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PRACTICES THAT CAN BE USED TO DEVELOP INNOVATION ECOSYSTEMS

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Abstract. The research examines national innovation ecosystems as strategic economic foundations which create technology progress and boost international competitiveness to fuel national economic expansion. Countries should activate integrated operational methods to encourage partnership activities among government entities and private industry along with academic institutions and civil society organizations because innovation cycles continue to speed up. Research reveals successful innovation ecosystem examples through three essential aspects which include public-private partnership-fostered startup-friendly conditions and cluster association platforms for scientific-industrial synergy and university-business collaborative frameworks for knowledge movement and business innovation.

The study provides substantial focus on how Industry 4.0 technologies transform manufacturing operations through automated control and artificial intelligence previously implemented data analytics. Several case studies detailed in the paper showcase successful models of innovation hubs alongside accelerators and regional centers which integrate key stakeholders from Germany, Israel and Ukraine. The approach includes educational efforts together with investment systems and policy-based incentives which support innovation development along with minimizing the early-stage risk.

Through research synthesis of international best practice examples the authors provides stepped-up guidance for leaders in business sectors along with academic institutions which need to enhance their innovation capabilities. An analysis confirms the necessity of teamwork between public and private sectors alongside specific funding allocation and planned support structures for building resilient innovation ecosystems which fulfill national requirements and global needs.

Key words: innovations; national innovation ecosystem; public governance mechanisms; cluster development; Industry 4.0; university-business collaboration; startup support.
JEL Classification: O38, O30, L52, H25.

INTRODUCTION

The creation of innovative ecosystems remains essential to promote economic expansion combined with technological progress and sustainable development. Business sectors together with research organizations and government departments along with other partners connect through dynamic networks to promote innovation. A properly functioning national innovation system brings

knowledge to different sectors while speeding up technological progress while building economic stability. The advancement of digital technologies under Industry 4.0 represents an essential method to create ecosystems but the innovation dynamics are primarily influenced by policy frameworks and educational systems as well as investment approaches. Economic growth depends heavily on small and medium-sized enterprises (SMEs) because their innovation developments lead to enhanced technological progress as well as marketplace success.

The innovation ecosystem of Ukraine has significant potential for development which can be accelerated through adoption of successful international methodologies. This article explores leading innovation ecosystem development models while determining essential opportunities to advance their establishment.

LITERATURE REVIEW

Filatov & Filatov (2024) examine how communication systems enable effective collaboration among stakeholder entities in cluster networks. This research investigates successful approaches and communication systems to boost stakeholder collaborations and operating efficiency. The success of innovative ecosystems depends heavily on well-established communication mechanisms according to Filatov & Filatov. The implementation of effective communication systems helps various groups including large enterprises along with SMEs and government entities and academic institutions to share goals while exchanging knowledge and expertise that reduces repetitive activities and supports innovation. Fostered by cluster-based models together with public-private partnerships stakeholders can achieve better collaboration results in sustainable innovation [1].

Tiutiunnyk et al. (2023) presents various sector aspects of Ukraine while focusing on implementing innovative ecosystems for sustainable development purposes in their research. The authors suggest converting existing aquaculture plants into cluster-based platforms which combine production activities with educational programs and artistic events. The method works towards developing environmentally secure areas within urban and rural territories while developing green employment opportunities and increasing awareness about nature conservation [6].

The article authored by I. Yaschyshyna (2024) investigates university and business partnerships through scientific collaboration by exploring ways to enhance partner selection process. This author demonstrates how university-business collaborations have grown essential for developing innovation and technological progress alongside economic development. This article investigates partnership success elements by examining strategic alignment together with financial incentives and legal basis as well as communication systems. The article examines numerous university-business partnership models through international best practices and successful case studies. The article emphasizes modern tools in both digital and analytics which help partner matching through dedicated databases combined with online networking systems and AI-powered analytics. The author suggests that improving these mechanisms can significantly enhance the efficiency of collaboration. These insights contribute to the broader discourse on strengthening university-industry linkages in an increasingly knowledge-driven economy [7].

The best practices for SME local innovation ecosystems (2020) explore strategies for fostering innovation within SMEs by leveraging local ecosystems. This research presents successful international models through case studies which illustrate how customized systems boost enterprise performance and develop technological capabilities. The success of innovation requires establishments to team up with businesses alongside universities and financial entities and government institutions to build an innovation-friendly environment. Also the research discusses challenges which SMEs encounter but provides solutions for overcoming resource limitations together with regulatory barriers and scaling issues. The research collects insights about successful university-business initiatives alongside government funding systems and digital innovation facilities to demonstrate methods strengthening innovation-powered economic development [13].

