CLUSTERING AS AN INNOVATIVE TOOL FOR ADMINISTERING THE DIGITAL ECONOMY AND SUSTAINABLE DEVELOPMENT

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The creation of clusters in modern agribusiness is a promising direction for the sustainable development of the country's economy due to the possibility of obtaining advantages in optimizing production processes, increasing the efficiency of resource use, forming venture capital, and stimulating innovation. We propose to define a cluster as a set of industries that are combined vertically and horizontally to gain competitive advantages. The advantage of this approach is the focus on management and sustainable development processes. A cluster in agribusiness is a set of agribusiness entities that function as a system and achieve higher performance results based on complementarity, cooperation, and coordination of activities. We consider a strategic alliance to be a type of cluster, the main advantage of which is flexibility and the inclusion of companies from different sectors, projects and government organizations. Studies have proven the establishment and effective functioning of creative clusters in Ukraine, which contribute to the formation of an innovative environment and favorable conditions for the functioning of clusters in other areas. A model of cluster sustainable development in Ukraine is proposed, which allows the level of influence of a set of factors on GDP, in particular, equipment and technology, labor force, level of investment attraction, exports and imports, etc.

Keywords: innovation, management decisions, entrepreneurship

DOI: 10.24263/EDSD-2024-6-13

Received 30.04.2024
Received in revised form 21.10.2024
Accepted 12.11.2024

Introduction

The general conditions for the information and telecommunication technologies sustainable development, as well as the ecosystem and infrastructure, are the most influential factors in the sustainable development of the Ukrainian public sector. Numerous skilled professionals and competitive salaries are the main prerequisites for dynamic economic growth in Ukraine's regions. The imperfect business environment (including deficiencies in the fiscal system, a high level of shadow economy, destroyed infrastructure, and corruption) as a key obstacle to entrepreneurial initiatives worsens economic security in general and negatively affects the quality of the public innovation system. Cluster cooperation in the economic sphere is seen as a way out of this situation.

The purpose of the article is to assess the innovation, investment and institutional environment of the regions in terms of the capacity and prospects for the sustainable development of clusters, trends, features, strategic priorities, directions of their functioning and specifics of asset capitalization. The objectives of the study were: 1) to assess the role of the innovation ecosystem and venture capital in the development of clusters in Ukraine; 2) to identify the institutional conditions for the formation of clusters in domestic agribusiness, as well as to justify the appropriate mechanism

for their creation (initiative of the business sector or central and local authorities), structure and system of interconnections in them.

Literature review

The expediency of forming cluster structures is justified by both practical experience and theoretical provisions. Analytical studies of the performance of enterprises show that cluster members achieve higher productivity, are more active in implementing innovations, and are characterized by better economic efficiency and profitability. Clusters are one of the most effective tools for the formation and implementation of an effective macroeconomic policy aimed at creating conditions for the sustainable development of the country's economy and ensuring environmental protection. These conditions can be ensured through the efficient allocation of resources and the improvement of internal and external strategic relations (Navickas, 2018; Prysiazhniuk, 2018; Cooke, 2015). Based on studies of various types of clusters in countries around the world proved that the effects of their activities are influenced by age (Jirčíková, 2013). It can be concluded that the effectiveness of work depends on the degree of interaction, time-tested reliability and consistency in problem-solving. Using the example of the aerospace sector, prove the possibility of changing clusters, i.e., their transition from one type to another (initially, clusters in this area were formed according to the geographical criterion, and later moved to a translocational community) (Turkina, 2016). This led to the strengthening of horizontal ties between partner organizations. One of the important roles played by clusters is to improve export performance by enhancing innovation in all sectors. Agglomeration economy of a regional cluster is a determining factor in ensuring innovative development and has an impact on export performance (Prim, 2016).

Practice of using geographical clusters demonstrates their effectiveness, in particular, with the example of the state of California. It is necessary to form clusters not on the principle of copying the best practical industry examples, but to take into account the peculiarities of the development of a particular region and the peculiarities of public policy (Hospers, 2009). Clusters contribute to the growth of business development opportunities in the global economy, as well as to the understanding of how to reconcile competition and cooperation. The location of enterprises affects management decision-making and creates prerequisites for economic research, in particular, on the example of the wine cluster (Danaa,n, 2013). The sustainable development of agribusiness is closely related to entrepreneurial initiative, which is influenced by a set of factors identified by cluster analysis methods. The main ones to be awareness and resistance to change, staff qualifications, regulatory framework, customer focus and ensuring sustainable development of the country's agricultural sector (Kucher, 2021; Khodakovsky, 2020).

