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# Mechanisms of public management of cross-border innovation clusters: International models and prospects for Ukrainian regions

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**Abstract.** The relevance of the research topic lies in the growing role of cross-border innovation clusters as an important tool for regional economic development and enhancing their competitiveness through integration into global economic and innovation networks. The aim of the study was to analyse the development of cross-border innovation clusters, identify their advantages and opportunities for internationalisation in the context of globalisation and European integration. To achieve this, conceptual analysis methods, case studies, and empirical research were employed, focusing on various cross-border clusters, particularly in Europe and beyond. The findings revealed that cross-border innovation clusters contribute to the reindustrialisation of regions, reduce dependency on large corporations, and create competitive advantages for small and medium-sized enterprises. Case study analysis, including examples such as Future Position X in Sweden and the Cascadia Innovation Corridor in North America, demonstrated the significant potential of cross-border initiatives to attract new technologies, resources, and international markets. Key factors influencing the effectiveness of such clusters were identified, including geopolitical and institutional proximity, scientific-technological interaction, as well as cultural and relational aspects of cross-regional collaboration. Additionally, a model for the internationalisation

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of regional clusters was developed, encompassing clear stages for the coordination and development of external relations, enabling the full realisation of the international potential of clusters and fostering their effective development. This study can be valuable for government bodies, regional administrations, cluster organisations, small and medium-sized enterprises, as well as academic institutions in the development of cross-border cooperation strategies, optimisation of internationalisation, and the enhancement of innovation development in border regions

**Keywords:** cohesion policy; innovation policy; innovation systems; regional development; sustainable development

## Introduction

Against the backdrop of increasing globalisation of the economy, the trend of regionalisation has strengthened, which has been scientifically described in terms of "glocalisation". In the 21st century, regions in many countries have become active and independent participants in economic processes, creating an objective precondition for the intensification of international competition and highlighting the need for new approaches to the development of national economies, taking regional factors into account. As international experience suggests, clusters play an important role in the process of shaping and implementing regional strategies, which have been thoroughly analysed by J. Engel (2023). Regional development scenarios, based on the concept of competitive advantages, theoretically and methodologically rely heavily on the cluster approach. Its use aims to increase the competitiveness of the regional economy, ensure the inflow of knowledge and skilled labour.

However, the mere existence of a cluster does not automatically make a region competitive. For this, the regional cluster must occupy a significant place in the system of economic relations at both national and possibly global levels. One solution to this task, according to M.M. Salikhov (2025), is the active development of international and foreign economic relations within clusters, i.e., their internationalisation. This includes seeking investors, suppliers, and markets, as well as integration into international industry networks, expert communities, the development of research and technological platforms, and diverse communications in the context of globalisation. The integration of Ukrainian regional clusters into global value creation chains will enhance the national scientific and technological base, increase the speed and quality of economic growth by improving the international competitiveness of the cluster and its participants. Importantly, the main function of clusters is to drive economic growth. Accordingly, as noted by M. Heidenreich & J. Mattes (2025), their internationalisation is not an end in itself, but one of the forms and tools for attracting the resources that the region lacks. In this regard, the most popular mechanism for such internationalisation is cross-border innovation clusters.

Cross-border clusters are networks of interconnected businesses, suppliers, and institutions in neighbouring countries that collaborate across national borders to enhance regional competitiveness, innovation, and economic development, leveraging shared geography and resources for mutual benefit. These clusters often focus on specific sectors, such as logistics, tourism, or technology, through joint projects and strategies. They are a strategic tool for peripheral regions to overcome border-related challenges and integrate into broader economic zones, improving trade and knowledge exchange (Reznikova *et al.*, 2020).

A key challenge facing regions today is the transition towards building a knowledge-based economy, where intellectual capital becomes central to the factors driving sustainable economic growth and social progress. In this regard, establishing innovation clusters in border regions, utilising the opportunities provided by cross-border cooperation, is essential to engage in more meaningful global economic interactions. Research by H.A. Alcalde-Heras *et al.* (2024) and N. Danko & O. Izmailov (2025) showed that the development and implementation of innovation is the most promising method for increasing the competitiveness of regional economies.

Despite the growing interest in cluster policy and internationalisation, a thorough analysis of the opportunities and challenges of integrating cross-border innovation clusters, particularly in the context of Ukraine's border regions, is still lacking. For Ukraine, which aspires to join the European Union, adopting best practices from Europe and other parts of the world in the formation and development of clusters has become one of the key reform priorities. Studying foreign experience in cluster policy will help draw conclusions about effective mechanisms for developing innovation clusters and forming networks between businesses, research institutions, and government bodies. The aim of this study was to analyse the development of cross-border innovation clusters as a tool for enhancing the competitiveness of border regions, specifically Ukraine, through integration into international economic and scientific-technological networks.

