THE ROLE OF UNIVERSITIES IN EDUCATION CLUSTERS IN SUSTAINABLE DEVELOPMENT

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Abstract. *This article analyzes the role and importance of higher education institutions within educational clusters in sustainable development. At a time when the quality of education and research is becoming an important issue worldwide, the transition of universities to new transformation models should be carried out on the basis of educational clusters. The article highlights the functions of universities in education, research and innovative development, their contribution to economic growth and social stability. The issues of the effectiveness of university activities, research results, cooperation with industry and their place in international rankings are discussed.*

Keywords: *higher education institutions, educational clusters, university transformation, innovation, research, educational economics, university model, entrepreneurial university, suistainable development.*

Introduction

Today, the development of higher education institutions depends not only on improving the quality of education, but also on the processes of developing scientific research, implementing innovative projects and having a real economic impact on society and suistainable development. Universities organized on the principles of educational clusters provide strong integration between science, business and the government. This article analyzes the role of universities within educational clusters and issues related to their research and innovation activities in sustainable development.

The demand for improved quality education in the global economy is constantly growing. The global demand for higher education continues to grow, with an additional 95 million students joining the existing student body by 2025, equivalent to the creation of 3 new universities every week over the next 10 years. The growing mismatch of skills remains one of the main problems of the labor market for most of the world's major economies. The education sector, in its current form, will remain one of the most prosperous sectors of our society, and its main tasks in the coming decade will be to develop new curricula that meet modern requirements, expand the capabilities of educational institutions, adapt to the labor market, teach through new educational technologies, and reduce the cost of education.

In industrialized societies, mass production, based on the strengthening of the division of labor in the economy and society, prevailed, while in the knowledge-based economy, economies are directly based on the production, distribution and use of knowledge and information. Such societies are currently becoming more advanced and are moving towards thought-based societies. In the thought-based society, along with new models of production and exchange, it is a society based on wisdom, based on serving the common good of society and acting collectively towards achieving global stability.

Literature review

If we consider the analysis of approaches, we can see that B. Clark was one of the first to observe the development of various forms of “harmonization” of higher education in advanced industrial countries. He already outlined a number of “ideas” for the adoption of higher education at that time. Although it is not clear how much of these ideas stemmed from the application of Clark’s analytical model or from his personal values and preferences, many of them remain very relevant for modern discussions about how universities and higher education systems should be organized. That is, the better resolution of values by different structures, the operation of vertical integration, the better functioning of rewards rather than government control, and the ambiguity of the purpose of higher education institutions leading to hesitations are still relevant. However, at the same time, these ideas pay less attention to the scientific

activity of higher education institutions and their cooperation with scientific research organizations.

In 1997, Etzkowitz and Leidersdorff proposed the triple helix model of educational clusters. Etzkowitz and Leidersdorff's introduction of the university-industry-government triple helix model mirrored Clark's coordination triangle, as it focused on the relationships between the university, government, and industry. They differ only in that Etzkowitz and Leidersdorff conceptualized the model during a period of active academic entrepreneurship.

Using their model, Etzkowitz and Leidersdorff emphasized the important role of universities in regional and innovative research. Both of them, while maintaining their common traditional role, recognized the important role of partnerships between universities, industry and government through business and educational activities. This means that universities participate in regional economic development by transforming their experience and knowledge resources into something meaningful and useful. For example, universities and other knowledge-producing organizations form the main spiral of knowledge production. The university produces more knowledge and transfers it to industry, while at the same time receiving additional funding from industry and government to strengthen research.

Research Methodology

Therefore, starting from now on, it is an urgent task to improve the current status of higher education institutions, which are the main mechanism of educational processes, expand the scope of their activities and establish their activities as a large institutional structure of the educational cluster. The core of the educational cluster, the university, which is a higher education institution providing educational services, is the main initiator of the educational cluster. The university (German: general) is a higher education institution, the main purpose of which is to train specialists in fundamental and applied sciences, as well as to conduct scientific research activities. The university combines several faculties, which are the main components of scientific knowledge, and they form a common set of various disciplines.