The advantages of the cluster approach provide opportunities for effective project implementation in the agricultural sector (Galchynska, 2021). In particular, this applies to the sustainable development of bioenergy in Ukraine. Clusters are based on regions where crops used in bioenergy are grown, and their goal is to improve the supply of energy resources to the regions. One of the important issues that the leadership of each country should address is food security, which can be eliminated by forming interregional clusters (Vasylieva, 2017). The efficiency and practical significance of the cluster approach in balancing supply and demand in the dairy and meat markets are substantiated. The importance of clusters in agribusiness for rural development (Castell, 2022). Clusters in rural areas, according to the authors, are most appropriate to form if there is an effective combination of demand for products (including those formed by the urban population) and the supply

that it can provide. The researchers emphasize the need to develop transport infrastructure for the sustainable development of clusters in the agricultural sector.

Materials and Methods

The methodological basis of the study is based on the fundamental provisions and principles of economic theory, public administration practice, system analysis and clustering concepts of open nonlinear systems. Research involved the use of Data envelopment analysis (DEA). The basic methods of the study were structural-functional and factor analyzes (which allowed to identify trends and features of cluster sustainable development in Ukraine and the factors and mechanisms of their activation). As a result of using a systematic approach to management, measures to improve the innovation system and the mechanism of public management of clusters are proposed. The hypothesis of the study is to intensify the development of agribusiness through the formation of integration formations and ensuring conditions for cooperation, efficient use of production resources, market formation, etc.

Results and Discussion

The conclusion that the analysis of modern competition allows us to draw is that competitiveness cannot be viewed as a macroeconomic phenomenon, managed by the government through the management of exchange rates, interest rates, and budget deficits. It is also not solely dependent on the natural resources available. We believe that the basic factor of competitiveness at the national level is productivity based on innovation. Currently, internal competition has become an incentive to improve efficiency. As for the industry, it is rather not a single sector, but a number of sectors that are connected technologically, geographically, and through other network or vertical ties. We propose to call such segments clusters. In a cluster, the mutual influence of all the determinants of the national rhombus is enhanced. That is why increasing the competitiveness of firms can be viewed through the prism of maintaining competitive advantages through a cluster.

Clusters are characterized by the accumulation of many firms and other structures linked by chains of vertical and horizontal organization (The concept, 2023). Clusters can be identified through common sales channels and the production of by-products or services. Identification of organizations that provide special skills, technology, information, capital or infrastructure, any group formations of the cluster, and searches for governmental and other legislative structures allow for a more complete definition of cluster chains. The cluster boundary should include all firms, industries, and organizations with which the linkages are essential. In fact, it is a transformation of the traditional sectoral approach in favor of integration, grouping of companies and sectors. Clusters are more in line with the nature of competition and sources of competitive advantage, because they are better than industries at covering connections, complementing each other, ensuring cross-sectoral cooperation, disseminating technologies, skills, information, improving marketing and understanding customer requirements. Such ties prove to be the most important levers of competition, productivity, identification of new business and innovation. Most of the cluster members do not compete with each other, but directly serve different segments of the industry. They share many common needs and opportunities, as well as common constraints and obstacles to productivity.

Considering a group of companies and organizations as a cluster allows for the identification of favorable opportunities for coordination and mutual improvement in the area of common interests, avoiding the threat of competition or intense rivalry. The cluster provides an opportunity for

constructive and effective dialog between companies, their suppliers, the government and other public institutions. Public and private investments aimed at improving the cluster's operating environment benefit many of its members. Assessment of the market situation through the sectoral approach has the potential to influence competition, while the cluster approach focuses on strengthening competition. By its very nature, it is a systematic approach to formulating a competitiveness strategy for enterprises. No country can be competitive in all areas of activity, so it can apply a cluster focus around key industries. The clusters should include the service sector (distribution and banking systems). This will bring products and technologies closer to the end user. Business benefits from cluster sustainable development under such conditions depend on the cluster's characteristics (ability to increase efficiency and reduce costs), its current activities, and the increased flexibility and innovation potential in creating new products, technologies and markets.

