IMPLEMENTATION OF KNOWLEDGE ECONOMY AND INNOVATION THROUGH BUSINESS EDUCATION

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Abstract: *The article's purpose is to analyse the issue of implementation of knowledge economy and innovation through business education based on cluster analysis. The role of knowledge economy, innovation transfer, entrepreneurship and business-education coopetition are grounded to achieve economic growth and sustainable development. Input data withing the distribution of the knowledge economy through business education include a data of 23 countries for the following indicators: new registered enterprises, labour force, employment in industry, proportion of population studying 'Business, Administration and Law', proportion of population studying 'Services' and proportion of population studying 'Economics'. Using data normalization, Ward and Sturges methods and Statgraphics Centurion 19 soft five clusters were determined to show hidden dependencies and structure in countries sample in this research context. The first cluster includes 2 countries (Austria and the United Kingdom), the second – 11 countries (Belgium, Portugal, Denmark, Italy, Lithuania, Latvia, Poland, Ukraine, Croatia, Norway, and the Netherlands), the third – 5 countries (Bulgaria, Spain, France, Switzerland, and Finland), the fourth – 3 countries (Estonia, Germany and Sweden), and the fifth – 2 countries (the Czech Republic and Hungary). Due to building dendrogram of distribution on clusters and graph of agglomeration distance the quality of countries distribution into clusters was confirmed. Obtained results can be useful for further research and improving the state innovation, information and educational policy based on positive experience of neighbour countries within certain formed cluster.*

Introduction

World practice has proven that the development of innovative technology occurs exclusively at the expense of knowledge, information, and the latest technologies. It is not raw materials and cheap labour that make an economy competitive, but precisely because of the source of knowledge, it becomes so, ensuring the creation of high-tech jobs in industry and entrepreneurship necessary to meet the economic and social needs of people. Knowledge is one of the most important factors of production. This resource manifests itself in synergy for the most efficient use of land, capital, and labour resources.

Only by overcoming the gap between the dominant production, which is based mainly on resource-extracting sectors of the economy, and the economy based on knowledge, it will be possible to ensure the dominance of an innovative model of socio-economic development. This is evidenced by the development of many countries in Europe. Their experience convincingly confirms that economic growth is possible only under conditions of transition to a knowledge economy, in which all national comparative advantages are lost. This is determined not by an excess of natural resources, but by the competitive application of innovations and knowledge or their combination.

The implementation of "competing" priorities: personality – education – economy and the corresponding economic, educational, scientific, and technical policy will ensure a high educational and professional level of the population. The formation of the national innovative economy requires solving the urgent task of forming the readiness of the youth and the population as a whole to adapt to the changing socio-economic situation. One of the ways to solve this problem is the development of entrepreneurship among young people.

Thus, the educational problems required by a knowledge-intensive economy are the problems of preparing entrepreneurs to enter society in the context of forming the economic culture of youth, expanding the entrepreneurial component of the innovative economy, and restructuring the content of higher economic education. Personal and professional competences that contribute to the comprehensive self-realization of an entrepreneur are formed by general and professional economic education in the conditions of globalization, information, and innovation trends.

In the conditions of an increasingly obvious wave development of the economy, especially with the further development of entrepreneurship as its paradigm, the issue of the development of the personality of a modern entrepreneur and the quality of a businessperson is of primary importance. Therefore, it is important to solve the problem of quality training of future entrepreneurship specialists, which requires rethinking and methodological justification of the process of business education.

The article's purpose is to analyse the issue of implementation of knowledge economy and innovation through business education based on cluster analysis.

Literature Review

The issue of knowledge economy, innovation transfer and business-education coopetition in this context is not new in economic science. In the conditions of global competition, the problem of creating a modern model of business education was actualized. Influence of business education on ease of doing business (Samoilikova et al., 2023), opportunities, and effects in 'business-education' system (Koibichuk et al., 2023), trends and impact of knowledge and innovation in business companies (Strielkowski et al., 2022), etc. – these aspects are only some examples of research and significant attention of scientists to the outlined issues.

