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PREREQUISITES AND POSSIBILITIES OF CREATING A MEDICAL ENGINEERING CLUSTER AS THE PART OF REGIONAL TERRITORIAL MARKETING

Abstract. *The article considers creating regional clusters to develop peripheral regions on the example of the Sumy region (Ukraine). The purpose of the paper is to determine the possibility of creating a medical engineering cluster in the city of Sumy and Sumy region, which will potentially increase the level of socio-economic development of the region. The urgency of solving this scientific problem lies in eliminating the disparity in the economic and social development of the regions. It is especially critical for peripheral regions, which are significantly inferior to industrial centers. It leads to some negative consequences, including a decrease in the region's investment attractiveness, the outflow of intellectual capital, and a negative balance of population growth. If this problem is not solved, it will lead to the formation of depressed regions and the deepening of social problems, the need to solve which will create additional burdens and state and local budgets.*

Systematization of literature sources and approaches to solving the problem of creating industrial clusters allows identifying key issues that should be taken into account when analyzing the existing conditions and prospects for building clusters. It also allowed us to determine the algorithm for creating an industrial cluster.

The methodological tools of the study were taxonomy to systematize approaches to the analysis of industrial clusters and SWOT analysis to identify strengths and weaknesses, opportunities, and threats that exist concerning the creation of medical engineering cluster in the study region

The study of the possibility of creating a medical engineering cluster on the Sumy and Sumy region territory in the article is carried out in the following logical sequence. First, the theoretical and methodological approaches to the definition of «cluster» and their classification are systematized. Second, the key benefits of stakeholders from building an industrial cluster are identified. Third, the cluster creation cycle is formed. Fourth, an analysis of the current state of development of industrial production, health care, and the scientific and educational potential of the region. Fifth, SWOT analysis of the creation of a medical engineering cluster in the Sumy region was carried out.

The results of the study can be helpful for local and state authorities, investors, and other stakeholders.

Keywords: cluster, region, health, industry, educational and scientific potential.

Introduction. The disproportion of socio-economic development of regions is a significant problem that needs to be addressed. One possible solution to this problem is to create industrial clusters. It will allow the most efficient use of limited resources and the development of production and social infrastructure. This paper investigates the possibilities of implementing such an option to create a medical engineering cluster in Sumy (Ukraine). The medical engineering cluster is a choice on peculiarities of the economic and scientific potential of the Sumy region. Today there are a large number of industrial enterprises in the region. It is mainly small and microbusiness. The same is true of health care. In addition, there are significant obstacles to attracting investment, including due to the uncomfortable transport links

between the city of Sumy and industrial hubs. An additional deterrent to attracting investment in health care in Sumy is the small population (less than 300 thousand people) and its low solvency. Despite this, new centers, clinics, and offices appear in the city. Still, the vast majority of investments in them are spent on diagnostic equipment due to the historical development of medicine in the region (the «Soviet model») and the rapid return on investment. However, the development of this area globally and in Ukraine shows a trend where investment in the latest equipment and treatment technologies increases (Rosokhata et al., 2020).

An integrated approach will be appropriate for the development of health care in the region. As the region has historically been industrial and has a robust higher education institution, Sumy State University combines training in all subject areas. In the current environment, it is appropriate to attract investment to organize a powerful production of products, tools, and equipment for medical purposes instead of investing in the establishment of medical institutions. It will be the basis for the innovative development of health care and a platform for testing new technologies and products.

Medical engineering and biomedicine occupy leading positions in many developed countries. A promising industry is being formed combined with the latest nano-, bio-, engineering, medical and information technologies in the world.

The creation of a medical engineering cluster in Sumy can ensure the sustainable development of the region by producing products in demand in the domestic and world markets with high added value. Potential results of the creation of the medical engineering cluster are the growth of economic development indicators of the region and the increase of the level of social standards.

Literature Review. The issue of creating medical-industrial clusters is in the field of research of scientists. The specificity of this topic explains the small number of publications in publications indexed in scientific and metric databases. Of particular note in the context of this study is the work (de Jager et al., 2019), which analyzes the networking of crucial sectors for the creation of the medical engineering cluster: the scientific community, health, and industry, and draws attention to the role of support from authorities for the design and development of the cluster. The formation of a regional cluster has been studied in Perry (1993), while creating a medical engineering cluster at the state level is the subject of research (Yeoh, 2008). Prospects for creating a medical-industrial cluster in the post-industrial region are the subject of research in scientific work (Davies et al., 2018). The innovative component of interaction in the medical engineering cluster was studied in the paper (Kuo, et al., 2013). In Baptista et al. (2013), although not the medical engineering cluster is studied, considerable attention is paid to the ability of regional clusters to counter modern economic challenges. Methods for assessing the competitiveness of the medical cluster have been proposed in studies Wang et al. (2011) and Lu (2011).