Forming strategic alliances as a type of cluster has a number of advantages. Unlike conventional long-term cooperation, where the parties are guided by stipulated agreements, strategic alliances are flexible structures. They provide for changes in initial conditions and risk sharing to achieve common strategic goals. Strategic alliances form a new business strategy, open up new and unique growth opportunities by bringing together partners, including customers, suppliers, competitors, developers, and government representatives, overcoming barriers between firms with different business management styles. The creation of strategic alliances reduces barriers and simplifies access to markets, increasing the level of competition and creating greater benefits for the participants. As a result, strategic networks emerge that flexibly connect all participants, regardless of their field of activity and place in the value chain (manufacturing, trading firms, research and design institutes, government agencies). Alliance members united by agreements are focused on achieving common goals (World, 2023). Commercial returns from cooperation are summarized by the results of their own independent activities.

Currently, there are more than 10,000 clusters in the world, the largest of which are located in China, the United States, Europe, and Japan (Global innovation, 2023). Clusters unite thousands of companies from various sectors of the economy, including IT, manufacturing, pharmaceuticals, biotechnology, etc. The development of clusters in the world is recognized as a consequence of increasing the innovativeness of enterprises, their competitiveness, economic diversification, labor productivity growth, and the creation of new jobs and employment. The problems associated with the sustainable development of clusters include their concentration in large places, uneven development of regions, insufficient financing of activities, and a lack of effective mechanisms for establishing cooperation, in particular with public authorities. The policies of the governments of the world's leading countries are focused on overcoming these problems.

There is no institutional environment for cluster associations in Ukraine, as clusters are not defined in national legislation as independent business entities, so there are no official statistics on the number of employees, profits, added value or generated income and activities. However, research suggests that creative industries, the IT sector, and industrial production are developing. Since all large companies are located in agglomerations, they form relevant clusters there. Currently, the state policy in Ukraine is aimed at preserving the Ukrainian language as a means of expressing the values of society. Television is the most popular media outlet in Ukraine (it reaches 80% of the audience). Online media and radio broadcasting are the second most popular. Print media are third in terms of audience (19%). Ukraine's media landscape is growing and increasingly in line with global trends, such as digitalization and digitalization, and the dominant role of social media. The Internet plays a

significant role in the everyday lives of Ukrainians: 21.4 million citizens are regular Internet users. These facts demonstrate the development of creative industries and their importance in the economy and social life of Ukraine, which reflects global trends. The development of creative industries in Ukraine is often organized in clusters. The analysis demonstrates the trends of creative clusters in Ukraine.

1. Revitalization initiatives: the revitalization of former plants and factories in Ivano-Frankivsk (Promprylad), Lviv (ReZavod), and Kharkiv (Fabrika.space) – this concept helps to transform former industrial sites into centers of creativity and knowledge in order to qualitatively change the urban environment. These projects focus on various areas of development, including urbanism, the new economy, contemporary art, and non-formal education. They aim to bring together citizens, businesses, non-governmental organizations and local authorities in the long term.

2. IT clusters have been launched in eleven cities in Ukraine, including Lviv, Lutsk, Ternopil, Ivano-Frankivsk, Vinnytsia, Odesa, Mykolaiv, Cherkasy, Dnipro, Kharkiv, Kyiv, etc. These clusters are designed to improve the quality of IT education, help universities make changes to their curricula in line with current trends, create conditions for the development of new IT projects, exchange of experience, organization of events, promotion of the IT industry, job creation (for example, the Kyiv IT cluster employs about 47% of all IT professionals in the city), and ensure maximum communication between IT companies, educational institutions, and government agencies. Lviv IT Cluster is a leading center of the Ukrainian IT industry. It unites 80 members and more than 10 thousand professionals. The cluster founded the annual specialized event Lviv IT-Arena and initiated construction projects such as IT House, IT House Premium, IT Village, IT House 2.0, and IT Park Innovation District. Lviv IT Cluster has not only successfully implemented its own projects but also influenced the development strategy of Lviv.

3. Cultural clusters, rich in cultural traditions and historical events of international significance, have enormous potential for growth. Ukraine, as a center for preserving national uniqueness and identity, is a carrier of the creative ideas of the Ukrainian people. The most developed crafts are pottery, blacksmithing and weaving. The most dynamic cultural clusters are the Suzirya Folk Art Crafts Cluster (Ivano-Frankivsk region), the Krolevets Creative Cluster (Sumy region), and cultural projects such as the Interregional Cluster of Folk Textile Crafts (Lviv, Ivano-Frankivsk, Kyiv, and Poltava regions), the Gogol Places of Poltava Region Cluster, and the Sorochynsky Fair Rural Development Cluster (Poltava region).