Akhnovska & Bolhov (2020) examined the essence, main features and trends of business education. Attention was focused on the need to distinguish different types of business education depending on the formal sign, form of education, age of the students and level of education.

Semenets (2016) determined the place of education in the system of factors of international competitiveness of the country, identified and analysed country's place according to indicators of the development of the education system, considered the essence, main characteristics, and features of the 'triple spiral' model of cooperation between universities, business, and the state, and substantiated the expediency and effectiveness of its

implementation for innovative development. A system of advantages for each of the institutes in the process of triple interaction was also drawn up and analysed, and areas of activity were proposed within the framework of building an effective partnership model of business, state, and universities. The role of universities and cooperation between science, business, local government and society has been highlighted in the Concentric Model of Knowledge Dissemination and Distribution (Kuzior & Kuzior, 2020). Kuzior A. (2021) draws attention to educational aspects and the role of managing product, process and breakthrough innovations in the context of achieving the sustainable development goals, while emphasizing the role of ethical values (Fobel et al., 2019).

The necessity of using the latest forms and technologies of business education of future entrepreneurship specialists was substantiated by Vagonova et al. (2017), who studied the issue of the manifestation of the relationship between the knowledge economy and the component of economic education – business education in the conditions of the formation of an innovative economy.

Klimenkova (2020) analysed the relationship between supply and demand in the labour market and its imbalance and studied the correspondence of the existing competencies of university graduates in comparison with the competencies demanded by the business environment – existing and expected competencies. In the context of demand on the labor market, the so-called competences of the future (Kuzior et al., 2023a; 2023b).

The impact of education quality on knowledge economy on the example of Algeria was investigated by Benrouina & Malki (2023). In particular, the authors investigated the impact of two indicators of the knowledge economy – the number of fixed-line subscribers and the number of Internet subscribers – on the Algerian education system.

Kharchenko (2023) studied education as business competitive advantage based on bibliometric and content analysis. The relationship between the level of education and the quality of business and leadership is considered. It is emphasized that matching the level of education with business needs can ensure a higher level of labour productivity and better company results.

The aspect of innovation, research and development in business environment and science ecosystem was analysed by Boiko et al. (2022). Open science gives rise to a taxonomy of several concepts, such as open access, open data, and open replicable research. The guiding principles of data management are becoming crucial for the widespread adoption of open science practices and their effective use in research, industry, business, and other sectors of the economy.

Despite the available scientific work, the question of implementation of knowledge economy and innovation through business education does not lose its relevance, and cluster analysis in this field was practically not used, which actualizes the chosen direction of research.

Methodology and research methods

Cluster analysis was used to group similar objects together into homogeneous clusters and to reveal hidden dependencies and structure in a sample dataset (Kaufman & Rousseeuw, 1990). Particularly, Ward's method was applied to implement cluster analysis based on a measure of the distance between them (Ward, 1963). Sturges method was previously used to identify the number of clusters. Also, for data normalization, a modification of logarithmic normalization was applied. To confirm the quality of the distribution of countries into clusters the dendrogram of distribution on clusters and graph of agglomeration distance were built and analysed (Stata, n.d.). For all calculations and graphs Statgraphics Centurion 19 soft was used (Polhemus, n.d.)

Informational base included input data for 23 countries withing the distribution of the knowledge economy through business education, especially the following indicators:
- new registered enterprises (Eurostat, n.d.d; Eurostat, n.d.e);
- labour force (Eurostat, n.d.b);
- employment in industry (Eurostat, n.d.b);
- proportion of population studying 'Business, Administration and Law' (Eurostat, n.d.a; Eurostat, n.d.c; Eurostat, n.d.f);
- proportion of population studying 'Services' (Eurostat, n.d.a; Eurostat, n.d.c; Eurostat, n.d.f);

‒ proportion of population studying 'Economics' (Eurostat, n.d.a; Eurostat, n.d.c; Eurostat, n.d.f).