## Materials and Methods

The study of cluster internationalisation is a relatively new subject in academic research, which requires the use of methods capable of comprehensively analysing complex economic processes. This research was based on the analysis of existing theoretical approaches and empirical data related to cross-border innovation clusters. The primary method employed in the research was systemic analysis, which allowed for the consideration of clusters as part of a broader regional economy, examining their interconnections with other economic entities, as well as with cross-border institutions. Qualitative research methods were used, including the analysis of scientific publications, monitoring regional initiatives and programmes, as well as the analysis of specific case studies of cross-border clusters. Additionally, conceptual review and modelling techniques were applied.

Conceptual analysis facilitated a deeper understanding of various subject areas, particularly the internationalisation of regional clusters, and enabled conceptual modelling of objects that reflect the essence and interrelations of these processes. In this context, objects were described not only through their basic properties but also through the properties of relations between them, significantly enhancing the theoretical analysis of complex subject areas.

The methodology of the study also involved the use of the case-study method, which was crucial for examining real examples of building and developing cross-border innovation clusters. This allowed for the analysis of cross-border cooperation experiences in different regions of the world, including clusters such as Future Position X (FPX) in Sweden, the Cascadia Innovation Corridor between British Columbia and Washington State, and the Hong Kong-Shenzhen cluster. As a result, basic principles defining the effectiveness of cluster internationalisation were formulated, and a model algorithm for organising this process was proposed.

An important element of the methodology was also the analysis of the impact of various factors on the effectiveness of cross-border cooperation, including geopolitical, economic, institutional, and technological aspects. Special attention was paid to internationalisation models for clusters, including the development of an algorithm to determine the stages of this process, which enables the evaluation of cooperation potential among participants and coordination of international relations at each stage of the cluster's development. Key research methods also included analysis of external connections, and benchmarking to compare clusters from different regions. This approach allowed for the identification of the strengths and weaknesses of cross-border innovation clusters.

The research's source base comprised academic works examining the cluster approach in economics and the internationalisation of business entities. Literature searches were conducted through scientometric databases such as ScienceDirect, MDPI, ResearchGate, and Taylor&Francis, as well as through direct searches on Google. Key search queries focused on cross-border cooperation between regions in the context of innovation development. This methodological approach, which combined conceptual analysis, case studies, and several analytical methods, provided a deep understanding of the processes of international integration of regional clusters and their development through cross-border cooperation.

## Results and Discussion

Cross-border innovation clusters are a significant tool for strengthening regional innovation potential. According to the Industry 4.0 concept presented at the Hannover Messe in Germany in 2011 (Włodarczyk, 2019), new opportunities for creating innovation clusters have emerged, combining innovations with networked production systems. A key feature of such clusters is the use of cutting-edge network technologies to develop new products and services. These cross-border innovation clusters result from the implementation of innovation strategies at the regional level. Their advantage lies in their ability to promote the reindustrialisation of regions, reduce dependence on mass production monopolies, and enable successful competition with large corporations by focusing on consumer needs.

Research on innovation in recent years has become a crucial part of regional scientific studies, particularly due to its growing significance in developing new knowledge and economic growth. Most of these works focus on the concept of regional innovation systems (RIS), where the emphasis is on how spatial proximity and institutional structures contribute to innovation, particularly in generating and disseminating knowledge (Asheim *et al.*, 2019). However, given that RIS often encompass cross-border contexts that include different countries or administrative units (Wang *et al.*, 2021; Chandra *et al.*, 2023), the term "cross-border regional innovation systems" (CBRIS) has been introduced.

The concept of CBRIS emerged from discussions emphasising the need to expand the understanding of regional innovation dynamics across national borders, regardless of what these "borders" may represent. Cross-border innovation systems have become an important topic not only because of their existence but also due to their growing significance in the context of the increasing need for regions to develop cooperative links and economic interaction with neighbouring territories. The interdependence of innovation processes across borders is often highlighted by political initiatives, demonstrating the importance of CBRIS not only as an analytical tool for studying realities but also as a means of shaping normative strategies that promote innovation (Derudder & Liu, 2025). Overall, the development of CBRIS highlights the potential to strengthen technologies and innovations across borders by integrating regional efforts and leveraging their complementarities.

N. Reznikova *et al.* (2020) identified several key determinants affecting the effectiveness of cross-border cooperation between regions. First, geopolitical factors such as proximity to peaceful or hostile states, as well as potential threats of border changes due to military conflicts, are crucial. Second, geoeconomic factors, particularly the ability to overcome technological asymmetry through integration into global value chains, are significant. This also includes the ability to engage in expansionist trade and investment activities, as well as utilising the potential of the internal market and diversifying the economic structure. Third is the institutional aspect, where higher institutional inclusiveness and a weaker extractive character of their activities make it easier to address structural defects and infrastructure deficiencies in the economy. This also contributes to a better ability of economic entities to adapt to the challenges of cross-border cooperation. The last factor is the structural aspect, considering the regional resource potential, including mineral and human resources. The existing specialisation of a region can either stimulate or limit the effectiveness of cooperation.

