Knowledge management:
seven effective examples of applying knowledge

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APPLICATION OF MODERN THEORIES TO COMPREHEND THE CONCEPTS OF THE KNOWLEDGE ECONOMY AND NATIONAL INNOVATION SYSTEM

Introduction

The strong dependence of the transition economy on raw materials with little added economic value is a major weakness of most transition economies, especially in light of political instability and constant fluctuations in world prices. This economic instability had a negative impact on most economic and social indicators, which seriously slowed down economic growth.

This situation strongly dictates the strategy developing urgency a for the transition to an economy based on knowledge and innovation, which could become in the future a source of sustainable economic growth in developing countries based on the high technologies development, and not on the resource potential primitive exploitation. At the same time, following an intensive growth path involves the formation of a National Innovation System (NIS) capable of transforming the traditional production-oriented economy into the knowledge economy.

As the research results show, an important role in accelerating this process is mainly played by innovation activity based on the intensive production of scientific and technical knowledge and its commercial exploitation, as well as significant investments in human and intellectual capital. This implies the need to determine the role, place and functions of the NIS and its subjects in the state economic policy.

The process of formation and development of the NIS also needs special tools for assessing the innovation effectiveness and the innovation system effectiveness as a whole by analyzing costs and results at all innovation process stages. However,

there aren`t serious studies in economics that use modern methods for measuring the effectiveness of NIS. Therefore, the application and new methods development in the assessing field the innovation system effectiveness is a necessity to ensure the competitiveness of the national economy in the long term.

The transition process to the knowledge economy is lengthy and complicated by constantly changing internal and external conditions. This imposes additional responsibility on public authorities, which must continuously monitor the process of formation and functioning of the NIS with subsequent comparison of the results with achievements in this area in other countries.

However, existing tools do not help to achieve this goal effectively and dynamically. Therefore, the new tool development for effective control and formation process coordination and development of the NIS is the most important task in the process of transition to the knowledge economy.

Based on the foregoing, the use of modern scientific tools and methods in studying the role of NIS in the transition context to the knowledge economy is a starting point and an urgent task for public authorities. This is necessary in order to accelerate the development of the innovation system on a sound scientific basis, which will result in the transformation of the emerging economy, traditionally based on the resource sector, into a knowledge-based economy. This will ensure sustainable economic growth in the long term and will make it possible to overcome the heavy burden of resource dependence, shifting the vector of countries' development towards scientific development and the use of high technologies, as well as increasing the volume of intellectual potential.

Thus, the present study makes a theoretical contribution to providing an analytical framework for management of the knowledge economy concept and represents an essential addition to the practical tools needed to successfully transition emerging countries to the knowledge economy based on new scientific methods.

The task of the study is to scientifically comprehend the concepts of the knowledge economy and National Innovation System (NIS), which resulted in the formation of new theoretical and analytical approaches to the study of these aspects.

Literature review

Research in the field of the knowledge economy is not new – many scientists have considered the problem of determining the role and place of knowledge in society and the economy. In particular, deserves special mention Fritz Machlup and his research on the growing role of knowledge in the economy[1], Alvin Toff-

[1] Lundvall B.A. *User-Producer Relationships, National systems of Innovation and Internationalism.* National Innovation Systems: Towards a Theory of Innovation and Interactive Learning, London: Pinter Publishers, 1992. 367 p.

ler[2], who detailed the future characteristics of the new economy in his book Future Shock, Manuel Castells[3], who substantiated the foundations of the information economy.

The author of the term «knowledge economy» is the scientist-economist Fritz Machlup. In 1962, he published a study on the impact of knowledge on GDP growth in the United States. The author pointed out 11 principles for studying the knowledge economy. Among these reasons, we note the following:

- close relationship between the level of labor productivity and economic growth and the level of knowledge in the country;
- shift in demand from physical labor to intellectual power;
- establishing the relationship between information and communication technologies (ICT) and the process of knowledge creation;
- refinement of methods for calculating national income.

Note that these principles reflected the beginning of the economic and social changes that accompanied the emergence of the knowledge economy as a result of the ICT revolution. Thus, we can conclude that Fritz Machlup is the author of the concept of the «knowledge economy», which depends mainly on innovative activities that use information and knowledge as a fundamental part of the product value chain.

There are many definitions of the knowledge economy, but they all focus on the basic principles that consider knowledge as the main material of the production cycle, giving the process of creating, sharing and disseminating knowledge a significant role in innovation.

For example, in the International Competitiveness Report in 1998, the knowledge economy was defined as «an economy based on the creation and exploitation of knowledge, where this mechanism plays a dominant role in the process of wealth creation»[4].

In this context, it should be noted that the essence of the knowledge economy should be understood not as a simple description of high-tech industries, but as «a description of new sources of competitive advantage that can be applied in all sectors of all companies and in all regions of agricultural activity in the field of software and biotechnology»[5].

On the other hand, there is another definition of the knowledge economy, which belongs to L.G. Batrakova, A.G. Kolpakova. They define the knowledge economy as «an advanced stage in the development of the post-industrial economy, which

[2] Toffler A. *The Future Shock*, New York: Random House, 1970. 541 p.

[3] Castells M. *The Informational City. Information Technology, Economic Restructuring and Urban Development*, 1-ed., Oxford: Wiley-Liss Inc., 1992. 416 p.

[4] Pryor A. Our competitive future: Building the knowledge-driven economy. *Computer Law & Security Review*. 1999. Vol. 15. Issue 2. P. 115-116.

[5] Leadbeater C. *New measures for the new economy Amsterdam*. Measuring and reporting intellectual capital: Experience, issues, and prospects. 1999. P. 1-42.

is an addition to the concept of an innovative economy, where the main factor in building the knowledge development is human capital»[6].

At the same time, T.L. Friedman[7] believes that the creation of knowledge and innovations and their implementation in people and means are becoming the most important factor in economic growth in the knowledge economy. On the other hand, A.B. Jones believes that «knowledge economy is a revolution; knowledge basically involves a radical change from a resource-based economy to a knowledge-based economy»[8].

In literature, economists from various points of view define the knowledge economy. Some economists see that the knowledge economy does not go beyond the classical economic classification of economic systems in accordance with Marx's concept. They believe that the knowledge economy is simply an economy in which knowledge becomes a commodity or product on the market[9].

On the other hand, there are those who believe that the knowledge economy is a new form of economic relations, which relies mainly on people who are able to create and develop new technologies[10]. However, this definition is limited. Because it focuses mainly on the human element and neglects other elements of the knowledge economy such as technological infrastructure and the innovation system.

There are also those who define the knowledge economy as a system for producing the necessary economic knowledge and a system for managing this knowledge[11].

In another study, R.A. Fatkhutdinov, he believes that the knowledge economy is a tool for increasing the competitiveness of the national economy due to the fact that effective knowledge management will increase overall labor productivity[12].

Other economists[13] believe that the knowledge economy is only a sector that is largely based on knowledge and works together with other sectors of the economy. One can also define the knowledge economy at the level of economic organizations, where it acts as an effective means of using intangible assets, the key to achieving a competitive advantage, which is so necessary for any company.

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[6] Batrakova, L.G., Kolpakova, A.G. Formation and development of the knowledge economy. *Pedagogical Bulletin*. 2012. No. 1(4). P. 117-120.

[7] Friedman T. L. *The World Is Flat: A Brief History of the Twenty-first Century* (Further Updated and Expanded), New York: MacMillan Inc., 2005. 488 p.

[8] Burton-Jones A. *Knowledge Capitalism: Business, Work, and Learning in the New Economy*, Oxford: Oxford University Press, 1999. 248 p.

[9] Tyukavkin I.N. Economics of knowledge. *Bulletin of the Samara State University.* 2014. No. 6(117). P. 145-150.

[10] Yuri V.S. Knowledge Economy and Reality, *Meteor City*. 2016. No. 4. P. 36-42.

[11] Ovchinnikov V.V. Modernization: knowledge economy. *Trends and Development Prospects*. 2011. No. 6(1). P. 401-414.

[12] Fatkhutdinov R.A. Economics of knowledge and tools of a competitive economy. *Modern Competition*. 2008. No. 6(12). P. 137-143.

[13] Ovchinnikov V.V. Modernization: knowledge economy. *Trends and Development Prospects*. 2011. No. 6(1). P. 401-414.