Results

At the end of the twentieth century, the UNESCO World Conference on Higher Education emphasized that the strategic task of education is to educate citizens to live independently, to teach them to organize their own workplace in entrepreneurial activities. This task has not lost its relevance even now.

The social goal of entrepreneurship is to satisfy an infinite number of human needs through the production of goods in the process of purposeful transformation of the finite number of available resources. Thus, higher economic education in this direction studies, particularly the nature of entrepreneurship, the foundations of its formation and functioning mechanisms, the details of the implementation of entrepreneurial skills in human capital, as well as the development of scientifically based concepts, principles and needs for the development of the direction, further development of entrepreneurship in the context of innovative economy.

At another UNESCO international conference, to implement a defined strategic task, higher education institutions were suggested to provide training that should both meet and anticipate social needs (UNESCO, 2009).

The total number of those wishing to receive an education was distributed by level of education and qualification as follows (Table 1).

Table 1. Number and structure of students in higher education

Indicator	Junior specialist	Bachelor	Specialist	Master
Total students, persons	462398			
Total students on education level, persons	55861	189366	96221	120950
Structure of applicants for education level, %	12	41	21	26
Part of specialty (selective)				
Economy, %	1,8	2,8	3	4,3
Accounting and taxation, %	4,9	3	4,6	4,3
Finance, banking and insurance, %	4,6	3,5	4	5,4
Management, %	2,1	3,9	3,5	7,7
Public management and administration, %		0,4	0,2	2,6
Marketing, %	1,2	1,4	0,8	1,4
Entrepreneurship, trade and stock exchange activity, %	4,2	2	1,6	2,1

Sources: systematized by the authors.

Analysing Table 1, the following conclusions can be drawn:

- the distribution of higher education applicants by educational levels shows that bachelors make up the largest group (41%), followed by masters (26%), specialists (21%) and junior specialists (12%). This shows the growing popularity of bachelor's and master's degrees, which are becoming increasingly popular choices among students.

- the most popular majors among students of higher education are Economics, Accounting and Taxation, Finance, Banking and Insurance, and Management. These specialties are represented at all levels of education (junior specialist, bachelor's, specialist, master's), but the proportion of graduates at the master's level in these fields is higher compared to other levels.

- Public Management and Administration is a less popular specialty but has a higher proportion of graduates at the master's level. This may indicate a growing interest in this field and a desire to obtain higher qualifications in

this area.

- the share of the specialty 'Marketing' increases at the master's level compared to other levels of education. This may indicate the importance and development of marketing competencies at a higher level of education.

Many educational institutions give preference to 'Management'. This creates many managers in the labour market who can analyse and optimize business processes and manage enterprises.

The 'Economics', 'Finance' and 'Accounting and Taxation' specialties train specialists to perform professional service functions in the management of certain types of corporate resources.

Some educational institutions offer studies in the areas of 'Entrepreneurship', 'Public Administration' and 'Marketing'. These subjects provide skills in researching social needs, developing product markets, opening a new business, transitioning to new business models, and interacting with society. states, authorities and communities, the spread of corporate culture, taking into account national and global trends in social development, etc.

Since in the knowledge economy there is a clear transition to the market of opportunities for the implementation of theory in practice, the main one of which is the ability of a person to become a producer of new business knowledge, the questions regarding training of experts necessary for this process are becoming relevant. The main thing that a future business professional should be able to do is to be able to create new knowledge in business. Therefore, the fundamental task of higher educational institutions is not only to teach students the complex of modern knowledge available in society, but to teach them to create (produce) knowledge and successfully implement it in practice.