A. Osarenkhoe & D. Fjellstrom (2022) investigated how a cluster organisation creates a platform to foster itsinternationalisation, thereby enhancing the competitiveness of its participants within the regional innovation system. This is achieved by providing access to global value chains

and promoting innovation. They applied an interaction approach, which emphasises the process of interaction, partners, relationships, and the environment of these relations. The qualitative research was conducted in the Swedish cluster organisation, Future Position X (FPX). Between 2017 and 2019, 58 interviews were conducted, including 48 in-depth interviews with key respondents, representatives from 28 small and medium-sized enterprises, 10 members of the regional innovation systems to which FPX belongs, and four managers of regional and local networks. Additionally, in 2021, online interviews were conducted with 10 members of the regional innovation systems via Microsoft Teams. The results revealed that the FPX cluster actively interacts with participants in the quadruple helix, facilitating the signing of new partnerships globally to ensure the necessary resources and expertise that allow firms in the FPX network to enter international markets. Thus, internationalisation expands the cluster's knowledge base beyond the usual environment of its participants. The common goal of these participants was to engage in new innovations, establishing companies, products, and services for sustainable and smart cities of the future. This encompasses both the private and public sectors, implementing projects in research, development, monitoring, and evaluation. A. Osarenkhoe & D. Fjellstrom (2022) noted that the FPX innovation platform is actively used by companies and organisations seeking new models of interaction with users, clients, or markets to support innovation.

J. Wang *et al.* (2021) explored the development of the cross-border innovation system of Hong Kong-Shenzhen, focusing on cognitive proximity, interaction between innovation actors, cooperation, and global connectivity. To achieve this, the authors analysed patent and publication data from 2001 to 2015. The results indicated substantial potential, particularly through the growing convergence of scientific research between the two cities, steady growth in collaboration outcomes, and complementarity among innovation actors. The authors highlighted that the effectiveness of cross-border regional innovation systems (CBRIS) can be systematically evaluated through the analysis of cognitive proximity, collaboration level, and connectivity between participants.

According to S. Neuberger *et al.* (2023), the innovation environment in cross-border agri-food enterprises significantly influences the processes of developing and launching innovative products. The authors developed a conceptual framework to define the "cross-border innovation environment", based on the theoretical foundations of innovation systems and innovation management. To analyse this, a series of semi-structured interviews were conducted with representatives of agri-food enterprises located in the Netherlands-Germany region of Rhine-Waal. The study showed that the innovation environment of these enterprises was mostly oriented towards national-level factors, while cross-border aspects and links between regions were less pronounced. Innovations in these enterprises were predominantly driven not only by scientific or research achievements but also largely by market demands and consumer needs. The researchers highlighted the importance of integrating clients and business partners during research and technological development stages, which is essential for overcoming current challenges, particularly those related to ecological transformation in line with the EU Green Deal requirements. Understanding how the innovation environment impacts innovation processes in agri-food enterprises can assist in the development of relevant policies.

F. Cappellano (2019) examined the concept of cross-border innovation economies using the example of the Cascadia Innovation Corridor – a geographical region located between British Columbia (Canada) and Washington State (USA), which is unique in its economic integration and development. Cascadia has become an important example of a region embedded in several socio-ecological discourses, with sustainable development as its core theme. This concept is supported by all political parties advocating for ecological positivism, which encompasses not only economic but also environmental aspects of development. In the 21st century, the two main cities of the Cascadia region – Seattle and Vancouver – have become key economic hubs, particularly in the high-tech sector. These cities are actively developing in fields such as computer science, aviation, logistics, and biotechnology, and have earned global recognition through world-class companies such as Microsoft, Amazon, and Boeing. Both cities share many economic clusters (Table 1), which fosters both cooperation and competition. The mobility of highly qualified labour is an important factor for the growth of these economies.

***Table 1.*** *Key economic sectors of Seattle and Vancouver, British Columbia*

| No. | Seattle | Vancouver, British Columbia |
|---|---|---|
| 1 | Business services | Business services |
| 2 | Aerospace and defense | Distribution and e-commerce |
| 3 | Distribution and e-commerce | Education and knowledge creation |
| 4 | Information technology and analytical instruments | Hospitality and tourism |
| 5 | Hospitality and tourism | Financial services |
| 6 | Education and knowledge creation | Transportation and logistics |
| 7 | Transportation and logistics | Marketing, design, and publishing |
| 8 | Marketing, design, and publishing | Wood products |
| 9 | Wood products | Information technology and analytical instruments |
| 10 | Insurance services | Communication equipment and services |

***Source:*** *F. Cappellano (2019)*

This table shows that both Seattle and Vancouver share similar economic sectors, which fosters the development of joint innovation initiatives and reduces barriers for inter-city collaborations. This synergy between the cities stimulates not only workforce mobility but also the exchange of knowledge, technologies, and investments. Since 2016, supported by Microsoft, the "Cascadia Innovation Corridor" initiative has aimed to transform the region into a global technology hub. The plan focuses on leveraging the region's competitive advantages to promote it on the global stage. One key element is the development of transportation infrastructure, including the high-speed rail project designed to connect the major cities of Cascadia and reduce travel time between them. This project has received funding from both the governments of British Columbia and Washington State, as well as private investors, highlighting support for regional integration. Additionally, alternative transportation options, such as hydroplanes, are being considered to connect Seattle and Vancouver, where major international tech companies are headquartered (Cappellano, 2019).