IT clusters in Ukraine are characterized by a high degree of specialization with an emphasis on software development, outsourcing, and cybersecurity. Regional IT clusters play an important role in promoting innovation and cooperation between IT companies, research institutes and educational institutions. Venture capital plays a significant role in the development of the IT sector in Ukraine, providing funding for startups and early-stage companies. The Ukrainian government could play a more active role in supporting the development of IT clusters by improving the regulatory framework, providing tax incentives, and investing in infrastructure. Currently, there are more than 20 regional IT clusters in Ukraine (Melnyk, 2022). The largest of them are located in Kyiv, Kharkiv, Lviv, Dnipro, and Odesa. These clusters unite thousands of IT companies specializing in software development, outsourcing, and other areas. Information technology determines the level of development of the national economy, and cluster cooperation among enterprises is an effective tool for integration into the global space, which helps to attract venture capital investments, develop the country's scientific potential, and increase the level of information and environmental security. The

sustainable development of regional clusters in Ukraine has a number of positive effects. First, they contribute to the growth of labor productivity and innovation in enterprises. Second, they create new jobs and increase employment. Third, they contribute to the diversification of the country's economy and increase its competitiveness. The Ukrainian government has taken a number of measures to support the development of regional clusters. In particular, it created the state program "Innovative Ukraine," which provides financial support to clusters. It also established the National Association of Clusters of Ukraine, which brings together representatives of clusters from across the country.

Despite the negative dynamics of recent years, the number of venture capital industry entities in Ukraine has doubled, and their share in the innovation and investment activities of enterprises has increased from 9% to 89%. At the same time, due to the stagnation of the Ukrainian stock market, the share of securities in the asset structure of innovative companies lost more than 77% of its volume (or 54.5%) in 2007-2017. Private individuals have invested over UAH 970 billion in Ukrainian venture capital funds, or 78% of the total investment volume. There is also a tendency to expand the investment presence of foreign legal entities, which is explained by the presence of high technologies (State, 2023). Among the positive changes in this area are the creation of an independent electronic public procurement system, the introduction of 4G connectivity standards and the expansion of 3G services, an electronic document management system, the opening of electronic state registers and a financial monitoring platform (National Monitoring System), and the automated collection of data on economic activities in various spheres of society. The salaries of specialists in Ukraine are four times lower than in the United States, and 2.6 times lower than in Germany and Israel.

Service industry structures are interested in creating clusters to jointly implement sector development projects at both the national and international levels through systemic transformations, social and infrastructure projects. Examples of successful clusters in the world include the California IT cluster (one of the largest, uniting thousands of companies), which promotes innovation in the IT sector (it has identified the United States as a world leader in artificial intelligence.), increase the competitiveness of American companies and create new jobs; the Chinese IT cluster (one of the largest, uniting thousands of companies), which promotes the development of the IT industry in China and increases employment; the German automotive cluster (one of the oldest and most developed), which contributed to the development of the automotive industry in Germany and provided the country with competitive advantages in the global market (Ukraine's, 2024), Transitioning Industrial (Clusters, 2024). The Finnish cybersecurity cluster is also well-known. Global cluster structures are becoming growth points and effective platforms for cooperation between the public sector, enterprises, organizations, institutions in the fields of business, education, science, infrastructure, and stimulate innovation, productivity, the availability of production factors, financial resources, and harmonization of the interests of all stakeholders.

A cluster is an independent institutional and investment environment for the development of regional companies and industries, is a center of venture capital for the development of a particular sector of the country. The organization of clusters forms powerful integration associations with high economic potential, which is necessary for the development of the national economy. Improving the instruments of the state policy of cluster development, forming an innovative ecosystem can increase their activity while simultaneously improving the perception of society and increasing the efficiency of their activities, and the transition to nature-based technologies will become the basis for sustainable regional development. Therefore, we believe that the IT industry, the industrial sector (mechanical engineering, metallurgy, chemical and food industries), agricultural production, and tourism are

promising areas for cluster development in Ukraine. Ukraine has significant potential in the development of innovations, including the development of artificial intelligence, machine learning, cybersecurity, etc. The development of clusters in these areas could help Ukraine become an innovation leader in the region. Such clusters can help increase the competitiveness and export of Ukrainian products, achieve brand recognition, popularize its rich history and culture, unique natural resources, and create new jobs.