Business education and the knowledge economy are interconnected, forming a synergistic effect of functioning the open dynamic system "education-knowledge". The openness of the system is characterized by number and influence of factors of the external environment, especially the process of entrepreneurial activity and the manifestation of human capital. The dynamism of the system depends on the speed of its adaptation to new conditions and requirements of the external environment. General and professional economic education is an important factor for modern society, especially for a society in transition, for its progressive development within the framework of global trends. This will allow to diversify the forms, methods and technologies of providing citizens with quality educational services in the economic and educational spheres. Just as business education dominates among the types of business education for those seeking education, their perception of the phenomenon of "entrepreneurship" as a social need, and business knowledge as self-esteem, it is necessary to shape the trend of higher education. The active, professional and creative attitude of future specialists to entrepreneurial activity is determined by the epoch itself. Therefore, business education should solve the urgent task of improving the quality of education and focus its efforts on the introduction of improved educational content and modern technologies into the educational process, and the organization of education. In view of this, the structure of economic education should include general educational and entrepreneurial content elements aimed at adapting the outlook and professional competencies of future entrepreneurs to the economic realities of the knowledge society.

A businessman needs a special type of thinking that does not record facts, but possesses the so-called "analyticity", giving a logical-mathematical assessment of the consequences of decisions made, an entrepreneur must be communicative and quickly adapt in the process of communicating with such groups of people: staff, customers, consumers, suppliers, founders, managers, competitors. Among the people of each group and between different groups, people with the most diverse psychological characteristics can be found. An entrepreneur must present the peculiarities of the psychological structure of the individual (Vagonova et al., 2017).

Business education (entrepreneurial education) is intended for those who have received such an education when they feel the need to apply their professional skills acquired through their own practical experience and to understand the essence of entrepreneurship as a socio-economic phenomenon. Conducting formal education, higher educational institutions should promote the professional mobility of teachers and future specialists in the field of entrepreneurship. This can only be achieved by building strong long-term business relationships. Sharing the knowledge economy through business education plays an important role in today's world, as it allows companies and organizations to grow and prosper in the face of constantly changing, innovative technologies and

globalization. Business education is aimed at providing knowledge and skills necessary for effective business management, entrepreneurship development and stimulation of innovative thinking. One of the main aspects of the distribution of the knowledge economy through business education is the training of qualified specialists. Many higher education institutions and business schools offer specialized programs in management, marketing, finance, and other fields, which allows students to acquire relevant knowledge and skills for working in business. In addition, there are specialized courses and trainings for enterprise workers, which allow to improve their efficiency and introduce innovative approaches into the production process. In addition, large corporations and enterprises invest significant resources in research and development. They collaborate with universities, research centres and other institutions to create new technologies, products, and services. This promotes innovative development and the introduction of new knowledge into business practice. In general, the distribution of the knowledge economy through business education affects the creation of competitive intellectual capital, the strengthening of the innovative potential of companies and the development of the business community (Table 2). It helps businesses adapt to the changes in today's world by providing them with the knowledge, skills, and resources they need to succeed.

Table 2. Input data withing the distribution of knowledge economy through business education

Country	New registered enterprises	Labor force	Employ-ment in industry	Proportion of population studying 'Business, Administration and Law'	Proportion of population studying 'Services'	Proportion of population studying 'Economics'
Austria	3486	4 535 197	25,6	24	7	11
Belgium	27248	5004772	21,3	22	3	11
Bulgaria	50753	3273146	29,8	30	4	10
United Kingdom	663616	33693492	18,5	26	10	5
Georgia	21262	2034776	12,4	17	9	7
Denmark	36384	3024435	18,6	17	3	9
Estonia	17696	694110	29,7	25	4	17
Spain	99231	23016544	19,6	28	5	11
Italy	102135	25584166	26,1	23	3	5
Lithuania	6352	1481027	25,1	27	4	14
Latvia	10318	1008672	24,4	28	4	9
Germany	70720	43294640	27,4	23	4	13
Poland	43523	18393553	31,4	22	5	15
Czechia	27881	5387517	38,1	0	5	16
Ukraine	48138	20770349	25	21	5	10
France	76276	30319992	20,3	33	4	5
Switzerland	24136	4889961	20,6	26	5	8
Sweden	49960	5245273	18,2	16	4	15
Croatia	13618	1833268	27	23	3	16
Finland	13590	2687198	22,2	23	4	6
Hungary	22328	4686095	30,4	16	4	21
Norway	2768877	2768877	19,5	17	5	16
Netherlands	9050417	67127	16,5	28	5	11

Sources: compiled by the authors.