A valuable contribution to understanding the factors that define innovation interactions in cross-border regions was made by H. Basche (2022). In his work, the author analysed the impact of institutional and technological proximity, spatial distance, and European integration on innovation links, measured by the number of joint patents in 45 cross-border regions of Europe. Using negative binomial gravity models, the scholar identified key determinants that explain variations in cross-border joint patenting levels. Specifically, the results show that spatial and technological distances consistently have a negative impact on joint patenting activity: the further the regions are from each other and the less technologically similar their innovation bases are, the fewer joint patents they generate. In contrast, institutional proximity, measured by the presence of a common official language, significantly stimulates such cooperation: regions with a shared language have 1.83-2.49 times more joint patents under otherwise equal conditions. An important and surprising finding was the role of European integration: longer EU membership is associated with reduced joint patenting activity, while membership in Central and Eastern European countries has a positive impact on patent cooperation. This means that, compared to cross-border regions of founding EU states, Eastern European cross-border regions demonstrate higher innovation interaction in the form of joint patents under the same conditions. Therefore, it is not only geographic and technological barriers that hinder innovation cooperation, but also cultural and institutional factors play a crucial role. These findings are especially relevant for Ukraine, which is currently working on developing cross-border innovation clusters, as they show that reducing institutional barriers and enhancing commonality (linguistic, regulatory, cultural) can foster greater innovation interaction in border regions.

Numerous studies dedicated to innovation and regional integration meticulously explore the barriers associated with the lack of geographical and relational aspects of territorial proximity. However, an analysis of existing thematic research has shown that the relationship between different types of territorial proximity and the level of integration is significantly more complex and ambiguous than the CBRIS concept suggests. For instance, contrary to expectations, even regions with a high level of relational proximity are rarely strongly integrated (Peck & Mulvey, 2018; van den Broek *et al.*, 2018; Cappellano & Makkonen, 2020). Moreover, cultural and institutional differences, which may initially seem to be barriers for cross-border innovation, sometimes not only do not hinder these processes but may even enhance them (Makkonen *et al.*, 2018). It turns out that the elements of the CBRIS model that influence cross-border integration are not always linearly related: some aspects of integration may promote innovation, while other integration models may have either no effect or a considerably weaker one.

N. Maroun (2025) analysed cross-border cooperation between clusters within the framework of the Euromed Clusters Forward (ECF) programme, funded by the European Union in coordination with ANIMA and Berytech. This initiative focuses on cluster development in the Mediterranean region by fostering cross-border cooperation between southern and European partners. The cooperation includes resource sharing, strategic coordination, and aligning efforts to address common challenges, thereby strengthening the overall sector and regional competitiveness. According to his conclusion, by working together, the involved clusters aim to expand their reach to global markets, increasing their collective impact and competitiveness internationally. Therefore, this enhances the efficiency and effectiveness of the entire value chain.

Knowledge transfer within clusters can be effectively simplified through structured initiatives, such as the Euromed Clusters Forward Face-to-Face Academy, which offers training programmes to support clusters in developing strategies to improve their value chains. Additionally, initiatives like technical assistance (TA) vouchers provide clusters with access to expert support, helping them stay updated on the latest trends in the industry. These structured programmes ensure that knowledge sharing is not merely incidental but an integral part of cluster cooperation. Clusters can form meaningful joint partnerships through initiatives like Cluster Connect, which fosters partnerships and partner searches between clusters and supporting organisations in various industrial ecosystems. This promotes collaboration between clusters and between small and medium-sized enterprises, providing businesses with access to new technologies, resources, and regional markets. This collaboration is further supported by initiatives such as Tech Days and joint projects, which serve as platforms for innovation and the establishment of strong cross-border partnerships.

Clusters can combine their resources and experience for targeted initiatives through political dialogue sessions and Tech Days within the Euromed Clusters Forward framework. These initiatives focus on common goals such

as sustainable development, digital transformation, and workforce development. By collectively addressing these challenges, clusters can create solutions that benefit all participants in their value chains. These targeted initiatives, aligned with international standards, particularly for entering EU markets, ensure the global competitiveness of the clusters.