Methodology

The task of the study is to scientifically comprehend the concepts of the knowledge economy and National Innovation System (NIS), which resulted in the formation of new theoretical and analytical approaches to the study of these aspects.

The theoretical and methodological study basis is the main conceptual micro and macroeconomics system, the knowledge management theory, the modern economic growth theory, including the theory of internal and external growth, the innovation management theory and the multidimensional innovation systems management, the theory of building scenarios using the foresight approach, methods assessment of the production systems efficiency, works of modern economists in the field of knowledge management and innovation systems.

In the study course, positivism was applied as the main methodological approach, mainly based on observation and knowledge obtained from the quantitative, logical and mathematical analysis of data and information related to the phenomena under study.

In addition, the following methodological approaches were widely used: inductive approach, mainly in the NIS structural components study; a systematic approach to the relationship study between the NIS subjects, both at the theoretical and practical levels; mathematical-system approach in the new tool development for monitoring the NIS evolution, studying the relationship between the process of formation and development of NIS and the transition process to the knowledge economy, as well as to determine the new knowledge economy index the and evaluate the NIS effectiveness based on the analysis of specific quantitative indicators.

Results

Disclosure of the essence and main theoretical directions of the knowledge economy

It should also be noted that the term knowledge economy is often used as a synonym for the new economy or innovation economy. Based on the above oh, we can derive the following definition of the knowledge economy.

The knowledge economy is a new economic system in which special attention is paid to intangible resources circulating in economic activity, both at the level of the national economy and in a single organization.

Currently, the activities of many organizations depend on intangible assets, including types of capital that have emerged in the context of the knowledge economy, such as human capital, social capital, intellectual capital, consumer capital. It should be recognized that knowledge differs from information in that in its format

«facts are present in the form of a certain structure, mechanisms or phenomena, they must be recognized as knowledge in a certain institutional context» [14].

Thus, we can define knowledge in the content of the knowledge economy as a set of classified data within a specific institutional context associated with the use of high technologies, and the effectiveness of their use in the economic sphere depends on how widespread they are in the organization and in society.

This definition can be expressed in the following equation[15]:

$$\boldsymbol{K} = [\boldsymbol{I} + \boldsymbol{T} + \boldsymbol{C}] \quad (1)$$

where:
(K) – knowledge;
(I) – information;
(T) – technology;
(C) – context;
(S) – exchange (Sharing).

In this context, the importance of the element S (exchange) in the knowledge economy should be noted. Initially, this phenomenon arose because information and communication technologies, as well as innovations in the field of transport, led to a change in the concept of ownership. The subjects of the knowledge economy have become more oriented towards the use of products in the form of rental rather than acquisition. This change at the level of ownership and the mechanisms of its transfer has led to a change in the concept of consumption, pricing mechanisms in the market[16] [17] and to the emergence of the so-called «sharing economy», an economy based on the concept of the advantage of rent and temporary use over other forms of interaction with property.

The theoretical definition of the characteristics of knowledge and their difference from other forms of intangible values makes it possible to substantiate their place and role in the knowledge economy, given the fact that they are a key material in the framework of production processes. Here are the main theses illustrating the importance of knowledge for modern society:

– knowledge is the foundation of the future value of a product that is created in the process of production activities at the micro and macro levels;

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[14] Prosvirina I.I., Taschev A.K. The knowledge economy and current trends in the use of labor. *Economics and Management*. 2014. No. 1. P. 73-79; Drobyshevskaya L.N., Popova E.D. Development of the knowledge economy in the era of digital transformations. *Creative Economy*. 2018. No. 12(4). P. 429-446.

[15] Nowacki R., Bachnik K. Innovations within knowledge management. *Journal of Business Research*. 2016. Vol. 69. Issue 5. P. 1577-1581.

[16] Habibi M.R., Davidson A., Laroche M. What managers should know about the sharing economy. *Business Horizons*. 2017. Vol. 60. Issue 1. P. 113-121.

[17] Zagainova A.A. Features of the development of the knowledge economy: theory and practice. *Polythematic Network Electronic Scientific Journal*. 2015. No. 113. P. 927-942.

- concrete results of mental work are documented knowledge, while undocumented knowledge plays a major role in innovation activity and is more easily and quickly transferred around the world[18];
- integrating documented knowledge with products and services significantly reduces the cost of infrastructure;
- knowledge generates and adds new knowledge as a result of their use, while material resources are depleted as a result of their use;
- maintaining a leading position in the knowledge economy is very difficult due to the exponential growth of the mass of knowledge and its high speed of dissemination;
- knowledge accumulated as a research result and development contributes to the innovative models creation that increase the technology level and create knowledge-intensive products embody a large amount of information and experience that can be further disseminated and developed[19].

In general, it can be said that knowledge is the main driver of value creation. For this reason, in our opinion, it is necessary to note the factors that determine the benefits that can be obtained because of the data processing, information and knowledge in order to improve welfare in the economy and society. These factors include the following:

- storage – a process that allows you to preserve the state of data, information and knowledge;
- use – use of data depending on their content;
- time – the interval required to make the transition from information to knowledge. Data is recorded and stored facts in real life. In a situation where we can organize and categorize this data in the form of a report, it turns into information.

As for the processing of information, it is carried out using the following processes:

- restructuring;
- definition of quantitative features;
- definition of qualitative features;
- clustering and classification into groups in certain contexts;
- training and distribution;

Because of this process, we obtain knowledge, which is processed through a process of deduction in accordance with a specific institutional structure and form in order to obtain abstractions that can be used in the creation of values.

[18] Shelestova D.A., Petrovich F.D. Economics of knowledge: the trajectory of institutional evolution. *Issues of economy regulation*. 2013. No. 4(1). P. 87-95; Lokhova T.V., Lagutin Yu.V. China in the knowledge economy: initial positions and prospects for cooperation. *News of higher educational institutions*. 2018. No. 2(46). P. 190-200.

[19] Zemtsov S.P., Komarov V.M. Formation of the knowledge economy in 1998-2012. *Innovations*. 2015. No. 10(204). P. 40-49.

The many characteristics distinguish the knowledge economy from traditional forms of the economy, which explores the nature of production relations, productive forces and production means. Therefore, in context the knowledge economy, a new direction of political economy is emerging[20], in which various economic and social components operate. The socio-historical subtext is the foundation of the knowledge economy, in which the productive forces form new types of economic and social relations, as a result, the knowledge economy can be characterized based on the following provisions:

- The knowledge economy is more diverse and complex than the traditional economy, as it contains more aspects related to human capital and information.
- Knowledge is considered the basic material in the knowledge economy, and its key advantage over other resources is self-reproducing and infinite.
- Knowledge is a universal source of goods production. This means that one party can use the same knowledge in one area without depriving the other party of the opportunity to use the same knowledge in another area.
- The skills required to work in the knowledge economy are fundamentally different from those required in the traditional economy[21]. The physical potential of the worker is no longer important – what is important is his mental ability, the level of scientific qualification and practical experience that he has in order to be able to work with the high level of technology used in the knowledge economy industries.
- The main elements used in the knowledge economy are: information, knowledge, acting as a productive factor and at the same time as a commodity, human capital, characterized by high technical and scientific potential, social capital, and involving network relations between innovative elements in society based on information and communication technologies.
- In the knowledge economy, the service sector is gaining the most importance, suggesting an increased level of activity and creativity of the workforce. It is no longer the production quantitative indicators that are important, but the productivity and labor quality with advanced technologies. The research and development sector is the most important element on which the knowledge economy depends. The process of knowledge creation that takes place in this sector provides the basic material for the knowledge economy. Changing the concept of education in the context of the knowledge economy. In this case, the system of lifelong learning becomes a priority, which provides for the integration of information and communication technologies in the education sector and contributes to the emergence and spread of distance and e-

[20] Batrakova, L.G., Kolpakova, A.G. Formation and development of the knowledge economy. *Pedagogical Bulletin*. 2012. No. 1(4). P. 117-120.