Cluster analysis, which is used to group similar objects together into homogeneous clusters, will be used to analyse the data. It helps reveal hidden dependencies and structure in a dataset.

As can be seen from Table 2, the indicators have different measurement units, so they should be normalized. Data normalization is the process of bringing data values to a common range or scale, usually between 0 and 1. This is done to ensure balance between different variables and to remove the influence of different ranges of values on data analysis. For data normalization, a modification of logarithmic normalization is used:

$$y_{ij} = \frac{1}{1 + e^{-3\frac{x_{ij} - p_i}{q_i - p_i}}}$$

(1)

Let's denote the data of new registered enterprises as K1, labour force – K2, employment in industry – K3, the share of the population that studied 'Business, administration and law' – K4, the share of the population that studied 'Services' – K5, the share of the population that studied 'Economics' – K6. The results of input data normalization are given in Table 3.

Table 3. Normalized data withing the distribution of knowledge economy through business education

Country	K1	K2	K3	K4	K5	K6
Austria	0,497	0,497	0,565	0,574	0,818	0,500
Belgium	0,499	0,506	0,337	0,426	0,378	0,500
Bulgaria	0,501	0,473	0,765	0,891	0,500	0,426
United Kingdom	0,552	0,905	0,216	0,711	0,953	0,142
Georgia	0,499	0,449	0,067	0,142	0,924	0,231
Denmark	0,500	0,468	0,219	0,142	0,378	0,354
Estonia	0,498	0,423	0,761	0,646	0,500	0,858
Spain	0,505	0,806	0,259	0,818	0,622	0,500
Italy	0,505	0,835	0,592	0,500	0,378	0,142
Lithuania	0,498	0,438	0,538	0,769	0,500	0,711
Latvia	0,498	0,429	0,500	0,818	0,500	0,354
Germany	0,503	0,953	0,659	0,500	0,500	0,646
Poland	0,501	0,744	0,822	0,426	0,622	0,769
Czechia	0,499	0,514	0,953	0,001	0,622	0,818
Ukraine	0,501	0,777	0,533	0,354	0,622	0,426
France	0,503	0,880	0,290	0,953	0,500	0,142
Switzerland	0,499	0,504	0,303	0,711	0,622	0,289
Sweden	0,501	0,511	0,205	0,109	0,500	0,769
Croatia	0,498	0,445	0,639	0,500	0,378	0,818
Finland	0,498	0,461	0,382	0,500	0,500	0,182
Hungary	0,499	0,500	0,788	0,109	0,500	0,953
Norway	0,713	0,463	0,255	0,142	0,622	0,818
Netherlands	0,953	0,411	0,151	0,818	0,622	0,500

Sources: calculated by the authors.

For cluster analysis of data, the number of clusters was determined using the Sturges formula:

$$n = 1 + 3.322 * \lg N \qquad (2)$$

where n is the number of clusters, N is the number of countries (research objects).

After calculations, it was determined that the number of clusters is 5.

Going directly to cluster analysis, Ward's method will be used to implement cluster analysis. It is used to group objects into clusters based on a measure of the distance between them. The Ward Method process includes the following steps. It starts with dividing each object into a separate cluster. The matrix of distances between objects is calculated. Joining the two most similar clusters that have the smallest distance to create a new cluster. The change in intra-cluster variance (within-cluster variance) is calculated to assess the quality of the connection. And steps 3-4 are repeated until one common cluster is formed or a given number of clusters is reached.

Ward's method has certain advantages, in particular, it can work with different types of data and allows to control the number of clusters. It is also practical for large data sets because it uses an incremental approach to computing the distance matrix.

However, it is worth noting that cluster analysis, including Ward's method, has its limitations. Clustering results may depend on the choice of distance metric and connection criterion. In addition, it is important to correctly interpret and analyse the obtained clusters in order to understand their meaning and connection with the original data (Figure 1).