Methodology and research methods. The paper investigates the hypothesis of the prerequisites for the creation of an industrial medical engineering cluster in the peripheral region (Sumy region, Ukraine), which will potentially contribute to its socio-economic development and maximize the use of territorial resources. The research uses taxonomy to systematize approaches to the analysis of industrial clusters. SWOT analysis applied to identify strengths and weaknesses, opportunities, and threats of creation of regional medical engineering cluster. The combination of these methods allows checking the hypothesis of the study. The information basis of the study is scientific publications and data from open sources, official information on the state of development of the Sumy region, and critical areas involved in the creation of a regional industrial medical engineering cluster.

Results. The concept of «cluster» concerning industries and companies was introduced as a scientific term within the well-known concept of «Porter's Rhombus» by the American economist Porter M. in the early '90s of the twentieth century (Porter, 1998). There are many definitions of the term cluster (Table 1) (Papizh, 2014). Still, in general, the cluster is a group of geographically localized related companies, suppliers of equipment, devices, services, infrastructure, research institutes, free economic zones, and

other existing companies complementing and enhancing each other's competitive advantages (Ekimova, 2009). The main distinguishing feature of the cluster is that the companies that are part of it interact and compete. There is a constant exchange of personnel, innovations, technologies, while sharing infrastructure, services, marketing promotion, and management. A significant difference of clusters is innovation orientation.

Table 1. Theoretical and methodological approaches to the definition of «cluster»

Author, source	Year	Definition of «cluster»
A. Marshall	1993	Clusters are geographically concentrated groups of related companies in their respective industries, specialized suppliers, and organizations involved in their activities (universities, trade associations, standardization agencies), which, competing with each other, at the same time, conduct joint work.
G.M.P. Swann, M.A. Preveser	1996	Cluster - a large group of firms related to industries in a particular area.
Michael E. Porter	1998	A cluster (industrial group) is a group of close, geographically interdependent companies and related organizations that operate together in a particular type of business, are characterized by common areas of activity, and complement each other. A cluster is a systemically organized group of economically interconnected firms, suppliers, related industries, and organizations that emerge in specific areas and countries to gain a competitive advantage.
E.J. Feser	1998	Clusters are not only interconnected and supportive industries and institutions but somewhat related and supportive industries and institutions that are more competitive based on their interrelationships.
J.A. Mingalyova, S.V.Tkachova	2000	A cluster is an industrial complex formed based on a territorial concentration of specialized suppliers, primary producers, and consumers connected by technological chains and as an alternative to the sectoral approach.
V. Chuzhikov	2001	Cluster - a competitive organizational form of a territorial-hierarchical production model with different levels of localization, which gives maximum economic and social effect by minimizing costs in relatively similar industries. At the heart of the cluster, the system provides such a prerequisite as concentration.
L.V. Batchenko, R.V. Mann, and others	2014	A cluster is a regional network structure focused on solving issues in the field of complex or targeted integration of economic entities and improving activities by forming a new communication system and intensifying the use of regional resources. The positive economic effect of the clusters is achieved through the synergistic use of the sum of management and resource potentials of economic entities and various organizations in the region.
M.P. Voinarenko	2011	The cluster is a territorial-branch voluntary association of enterprises that closely cooperate with scientific institutions and local authorities.
O.L. Chernelevskaya, L.M. Chernelevsky	2012	A cluster is a territorial-branch voluntary association of business structures that work closely with research institutions and local authorities to increase the competitiveness of their products and economic growth of the territory of operation.

Sources: developed by the authors based on (Papizh, 2014).

Analysis of research in the field of formation and functioning of industrial clusters allows determining approaches to their classification. To date, various scientists have proposed a variety of categories of clusters. Thus, Michael Porter points out (Porter, 2006) that clusters differ in the following features: 1) size, boundaries and breadth of coverage; 2) level of development; 3) size and combination of companies

included in the cluster structure; 4) structure of industries included in the cluster; 5) liaison with higher education institutions for the development of research and innovation opportunities.