The topic of startups has been explored by scholars such as O.O. Kurchenko, L.I. Mulik, S.O. Solntsev, H.O. Shvets, N.I. Sytnyk, and N.Y. Podolchak. In the context of European integration processes in Ukraine, interest in startups is also reflected in studies by entrepreneurs and experts such as R.I. Babyachok and I.I. Kulchytskyi. Research on public governance and innovation has been conducted by O.I. Bilyk, V.Y. Karkovska, N.Y. Podolchak, O.V. Khimych, and others. However, issues related to best cases and practices that can be used to develop innovation ecosystems have only been addressed in a fragmentary manner.

PAPER OBJECTIVE

The objective of this paper is to analyze the mechanisms for developing national innovation ecosystems, with a particular focus on: the role of industrial clusters and business networks in fostering innovation; effective models of university-business-government cooperation; the impact of digital transformation, including Industry 4.0, on innovation capacity; policy measures that facilitate innovation-driven economic development; an overview of best global practices that may be suitable for implementation in national conditions.

METHODOLOGY

This article is based on a qualitative literature review, incorporating academic sources and case articles. The analysis focuses on three key dimensions:
- examining strategies for fostering innovation;
- assessing the effectiveness of regional innovation hubs and business clusters;
- evaluating the role of Industry 4.0 and other digital initiatives in strengthening innovation ecosystems.

RESULT AND DISCUSSION

Economic development along with technological innovation depends heavily on the development of innovative ecosystems. Current global developments demonstrate that nations and regions moving forward correctly implement complete systems designed to support innovation creation. A review of successful innovative ecosystem development models can be found in this article.

1. The government provides assistance to startups together with recently launched businesses.

To build active startup society governments need to create friendly policies and support systems and give startups access to advice alongside funding opportunities. The best practices to support startups include streamlined business registration processes and startup accelerators as well as innovation competitions funded by the government [13].

Countries establish regional hubs to concentrate on building industry-focused innovative ecosystems which develop through regional clusters. Evaluations of these hubs take place through startup quantity assessment together with innovative solution monitoring and specialized laboratory tracking as well as marketplace sharing which produces employment opportunities [11].

Such facilities act as centers that unite businesses with research organizations along with financial support entities and government bodies to implement technology advancements. The developments in digital economy, automation, robotics for manufacturing processes benefit from their support.

The German initiative known as Industry 4.0 works to establish smart manufacturing while maintaining international leadership positions according to ranking systems [3]. Germany maintains more than 25 innovation hubs throughout the nation that provide small and medium-sized

enterprises (SMEs) with tools to understand new technologies like artificial intelligence as well as the Internet of things and big data.

Industry 4.0 processes large machine-generated data which leads to enhanced production of quality products at reduced costs through automatic analysis systems. The combination of better production efficiency leads to economic transformation and boosted industrial growth and workforce modification which enhance company and city and regional competitive advantages [5].

The following factors represent critical success elements for regional industry hubs focusing on Industry 4.0 operation:

- The innovation sector receives government backing and tax benefits from local authorities for innovative companies.
- Integration of startups into the supply chains of large enterprises.
- The infrastructure provides businesses with membership to accelerators as well as business incubators and grants for financial support.
- The organization should establish educational programs to train high-tech field specialists.

For example, the technology parks with backing from government funds in Israel facilitate fast company development across cyber security, biotechnology and IT sectors [9]. Ukraine maybe adopts successful startup ecosystem models which Israeli society has demonstrated through its achievements.

2. Collaboration between science and business in cluster associations.

Companies from the business sector together with scientific establishments exist outside isolated environments because their interactive networks extend beyond national and regional boundaries as knowledge generation and innovation distribution and utilization occur on a global scale. Companies from the business sector form part of extended relationships which extend across worldwide networks. Companies from the business sector are growing ecosystems with other organizations and educational institutions and scientific institutions due to the demanding competitive environment where speed to market and developing unique customer value play major roles [4].

It is important to note that technological advancement receives its momentum from clusters through their provision of tools and guidance along with networking resources. A successful cluster model combines private-public alliances with research site availability as well as international networking ties [13].