[21] Gagarina G.Yu. The role of human and social capital in ensuring the competitiveness. *Territory and Planning*. 2012. No. 5(41). P. 5-11.

learning. In the knowledge economy, access to knowledge is open and not restricted. However, it would be wrong to talk about complete freedom of access, especially when it comes to the exchange of knowledge and scientific technical information at the international level. It should be recognized that developed countries still retain a monopoly on the results of the innovation process, despite the activity of developing countries seeking to master foreign technologies for their own benefit. This leads to the emergence of the so-called digital knowledge divide between developed and developing countries. There is also «a conflict between developing and developed economies in this area, especially in the area of patents and intellectual property rights»[22].

– Information and communication technologies play an important role in the knowledge economy, especially computer technologies, which are of great importance in data processing and accelerate this process in society and the economy. To illustrate this statement, it is advisable to consider some laws related to the peculiarities of the information flows operation, in accordance with Moore's Law, the speed of these processors is constantly growing, and their costs tend to decrease. Moore predicted that «the speed of transistors in computers doubles every 18 months as their average cost decreases»[23].

Reality has proven that Moore's Law is true for processor speeds, but as far as cost is concerned, reality has shown that the average cost of information processors is declining faster than Moore expected. This indicates an even greater acceleration that is taking place in the field of information processing.

– In addition to Moore's law, one more law can be mentioned related to the benefit received from the network of users in the context of the knowledge economy. This law is Metcalfe's Law, the essence of which is that «The value of connected networks is equal to the square of the number of network members»[24].

$$V = n^2 \tag{2}$$

– Another law that demonstrates the interdependence of the strength of communication and the power of computer systems is the law of Gelder (Gilder's Law), who believed that «the strength of communication in a broadband network increases, three times the power of computers»[25].

[22] Weber S., Bussell J. Will information technology reshape the North-South asymmetry of power in the global political economy? *Studies in Comparative International Development*. 2005. Vol. 40. Issue 2. P. 62-84.

[23] Mpango P. *Socio-Economic Transformation for Poverty Reduction: Eight Key Messages for Unlocking Tanzania's Potential*, REPOA Brief Number 37. 2013. 4 p.

[24] Nugrahaeni R.A., Mutijarsa K. *Comparative analysis of machine learning KNN, SVM, and random forests algorithm for facial expression classification IEEE*, 2017. P. 163-168.

[25] Ogunsola L.A. Developing countries and the need for knowledge-based economy: the problems and challenges ahead. *Ozean Journal of Social Sciences*. 2008. Vol. 1. Issue 1. P. 1-11.

Thus, these three laws confirm the dominant position in the ICT market, since they determine the mechanisms for the exchange, dissemination and use of information and knowledge in the knowledge economy.

Also the role of ICT in accelerating the process of processing information and turning it into knowledge, especially in the field of data analysis in various sectors of the economy. It is a vector for the future direction of the information and communication technology markets.

Study of the mechanism and analysis of the transition means to a knowledge economy

Currently, there are many processes of rapid economic and social transformation affecting many countries of the world, such as China, the countries of Southeast Asia, and many others. Based on the experience of these countries, we can argue that the economic and social transformation process is «a process that increases the share of output produced in non-agricultural industries; this process includes the transition from an agrarian society to a society based on industry or services with a high percentage of contribution to GDP»[26]. This definition can be supplemented in the course of considering the phenomenon of socio-economic transformations, which in essence is a process of transition from a predominantly industrial economic activity to a society oriented towards an innovative economy. This process is accompanied by social and political changes aimed at increasing the mobility of labor and other resources, which contributes to the mutual exchange of knowledge in order to improve the well-being of the population.

Based on the presented considerations, it is possible to single out the most significant characteristics of the transformation process in accordance with the following factors[27]:

- instability: the transformation stage is characterized by instability, as all the old economic standards and laws are radically changed, which creates an unstable state in the economy;
- non-linear trend: since the transformation process represents a qualitative leap in the economy and society, it is not associated with a linear trajectory of the development of the situation. This suggests a departure from the traditional direction and demonstrates the unevenness of the evolutionary process;
- transition: this is the stage in which old structures are abolished and conflict arises between existing and new systems. The old system resists change at all levels;
- globality: the knowledge economy opens the way to change not only at the local level, but also at the global level, and also establishes a new type of development associated with activities in the international arena. This is due to

[26] Mpango P. *Socio-Economic Transformation for Poverty Reduction: Eight Key Messages for Unlocking Tanzania's Potential*, REPOA Brief Number 37. 2013. 4 p.

[27] Zhuravlev. G. P. *New Course in Economic Theory*, Derzhavina, 2009. 675 p.

the fact that the knowledge economy is a synaptic economy, i.e. a complex of economic ties of the highest order.

Based on the above definition of the knowledge economy, its main characteristics and the results of the economic transformation process analysis, we can identify the main means of transition to the knowledge economy. Means of transition to the knowledge economy:

- A quality system of education, training, research and development, which is crucial in the process of knowledge growth in the economy and society.
- High level of investment in areas of activity directly related to the knowledge economy.
- Concentration of state support for innovation activity by improving the technological infrastructure, in the absence of which innovation activity cannot spread to all economy areas and demonstrate efficiency in the good value chain.
- A clear technology and innovation strategy that includes all knowledge economy elements and the interactive relationship between them. In addition, the goals within this strategy should be clear and specific, taking into account the strengths and weaknesses of the economy and society that emerge in the transformation process.
- Legal and legislative environment in the innovation field. The environment mission is to promote and stimulate the subjects work in the knowledge economy.
- Efficient clustering between subjects in the economy and society[28], which refers to private sector organizations, government agencies, research associations and other formations of civil society. Obviously, the coordination of the activities of these entities will contribute to greater results in terms of productivity.
- Large-scale investment in intellectual and human capital[29], in order to increase knowledge capital, which is considered the most important capital type in the modern economy.
- Strengthening the links between subjects in the knowledge economy through a high level technology network.
- Institutionalization of economic relations between the main subjects of the economy is an endogenous factor, which has a significant impact on the process of building and transition to the knowledge economy[30].

[28] Babkin A.V., Chistyakova O.V. Digital Economy and Its Impact on the Competitiveness of Entrepreneurial Structures. *Journal of Entrepreneurship*. 2017. No. 8. P. 8-38; Salimyanova I.G., Dyachuk E. Innovative environment and national innovation system. *Economics and Entrepreneurship*. 2015. No. 10(63). P. 99-102; Salimyanova I.G., Pogoreltsev A.S. Categories of information support of innovative activity. *Innovative Activity*. 2016. No. 2(37). P. 53-60.

[29] Untura G.A. Assessing the Impact of Human Capital on the Economic Growth Under Financial Constraints. *Spatial Economics*. 2019. No. 15(1). P. 109-133.

[30] Tsyrenov D. Institutionalization of the knowledge economy. *Baikal Research Journal*. 2016. No. 7(2). P. 12-20.

- Creation and development of modern science cities, which are a kind of intellectual incubators. They provide incentives for innovation, sharing, evaluation and continuous updating, which implies continuous interaction between specialists and scientists[31] [32].
- A strong and growing middle class that is an effective springboard for socio-economic transformation, actively adapting and applying new knowledge and technologies. Thus, this social class will serve as a link between the political, social and economic spheres.

In addition to the means necessary for knowledge economy transit, it is necessary to analyze the transition process complex mechanism. Transition mechanism stages to the knowledge economy:

1. Improve the status of knowledge workers in the knowledge sector and provide them with financial support. As well as the motivation of talented young people to move towards educational and scientific fields.
2. Creation of a knowledge market institution that provides access to knowledge, but with the obligatory condition of controlling the commercial use of knowledge as a commodity. The institution of the knowledge market is considered an important element of the knowledge economy, defining the rules in the field of commercial use of information, patent issues and intellectual property rights.
3. Structural changes in the model of education by updating the curriculum and focusing on the practical aspects of the educational process. In addition, ensuring a close relationship between the content of educational materials and market requirements.
4. Project financing in the acquisition field and new knowledge dissemination (scientific, educational organizations, ICT companies, R&D institutes and others).
5. Improving innovation management, which is based on relationships with organization employees, given that these employees are creators and knowledge potential carriers. In this context, «innovative knowledge management processes should be designed to leverage the workforce experience and add new meaning by encouraging people to work on new information, extract important data, and handle the needs of the organization appropriately»[33].
6. The state should play an important role in coordinating between the economic activities and social subjects by creating a legislative framework, in accordance with the requirements of the transition process to the knowledge

[31] Kuznetsov S.V., Gorin E.A., Imzalieva M. Innovative dynamics in the economy: expectations and results. *Innovations*. 2019. No. 9(251). P. 38-44.