Cluster Summary

Cluster	Members	Percent
1	2	8,70
2	11	47,83
3	5	21,74
4	3	13,04
5	2	8,70

Centroids

Cluster	K1	K2	K3	K4	K5	K6
1	0,1145	0,5275	0,19	0,6425	0,8855	0,321
2	0,298727	0,388273	0,661273	0,457909	0,5	0,511182
3	0,7448	0,6766	0,2526	0,7746	0,5488	0,3078
4	0,182	0,857333	0,352333	0,418333	0,5	0,757667
5	0,818	0,7025	0,912	0,055	0,561	0,8855

Figure 1. The results of cluster analysis withing the distribution of knowledge economy through business education

Sources: calculated by the authors using Statgraphics Centurion 19.

Consequently, the clustering procedure produced 5 clusters from the 23 provided observations. To form clusters, the procedure was started with each observation in a separate group. The two observations that were closest to each other were then combined to form a new group. After recomputing the distance between the groups, the two closest groups were merged again. This process was repeated until only 5 groups remained. The first cluster included 2 countries, the second – 11 countries, the third – 5 countries, the fourth – 3 countries, and the fifth – 2 countries (Figure 2).

Membership Table
Clustering Method: Ward's
Distance Metric: Squared Euclidean

Row	Cluster
1	1
2	2
3	3
4	1
5	2
6	2
7	4
8	3
9	2
10	2
11	2
12	4
13	2
14	5
15	2
16	3
17	3
18	4
19	2
20	3
21	5
22	2
23	2

Figure 2. Membership table withing the distribution of knowledge economy through business education

Sources: calculated by the authors using Statgraphics Centurion 19.

After analysing the membership table, it was grounding that:

- Austria and the United Kingdom belong to the first cluster;

- Belgium, Portugal, Denmark, Italy, Lithuania, Latvia, Poland, Ukraine, Croatia, Norway, the Netherlands – to the second;

- Bulgaria, Spain, France, Switzerland, Finland – to the third;

- Estonia, Germany, Sweden – to the fourth;

- the Czech Republic and Hungary – to the fifth.

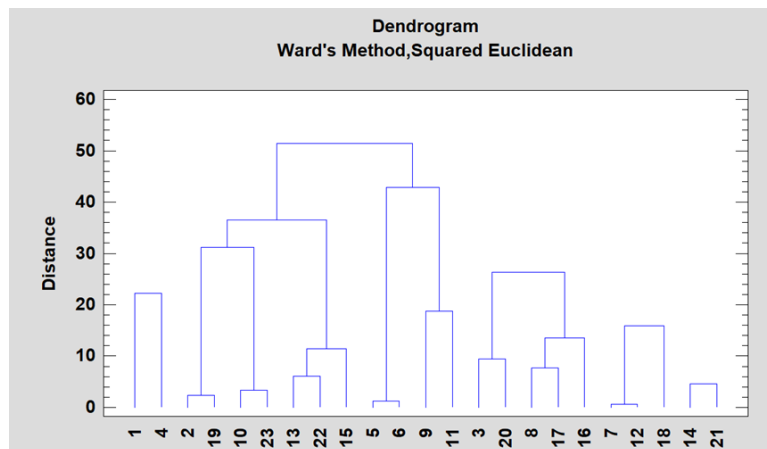The dendrogram of distribution is shown in Figure 3.

Figure 3. The dendrogram of distribution on clusters

Sources: built by the authors using Statgraphics Centurion 19.

An agglomeration plot shows which observations were clustered at each stage of the clustering process. For example, at the first stage, observation 7 was combined with observation 12. The distance between the groups when combined was 0.575218. It also shows that the next stage at which this merged group was further merged with another cluster was stage 11.