The proposed economic and mathematical model of cluster development in Ukraine includes the following parameters: Y – Ukraine's GDP, K – capital, L – labor force, A – technological level, C – consumption, I – investment, X – exports, M – imports. Then the model of Ukraine's development in the case of cluster development can be represented by the following equation:

$$Y = f(K, L, A, C, I, X, M) \quad (1)$$

where f is a function that reflects the impact of production, consumption, investment, exports, and imports on GDP.

The experience of cluster development illustrates their ability to contribute to the growth of labor productivity and innovation of enterprises. This leads to an increase in the technological level A and the amount of capital K. In addition, the development of clusters encourages greater integration of enterprises and increased efficiency of their production, resulting in increased consumption C, investment I, and GDP growth in Ukraine. The stages of diagnostics and innovative sustainable development of the agricultural sector are shown in Figure 1.

A cluster in agribusiness is a modern association of various entities that, through mutually beneficial cooperation and complementing each other's activities, achieve higher business results. Such associations achieve higher productivity and efficiency, have the ability to offer a better level of service, and are aimed at strengthening the competitiveness of the cluster's products or services on the international market. The peculiarity of clusters is that it ensures close cooperation between different business entities, not just enterprises within the product chain. The concept of cluster development is fully consistent with the changes in productive forces and industrial relations in the context of the formation of a new type of economy or Industry 4.0. The post-industrial economy is characterized by close cooperation, a high degree of integration of business entities within the product chain, the prevalence of horizontal ties between business entities, and the construction of a grid business model. Cluster structures base their activities on the principles of continuous improvement, innovation, scientific and information support. Thus, the commercial sphere is added to resource supply companies, agricultural producers, and processing enterprises. These are organizations that form infrastructure support, provide the necessary advisory and educational services, offer related services, complement activities with other business processes, and increase the consumer value of products or services provided (Figure 2). Consequently, close thematic production links are established with other cluster members. For example, consider the role and importance of a higher education institution in a cluster. Focusing on market needs, programs are developed within the cluster's specialization and filled with academic disciplines to develop relevant competencies in future professionals. Scientific advice is provided to entrepreneurs and research is conducted on the problems of companies in the cluster.