Ukrainian researcher O. Demedyuk (2020) attempted to identify the prospects for the development of cross-border clusters along Ukraine's western border, considering their proximity to the EU, the specialisation of neighbouring regions, and the peculiarities of cluster functioning in Ukraine. The article discusses the specifics of cluster policies in both the EU and Ukraine. The author noted that geographic proximity to the European Union and a shared border with four of its member states open significant opportunities for Ukrainian companies, especially those based in border regions. These companies can adopt positive experiences in clustering from neighbouring countries, expand their activities beyond the border, participate in EU cluster development initiatives and programmes, or even create cross-border clusters that meet modern European standards in this field. The article also emphasises the importance of one of the key directions of European cluster policy: the internationalisation of clusters. This process involves activating network cooperation between clusters and business structures across borders and between different sectors in both Europe and third countries. To achieve this goal, several initiatives have been launched, including the European Cluster Collaboration Platform. It provides companies with the opportunity to present themselves, exchange experiences, find partners for cooperation, and access information about already implemented or ongoing cluster development projects. Furthermore, the platform offers data on current calls within development programmes. Under its aegis, international events are held to find partners both within EU member states and third countries, including Ukraine. These events often take place in countries outside the European Union, demonstrating an open approach to cooperation. However, an analysis of cluster functioning on Ukraine's western border revealed certain issues. The activities of some clusters remain declarative, and after their establishment, there has been little follow-up action. For example, Lviv region has the largest number of clusters, while in Zakarpattia, despite having significant potential-particularly in logistics and cross-border activities – this area is largely ignored. Attracting EU funding through joint projects plays an important role in stimulating regional economic development, creating new jobs, and enhancing the investment attractiveness of border areas.

Cooperation between the border regions of Ukraine and EU countries is gradually becoming a powerful driver of innovative consolidation and knowledge exchange, realised through the Interreg NEXT cross-border cooperation programmes. This strengthens integration with the EU at the local level, attracts funding, and supports the implementation of EU law, which is crucial for Ukraine's European integration. Ukraine has actively joined several programmes, including Interreg NEXT Poland-Ukraine and Romania-Ukraine, which create opportunities for joint projects in regional development, business, and infrastructure. This cooperation enables the adoption of the European Union's experience in innovation, energy, ecology, and governance, which supports the implementation of modern approaches in these areas (Volkova, 2023).

Therefore, in Ukraine, cross-border cooperation (CBC) is considered from two key perspectives: as a tool for the development of border areas and as an instrument for realising the country's European integration goals. However, the development of CBC between Ukraine's border regions and neighbouring countries is significantly hindered by excessive ambition, the political situation, and the unclear definition of the role of European regions on the borders of Ukraine and Central European states. Although there is a declared desire to jointly solve problems in various spheres of public life, clear mechanisms to achieve these goals are still lacking. Additionally, regional cooperation projects in Ukraine are primarily implemented based on practical experience, which is done without proper theoretical or methodological foundations. As a result, there is an urgent need to create scientifically grounded frameworks that would facilitate more effective interaction between the border regions of Ukraine and the EU. These approaches could become a driving force for innovative development, the unification of efforts, and knowledge exchange.

In this context, it should be noted that traditionally an innovation cluster is seen as a set of interconnected economic actors located within a single geographical area (local clusters) or territorially distant (regional clusters), functioning within one or more industries and concentrating their resources. Based on the theory of multiplicities, the basic types of innovation clusters are identified (linked clusters – type A, new industrial zones – type B, innovation environment – type C, and neighbouring clusters – type D), which are characterised by the features of geographical location, the specifics of interaction and cooperation processes among cluster participants, as well as the degree of their integration (Table 2). The definition of the appropriate model for the internationalisation of a regional cluster is aimed at identifying the untapped potential for international cooperation among the cluster participants and adjusting the work on the development of its external connections. This allows for the optimisation of internationalisation strategies by taking into account the strengths and weaknesses of existing approaches. A brief description of the models is presented in Table 3. It is also possible to combine models, which allows for classifying various approaches to internationalisation depending on the level of involvement of cluster participants and their strategic orientations. The result of the formation and operation of an innovative cluster is the creation of innovation that will contribute to the emergence of competitive advantages. An important feature of any innovative cluster is the innovation-oriented

nature of its activities. Therefore, all cluster formations, regardless of their type, must continuously consider current trends and the latest changes, as well as seek ways to enhance their competitiveness.

***Table 2.*** *Characteristics of innovation clusters*

| Type of innovation cluster | Cluster characteristics |
|---|---|
| Type A.<br>Related clusters | ▪ location: within a city, often in the city centre;<br>▪ quick response to innovations;<br>▪ flexibility of the cluster;<br>▪ openness of the cluster |
| Type B.<br>New industrial zones | ▪ combination of large enterprises and small/medium businesses;<br>▪ location: outside the city;<br>▪ macro-international trade;<br>▪ effort to influence innovation through the planning of actions by manufacturers and suppliers;<br>▪ closed nature of the cluster |
| Type C.<br>Innovation environment | ▪ location: outside the city;<br>▪ importance of social capital;<br>▪ high degree of integration with the regional economy |
| Type D.<br>Neighbouring clusters | ▪ small and medium-sized enterprises and micro-firms;<br>▪ location: outside the city;<br>▪ micro-international trade;<br>▪ the region is a location, not part of the production system |