[32] Carrillo F.J. Knowledge cities: approaches, experiences and perspectives, New York: Routledge Taylor & Francis Group, 2006. 287 p.

[33] Nowacki R., Bachnik K. Innovations within knowledge management. *Journal of Business Research*. 2016. Vol. 69. Issue 5. P. 1577-1581.

economy. Moreover, the openness of data on relevant government activities can positively influence the formation of the knowledge base in the country[34].

7. The creation of an innovation platform brings together all participants in the innovation field and serves as a marketplace for innovation projects. The creation of an innovation platform is possible at the industry level or at the economy level. The platform takes into account all internal and external elements (process, products, investments, customers, regulations, industry, competitors)[35].
8. Take the necessary measures to increase the level of systemic economic openness that takes into account the needs of the local economy and allows you to focus on strengths in this area. Since economic transparency in the knowledge economy does not only take the form of loyalty to external information, but is also what is commonly referred to as «open source, open access, open economy, open government, open innovation»[36].

National innovation system: definition, characteristics, principles, and factors of formation and development

The definition of a national innovation system is impossible without understanding the conceptual and theoretical foundations of the innovation essence and innovation activity. The very concept of innovation, according to some sources, was first proposed by Schumpeter, who saw in it a certain object presented by an entrepreneur on the market, in the form of a new product created as a result of a new process or from new raw materials[37]. Thus, Schumpeter is the actual founder of the innovation concept in the «economic» sense. In particular, he believed that the main driver of capitalism and profit is innovation, arguing that «without innovation, there are no entrepreneurs, no entrepreneurial achievements, no capitalist benefit, and no motive for capitalism to work»[38]. There are many definitions of the concept of «innovation» (Table 1).

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[34] Lee J.N., Ham J., Choi B. *Effect of Government Data Openness on a Knowledge-based Economy Elsevier B.V.*, 2016. 158-167 p.

[35] Jha A.K., Bose I., Ngai E.W.T. Platform based innovation: The case of Bosch India. *International Journal of Production Economics*. 2015. Vol. 171. P. 250-265.

[36] Lundgren A., Westlund H. The openness buzz in the knowledge economy: Towards taxonomy. *Environment and Planning*. 2017. Vol. 35. Issue 6. P. 975-989.

[37] Schumpeter J.A. *Business Cycles: A Theoretical, Historical and Statistical Analysis of the Capitalist Process*, New York, 1939. 461 p.

[38] Schumpeter J.A. *The theory of economic development – An inquiry into profits, capital, credit, interest, and the business cycle*, Harvard University Press, 1934. 255 p.

Table 1. Overview of the «innovation» definition

Author	Definition of the concept of «innovation»
Joseph Schumpeter[39]	– Introduction of a new product or modifications made to an existing product; – New innovation process in the industry; – Opening of a new market; – Development of new sources of raw materials supply; – Other changes in the organization
P. Drucker[40] [41]	One of the two main functions of an organization.
Howard & Sheth[42]	Any new item brought to the customer, whether it is new or not.
Downs & Mohr[43]	The extent to which specific new changes are implemented in an organization
C. Simmonds[44]	New ideas that include: new products and services; new use of existing products; new markets for existing products or new marketing methods
A.I. Prigogine[45]	A purposeful change introduces into a certain social unit – organization, settlement, society, group – new, relatively stable elements
Kovin J.G.[46], Lumpkin & Dess[47]	A process that provides added value and novelty to the organization, suppliers and customers; development of new procedures, solutions, products and services, as well as new ways of marketing
Nohria & Gulati[48]	Any policy, structure, method, process, product, or market opportunity that a manager perceives as something new.
Karmyshev Y.A.[49]	A new product designed to meet the final demand of society

[39] Schumpeter J.A. *Business Cycles: A Theoretical, Historical and Statistical Analysis of the Capitalist Process*, New York, 1939. 461 p.

[40] Drucker P.F. *Post-capitalist society*, Oxford: HarperBusiness, 1993. 232 p.

[41] Ulin R.P. The Practice of Management by Peter F. Druc*ker*, Challenge. 1954. Vol. 3. Issue.3. P. 61-64.

[42] Haines G.H., Howard J.A., Sheth J.N. The Theory of Buyer Behavior. Journal of the American Stat*istical Association*. 1970. Vol. 65. Issue 331. P. 1406-1407.

[43] Downs G.W., Mohr L.B. Conceptual Issues in the Study of Innovation. *Administrative Scienc*e Quarterly. 1976. Vol. 21. Issue 4. P. 700-714.

[44] Simmonds K. Marketing as Innovation the eighth paradigm. *Journal of Management* Studies. 1986. Vol. 23. Issue 5. P. 479-500.

[45] Prigogine A.I. *Innovation: incentives and obstacles. Social problems of innovation,* Science, 1989. 271 p.

[46] Covin J.G. S.D.P. A conceptual model of entrepreneurship as firm behavior. Entrepreneurship. *Critical perspective*s on business and management. 1991. Vol. 3. P. 5-28.

[47] Lumpkin G. T., Dess G. G. Clarifying the entrepreneurial orientation construct and linking it to performance. *Academy of Management Review*. 1996. Vol. 2. Issue 1. P. 135-172.

[48] Nohria N., Gulati R. Is slack good or bad for innovation? *Academy of Manag*ement Journal. 1996. Vol. 39. Issue 5. P. 1245-1264.

[49] Karmyshev Yu.A. Analysis of the conceptual apparatus of innovation. Bulletin of the University. 1997. No.2.P.75-81.

Author	Definition of the concept of «innovation»
Rogers & Wright[50]	Innovation includes both the creation of knowledge and the dissemination of existing knowledge
Skrylnikova N.A.[51]	A set of scientific, technological, organizational, informational, financial and commercial activities for the transformation of scientific knowledge into new products and technologies, carried out by individuals, firms and the government
Boer & During[52]	Creation of a new association product-market-technology-organization.
Fagerberg[53]	Innovation is the first step in commercializing an idea.
Agarkov S.A., Kuznetsova E.S., Gryaznova M.O.[54]	Innovation is the end result of introducing innovation in order to change the object of management and obtain an economic, social, environmental, scientific, technical or other type of effect
Ovchinnikova A.V.[55]	Innovation is the result of creative, intellectual work to create a product, service, technology, organizational and economic form and entrepreneurial work for their practical implementation in the market
Costello T. P.B.[56]	Innovation is a word that gets used a lot in the business world, and for companies, it usually means something risky, costly, time-consuming.
Courvisanos & Mackenzie[57]	The result of appropriated knowledge and entrepreneurship operating in the institutional environment of innovation systems.
Sirotkina N.V., ChuprovaI[58]	Innovation is a complex process of creating, disseminating and using innovations to meet specific needs
Stenberg[59]	A new idea, product, device, or novelty.

[50] Rogers E. W., Wright P. M. Measuring organizational performance in strategic human resource management: Problems, prospects and performance information markets. *Human Resource Management Review*. 1998. Vol. 8. Issue 3. P. 311-331.

[51] Skrylnikova N.A. Innovative activity: micro-, meso- and macroeconomic characteristics. *University Bulletin*. 1999. No. 267. P. 52-56.

[52] Boer H., During W.E. Innovation, what innovation? A comparison between product, process and organizational innovation. Inter*national Journal of Technology Management*. 2001. Vol. 22. P. 83-107.

[53] Fagerberg J. *Centre for Technology, Innovation and Culture, U*niversity of Oslo. I*nnovation: A Guide to the Literature*, Oslo. 2003.

[54] Agarkov S.A., Kuznetsova E.S., Gryaznova M.O. Innovation management and state innovation policy. *Academy of Natural Sciences*, 2011. 143 p.

[55] Ovchinnikova A.V. National innovation system. *University Bulletin*. 2012. No. 4. P. 61-69.

[56] Costello T. P.B. Innovation. *IT Professional*. 2013. Vol. 15. Issue 3. P. 62-64.

[57] Courvisanos J., Mackenzie S. Innovation economics and the role of the innovative entrepreneur in economic theory. *Journal of Innovation Economics*. 2014. Vol. 2. Issue 14. P. 41-61.

