategies within the framework of European Smart Specialisation strategies and Horizon Europe, Interreg, and Erasmus+ programmes is analysed, confirming their effectiveness in transnational innovation projects. The formation of partnership structures, stakeholder interaction, and the socio-ecological dimensions of sustainable development are revealed. The proposal is for helical models to be considered a key tool in SME support policies in the context of European integration.

Keywords: organizational and economic support, innovative entrepreneurship, helix models, Triple Helix, Quadruple Helix, Quintuple Helix, European innovation programmes.

У статті здійснено комплексне дослідження гелікних моделей як сучасної методологічної основи організаційно-економічного забезпечення інноваційного підприємництва. У фокусі наукового аналізу перебувають моделі Triple Helix, Quadruple Helix та Quintuple Helix, які відображають коеволюційну взаємодію між наукою, бізнесом, державою, громадянським суспільством і природним середовищем. Автором обґрунтовано, що застосування таких моделей дозволяє подолати фрагментацію управлінських рішень, забезпечити системність та адаптивність інструментів підтримки підприємництва в умовах цифровізації, динамічних змін зовнішнього середовища, зростаючих екологічних викликів і посилення глобальної конкуренції. У роботі висвітлено еволюційний характер формування гелікних моделей: від класичної трикомпонентної взаємодії до складних екосистемних підходів, які враховують соціально-культурні та екологічні чинники. Проведено порівняльний аналіз моделей за суб'єктною структурою, рівнем інтеграції, фокусом взаємодії та прикладами практичного застосування в європейських регіонах. Розкрито потенціал цих моделей як дієвих методологічних інструментів розробки стратегій Smart Specialisation, інноваційної дипломатії, екологічно орієнтованого підприємництва та міжсекторальної кооперації. Окрема увага приділена вивченню програм Horizon Europe, Interreg, Erasmus+, Digital Europe, LIFE Programme, у межах яких гелікснi моделі застосовуються як обов'язкова рамка для формування консорціумів, оцінки потреб стейкхолдерів, моніторингу результатів і формулювання політик сталого розвитку. Наведено успішні приклади реалізації моделей у таких регіонах, як Каталонія (Іспанія), Східна Фінляндія, Лодзьке воєводство (Польща), Південно-Моравський край (Чехія), що демонструють практичну релевантність концепції для формування інноваційно-активного підприємницького середовища.

Запропоновано рекомендації щодо інтеграції гелікcних моделей у національну систему підтримки підприємництва з урахуванням європейських практик, зокрема в напрямках кластерної політики, інституційного посередництва, цифрових платформ і регіональної інноваційної екосистеми. Результати дослідження можуть стати основою для удосконалення управлінських рішень та розробки державної політики підтримки малого та середнього бізнесу в контексті євроінтеграції України.

Ключові слова: організаційно-економічне забезпечення, інноваційне підприємництво, гелікcні моделі, Triple Helix, Quadruple Helix, Quintuple Helix, європейські інноваційні програми.

Problem statement. In contemporary economic transformation, digitalisation and intensified global competition, a review of the methodological foundations of organisational and economic support for entrepreneurship is imperative. Conventional models neglect to consider the entirety of the interaction between the subjects involved in the innovation process, thereby diminishing the efficacy of entrepreneurial potential. Because of this, the present study considers helical models (Triple, Quadruple, Quintuple Helix) to ensure the systematic integration of science, business, government, society, and the natural environment in support of entrepreneurial activity.

An analysis of recent studies and publications. Etzkowitz H. and Leydesdorff L. [4], who substantiated the triple helix model as the basis for innovation policy, studied the issue of cross-sectoral interaction in the innovation economy. Carayannis E. G. and Campbell D. F. J. [1, 2] developed the approach to include a four-link and a five-link model, incorporating civil society and the natural environment. The works of Leydesdorff L. [9], Cavallo A., Ghezzi A., Balocco R. [3], as well as González-Martínez P., García-Pérez-de-Lema Doming, Castillo-Vergara M., Bent Hansen P. [6] reveal the potential of helix models in the formation of regional innovation ecosystems. Concurrently, domestic science has not conducted sufficient research into applying these models as the basis for entrepreneurship's organisational and economic support, particularly in European business support programmes.

Problem statement. This article aims to provide a theoretical justification for the use of helix models as a methodological basis for the organisational and economic support of innovative entrepreneurship in the context of integration into the European space.