***Source:*** *created by the authors based on O. Mordvinov et al. (2021), D. Castellani et al. (2022), H. Karolyi et al. (2025)*

***Table 3.*** *Typology of regional cluster internationalisation models*

| Model name and description | Advantages | Disadvantages | Strategies |
|---|---|---|---|
| "Priority participation": one group of cluster participants serves as the main driver of internationalisation, while the other two groups are also involved in developing external relations but with less noticeable contributions | ▪ clearly defined focus of internationalisation;<br>▪ resource support for the chosen direction | ▪ untapped potential in other directions;<br>▪ less active participants may perceive internationalisation as someone else's responsibility | ▪ most active involvement of lagging participants in the internationalisation processes;<br>▪ development of common areas in the cluster's internationalisation |
| "Equal participation": at least two groups of cluster participants are equally involved in the internationalisation process. The concept of equal participation should be considered in the sense that the contribution to the development of external relations is equally high | ▪ strong competitive positions in the international sphere;<br>▪ consistency in actions among participants regarding external relations development;<br>▪ maximum realisation of internationalisation potential | ▪ risk of conflicts of interest among participants, or conversely, dilution of priorities and responsibility;<br>▪ maintaining balance requires significant effort and resources | ▪ regular assessment of participants' activities, adjusting internationalisation priorities;<br>▪ maintaining balance by the cluster organisation;<br>▪ searching for new internationalisation goals |
| "Exclusion participation": at least one group of cluster participants is not involved in the internationalisation process | ▪ indicates lack of urgency and artificial development of the cluster;<br>▪ can be a temporary phenomenon | ▪ uneven development of international connections of the cluster;<br>▪ lost opportunities in the "excluded" direction;<br>▪ risk of weakening the cluster's competitive position | ▪ analysing the internationalisation potential of the "excluded" participant;<br>▪ engaging the "excluded" participant in international projects of other cluster participants |

***Source:*** *created by the authors based on B. Sousa (2025), I. Piatnychuk et al. (2025)*

Based on the characteristics of the basic types of innovation clusters, it can outline their distinctive features, which reflect the presence of internal links between firms and individual participants in innovation activities, including both trade and non-trade relations, and related to social capital (qualified and trained personnel), physical capital (financing from company funds, venture capital, public grants, and loans). Therefore, participants in innovation clusters operate within a regional production network, in line with regional priorities and goals for innovation development.

In the current period, among the diversity of cluster formations, the innovative type of cluster has gained particular significance, as it uses innovation as a technology to achieve competitive advantages and as a means of achieving success, as well as a strategy for future development. For a regular cluster, innovation may manifest at a certain stage of the technological cycle, meaning that within an innovation cluster, the process from the idea's inception to its implementation must be ensured. Innovation clusters should be formed around specific areas of economic activity, such as covering one or more industries or even economic sectors, and should be oriented towards the production of final innovative products. In turn, the involvement of foreign partners in the cluster promotes investment from both the private and public sectors abroad, while foreign partners from the cross-border space can take on the role

of monitoring the cluster's activities, as well as facilitating the exchange of experience, particularly in the area of scientific developments, among others.

Economic and innovation links often span regional administrative boundaries, including international ones. However, political efforts frequently overlook this fact, thereby limiting the economic and innovative potential of many border regions. Promoting cross-border regional innovation policy is challenging due to several barriers, including those created by the policy itself. At the same time, political will is a crucial factor in launching or ensuring long-term support for cross-border efforts. Typically, the local level has the most interest, as it directly feels the costs and benefits. For innovation policy, the region is generally a more suitable scale than individual localities, as it encompasses the relevant range of firms, universities, employees, and other participants in innovation activities. National (and supranational) governments can either promote or hinder cross-border cooperation in the policy realm, depending on regulation and funding across a wide range of policies impacting the cross-border territory.

The formation and operation of innovation clusters in border regions within the framework of cross-border cooperation essentially aligns with the development of regional innovation clusters as a whole. However, an innovation cluster in a border region, which is formed, operates, and will develop under cross-border cooperation conditions, differs from a regional innovation cluster and enables the utilisation of advantages inherent in cross-border cooperation, defined by its territorial placement. A cross-border innovation cluster involves the unification of relevant participants who gain positive effects and competitive advantages from collaborating within the respective cross-border space.

Intersectoral connectivity, which is an integral part of the cluster concept, is a decisive factor for creating a critical mass for transformative activities. Furthermore, clusters often bring together participants of the quadruple helix, which is critically important for cooperative leadership in the process of entrepreneurial innovation. H. Alcalde-Heras *et al.* (2024) examined the characteristics that allow cross-border cooperation initiatives to evolve into cross-border clusters that support smart specialisation strategies. The study focused on how to eliminate barriers to traditional cooperation and encourage companies to adhere to smart specialisation plans. The analysis was based on the development project of a cross-border cluster in the cross-border region of Nouvelle-Aquitaine – Basque Country – Navarre (NAEN). The authors identified six critical opportunities that cross-border cooperation projects should develop to support the emergence of cross-border clusters: adaptability, territorial connection, network management group profile, facilitation, openness, and acceleration.