[58] Sirotkina N.V., Chuprova I. Innovative strategy for the development of high-tech regions. A new look from the standpoint of the formation of the knowledge economy. *Region: systems, economics, management*. 2016. No. 3(34). pp. 36-42.

[59] Stenberg A. *What does Innovation* mean-a term without a clear definition, Halmstand: Halmstand University. 2017.

tab. 1. cont.

Author	Definition of the concept of «innovation»
Fruehauf, Kohun, Lesjak, Solek-Borowska & Paliszkiewicz[60]	All activities related to technological progress.
Ekaterina B.D.[61]	Invention or innovation after the process of commercialization, demanded and implemented – introduced to the market

According to the analyzed definitions, we find that the concept of innovation is associated with the production of products, ideas, processes, markets or new organizational methods in the context of economic activity, the development degree that depends on the level of progress in technology.

Thus, we can say that innovation covers all economy aspects, one way or another connected with the production, organization, marketing or goods distribution. However, not all economic activities in general are innovative, since there are a number of characteristics that distinguish innovative activity from other types of economic relations. Below we present the most significant.

- Innovative activity includes a fundamentally new factor of industrial growth at all production stages: research, production, distribution, consumption, and disposal.
- Significant investment in basic and applied research and development, which is the main and fundamental element of all innovation.
- Technological changes in production conditions.
- The growth and complexity of the nature of the society needs.
- Increasing the role of human capital.
- All internal innovations are motivated by profit and economic efficiency in a competitive environment.

Thus, all the above characteristics show the difference between innovative activity and traditional economic relations; in the future, they will serve as the theoretical basis of this study in the following sections. Most types of innovative activity have been studied in the economic literature at the micro level, that is, at the organization level. These studies explored the mechanisms of knowledge creation and management (works by Nonaka[62] and works by Alavi and

[60] Fruehauf J., Kohun F.G., Lesjak D., Solek-Borowska C., Paliszkiewicz J. *Global Definition of the Term Innovation: The So*cial Factors Influencing Individu*al Understan*ding, ToKnowPress, 2017. P. 637-644.

[61] Ekaterina B.D. Economic essence and nature of innovation. *Bulletin of VSUIT*. 2017. No. 79(1). pp. 326-331.

[62] Nonaka I., Konno N. The Concept of "Ba": Building a Foundation for Knowledge Creation. *California Management Review*. 1998. Vol. 40. Issue 3. P. 40-54; Nonaka I., Takeuchi H. *The Knowledge-*

Leidner[63]). Some other scholars have considered innovation management in large companies or even at the global level[64]. However, in our opinion, the complex nature of the relationship between the subjects of the macroeconomic economy requires a more detailed study of the innovation management issues at the macro level.

Historically, the origin of the national innovation concept a system has been associated with the measurement of overall economic performance in the field technological activity, as well as the development of industrial policies and strategies that increase productivity. In addition, the concept studying expediency is due to the need to analyze the influence of the technological factor on the national economy dynamics and on the general macroeconomic country indicators. The national innovation system concept emergence was the result of a collaboration between Freeman and Lundvall, who built the first model of the national innovation system concept. Freeman defines the national innovation system as «a network of private and public institutions involved in the import, modification and implementation of new technologies». And Lundvall – as «all elements and interactive relations in the field of production, distribution and use of economically useful knowledge that are within the national state borders»[65].

We can say there are two fundamental approaches to the national innovation system definition:

1. Alborg (Aalborg) approach. Built on the basis of the «national production system» concept, which implies a rethinking of the national production system essence with the removal of special attention to innovation and innovation activities, as well as their impact on macroeconomic indicators. The approach developed at the same name university was based on the work of Bjorn Johnson[66], which links innovation and learning to the socioeconomic characteristics of national institutions. In other words, the approach of Alborg University was that innovation is an essential element of the national production system.

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creating company: How Japanese companies create the dynamics of innovation, Oxford: Oxford University Press, 1995. 284 p.

[63] Alavi M., Leidner D.E. Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS Quarterly: Management Information Systems*. 2001. Vol. 25. Issue 1. P. 107-136.

[64] Dereli D.D. Innovation Management in Global Competition and Competitive Advantage. *Social and Behavioral Sciences*. 2015. Vol. 195. Issue 3. P. 365-1370.

[65] Freeman C., Lundvall B. A. *Small countries facing the technological revolution,* London; New York: Pinter, 1988. 303 p.

[66] Johnson B. *Institutional learning. National Innovation Systems: Towards a Theory of Innovation and Interactive Learning,* London: Pinter Publishers, 1992. 367 p.

2. Sussex approach (Sussex). The pioneers of this approach are Fagerberg[67] and Rothwell[68], who believe that all innovations arise from the national scientific and technical system. Thus, this approach differs from the previous one in terms of determining the origin of innovations.

It should be noted that the first steps of Freeman and Lundvall in building the concept of a national innovation system were aimed at understanding macroeconomic indicators in terms of competitiveness and economic growth[69]. However, at present, the changeable nature and dynamics of the national economic systems development are making their own adjustments to this theory. Thus, the regulatory and institutional framework governing the work of the participants in the system is mainly aimed at increasing the catalytic activity of innovative production, which, in turn, significantly affects the overall macroeconomic indicators.

Somewhat later, the concept of a national innovation system was expanded. Moreover, each researcher studied it from his own point of view. For example, Nelson defines it as «a group of institutions that, from interaction, determine the innovative activity of national companies»[70]. And Metcalfe[71] defines it as follows: «A group of institutions that individually or collectively contribute to the development and implementation of new technologies, provide governments with the opportunity to apply their innovation policies and strategies to develop the innovation process». Adquist believes that the national innovation system is «a set of important economic, social, political, organizational and institutional factors that influence the development of the dissemination, application or implementation of innovations»[72]. Later, Lundvall defined an innovation system as containing or consisting of «a set of elements located within the boundaries of the nation-state, and the relationships between these elements, which simultaneously affect the production, dissemination and use of economically useful new knowledge»[73].

Guan and Chen studied the innovation system from the subjects view point, where they defined the national innovation system as «a group of entities that in-

[67] Fagerberg J. *Technology, Growth and Trade: Schumpeterian Perspectives*, Brighton: University of Sussex, 1988.

[68] Rothwell R. Factors for Success in Industrial Innovation. *Journal of General Management*. 1974. Vol. 2. Issue 2. P. 57-65.

[69] Freeman C., Lundvall B. A. *Small countries facing the technological revolution,* London; NewYork:Pinter, 1988. 303 p.

[70] Nelson R.R., Rosenberg N. *Technical Innovation and National Systems*, New York: Oxford University Press, 1993. 525 p.

[71] Metcalfe J.S. *The Economic Foundations of Technology Policy: Equilibrium and Evolutionary Perspectives*, Oxford: Blackwell Publisher Ltd, 1994. 600 p.

[72] Edquist C. *Systems of Innovation: Perspectives and Challenges*, Oxford: Oxford University Press, 2009. P. 181-208.

[73] Lundvall B.A. *User-Producer Relationships, National systems of Innovation and Internationalism.* National Innovation Systems: Towards a Theory of Innovation and Interactive Learning, London: Pinter Publishers, 1992. 367 p.

clude universities and other research institutions, companies, intermediaries and the state that produce, introduce innovations»[74].

As part of a more precise conceptual definition of the system elements and the subject's functions in it, Eggink defines the national innovation system as «the subjects and types sum of their activities and relationships, as well as the socio-economic environment, in which the subjects interact functions to determine the system innovative characteristics»[75].

In domestic literature, the concept of a national innovation system has been widely studied from different viewpoints. However, most of the definitions presented by economists can be considered derived from the original foreign concept definitions. These definitions are limited to defining the main subjects and their main functions in the production and exchange of new technologies. Rudenko M.N. and Shnurenko A.V. define as «a set of economic entities and institutions with the help of which activities are carried out to create, store, disseminate and use new knowledge and technologies»[76]. On the other hand, Ovchinnikova A.V. defines it as «one of the economic and social subsystems of the knowledge economy, which is both a necessary condition for the transition to a new system of economic relations and the end result of its transformation»[77]. Stochevan O.A. defines as «a set of interrelated organizations, financial institutions, state regulation instruments within national borders»[78]. Krasnoperova T.Ya. gives a more detailed definition – «it is an evolutionarily developing subsystem of the national economic system, which is a set of interconnected subjects of the innovation infrastructure and institutions of a financial, legal and social nature, purposefully generating and transforming scientific knowledge into new technologies, products, services, their commercialization and financing for the realization of economic interests»[79].