The inability to accurately regulate the parameters of clusters is because the typology of successful clusters is very diverse. M. Enright proposes (Enright, 2004) to classify clusters depending on the stage of their development:

1) Working clusters. These clusters are characterized by cluster strengthening and market expansion, the provision of «new blood», and the possibility of internationalization.

2) Latent clusters. Typical characteristics of such clusters are expanding existing connections, promoting new relationships, external contacts, and identifying and developing leadership opportunities.

3) Potential clusters. Such clusters are characterized by building from base points and formative connections, defining infrastructure, conducting training and coaching, and building partnerships.

4) «Politically advanced» clusters characterized by the construction of new base points, identification of potential participants, the impetus for creating demand, and identifying key barriers to development.

5) «Desired» clusters are characterized by the following areas: formulation of the desired, assessment of essential potential and capabilities, exploration and analysis, start building basic capabilities, seeking external assistance opportunities, and actions to limit potential harm.

Scientist D. Hart proposed (Hart, 2012) to classify clusters depending on the types of connections and the composition of participants:

1) Connected clusters - groups of companies located nearby, combined to reduce costs. The main economic advantage of such clusters is usually called the reduction of «operating costs», especially transport. Interacting, cluster companies can reduce risks by sharing them among themselves by uniting in a syndicate.

2) New industrial zones, which are usually knowledge-intensive. Among the participants of such industrial zones are most often companies working in the field of high technology. When creating new products, they mainly rely on research. The new industrial zones bring together firms of all sizes, from multinational corporations to small and medium-sized businesses. Large companies often form long-term relationships with their smaller suppliers to work together on projects.

3) Innovation environment. It establishes social ties 1) between individual participants working in one company, 2) between employees of different companies. Cumulative and collective learning process stimulates the innovation process through informal exchange of information and expertise.

4) Neighboring clusters show a greater degree of internal heterogeneity in terms of production organization. All types of connections within such a cluster are limited, but external relations are highly developed. They are located relatively short of each other, but they are not tied to the region in which they are located. Such firms have a high innovative potential and produce unique products, which are then sold worldwide. Most often, such firms have regular customers.

The author Altukhova (2015) proposes to systematize the classification of clusters on the following grounds:

1) depending on the stage of development;
2) the potential of markets beaten down;
3) the structure of construction and the nature of cluster-forming bonds;
4) by hierarchical structure;
5) concerning innovations;
6) by the nature of the infrastructure base based on which the cluster is formed;
7) by the nature of relations with the state.

According to available research, the main benefits for small and micro businesses from cluster development are increased efficiency and reduced costs in current activities and the development of new

markets, increased flexibility, and innovation potential in creating and implementing new products and technologies.

From the point of view of the region's development, the main benefits are creating new companies and, consequently, new jobs, the inflow of investments, due to the increase of innovation potential, growth of income in the form of taxes.

The business benefits in the form of:

– access to quality specialized service;
– access to various financial structures;
– increasing the efficiency of the supply of raw materials, components, equipment, and components;
– access to specialized human and production resources.

Cluster formation requires the successive passage of certain stages, the so-called cluster formation cycle. The cluster formation and management cycle is a constant joint work of cluster stakeholders in planning, organization, coordination, control, motivation, and training, consisting of the following phases (Fig. 1).