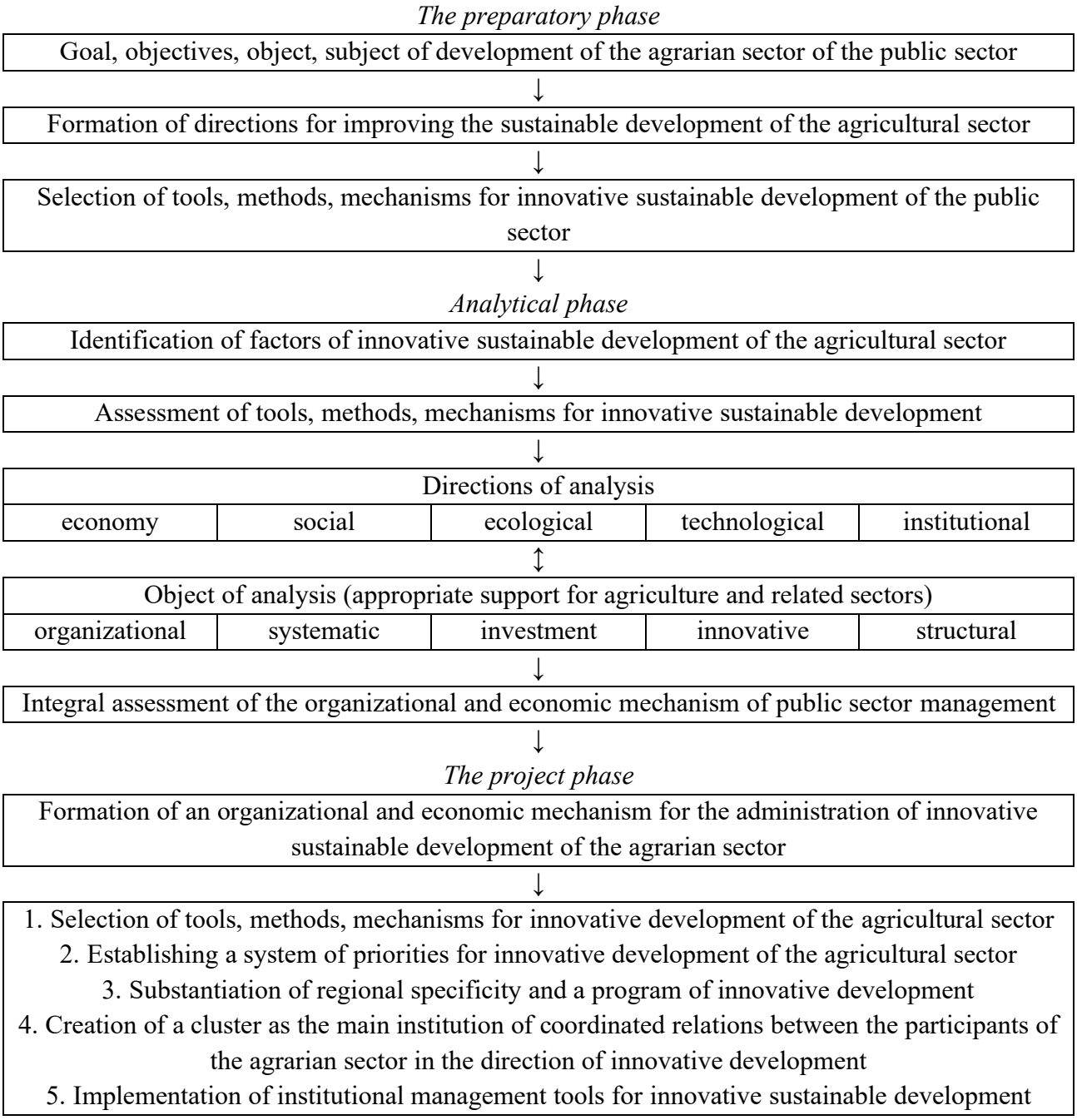

Figure 1. Stages of diagnostics and innovative development of the public sector
(Source: own research)