Modern competition is global, and therefore, neighbouring regions may need to resort to "cooptation" – collaboration aimed at strengthening competitive positions. It is important to understand the potential costs and benefits, as well as the alignment or lack of appropriate incentives. Usually, favourable conditions for innovation in a region increase the benefits and reduce costs. However, implementing innovation policy can be challenging, as it is difficult to predict the outcomes given the initial costs and the uncertainty that often accompanies investments in this area. Furthermore, over time, additional measures can be taken to increase economic efficiency. The cost of lack of cooperation may even turn out to be higher. Experts of Organisation for Economic Co-operation and Development (OECD) C. Nauwelaers *et al.* (2013) provided several key recommendations for managing cross-border cooperation:

- policies should be motivated to address this issue, understanding that their timelines and motivations are typically short-term;
- identify the points for national (supranational) governments where they can support cross-border efforts;
- assess various costs and benefits, as well as their alignment at the international level to ensure long-term cooperation that fosters trust;
- involve non-governmental structures in governance by creating secretariats that support the activities of official (even informal) governance bodies.

Cross-border tools will be more effective if they are part of a broader strategy or action plan based on data, participant mapping, and analytics. Sometimes, cross-border political tools serve as experimental tests, allowing participants to test them in traditional innovation programmes. However, since government funding is often limited by national borders, an alternative solution is to harmonise tools across borders, allowing participants from different jurisdictions to cooperate more effectively. Tools that force cooperation when barriers exist (due to regulations, funding, or lack of quality partners) cannot be sustainable. International experience with various political tools allows identifying their advantages and disadvantages so that lessons learned can be applied in other regions.

Based on the network model of internationalisation developed by J. Johansson and L. Matgsok, four scenarios of regional cluster internationalisation can be identified (Formahl & Grashof, 2021):

- "Potential internationalisation": neither the cluster itself nor the region where it is based has developed international and foreign economic relations;
- "Internationalisation alone": the cluster already has developed relationships with foreign partners, but the region does not engage in active international activity. Advantage – the cluster holds a pioneering position. Disadvantage – lack of necessary support from regional institutions;
- "Delayed internationalisation": the cluster, with low levels of international contacts, is located in a region where other entities are actively developing external connections. Advantage – integration into the international space is facilitated by actively learning from the leaders. Disadvantages – high competition and lost opportunities;
- "Supported internationalisation": both the cluster and its base are characterised by a high level of internationalisation. In this situation, the cluster can make the most

of the region's external connections, while the region gains maximum benefits from the cluster's international activity.

One of the issues with the internationalisation of regional clusters is the underdeveloped coordination system and fragmented methodological support for this process, which leads to the need to create comprehensive methodological developments. The creation of these developments is one of the most important functions of public management in cross-border innovation clusters. The internationalisation algorithm for the cluster should be understood as a specific sequence of actions aimed at developing international and foreign economic relations within the cluster. The content of its main stages is presented in Table 4.

***Table 4.*** *Content of the main stages of the internationalisation algorithm for a regional cluster*

| Stage title | Description |
|---|---|
| 1. Goal setting | ■ identifying participants interested in the development of international cooperation at a specific stage of the cluster's life cycle and studying their motivation;<br>■ developing a goal tree;<br>■ defining target indicators for internationalisation effectiveness |
| 2. Diagnosis | ■ assessing the cluster's existing external connections, international potential, resource capabilities, and limitations for internationalisation;<br>■ analyiing the external environment;<br>■ studying foreign cluster websites and databases, specialised cluster development institutes, and promoting international cooperation;<br>■ analysing statistical information, benchmarking domestic and foreign clusters using case study methods (successful practice analysis) and active participation (attending specialised seminars, exhibitions, conferences) |
| 3. Programme development | ■ SWOT analysis of internationalisation vectors, assessing the prospects for developing the cluster's external connections;<br>■ designing key measures to implement strategic priorities and target indicators for internationalisation in key areas;<br>■ developing effectiveness indicators (target indicators for programme implementation) |
| 4. Preparation | ■ distributing responsibility for the development of international activities and creating a coordination mechanism;<br>■ searching for and attracting necessary resources, their distribution;<br>■ operational planning of international activities;<br>■ employee training;<br>■ establishing contacts with administrations, embassies, international organisations in Ukraine, trade missions abroad, chambers of commerce;<br>■ selecting partners;<br>■ preparing and disseminating information about the cluster and its participants |
| 5. Project organisation | ■ developing specific projects for the development of international cooperation in various areas: education, research, manufacturing, organisational, marketing;<br>■ implementing initial projects;<br>■ evaluating results;<br>■ feedback;<br>■ disseminating positive experiences |
| 6. Functioning | ■ maintaining information about the cluster and its participants in international databases;<br>■ participating in specialised events and organising events with invitations for foreign participants;<br>■ systematising international contacts of cluster participants and stimulating knowledge exchange;<br>■ interacting with government structures and development institutes;<br>■ interacting with foreign clusters at professional community platforms, expanding the pool of partners;<br>■ regularly upgrading specialists' qualifications |