In this regard, it should be noted that researchers of the innovation system often used different approaches to its definition in level terms of measurement and identification of subjects and their activities. For example, the regional innovation system concept emerged as an expression of a narrower geographical understand-

[74] Guan J., Chen K. Modeling the relative efficiency of national innovation systems. *Research Policy*. 2012. Vol. 41. Issue 1. P. 102-115.

[75] Eggink M. The Components of an Innovation System: A Conceptual Innovation System Framework. *Journal of Innovation and Business Best Practices*. 2013. Vol. 13. Issue 2013. P. 1-12.

[76] Rudenko M.N., Shnurenko A. National innovation system: structure and main components. *Problems of Modern Economics*. 2010. No. 2(2). P. 119-124.

[77] Ovchinnikova A.V. National innovation system. *University Bulletin*. 2012. No.4. P. 61-69.

[78] Stochevan O.A. *Priorities and prerequisites for the formation of a national innovation system*, Publishing House of St. Petersburg State University of Economics, 2005. 16 p.

[79] Krasnoperova T.Ya. National innovation system: structure, the role of the financial component. *Scientific and technical bulletin of information technologies, mechanics and optics*. 2013. No. 6(88). P. 152-156.

ing of the participant's activities nature in the innovation system[80]. However, there are certain difficulties associated with this analysis level. On the one hand, many researchers have argued that the regional innovation system can be studied (Braczyk, Cooke, Heidenreich[81]; Boschma[82]; Schrempf, Kaplan & Schroeder[83]). Others were convinced that the national innovation system can only be considered as a whole. There is a third approach[84], which suggests that the national innovation system should be interpreted in the form of industry innovation systems. In general, we tend to agree with the researchers opinion Oh, Phillips, Park & Lee[85], Roblek, Pejić, Meško & Bertoncelj[86]. In our opinion, the main approach to the study of the innovation system in the country should be based on a practical study of the specific characteristics of innovation and technological activity, demonstrating the level of development and quality of innovation relations among entities within the economic state system.

Based on the foregoing, we can give an exhaustive, in our opinion, definition of the national innovation system. A network structure that includes all institutions, organizations and entities involved in the creation, exchange and knowledge dissemination, technologies and innovations, both in private, and in the public sectors, with particular attention to the state role importance in coordinating the work of all system elements in order to increase its efficiency and productivity.

First, it should be noted the need to distinguish between the national innovation system and the national production system. The national system of production is a broader concept that covers all types of economic activity related to the production of goods and services in macroeconomic level. It involves the study and analysis of the productivity of the national industry, the evaluation of the effectiveness of all public and private systems built into the network of economic ties, the development of strategic plans for the development of the economy and control over their implementation. As for the national innovation system, it is associated with a specific type of economic relations, which are innovative activities

[80] Vasin S.M., Gamidullaeva L.A. Region as a locus of innovation activity. *Theoretical and Applied Economics*. 2018. No. 2. P. 1-11.

[81] Braczyk H.-J., Cooke P., Heidenreich M. *Regional innovation systems*, London: University College London Press, 1998. 487 p.

[82] Boschma R.A. Proximity and innovation: A critical assessment. *Regional Studies*. 2005. Vol. 39. Issue 1. P. 61-74.

[83] Schrempf B., Kaplan D., Schroeder D. *National, Regional, and Sectoral Systems of Innovation – An overview.* 2013. European Comission. 32 p.

[84] Courvisanos J., Mackenzie S. Innovation economics and the role of the innovative entrepreneur in economic theory. *Journal of Innovation Economics*. 2014. Vol. 2. Issue 14. P. 41-61.

[85] Oh D.-S., Phillips F., Park S., Lee E. Innovation ecosystems: A critical examination. *Technovation*.2016.Vol.54.P.1-6.

[86] Roblek V., Pejić B.M., Meško M., Bertoncelj A. The impact of social media to value added in knowledge-based industries. *Kybernetes*. 2013. Vol. 42. Issue 4. P. 554-568.

related to the production, exchange and dissemination of scientific information and technologies.

At the same time, it should be emphasized that the national innovation system is not independent of the rest of the production systems of the country's economy. It is a conceptual basis for studying the interactions and relations taking place in the field of scientific and technological activities, as well as a tool for analyzing the existing innovation policy that corresponds to the intellectual potential of a particular state.

The main goal of the national innovation system is to manage innovation and technological activities, as well as to increase the efficiency of these activities in order to increase the competitiveness of the national economy at the international level.

The functioning of the national innovation system is aimed at increasing the flow of knowledge, technology and innovation by effectively managing the main and auxiliary relations between the subjects of the system in the course of creating an appropriate economic, social and research environment[87].

The National Innovation System is a functional tool in the knowledge-based economy, which accelerates the mechanisms for the production and exchange of information and experience and makes innovation viable for further commercial exploitation in the market. Consequently, there is an increase in the value added of products, which contributes to an increase in the competitiveness of the entire national economy. However, it should be noted the close interconnection and dialectical nature of the relationship between the components of the national innovation system and the knowledge economy, which, intersecting, create a wide area for the production, exchange, dissemination and exploitation of scientific and intellectual information. Thus, the result of the process of transition to the knowledge economy depends on the level of development of innovation activities carried out by the subjects of the national innovation system. But, on the other hand, the success of the process of formation and development of the national innovation system depends on the development of mechanisms for the creation, dissemination and exchange of knowledge between individuals and institutions of the economy and society, as well as on the unlimited access to knowledge for all participants. In addition, it is important to have an institutional and legislative framework for organizing activities related to the production of value added and knowledge-based innovation. The following figure illustrates the features of the relationship between the knowledge-based economy and the national innovation system.

In the same context, it can be considered that the conceptual differences establishment between the innovation system and the knowledge economy is necessary. The national innovation system is only one of the knowledge economy components, which has a more ramified structure. It should be taken into account that the

[87] Metcalfe S., Ramlogan R. Innovation systems and the competitive process in developing economies. *Quarterly Review of Economics and Finance*. 2008. Vol. 48. Issue 2. P. 433-446.

geographically innovative system does not necessarily cover all economic activities in the particular country territory. The distribution of the innovation activity subjects and the relationships network between them can be limited only to the regional level, while the knowledge-based economy covers all knowledge-intensive economic phenomena, as well as activities directly dependent on knowledge. In other words, knowledge is not the main production processes component. Another semantic distinction that needs to be made between the national innovation system and the knowledge economy is that the former is an expression of the driving forces behind the commercial knowledge production process. In addition, there is the most important system component – the education sector, covering all levels: from schools to academies and universities. It is the foundation for building a technological infrastructure network, representing the physical basis of the knowledge-based economy. As for the characteristics of the national innovation system, there are two main approaches to their definition:

1. Narrow approach. This approach takes into account the national innovation system characteristics at the subject's private innovation activities level, i.e. organizations, institutions and enterprises that create and apply scientific and technical innovations. In this context, we can consider that the most important characteristics of a national innovation system are:
   - Companies, organizations and institutions operating within the national innovation system.
   - Research and development activities, which are the most important activities aspects within the national innovation system.
   - Development of fundamental and applied research, representing a holistic mechanism, on the results of which innovations are based.
   - Creation of human capital and development of workers skills in the production field, exchange and dissemination of knowledge and technology, which is the most important condition for the successful functioning of the national innovation system.
   - Scope of innovative companies activity, including the private and public sectors[88]
2. Broad approach. It takes into account the national innovation system from a global viewpoint, taking into account the specifics of the cultural, social and political environment[89]. This means a broad approach to the analysis of the national innovation system takes into account the institutional aspect of the subjects scope, in which innovation institutions and companies cannot

[88] Johnson B. *Institutional learning. National Innovation Systems: Towards a Theory of Innovation and Interactive Learning,* London: Pinter Publishers, 1992. 367 p.

[89] Schrempf B., Kaplan D., Schroeder D. *National, Regional, and Sectoral Systems of Innovation – An overview.* 2013. European Comission. 32 p.

work without cooperation with other companies and institutions within the relevant laws framework[90].