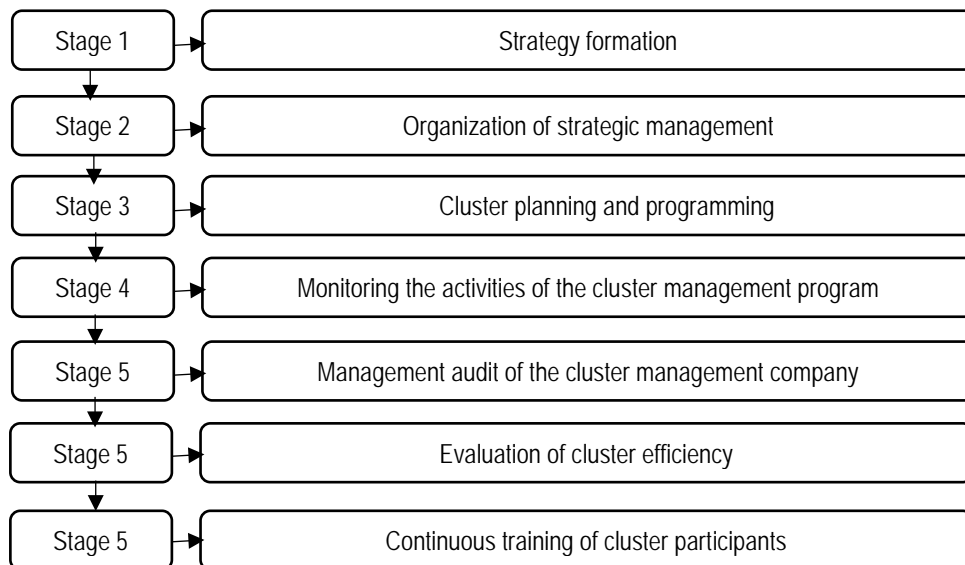| Stage 1 | Strategy formation |
Stage 2	Organization of strategic management
Stage 3	Cluster planning and programming
Stage 4	Monitoring the activities of the cluster management program
Stage 5	Management audit of the cluster management company
Stage 5	Evaluation of cluster efficiency
Stage 5	Continuous training of cluster participants

Figure 1. The cluster formation and management cycle
Sources: developed by the authors.

A strategic session may be convened to make strategic decisions regarding the establishment and operation of the cluster. The strategic choices should include the following:

– formation of the concept of cluster competitiveness;
– determining the benefits of stakeholders and their impact on cluster development;
– identification of directions and opportunities for cluster development in the medium and long term;
– determining the financial strategy of the cluster and its resources;
– determination of the expected effects from cluster implementation and methods for evaluating the effectiveness of the cluster.

The basis of the concept of the cluster is formed by the concept of its competitiveness, which provides:

– model of cluster positioning in the value chain (main and auxiliary activities; existing forms of cooperation and interaction of companies in the value chain; promising forms of collaboration and interaction in the value chain);

– the concept of forming unique goods and services for customers and consumers outside the region of the cluster;

– the concept of responding to environmental influences.

One of the critical elements on which the success of a cluster project depends is its financial strategy. It includes rules, principles, and restrictions on attracting investment to the cluster and managing its financial resources. The financial resources of the cluster include contributions of cluster members, loans for business plans, contributions and subsidies for government support programs, research grants, grants for business plan development, venture financing, direct investment in the business of cluster members, project financing, etc.

The model of cluster efficiency assessment is developed by the concept of competitiveness and reflects the critical directions of cluster development.

However, before forming an industrial cluster, it is necessary to determine the conditions for its creation. A comprehensive analysis of the region's state, where it is proposed to create an industrial cluster, allows assessing the feasibility of clustering. On the example of the Sumy region, located on the border of Ukraine and Russia, the work checked the necessary conditions for creating a medical engineering cluster. To this end, an analysis of the current state of development of industrial production, health care, and the scientific and educational potential of the region.

The status of industrial development. The analysis results showed that in the city of Sumy located more than 3,000 enterprises. More than half of them are manufacturing enterprises, of which 95% are small or microbusiness. It according to official data (Sumy city development strategy, 2019). Among the activities of the processing industry in the Sumy and Sumy region, the largest share of enterprises that produce food. The percentage of machine-building enterprises is 18.6%; production of chemicals and chemical products - 12.2%; production of rubber and plastic products, other non-metallic mineral products - 9.6%. The share of enterprises in metallurgical production, production of finished metal products is 9.0%. The percentage of other industries does not exceed 4% (Main Department of Statistics in Sumy region, 2020).
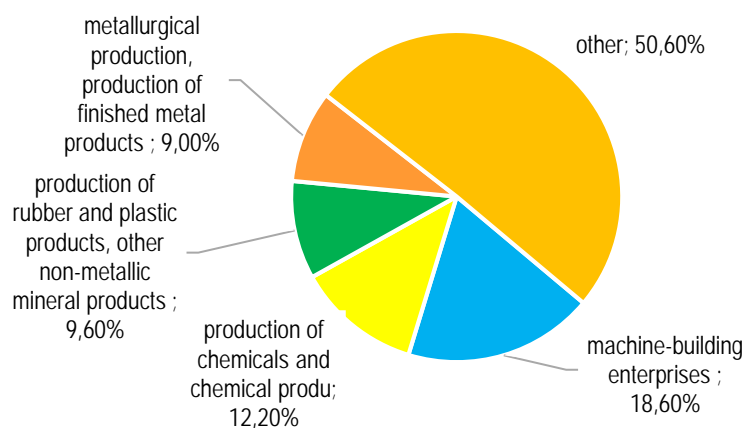

Figure 2. The structure of industrial production of Sumy region
Sources: developed by the authors.