The main difference between a university and other educational institutions is its unique positioning. While other educational institutions are engaged in training specialists, universities are positioned as centers of education, research, and innovation, as entities that ensure the socio-economic and cultural development of society.

Universities can be divided into several types based on the nature of their activities and their main mission, as well as their inability to perform several functions at the same time. For example, it can be divided into classical universities, entrepreneurial universities, scientific research, corporate, branch, and virtual universities.

These universities differ fundamentally from each other in terms of their purpose, mission, role in society, effective activities for the national economy, and sources of income. It should also be taken into account that these universities can transition from one form to another and improve through development.

Table 1

Types of universities, their mission and sources of income

University types	**University Mission**
Classical University	The mission of the university is based on universal human values. The main focus is on training highly qualified personnel in fundamental and applied sciences and conducting scientific research in the relevant areas. The main source of funding is the state budget and funds received from scientific research.
University of Entrepreneurship	The mission is to contribute to the development of society (region, area) by establishing entrepreneurial activity in the field of high technologies. The main source of financing is, in addition to the state budget, contracts for the purposeful development and implementation of joint projects with business and sources of enterprises. Also, startups and spin-off

	companies within the university can provide a certain level of income.
Scientific Research University	Its mission is to train highly qualified personnel in the field of education, who will be engaged in advanced research and development in scientific areas during their studies. The university is an advanced scientific, educational, analytical, consulting and design center, making a significant contribution to the innovative development of the country and society as a whole. Non-budgetary sources of funding include funds from research projects, expert and consulting activities.
Corporate University	The university's activities are aimed at training and developing professional competencies of employees, as well as establishing long-term external relations with business corporations through research and consulting in the field of strategic management of the organization. The main source of funding is orders from corporations for personnel training, research and consulting, as well as government orders for personnel training.
Network University	The university's activities aim to solve urgent social development problems of a particular sector or region through training students in interdisciplinary research disciplines, conducting complex scientific research and experimental design work, and conducting expert and analytical activities. The activities are carried out using Internet networks and computer technologies. The main source of financing is the state budget (state order for personnel training). Part of the university's income comes from payments for educational services by the population and funds from targeted orders for training employees by corporations.

Virtual university	The goal of the university is to create an open and flexible distance education system, which is implemented using various Internet technologies and software applications. The main sources of funding are state orders for personnel training; which consists of payments for educational services by the population, training of employees by corporations, targeted orders for scientific research, and innovative developments in the field of virtual education.

From the table data it can be seen that as a result of the expansion of the mission of universities, they can act not only as a provider of knowledge and education, but also as a large institutional structure engaged in scientific activities, implementing scientific research projects, and providing analytical and consulting business services. The sources of income of universities can also consist not only of funds received from educational services, but also of state orders for personnel training; payments for educational services by the population, funds from targeted orders for personnel training by corporations, scientific research, and innovative developments in the field of virtual education.

Analysis and results

The modern stage of development of the world economy is characterized by the active entry into industrial revolutions. This situation, in turn, requires the implementation of dynamic, large-scale and multifaceted changes in the field of higher education. Leading universities of the world are currently working on the search for new models in the field of education, radically changing their goals and opportunities to go beyond the boundaries of their traditional functions and institutional forms. Given that these changes require complex measures and cover all institutions of society, it can be said that new models of transformation of universities are being formed in the world.

Historical and cultural analysis of the diversity of national systems of university education allows us to see the experience of the transformation of universities, that is, the transition from the University 1.0 model to the University 4.0 model. If the basis

of the University 1.0 model was the internal relations of the educational environment and, above all, educational activities, then in the University 2.0 model the idea of the unity of educational and research processes takes center stage. At the same time, if the main mission of the teaching university is to form and improve national societies and cultures, then the main goal of the research university, while maintaining the functions of the university in the field of education, also involves reaching a global level in scientific activity. Why a global level? Because science is created in direct connection with collaborative activities and processes at the international level.