The quality of the distribution of countries into clusters is also confirmed by the agglomeration protocol (Figure 4).
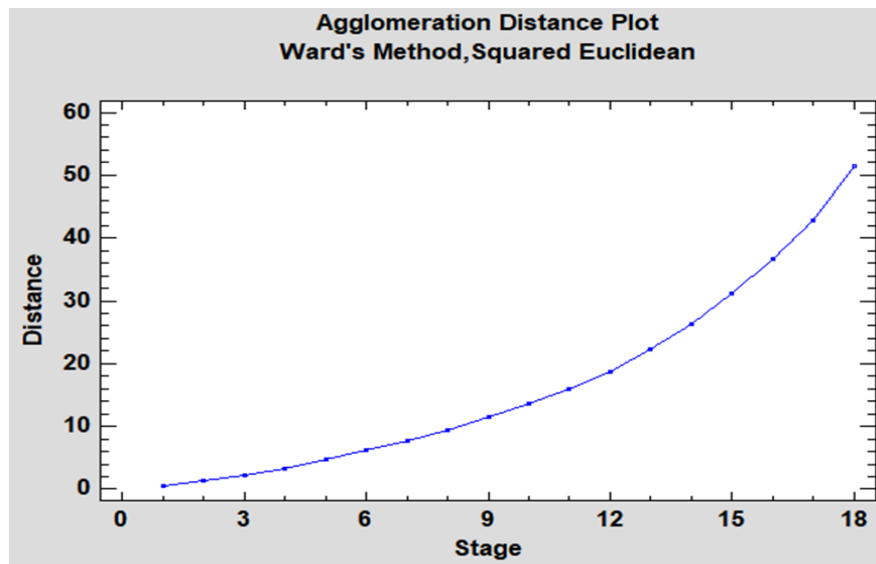

Figure 4. Graph of agglomeration distance

Sources: built by the authors using Statgraphics Centurion 19.

There are no sharp jumps between the steps of the clustering, so the quality of the distribution of countries into clusters is also confirmed.

Implementation of knowledge economy and innovation through business education is an approach aimed at using educational programs and educational initiatives to develop the knowledge economy in the modern business environment. This approach assumes that knowledge and innovation are key resources for achieving competitive advantage, stimulating economic growth and development.

The main principles and elements of the implementation of the knowledge economy through business education include:

Business education: Development and implementation of educational programs aimed at the formation of key knowledge and skills necessary for successful activity in the modern business environment. This may include training of university students, advanced training for workers and managers of enterprises, professional retraining, etc.

Development of key competencies: Emphasis on the development of skills and competencies that meet the requirements of modern business. This can include critical thinking, creativity, communication skills, management skills, the ability to collaborate, etc.

Stimulating innovation: Business education programs can help to create an innovative culture that promotes the creation of new ideas, the development of new products and services, and the introduction of new technologies and work methods.

Partnership with business: An important component of the success of the implementation of the knowledge economy is the cooperation between educational institutions and enterprises. This may include student internships, joint research projects, consulting from business experts, and other forms of interaction.

Continuous education: Development of a culture of lifelong learning that promotes continuous improvement of

skills and adaptation to changes in the business environment. This may include online training, refresher courses, seminars, and conferences.

In general, the implementation of the knowledge economy through business education is aimed at creating a favourable environment for the development of knowledge, innovation, and competitiveness in modern business. This approach supports the continuous development and improvement of the skills and knowledge of employees, which leads to the success of organizations and economic growth.

Conclusions

The article's purpose was to analyse the issue of implementation of knowledge economy and innovation through business education based on cluster analysis. Using data normalization, Ward and Sturges methods and Statgraphics Centurion 19 soft five clusters withing the distribution of knowledge economy through business education were determined in the following way: 1) Austria and the United Kingdom; 2) Belgium, Portugal, Denmark, Italy, Lithuania, Latvia, Poland, Ukraine, Croatia, Norway and the Netherlands; 3) Bulgaria, Spain, France, Switzerland and Finland; 4) Estonia, Germany and Sweden; 5) the Czech Republic and Hungary. The obtained results show hidden dependencies and structure in this research context. Due to building dendrogram of distribution on clusters and graph of agglomeration distance the quality of countries distribution into above clusters was confirmed.

This study has certain limitations related to the number of sample countries. Further research should be aimed at expanding the sample of countries, formalizing, and evaluating indicators impact withing the distribution of knowledge economy through business education.

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