***Source:*** *created by the authors*

One of the challenges in the management of the internationalisation of regional clusters is the weak development of the coordination system and methodological support for this process. The proposed algorithm for developing a regional cluster internationalisation programme is aimed at organising the activities of the cluster's participants and coordinators to maximise the realisation of its international and external economic potential. It is also appropriate for developing programmes to strengthen, restructure, and optimise cooperation between the border regions of Ukraine and EU countries.

## Conclusions

The article explored the advantages and opportunities of creating innovative clusters in border regions through cross-border cooperation. The results confirmed that such cooperation has a significant impact on enhancing regional competitiveness, fostering innovation, and improving the overall quality of life for local populations. In this context, a cluster serves as a direct tool for introducing economic and innovation-driven changes within a region. This is supported by the successful use of the cluster model in other countries, where such initiatives have proven effective. Cross-border sectoral clusters are presented as vibrant, dynamic platforms for interconnected knowledge-based activities, shared among complementary partners in a close geographical setting, where success lies in the ability to leverage the experience of their members to boost the overall competitiveness of the group. The strong dynamics of innovation generation in regions are crucial for achieving national and regional growth targets. Furthermore, clusters are not bound by borders but are often distributed across

several different territories, which promotes inter-regional collaboration, often seen as an advantage in reaching a critical mass in transformational operations. The importance of such initiatives is underlined by clusters' ability to stimulate regional value chains and contribute to global innovations and economic growth.

The article discusses four internationalisation scenarios for clusters, including "potential internationalisation", "internationalisation in isolation", "late internationalisation", and "supported internationalisation", which allowed for the analysis of clusters' involvement in international processes. An internationalisation algorithm was also developed for clusters, including stages from goal setting to project implementation, aimed at effectively organising international cooperation. Key aspects of this process included analysing external links, developing strategic priorities, and coordinating actions among all cluster participants. Conceptually, this approach enables the classification of various internationalisation strategies and helps determine the most effective paths for international cooperation. The results obtained demonstrate that the internationalisation of clusters in border regions is an important tool for their integration into global economic and innovation networks.

Further research should focus on studying the impact of cultural and institutional barriers on the effectiveness of cross-border innovation clusters, as well as developing new models for improving collaboration between different regions. Additionally, it is essential to explore mechanisms for supporting cross-border initiatives from both public and private entities to ensure the sustainable development of such clusters.

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## Conflict of Interest

None.

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# Механізми публічного управління транскордонними інноваційними кластерами: міжнародні моделі та перспективи українських регіонів

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**Анотація.** Актуальність теми дослідження полягає в зростаючій ролі транскордонних інноваційних кластерів як важливого інструменту для розвитку регіональних економік та підвищення їх конкурентоспроможності через інтеграцію в глобальні економічні та інноваційні мережі. Метою роботи був аналіз розвитку транскордонних інноваційних кластерів, виявлення їх переваг та можливостей для інтернаціоналізації в контексті глобалізації та євроінтеграції. Для досягнення мети було використано методи концептуального аналізу, кейс-стаді, а також емпіричне дослідження на прикладі різних транскордонних кластерів, зокрема в Європі та за її межами. Результати дослідження показали, що транскордонні інноваційні кластери сприяють реіндустріалізації регіонів, зменшують залежність від великих корпорацій і створюють конкурентні переваги для малих і середніх підприємств. Аналіз кейсів, зокрема таких як Future Position X у Швеції, Інноваційний Коридор Каскадії в Північній Америці та інші, продемонстрував значний потенціал транскордонних ініціатив для залучення нових технологій, ресурсів і міжнародних ринків. Визначено важливі фактори, що впливають на ефективність таких кластерів, зокрема геополітична і інституційна близькість, науково-технологічна взаємодія, а також культурні та реляційні аспекти співпраці між регіонами. Крім того, було розроблено модель інтернаціоналізації регіональних кластерів, яка включає чіткі етапи координації та розвитку зовнішніх зв'язків, що дозволяє максимально реалізувати міжнародний потенціал кластерів та сприяє їх ефективному розвитку. Це дослідження може бути корисним для державних органів, регіональних адміністрацій, кластерних організацій, малих та середніх підприємств, а також академічних установ для розробки стратегій транскордонної співпраці, оптимізації інтернаціоналізації та покращення інноваційного розвитку в прикордонних регіонах

**Ключові слова:** політика згуртування; інноваційна політика; інноваційні системи; регіональний розвиток; сталий розвиток

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