A comparative analysis of educational and research universities shows that, first of all, there are differences in the personnel they train, that is, in the first type of university, the teacher's activity consists of educational, methodological and educational work, while in the second type of university, the teacher is primarily a scientist who, in addition to conducting scientific research, also teaches students. Secondly, these universities also differ in terms of infrastructure, that is, while traditional educational universities consist of educational departments, departments and centers, research universities include structures working with scientific projects rather than methodological departments.

As a result of the deepening of market relations and the increasing demands of business representatives for innovations and developments, the entrepreneurship 3.0 university model is taking shape. The entrepreneurial university envisages the transformation of education into a service sector, and knowledge from a social good into a commodity. These universities often lose their autonomy and independence, operating on the orders of business structures, sponsors and the state.

Barton Clark, the founder of entrepreneurial universities, defines their main mission as an “innovative university” in order to avoid too many complications in the process of institutional construction. In this 3.0. innovative university, a synergistic effect is formed at the national (educational), global (scientific) and regional (entrepreneurship) levels. This effect allows the entrepreneurial university to gain social significance and status in the new conditions due to changes in the education, business and government systems. “Entrepreneurship” is accepted in this study as a

characteristic of social systems; that is, as a system of entire universities and their internal departments, research centers, faculties and schools. The main factor influencing the development of entrepreneurial universities is the risk-taking in starting new practices, the outcome of which is doubtful. An entrepreneurial university actively seeks to introduce innovations in its own business. It seeks to develop serious organizational changes in order to achieve a more promising position for the future. Entrepreneurial universities seek to become self-sufficient universities that are important players on their terms.

The University 3.0 model is a transformation from the 1.0 and 2.0 models and becomes a structure that simultaneously implements three missions: education, scientific research, and innovative activities aimed at the commercialization of knowledge. In modern conditions, the mission of the future-oriented University 4.0 model is not only for education, scientific research, and innovation but also for solving the problems of sustainable development of society of various institutional structural structures of society. Additionally, integration is given priority.

Today, in the era of information technology development, the University 4.0 model is also entering the field of dialogue. This model is characterized by a single digital space and adaptive technologies. This university model, which primarily functions as an educational institution, is distinguished by the training of personnel who can think systematically and individually and can be successful in all aspects. Management and communications at the university involve the use of digital tools (artificial intelligence, big data analysis) and individual and adaptive (adaptive) educational programs. University 4.0 aims to become the center of regional and network educational ecosystems, as well as a global educational center. The University 4.0 model mainly describes the university of the future and operates to advance global higher education.

Table 2

The main characteristics of models 1.0 - 4.0 of universities

Feature	**University 1.0**	**University 2.0**	**University 3.0**	**University 4.0**
Mission	Education	Education and science	Education, science and innovation	Impact on education, science, innovation, integration, sustainable development of society
Strategic goal	Personnel training	Production of new scientific knowledge, training of personnel	Influence economic growth through training and innovation	Global impact on the sustainable development of society, ecosystem integration
Place and role in education	Education is the process of imparting accumulated knowledge	Education in the process of developing new scientific knowledge	Education in real innovative projects	Foresight-learning in scientific-educational ecosystems
Financial model	Single-channel funding priority	Availability of multiple sources of income	Diversification of sources of income	Diversification of sources of income, financial independence
Impact on society	Impact on human resources	Impact on personnel and scientific potential	Impact on the technological development of the economy	Global impact on sustainable development processes

Systematicity	The university operates as a relatively closed system.	The university operates as an open system.	The university operates as part of an ecosystem. (The education cluster is the ecosystem, and the university is its core)	The university is a unique ecosystem (Education cluster organizer and manager, developer)

As the core of the educational cluster, the HEI should strive for the University 3.0 model and transition from an entrepreneurial university to a research and corporate university. Through research and consulting, this university aims to establish long-term external relations with business corporations, fostering effective joint activities among cluster participants based on national interests.

A university that serves as the core of the educational cluster should integrate education, research, entrepreneurship, and corporate features.