Presentation of the primary research material. The advent of helical models was preceded by the realisation of the limitations of traditional linear models of innovation, which failed to account for the complex interactions between different sectors of society. In the 1990s, the growing role of universities in the commercialisation of knowledge and the need to involve the state as a coordinator of these processes provided the backdrop against which a model was required to reflect the co-evolutionary links between science, business, and the state. This development subsequently gave rise to the conceptualisation of the Triple Helix model [4]. The evolution of the innovation environment, characterised by an emphasis on the social relevance of technologies, has given rise to the expansion of the model to the Quadruple Helix, which incorporates civil society. The mounting pressure of environmental challenges has led to the emergence of the Quintuple Helix, a model that considers the impact of the natural environment [1, 2].

The concept of the Triple Helix emerged in the 1990s as a response to the necessity for interaction between universities, business, and the state as key players in innovative development. This approach entails a paradigm shift wherein universities transcend their traditional role as mere providers of human resources, instead assuming a more proactive stance as active participants in innovative endeavours. The state is responsible for establishing the regulatory framework and institutional infrastructure, while the business sector is tasked with commercializing knowledge [4]. The Triple Helix model has become a widely adopted framework in the development of innovation policy, particularly within the domain of regional development.

The Quadruple Helix model emerged in the early 2000s, influenced by social transformations and the necessity to consider the interests of civil society. The media, public organisations, educational platforms, and other elements of the social space join the three primary actors. This approach renders innovation socially relevant, incorporating cultural values, social practices, and public communications [1].

The Quintuple Helix model emerged in the 2010s as a response to sustainable development challenges. The model under discussion incorporates a fifth element, the natural environment, thus complementing

the previous model. Consequently, nature is regarded as a dynamic participant in the system of interactions, thereby facilitating the integration of the ecological dimension into innovative development [2]. This approach is becoming increasingly relevant in the context of climate change, environmental, social, and governance (ESG) approaches, and the green transition.

Table 1 compares helix models of organisational and economic support for innovative entrepreneurship.

In practice, helical models have become the foundation for the formation of Smart Specialisation Strategies (S3) in European Union countries, particularly in regions such as Catalonia (Spain), Eastern Finland, Łódź Province (Poland) and South Moravia Region (Czech Republic), where cluster approaches are implemented based on the interaction of four or five key actors [2; 5]. In the Horizon Europe, Interreg, Erasmus+, Digital Europe, and LIFE Programme, the use of the Quadruple Helix or Quintuple Helix approach is enshrined as one of the mandatory conditions for structuring consortia, identifying stakeholder needs, and developing roadmaps, performance indicators, and mechanisms for monitoring innovation policies [10; 7].

Consequently, Horizon Europe projects (e.g., RRI2SCALE, TeRRItoria, SeeRRI) employ coordination mechanisms between universities, companies, local authorities, and public organisations, thereby facilitating the establishment of sustainable models of socially responsible entrepreneurship and scientific diplomacy [2; 10]. Interreg programmes (e.g., InnoHEIs, BRIDGES, ClusterFY) have been identified as a significant catalyst for the development of innovative ecosystems, through the establishment of platforms that facilitate multi-level interaction between regional institutions, research institutions, and business structures [8]. Within the scope of the Erasmus+ programme, initiatives such as HEInnovate and EntreCompEdu offer support for entrepreneurial education, emphasising community involvement and environmental awareness. This approach is in alignment with the Quintuple Helix logic [7].

This demonstrates the effectiveness of helix models as tools for organisational and economic support of innovative activities in the context of projects involving transnational cooperation, digital transformation, green transition, and increasing the sustainability of entrepreneurial ecosystems in the face of climate challenges and socio-economic turbulence.

Helix models can demonstrate their potential within the confines of the academic environment and as an applied methodology for forming partnership structures within regional innovation systems. Furthermore, these models can potentially develop clusters and digital platforms to support small and medium-sized enterprises.

Conclusions. It is evident that Helix models of interaction constitute an effective tool for the organisational and economic support of innovative entrepreneurship. These mechanisms facilitate overcoming fragmentation in the interaction between science, business, government, and society. Their practical significance is confirmed by their widespread implementation in EU programmes, which opens up new prospects for Ukrainian enterprises in the context of European integration. It is recommended that future research endeavours concentrate on the development of models for adapting helix structures to the national business environment, with a view to expanding their application in SME development policies.

Table 1

A comparative analysis of the characteristics of helix models in the context of organisational and economic support for innovative entrepreneurship

Model	Main subjects of interaction	Focus of interaction	Integration level	Examples of application in the EU
Triple Helix	Universities – Business – Government	Innovation and commercialization of knowledge	Institutional	S3, regional innovation strategies
Quadruple Helix	Triple Helix + Civil society	Social relevance of innovations	Social	Horizon Europe, Interreg, Cultural projects
Quintuple Helix	Quadruple Helix + Natural environment	Sustainable development, environmental innovation	Ecosystem	Green Deal, Innovative policies for sustainable development

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