The results of a study of industrial enterprises indicate that one of the trends in modern enterprise development is the so-called outsourcing of business processes. Today, in the engineering industry, business process outsourcing already accounts for up to 85% of the total (Ivchenko, 2009). A significant proportion of the region's processing companies operate on outsourcing, ie perform a limited number of operations and not produce the final product.

Health status. Sumy region's health care system is represented by municipal institutions of Sumy City Council. These institutions include 11 institutions of regional subordination. There are more than 600 private entities. It has more than 100 enterprises and almost 500 natural persons-entrepreneurs. It according to official data. At the same time, the share of small and micro enterprises in the healthcare sector is nearly 65% of their total number. A significant number of companies specialize in providing services of one profile.

At the same time, according to statistics (Main Department of Statistics in Sumy region, 2020), the volume of capital investment in health care is only 2.4% of the total in the Sumy region. The capacity of direct investments in the economy of the city of Sumy is 54% of the total number of direct investments in the Sumy region. At the same time, the vast majority of them go to investment in manufacturing and construction. At the same time, the development of the health care system is now concentrated in the diagnostic field. Even these small investments are mainly focused on the purchase of diagnostic equipment. About 5% of the total investment in this area is attracted to equipment and technologies for treatment. The investment attractiveness of the health sector in Sumy, with declining living standards in the region, rising unemployment, and declining population (Sumy city development strategy, 2019), is declining. The critical task of healthcare companies is to maintain an acceptable level of profitability, which affects the pace and volume of innovation in the industry, which is at an unsatisfactory level (Main Department of Statistics in Sumy region, 2020).

Educational and scientific potential. There are 14 higher education institutions in the Sumy region, 12 of them in Sumy. About 27 thousand students' study in higher education institutions, of which 2570 are international students from almost 50 countries (Sumy city development strategy, 2019; Main Department of Statistics in Sumy region, 2020). Sumy State University is considered to be the fundamental institution of higher education in Sumy, where 50% (13.5 thousand) of the total number and about 65% (1650) of all international students of Sumy study (Sumy State University, 2020).

The analysis of higher education institutions in Sumy shows that today, there are four such institutions, 3 of which are specialized - training specialists in the agro-industrial complex, training of teachers, and specialists for the Ministry of Internal Affairs. The only one institution of higher education in Sumy provides training in all subject areas, namely: Social Sciences, Engineering and Technology, Life Sciences and Medicine, Natural Sciences and Arts and Humanities. It allows us to classify the university as a multidisciplinary complex (comprehensive) institution of higher education, according to QS Classifications (Strategic development plan of Sumy State University, 2020).

The analysis allows us to state the existence of basic conditions for the creation of a medical engineering cluster in the Sumy region. A significant basis for this is the presence in Sumy of one of the leading universities in Ukraine, which trains specialists and conducts research in crucial subject areas for the cluster. The advantages of Sumy State University for the medical engineering cluster are based on its reputation in the international scientific and educational space, a significant number of specialties, and high scientific performance. However, the weaknesses are the lack of spin-off enterprises and legal entities in the research and training and production complex of the university and activities in the format of a scientific and/or technological (technical) park. A more detailed analysis (Table 2) shows that the main advantages of the cluster are related to the scientific potential, the available research results, and the available industrial opportunities of the region.

Table 2. The results of SWOT-analysis of the feasibility of creating a medical engineering cluster in the Sumy region

Strengths	Weaknesses
1. The presence of a multidisciplinary higher education institution which occupies leading positions in information technology, mechanical engineering, management, and health care. 2. The presence of a functioning powerful computing center allows you to solve complex problems of modeling and design complex systems, and process large amounts of data. 3. The availability of capacity in instrument making, processing of materials, which allows you to create and manufacture products, equipment, and sensors for medical purposes. 4. Created interdisciplinary centers and laboratories that successfully deal with engineering problems in medicine. 5. High level of training of highly qualified personnel for medical engineering: specialists in information technology, materials science, engineering technology, engineering mechanics, and, directly, medicine	1. Difficulties in defining the tasks and commercial prospects of scientific developments. 2. Lack of marketing information. 3. Insufficient investment and difficulties in attracting them to the region. 4. Use of obsolete equipment in the industrial sector
Opportunities	Threats
1. Prospects of medical engineering in the world. 2. Dynamic development of the health care sector in Ukraine as a consequence of the implementation of health care reform. 3. Development of the private sector in the field of health care	1. Declining demand due to an unstable economy. 2. Personnel problems due to labor migration. 3. Possible technological lag due to lack or insufficiency of investment in crucial areas for the cluster.