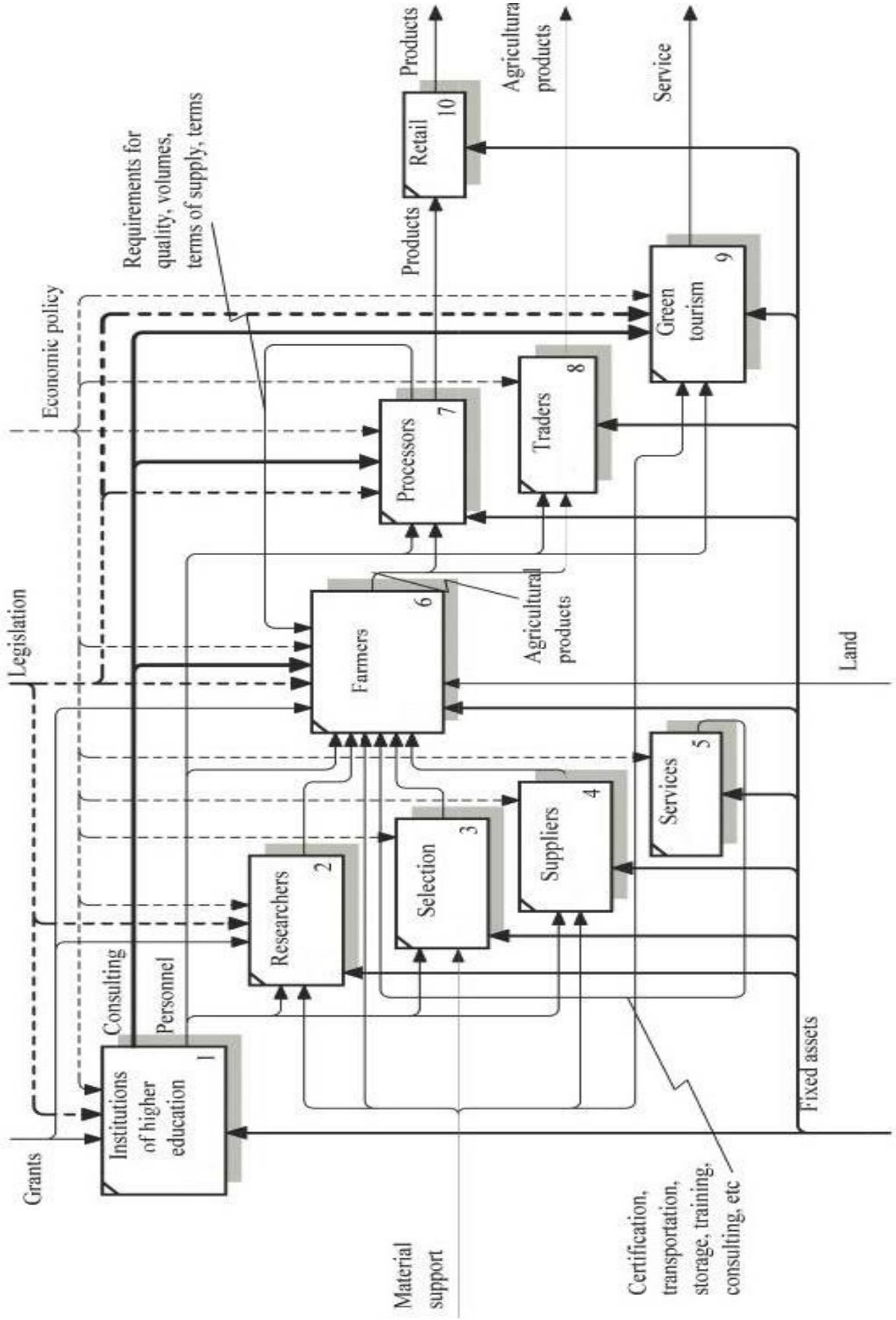

Figure 2. Structure and system of interconnections in the cluster
(Source: own research)

Higher education institutions provide training and professional development for company employees. They cooperate with companies to adapt educational programs, provide internships for students at cluster enterprises, introduce dual forms of education, and conduct research at enterprises. They jointly organize startup and business idea competitions among researchers, students, and entrepreneurs. Best practices are disseminated. On the other hand, without such integration of education and business, the training of specialists becomes ineffective, resources are spent on retraining specialists upon employment, and the research and development performed is disconnected from market needs and remains unused by enterprises. As a result, the demand for educational services from future applicants' decreases, the resource potential decreases, highly qualified specialists lose motivation or move to other areas or regions, and significant opportunities for economic growth are lost.

According to independent estimates by experts from the University of Wisconsin-Madison and the University of Toronto, the development of industry clusters will lead to a 1.5-2.0% increase in the country's GDP. They ensure higher competitiveness of business structures (Figure 3, Table 1).

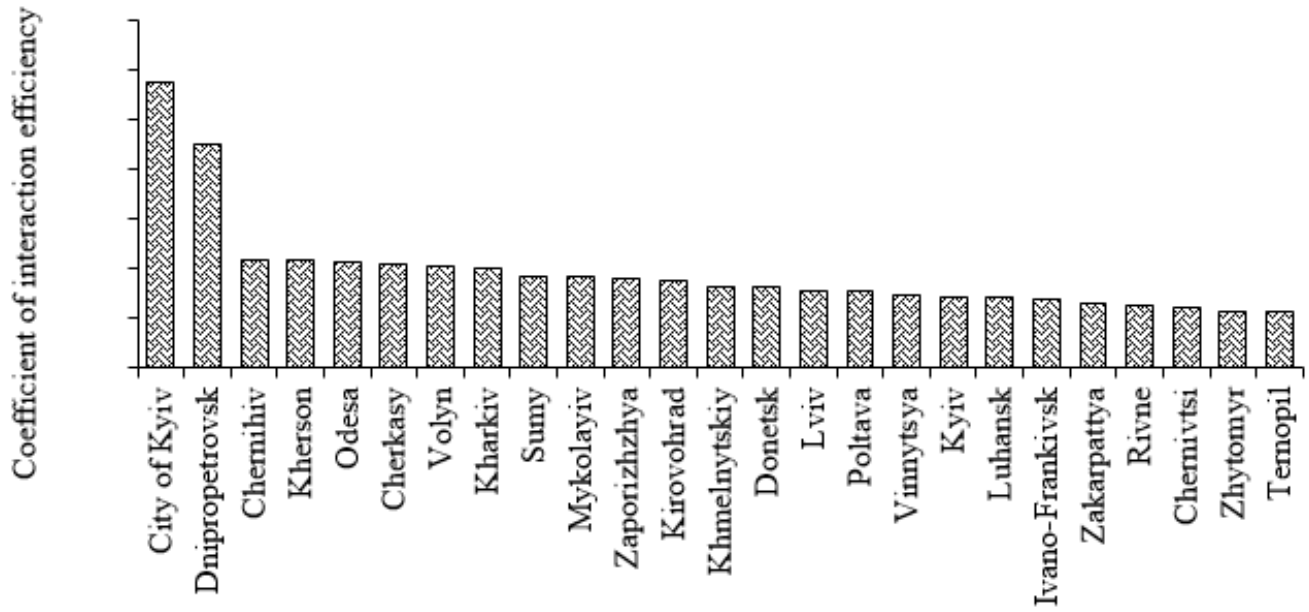

Figure 3. Efficiency of production relationships of business entities
(Source: own research based on (State, 2023)