In this regard, the following points can be noted:

- The legal and regulatory environment is a key and important factor in facilitating innovation and facilitates the effective collaboration of the system elements.
- The state plays a key role in improving the working conditions of the subjects of the national innovation system. It also provides synergy between these entities.
- Civil society plays an important role in the creation and dissemination of knowledge and thus accelerates the accumulation of knowledge within the system[91].
- The research and education sector is the most significant source of fundamental and applied knowledge needed to create an innovative business environment through the interaction of the public and business sectors.

The process of formation and development of the national innovation system in the country takes place in accordance with the transition to the knowledge economy, which is closely related to the world economy globalization. All this contributes to the information openness and the range expansion of joint innovation activities at the international level. In other words, openness to the external environment is the most important condition for the knowledge economy successful transition. Determining the principles and factors necessary for the formation and development of a national innovation system requires identifying the key components of this system.

So, the national innovation system is based on three main aspects:

- subjects;
- functions of subjects;
- relations between subjects;

Thus, the process of formation and development of the system includes the definition of goals, principles, functions and methods of managing the above components.

Essence analysis of the subject's development process is the first step in the national innovation system formation in any country. Below are a basic principles number for the subject's development of the national innovation system.

- The need to improve the quality of human resources needed for the scientific and technical process. The more innovative an economy is, the more qualified people are required to create new products and services[92].

[90] Lokhova T.V., Lagutin Yu.V. China in the knowledge economy: initial positions and prospects for cooperation. *News of Higher Educational Institutions*. 2018. No. 2(46). P. 190-200.

[91] Boschma R.A. Proximity and innovation: A critical assessment. *Regional Studies*. 2005. Vol. 39. Issue 1. P. 61-74.

[92] Braczyk H.-J., Cooke P., Heidenreich M. *Regional innovation systems*, London: University College London Press, 1998. 487 p.

- Increasing investment in education, since educated people are a necessary element in disseminating new knowledge and turning it into innovation. Studies have shown that the more spending is allocated to education, the greater the number of patents increases in the country[93]. The support of educational institutions is an important factor in ensuring the high quality of human capital required for organizations working in the innovation field[94].
- Entrepreneurs are key subjects in the national innovation system, as they implement new ideas, embodying them in finished goods and services. Schumpeter defines the main goals of an entrepreneur working in the innovation field[95]. These include the following:
- Production of new products and services and production of high quality products;
- Creation of an organizational forms new type at different levels of business, increase in the venture capital amount.
- Creation of a new market, corresponding to the general trend of globalization processes business contacts implementation at the international level.
- Reforming the banking system with a special focus on risk management. Here, the high-risk innovation nature should be emphasized, which requires long-term investments and a revision of the risk insurance system[96].
- The most important organizations of the national innovation system are firms and enterprises, universities, schools, research and financial institutions, national agencies[97]. Therefore, it is necessary to form a unifying institutional structure of a higher order. It will contribute to the creation of a working environment for all these entities. This is for the purpose of ensuring their mobility and increasing the efficiency of joint work in the production field and new knowledge dissemination. In addition, this is transform it into innovations and further implementation in finished products and services on the market.
- The public sector should be given the main role at the initial stage of the national innovation system formation, since the government apparatus is the most organized entity with the maximum financial and administrative capabilities.

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[93] Jha A.K., Bose I., Ngai E.W.T. Platform based innovation: The case of Bosch India. *Internftional Journal of Production Economics*. 2015. Vol. 171. P. 250-265.

[94] Carrillo F.J. Knowledge cities: approaches, experiences and perspectives, New York: Routledge Taylor & Francis Group, 2006. 287 p.

[95] Zagainova A.A. Features of the development of the knowledge economy: theory and practice. *Polythematic Network Electronic Scientific Journal*. 2015. no. 113. P. 927-942.

[96] Ogunsola L.A. Developing countries and the need for knowledge-based economy: the problems and challenges ahead. *Ozean Journal of Social Sciences*. 2008. Vol. 1. Issue 1. P. 1-11.

[97] Babkin A.V., Chistyakova O.V. Digital Economy and Its Impact on the Competitiveness of Entrepreneurial Structures. *Journal of Entrepreneurship*. 2017. No. 8. P. 8-38.

Below are the tasks that, in our opinion, need to be solved in order to achieve the national innovation system forming goal.

- Improving the financial institutions efficiency in the economy, which plays an important role in determining the functions of subjects within the innovation system.
- Clarification of the system elements functions related to the institutional foundations development that are in its operation area. Creating a healthy institutional environment provides a more cooperation effective level between the subjects of the national innovation system.
- Formation of the measures set to protect intellectual property rights, which is a necessary condition for motivating the subjects of the innovation system to work intensively and create new science-intensive products.
- Development of an innovation policy based on the consumer's needs, since close interaction with the latter contributes to the new products continuous improvement and ensures their distribution on the market[98].
- State support for educational institutions in order to increase the overall education level in the country, improve the human capital quality, and accumulate intellectual potential. On the other hand, educational institutions themselves are the innovations creators, and, in this regard, it is necessary to increase budget spending to stimulate R&D.
- The state role should be strengthened in the innovation policy field aimed at activating entrepreneurial activity by providing appropriate legislative and legal conditions for the work of small and medium-sized businesses.

The relationships quality and clear coordination of the subject's activities is one of the most important prerequisites for the national innovation system formation. In our opinion, the main conditions for increasing the participant's joint work efficiency in the production of scientific and intellectual potential should be the following:

- The national innovation system development requires, first of all, the creation and development of innovative, technological and intellectual potential. In addition, the main personals ability to disseminate innovations within the system is formed.
- Development of a cooperation structure between the subjects by linking their work with a single national knowledge base and infrastructure.
- Encouragement and support of joint projects, the so-called spin-offs, between universities, industries and the business sector.
- In order to strengthen relations between personals, it is necessary to activate the innovative intermediaries role, which are industrial and commercial associations, economic development agencies, commerce chambers and in-

[98] Oh D.-S., Phillips F., Park S., Lee E. Innovation ecosystems: A critical examination. *Technovation*. 2016. Vol.54. P. 1-6.

dustry, technology parks, business incubators, research institutes, technology transfer companies, innovation centers, high-tech activities industrial zones, venture funds, quality management and certification organizations. The intermediary's advantage is to combine several entities into an innovation system within one business[99].

- To avoid system failure, the public sector has a key role to play as a facilitator, catalyst, risk insurer and resource distributor within the system.
- Providing state financial support for private sector companies involved in the production and dissemination of new technologies and innovations, which contributes to an increase in the efficiency and intensity of R&D and the growth of patenting in private companies[100].
- Tax incentives provision by the government to the private sector associated with R&D[101].
- Technology incubators creation are an important tool for working on new projects. These incubators, in particular, provide the necessary resources and services to developing companies.
- Ensuring the stability and economy efficiency, demonstrating strong economic growth[102]. In other words, this means creating a healthy macroeconomic environment that promotes the free and participants active functioning in the national innovation system[103].

All the above processes taking place in the national innovation system should be subject to comprehensive monitoring and control by the state in order to develop a promising strategy for innovation policy.

Modeling the functional interaction dynamics between the national innovation system subjects

Constant knowledge generate innovation flows in the economy, as well as introduce imbalances in established production patterns and consumption. The new subject's emergence in the innovation system leads to a fundamental change in the entire economic model. These subjects are scientific and educational institutions. It is obvious that the highly intelligent information production and the new technological approaches formation affects not only the scientific environment, but

[99] Nugrahaeni R.A., Mutijarsa K. *Comparative analysis of machine learning KNN, SVM, and random forests algorithm for facial expression classification IEEE*, 2017. P. 163-168.

[100] Haines G.H., Howard J.A., Sheth J.N. The Theory of Buyer Behavior. *Journal of the American Statistical Association*. 1970. Vol. 65. Issue 331. P. 1406-1407.

[101] Simmonds K. Marketing as Innovation the eighth paradigm. *Journal of Management Studies*. 1986. Vol. 23. Issue 5. P. 479–500.

[102] Salimyanova I. G., Pogoreltsev A. S. Categories of information support of innovative activity. *Innovative Activity*. 2016. No. 2(37). P. 53-60.