By establishing continuous integration links within the University 3.0 model, the educational cluster will evolve into the University 4.0 model. This transformation will incorporate network and virtual university features, strengthen integration mechanisms, and enhance self-organization and self-development. Ultimately, the educational cluster will become an educational ecosystem, driving the national economy.

Table 3

Stages of educational ecosystem formation

Educational field 2002	**Education cluster 2015**	**An educational ecosystem 2019**
Partners-participants have been identified	Strong mutual relations are established between	Integration mechanisms have been developed,

	the participants of the organizational structure	self-organization and self-development have been implemented
Partners - schools, colleges, HEIs	Co-participants are schools, colleges, HEIs, scientific research institutes, authorities, business representatives	Co-participants are schools, colleges, HEIs, scientific research institutes, authorities, business representatives and public organizations.

Before the 2000s, educational ecosystems emerged as collaborative spaces where schools, colleges, and universities worked together. Stronger cooperation, increased integration, and a growing demand for high-quality education led to the emergence of educational clusters. In educational clusters, strong ties were established between cluster participants and an expanded group of stakeholders was established, that is, government and business representatives acted as cluster participants and customers of the main educational services.

As a result of the strengthening of integrative mechanisms and the further expansion of stakeholders, the activities of self-organizing and managing and developing educational ecosystems are starting to take place.

The university, which has created its own ecosystem, can serve as a development model for all other universities, operating regionally and globally in the 3.0 and 4.0 models and ranking in the top 20 in the international rankings of world universities (QS international rankings), with strategic directions and unique characteristics for establishing higher education, scientific activities, and integration ties.

Conclusion

The following can be cited as conclusions on the activities of universities:

1. In knowledge-based societies, universities—long considered centers of education and science—are now key drivers of economic growth.

2. University development fosters the creation of innovation centers, where research and entrepreneurship drive technological progress.

3. Universities, in addition to providing education and knowledge, are also a major arena for entrepreneurial activity.

4. High competition in the educational market accelerates the integration of universities into the system of international relations.

5. Universities, as the core of the educational cluster, are managers that carry out beneficial activities in cooperation with various research and design organizations, investors, educational institutions, and government authorities.

In modern conditions, the role of new managers in the field of higher education - university managers - is increasing. Their activity is to organize various forms of entrepreneurial activity at the university by developing the initiatives of university employees, primarily teachers. According to J. Wissem, it is precisely entrepreneurial activity that is consistent with the three missions of the university: education, science and commercialization. The crisis that modern universities are experiencing is also associated with the failure of university professors to adapt to modern changes. It is university professors, according to Barton Clark, who are of particular importance compared to other employees, because they are managers of the education system who can connect science with education, science with commerce and, ultimately, with entrepreneurial activity.

Based on the above, the educational, scientific and entrepreneurial activities of HEIs in the educational services market, their activities in the educational cluster in cooperation with business and government, scientific organizations, as well as non-governmental and non-profit organizations, can be considered a national model of an educational cluster.

In the national educational model of the educational cluster, higher education institutions, that is, universities, are the main participants. Higher education institutions operate in two markets: the market for educational services and the market for educational resources. Based on their scientific, educational and entrepreneurial potential, they offer leading specialists in their field, researchers, knowledge and

scientific developments, technologies and patents obtained for them to the educational resources market. Knowledge is the main factor of production, it is a social good. State organizations, business enterprises, and non-governmental and non-profit organizations absorb the resources formed in the educational resources market by making expenditures. These expenditures replenish their budgets as income from entrepreneurship for higher education institutions. State organizations, business enterprises, and non-governmental and non-profit organizations effectively use educational resources to establish their production activities, receive income and profit, and participate in the formation of the state budget revenue.

Consumers demand educational services and spend on quality educational services. These costs serve as a source of income for HEIs that deliver quality educational services to the educational services market. OTMs also pay taxes to the state budget from this income. The government can provide education loans for consumers, and subsidies for the support of HEIs.