Research confirm that enterprises in industrial agglomerations, regions of concentration of business entities work much more efficiently. Agglomeration of enterprises facilitates the exchange with business entities of information, technologies, knowledge, experience, and allows you to save on logistics costs. Such associations of enterprises allow to act in common interests on regional and global markets. Accelerated introduction of modern information technologies into all spheres of public life, development of the digital economy and national information infrastructure, integration into the global information space and improvement of information security conditions are strategic goals of the information society development in Ukraine. Currently, new forms of network organization of business and its cluster cooperation in the field of information technology are being

actively created, based on the joint efforts of IT companies, scientific and educational institutions, non-governmental organizations and other entities.

Table 1. Ukrainian regions are ranked by economic development indicators in 2010-2021

Region	Inputs			Outputs	
	Number of active business entities, thsd. units	Number of persons employed of business entities, thsd. persons	Capital investments, billions UAH	Turnover of business entities, billions UAH	Net profit enterprises, billions UAH
Luhansk	68.10	271.73	14.01	326.27	25.16
Chernivtsi	41.09	180.51	8.26	269.01	8.81
Zakarpattya	153.26	874.26	65.47	1683.61	171.28
Kherson	61.75	351.31	30.07	649.26	45.77
Rivne	50.42	210.16	9.48	189.32	10.05
Ternopil	47.95	160.01	5.13	117.85	5.20
Kirovohrad	76.18	368.32	18.27	487.73	41.56
Sumy	55.20	198.54	8.41	194.61	14.17
Zhytomyr	113.45	478.07	35.93	818.53	46.91
Ivano-Frankivsk	37.19	159.76	6.54	173.82	14.41
Khmelnytskiy	21.09	98.13	3.29	66.45	6.14
Volyn	132.74	543.36	24.04	680.28	14.09
Mykolayiv	54.39	193.45	8.27	270.88	15.01
Chernihiv	132.86	465.86	18.85	670.63	26.27
Vinnytsya	65.37	304.35	23.81	464.41	43.30
Cherkasy	43.52	176.21	6.08	140.36	9.03
Poltava	41.74	186.05	7.47	180.44	17.78
Zaporizhzhya	38.23	155.44	8.54	149.57	11.80
Donetsk	167.69	619.75	19.44	698.62	30.13
Odesa	42.88	146.13	5.16	135.82	14.56
Lviv	61.91	215.63	10.87	203.83	23.37
Kharkiv	55.15	221.58	9.59	355.51	19.04
Kyiv	40.27	119.24	3.40	75.57	1.46
Dnipropetrovsk	41.31	172.20	8.37	307.10	19.78
City of Kyiv	312.60	2186.02	170.05	5930.59	250.21

Source: own research based on (State, 2023)

Conclusions

Institutional and investment development of clusters in Ukraine is based on solving numerous problems of the current legislation and determining the organizational and economic priorities of state policy. The development of regional agribusiness clusters in Ukraine is a promising strategy for overcoming these problems, aimed at stimulating innovation and economic growth. It has been proven that clustering in Ukraine can have a significant impact on GDP growth through the combination of capital, labor, technological support, consumption, investment attraction, and growth

in exports and imports. Regional clusters foster innovation, are a center of venture capital, increase the competitiveness of enterprises and create new jobs. In the absence of a legislative and statistical framework for the functioning of clusters in general and in agribusiness in particular, the Government should continue to support their development by creating a favorable institutional and investment environment. The proposed model of cluster formation focuses on interaction, establishing close cooperation between its elements. The decisive role of educational institutions as centers of information and ensuring close interaction between all components of the cluster is proved. Thus, clustering of agribusiness will contribute to the transparent and balanced functioning of the country's economic system and is an important basis for the development of innovative capital sensitive to the quality of the environment. In view of this, we see the formation of an economic and mathematical model of cluster functioning in the agricultural sector as a prospect for further research.

Conflict of interest

The authors state no conflict of interest.

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