But formation of effective economic clusters and significant synergy effects depend on merging at least thirty to fifty organizations or enterprises according to leading countries' experience. The interconnected nature of economic clusters boosts a nation's societal and economic operation alongside export strength and market competitiveness at both national and regional zones [2].

For example, the Ukrainian Cluster Alliance presents a model of successful scientific institution-business cooperation. Thus, the Podil Fashion Cluster together with Khmelnytskyi National University produced two industry guides for light industry while completing 16 collaborative projects [14].

The cluster model provides communities with one of the most successful instruments to build innovation ecosystems throughout their regions. The collaboration includes direct work between enterprises while universities and research centers and government bodies support creation of competitive products and technologies.

The cluster development model achieved success when implemented by Finland and Slovakia as other nations. The cluster system in Finland operates through 13 high-tech organizations including Clean tech Finland and Health Bio to convert scientific research into global market products. The automotive cluster in Slovakia works to attract investments and train professional automotive engineers [8].

As part of its strategic approach Ukraine should build regional innovation centers which utilize already existing technological infrastructure and capabilities.

3. University-business cooperation through technology integration via partnerships.

Effective collaborations between universities and businesses enable the exchange of knowledge together with research development and educational programs responsive to business needs. Joint research collaborations with additional technology transfer offices forming innovation clusters lead to successful results. Higher education institutions must create entrepreneurial centers and start-up facilities which also need to reflect industry requirements in their educational programs [13]

Research cooperation and educational partnerships represent the two fundamental categories of university-business cooperation. University-business research partnerships are more commonly found across the world. Research collaboration contains two main categories which are starting fresh research projects alongside applying market solutions for current scientific findings [8]

The primary reason for business-university partnerships involves obtaining competitive benefits by accessing intellectual properties alongside advanced technological innovations. Organizations find it impractical to sustain their own R&D departments because developing technology prototypes requires considerable time period alongside substantial financial resources. Organizations build an academic partnership network which helps them achieve faster development of their proprietary technologies. The collaboration process requires business entities to support related startup enterprises while initiating research activities jointly with universities and technology companies. The company dedicates itself to performing commercialization tests on the outcomes of such research. When the project generates profits from intellectual property usage the partner gets a share from those gains according to the agreement [4].

At the same time, the innovation ecosystem depends on universities because they serve as a base for scientific research and professional training. The innovation centers support scientific commercialization by transferring scientific developments into business applications. Universities together with innovation centers form critical contributors to innovation ecosystem development.

For example, the Smart Engineering project received a techno-economic feasibility study from the University of Stuttgart in Germany before its implementation by Rittal and Eplan and Phoenix Contact. Also, Siemens and other major corporations work together with small development firms by incorporating their products with technological solutions. Therefore, the development of sustainable technological ecosystems occurs while rapid innovation deployment takes place. The essential nature of established innovation ecosystems includes significant funding for conducting research and development activities. For example, General Electric dedicated more than $1 billion to its Predix platform because significant research and development funding remains vital for business competitiveness [10].

The following practices represent best approaches for university-business joint operations:

- Students at MIT benefit from startup-backed funding at the Martin Trust Center for MIT Entrepreneurship that yearly provides financial support to over 250 projects and draws international investors.
- The Lviv example shows how Tech StartUp School acts as a university-based incubator by running education programs about entrepreneurship development and innovation implementation.
- Educational programs featuring integrated academic education alongside company-oriented practice exist as a joint training approach.
- The funds managed by universities provide financial support to graduate startups. The essential mechanisms for funding startups include venture capital together with angel investors and government-backed funds [13]. Ukraine needs to implement funding mechanisms that decrease venture risks during each startup development stage to boost early-stage investment. Co-development programs that unite public sector funds with private sector budgets help organizations obtain better financial resources.
- Initiatives between the government and organizations include financial supports that provide funding and tax advantages to creative businesses.

- Joint R&D centers (e.g., Bosch's partnerships with European technical universities).
- Participation of corporations in hackathons and startup competitions to find innovative solutions to their problems.
- Investments in technology parks (a legal entity or group of legal entities operating under a joint activity agreement without creating a legal entity and without pooling contributions in order to create organizational foundations for the implementation of technology park projects for the industrial implementation of high-tech developments, high technologies, and ensuring the industrial production of products competitive on the world market) and business incubators (an organization that provides, under certain conditions and for a certain period of time, specially equipped premises and other property to small and medium-sized businesses starting their activities, in order to assist them in gaining financial independence). Rational financial backing creates opportunities for innovation development.
- Participation in the European Horizon Europe program which serves as the biggest EU initiative for research and innovation funding to support climate change and healthcare and digitalization projects.