Higher education institutions can provide educational and consulting services to government organizations, business enterprises, and non-governmental and non-profit organizations, such as improving the skills of their employees and retraining them, based on their requirements, as well as create new modern technologies for them to further improve production and service sectors based on the implementation of scientific research projects.

Recommendations

As the core of an educational cluster, a higher education institution's performance can be evaluated based on the following indicators:

Educational efficiency:

- the employment rate of graduates by specialty;
- the percentage of students who successfully complete their studies;
- the ratio of the number of students admitted to a higher education institution and the number of students who graduate.

Scientific research activities:

- the number of patents obtained by university scientists;
- scientific research carried out at the university and their introduction into production;
- publication of scientific articles in international journals.

Innovation and technology transfer: Number of university startup projects and innovative initiatives, number of new technologies introduced into cluster enterprises.

Level of cooperation: Number of joint programs between educational and industrial enterprises, indicators of financial or technological support provided by enterprises to the university.

Adaptability to the labor market: how quickly the university's educational programs adapt to the demands of the labor market, the availability of dual education programs and internship bases for students.

Social indicators: Expanding access to education for young people in the region, special quotas or programs for children from low-income families.

International cooperation: University's position in international rankings, number of projects involving international students and teachers.

The following directions and measures are important for the analysis and development of the higher education institution, which is the core of the educational cluster:

1. Analysis of educational effectiveness:

– Student graduation and employment: monitoring how many graduates are employed in a job appropriate to their specialty, revising training programs for occupations in high demand in the labor market.

– Mobility and international opportunities: Increasing the level of students' access to education or internships at foreign universities, introducing a dual education system or joint programs.

2. Analysis and development of research activities:

– Scientific articles and patents: Evaluating scientists by the number of articles and their impact factor, increasing the level of implementation of patented inventions into production.

– Research funding: Improve mechanisms for attracting grants and investments for university research, and strengthen financial cooperation with the government, the private sector, and international organizations.

3. Development of innovation and technology transfer:

– Startups and Incubators: Creation of startup incubators and accelerators to implement innovative ideas of students and researchers.

– Technological platform and infrastructure: Establishment of modern laboratories, digital platform and scientific research centers in the university.

– Technology Transfer: Creating mechanisms to ensure the application of university research to local industry.

4. Cooperation and links with production:

– Cooperation with enterprises: Introducing joint educational programs with enterprises, expanding the dual education system in them, and concluding agreements with specific enterprises to provide employment for each graduate.

– Training of professionals suitable for the industry: regularly analyzing the requirements of the labor market and aligning the educational programs with these requirements.

5. Support for social development:

– Expanding access to education: Creating special programs for young people in low-income and remote areas, improving mechanisms that facilitate employment for graduates in the area.

– Trainings and training: Organization of regular training courses for employees and teachers in production enterprises.

6. Increasing the position in international rankings:

– Analysis of ranking indicators: analysis of the strengths and weaknesses of the university in the international rankings of QS, THE or ARWU.

– International cooperation: Strengthening cooperation with foreign universities, organizing joint research and academic programs.

– Attracting foreign students: aligning educational programs with international standards, offering multilingual courses.

7. Digitization and use of modern technologies:

– Online learning platforms: Implementation of modern online learning platforms and expansion of distance learning opportunities.

– Student Activity Monitoring: Monitoring of student learning and research activities through automated systems.

– VR/AR technologies: Making the educational process more engaging through the use of virtual and augmented reality.

The implementation of complex measures in these areas will help to make the university's activities more effective.

Universities in today's era of global change are considered not only as centers of education, but also as an important element of scientific research, innovation and economic development. In the process of transition from 1.0 to 4.0 model, universities are expanding their functions and paying great attention to scientific research and entrepreneurial activities. The formation of educational clusters increases the efficiency of higher education institutions and strengthens their connection with society and the economy. Also, the contribution of universities to economic development through the educational services market and scientific research is increasing. As a result, the introduction of educational clusters ensures the sustainable development of the higher education system.

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