Sources: developed by the authors.

As a result of the analysis, it is possible to make an optimistic forecast about creating a medical engineering cluster in the Sumy region. It is due to the presence of the necessary prerequisites for its creation. Instead, risks and threats are primarily potentials.

Conclusions. The paper considers creating a medical engineering cluster in the city of Sumy and Sumy region as a mechanism for improving the level of socio-economic development of the peripheral region. The article identifies key areas that can become the basis for a medical engineering cluster. One of these areas is the development of industry, particularly the production of devices and tools. Another area is the development of the medical industry. As a basis for creating a medical engineering cluster, the medical industry is considered in two aspects: healthcare facilities and diagnostic centers and enterprises and entrepreneurs that produce related products or provide ancillary services. The last critical area is education and science. Given the specifics of the medical engineering cluster, its successful implementation can be only based on solid scientific potential and sufficient opportunities for the training of highly qualified professionals.

Based on the analysis, it can be argued that the current state and potential of critical areas involved in the formation of the medical engineering cluster allow assessing the prospects of this idea positively. Sumy state university can play a crucial role in a cluster design. The high scientific level and research results enable giving a positive assessment of the opportunities for creating a regional cluster. Additionally,

the educational potential of the region is high. Also, the availability of production infrastructure, particularly in mechanical engineering, is enough to start medical and engineering cluster design.

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Передумови та можливості створення медико-інженерного кластеру як частина територіального маркетингу регіону

У статті розглянуто питання створення регіональних кластерів для розвитку периферійних регіонів на прикладі Сумської області (Україна). Мета статті визначити можливість створення медико-інженерного кластеру на території

м. Суми та Сумської області, що потенційно дозволить підвищити рівень соціально-економічного розвитку регіону. Актуальність вирішення даної наукової проблеми полягає в необхідності усунення диспропорції економічного та соціального розвитку регіонів. Це особливо критично для периферійних регіонів, які суттєво поступаються промисловим центрам. Це призводить до низки негативних наслідків, у тому числі зниженні інвестиційної привабливості регіону, відтоку інтелектуального капіталу та негативного сальдо приросту населення. Якщо дана проблема не буде вирішена, це призведе до утворення депресивних регіонів та поглиблення соціальних проблем, необхідність вирішення яких створить додаткове навантаження та державний та місцеві бюджети.

Систематизація літературних джерел та підходів до вирішення проблеми створення індустріальних кластерів дозволила визначити ключові питання, які повинні враховуватися при аналізі наявних умов та перспектив створення кластерів. Також це дозволило визначити алгоритм створення індустріального кластеру.

Методичним інструментарієм проведеного дослідження стали таксономія для систематизації підходів до аналізу індустріальних кластерів та SWOT-аналіз для визначення сильних та слабких сторін, можливостей та загроз, які існують стосовно створення медико-інженерного кластеру на території досліджуваного регіону

Дослідження питання можливості створення медико-інженерного кластеру на території м. Суми та Сумської області в статті здійснено в наступній логічній послідовності. По-перше, систематизовано теоретико-методичні підходи до визначення поняття «кластер» та їх класифікації. По-друге, визначено ключові переваги стейкхолдерів від створення індустріального кластеру. По-третє, сформовано цикл створення кластеру. По-четверте, здійснено аналіз сучасного стану розвитку промислового виробництва, сфери охорони здоров'я, а також наукового та освітнього потенціалу регіону. По-п'яте, здійснено SWOT-аналіз створення медико-інженерного кластеру на території Сумського регіону.

Результати проведеного дослідження можуть бути корисними для органів місцевої та державної влади, інвесторів та інших стейкхолдерів.

Ключові слова: кластер, регіон, охорона здоров'я, промисловість, освітній та науковий потенціал.