So, the cluster cooperation mechanism enables progressive collaboration between large industrial enterprises and business structures together with SMEs and academic institutions and government bodies with local authorities to drive market competitiveness worldwide [1]

It is also a good practice when, large corporations regularly unite with startups and universities and research institutions to deploy modern innovative technologies while optimizing business operational procedures. For example, Open Innovation at Siemens functions through startup cooperation in artificial intelligence and automation by leveraging open innovation capabilities to bring new solutions into its portfolio [12].

Well, teamwork between different fields speeds up innovation through the combination of numerous skill sets. Business success through innovation requires organizations to create innovation consortia along with industry and academic collaborations and shared research facilities. National and global challenges require companies to participate in cross-sectoral projects which receive policy-led incentives [13].

CONCLUSION

A robust national innovation ecosystem emerges through combined ventures and business connectivity together with research partnerships. Industry 4.0 serves as a critical innovation tool but the essential factors for growth include regulatory frameworks in addition to investment incentives.

The research points out successful methods for ecosystem building while presenting systematic plans to promote lasting innovation development. Ukraine's innovation system will see a big improvement through the implementation of these practices. At the same time, success in sustainable growth requires institutions to establish various cooperative networks. That is, sustainable economic growth depends on enhanced cooperation between academic institutions and private sectors and government bodies besides better funding access alongside digital transformation initiatives.

Ukraine should implement specific initiatives to establish itself as an innovation center in Eastern Europe. International experiences will help Ukraine establish an innovation-based economy which follows global technological progress.

Based on the above, we can conclude that these practices are key components that significantly boost innovation ecosystem development efficiency which simultaneously produces meaningful economic growth and technological advancement.

Future research needs to develop quantitative formulas measuring innovation ecosystem efficiency along with evaluation protocols for diverse economic frameworks in which different systems adapt.

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ПРАКТИКИ, ЯКІ МОЖУТЬ БУТИ ВИКОРИСТАНІ ДЛЯ РОЗРОБКИ ІННОВАЦІЙНИХ ЕКОСИСТЕМ

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Мета дослідження полягає у розгляді національних інноваційних екосистем як економічної основи для технологічного прогресу та підвищення міжнародної конкурентоспроможності щодо стимулювання національної економіки. В умовах постійного прискорення інноваційних циклів країни мають впроваджувати цілісні підходи до стимулювання партнерства між державними інституціями, приватним сектором, академічними установами та організаціями громадянського суспільства. Зокрема, у статті розкриваються конкретні аспекти формування ефективної інноваційної екосистеми: створення сприятливого середовища для розвитку стартапів, розвиток кластерних асоціацій для посилення науково-промислової синергії, а також налагодження співпраці між університетами та бізнесом для обміну знаннями, комерціалізації наукових результатів і впровадження новітніх технологій..

Дослідження приділяє значну увагу тому, як технології «Промисловості 4.0» трансформують виробничі операції за допомогою автоматизованого контролю та штучного інтелекту. Кілька прикладів, детально описаних у статті, демонструють успішні моделі інноваційних центрів поряд із акселераторами та регіональними центрами, які об'єднують ключові зацікавлені сторони у Німеччині, Ізраїлі, Словаччини та Україні.

Наведений авторами міжнародний досвід може бути використаний державними управлінцями, бізнес-лідерами і науковцями, які працюють над формуванням стійкої національної інноваційної екосистеми. Така екосистема повинна ґрунтуватися на міжсекторальній співпраці, цільовому фінансуванні та стратегічних інституційних інструментах, здатних реагувати на національні виклики та глобальні технологічні тренди.

У процесі дослідження застосовувалися методи системного аналізу, синтезу та порівняльного підходу. Інформаційною базою стали наукові дослідження вітчизняних і зарубіжних фахівців, статистичні дані та аналітичні матеріали. У роботі використані матеріали наукових публікацій і періодичних видань.

Ключові слова: інновації; національна інноваційна екосистема; механізми публічного управління; розвиток кластерів; Індустрія 4.0; співпраця університету та бізнесу; підтримка стартапів.