[103] Courvisanos J., Mackenzie S. Innovation economics and the role of the innovative entrepreneur in economic theory. *Journal of Innovation Economics*. 2014. Vol. 2. Issue 14. P. 41-61.

also the social, economic and political life aspects in the country[104] [105]. As a result, economic relations based on the traditional production model are giving way to a new knowledge-based economy form[106].

This process of transformation is embodied in economic theory through the transition from the neoclassical school, which focuses on the market equilibrium mechanism, to evolutionary economic theory, which focuses on innovation. Schumpeter believed that the innovation dynamics is constantly destabilizing the market. According to the development neoclassical model, the potential for innovation and technological development is an exogenous factor and is based on scientific research produced in a free market. Thus, the state role in the innovation system field is limited, which means a control lack and financial support, which is so necessary for the scientific sphere. On the contrary, supporters of the evolutionary and institutional economy consider innovation model to be an endogenous factor and argue the need for state participation in the innovation management[107].

The transition to the institutional economy model marked a relationships system revision between science, industry and the state. Thus, the functional interaction study between these subjects is a necessary condition for the formation of an effective innovation management system. Here it should be noted that the functional innovation system subject's area affects many life aspects, ranging from politics, social and cultural environment and ending with environmental, geographical and global conditions. Each of these aspects build their own independent model, filled with specific components built into the overall innovation system.

However, it should be noted that the production and transfer knowledge process, innovations and technologies could be improved or, on the contrary, hindered due to the various institutional conditions impact. Thus, the functions and the subjects themselves are subject to evolutionary changes in the conditions of interactive relations between them within the national innovation system framework. The education sector is an important source of human capital formation in the knowledge economy. The function of primary and secondary education is to prepare people learning capable, to provide them with the information base necessary for the realization of their cognitive abilities, and to provide them with the basic skills with which the scientific knowledge system will be built. Thus, the education sector is important in providing the fundamental basis terms of human capital.

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[104] Nonaka I., Konno N. The Concept of "Ba": Building a Foundation for Knowledge Creation. *California Management Review*. 1998. Vol. 40. Issue 3. P. 40-54.

[105] Nonaka I., Takeuchi H. *The Knowledge-creating company: How Japanese companies create the dynamics of innovation*, Oxford: Oxford University Press, 1995. 284 p.

[106] Alavi M., Leidner D.E. Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS Quarterly: Management Information Systems*. 2001. Vol. 25. Issue 1. P. 107-136.

[107] Salimyanova I.G., Pogoreltsev A.S. Categories of information support of innovative activity. *Innovative Activity*. 2016. No. 2(37). P. 53-60.

At the next stage, universities play a major role in filling the national innovation system with scientific knowledge obtained as a research result. In addition, universities contribute to an increase in the number of highly educated people in demand in the labor market in accordance with the national economy needs. All this is the basis for accelerating and activating the mechanisms for the scientific capital production, which will subsequently be commercially used by business, industry and the state. As for industry, the entity function in the national innovation system is to transform applied scientific knowledge into new products with high benefit, which is essential in a competitive economy. Thus, the scientific sector produces a fundamental complex and applied research, while the manufacturing sector, based on these innovative developments, solves the problem of meeting specific market needs.

In order to realize the production of innovations and technologies, industrial enterprises cooperate with research institutes and universities through various forms of innovative joint activities, such as patents, licenses, copyrights and partnerships. All this is happening against the state control background and management measures aimed at improving the institutional and legal environment.

However, before examining the relationship nature of functional interaction between universities and industry, we must elucidate the form and structure of the knowledge production process that determines the innovation quality.

Let us consider different modes of knowledge production in the national innovation system.

1. Mode 1. The classical model of knowledge production based on the scientific knowledge creation within the higher educational institutions walls. That is, innovations are generated exclusively by research conducted in the university community[108]. The linear innovation model demonstrates the movement of innovation under this regime[109].
2. Mode 2. It can be said that the knowledge production under mode 1 is limited to the academic field or universities[110], while mode 2 is based on the participation of more than one party or several multidisciplinary teams that come together to solve a specific problem and are valid until the desired result is obtained[111]. This second type of knowledge production corresponds to the non-linear innovation model.
3. Mode 3. It is a combination of fundamental and applied research carried out in the creating innovations process. In other words, this is the scientific activity results maximum exploitation.

[108] Boschma R.A. Proximity and innovation: A critical assessment. *Regional Studies*. 2005. Vol. 39. Issue 1. P. 61-74.

[109] Costello T.P.B. Innovation. *IT Professional*. 2013. Vol. 15. Issue 3. P. 62-64.

[110] Rothwell R. Factors for Success in Industrial Innovation. *Journal of General Management*. 1974. Vol. 2. Issue 2. P. 57-65.

[111] Schumpeter J. A. *Business Cycles: A Theoretical, Historical and Statistical Analysis of the Capitalist Process*, New York, 1939. 461 p.

Based on the results of studying the forms of knowledge production, innovative models, the relationship nature between universities and industry, we can conclude that the relationship between science and industry plays a decisive role in the national innovation system. The most striking functional activities examples of these two entities are spin-offs, which reflect a productive partnership form in which universities offer scientific knowledge, and industry creates new technologies, realizing them in specific benefits.

As noted above, there are many other examples of interactive functional relationships between universities and industry, such as patents, licenses, and others. However, links between universities and industry are constantly spiraling. The double helix model clearly reflects the development of these functional relationships. As a result, the following relationship scheme is built:

1. Universities provide research and development results to the industry sector in the form of new scientific and practical knowledge.
2. The industry uses this knowledge commercially: turns it into innovations, embodied in products, and puts it on the market.
3. After the business sector profits from the innovations sale embodied in products, universities receive a share of these revenues.
4. As a result of the increase in income of universities due to interactive relations with the business sector, the former expand and develop their research activities.
5. The new level of cooperative interaction between universities and industry is more complex. Its results are more valuable and significant from the market viewpoint, and in addition, the knowledge accumulation process is self-sustaining, which is expressed in the constant development and improvement of the entire system.

It should be noted that the result of cooperation between industry and science could not be understood in a purely utilitarian sense. Of course, the innovations commercialization is the most important task of the knowledge economy, but we must not forget that scientific information in itself is a value of the highest order, and not all fundamental research can bring momentary profit. That is why the relationship between production and science should not be simplified to the level of primitive commercial benefits, and in this respect it is necessary to emphasize the need to involve the state and involve its structures in the innovation system.

Thus, the innovation system subjects are in constant interaction, which, on the one hand, is based on a mutually beneficial exchange of scientific information and experience, and on the other hand, on the need idea to accumulate intellectual potential and promote knowledge to the public in order to increase the competitiveness of the national economy and population general welfare.

The analytical model creation of functional relations between the subjects of the national innovation system requires, first, the organizations operating identifica-

tion in this system, which are its main participants. There are five main organizations types in the national innovation system[112]:

1. Government organizations (local, regional, national and international). Their mission is to develop an innovative development strategy.
2. Linking organizations such as research councils and associations. They are considered intermediaries between the state and the scientific sector.
3. Private companies affiliated with research institutions.
4. Universities and other educational institutions.
5. Public and private organizations that play a special role in the national innovation system (public laboratories, technology transfer agencies, joint research institutes, patent offices and educational institutions).

These organizations can be considered as functional subjects national innovation system forms.

In order to analyze the interaction nature between the system subjects, it is necessary to expand the double helix model by adding the state as a third subject in the national innovation system. The role of government is essential, and government intervention in the economy as a whole is justified by the need to overcome market defects that hinder the creation and application of new knowledge[113]. Therefore, it is better to clarify and analyze the state role in the national innovation system using the systemic failures theory, which explains the unsatisfactory results of cooperation between various parties within the innovation system[114]. The system inefficiency, in turn, leads to an imbalance in relations between institutions and organizations. Thus, the state role is not only to support innovative activities, but also to ensure the smooth functioning of the national innovation system.

The innovation system inadequacy is explained by the insufficient cooperation degree between the national innovation system subjects and the fundamental research disunity conducted by universities, public research laboratories and applied scientific work in the business sector. We can distinguish the following types of failures in the national innovation system:

– Failure of capacity means that companies and organizations cannot act in their own interests (due to poor management, lack of technical competence, and lack of ability to learn or inability to use available technologies). We can say that such a systemic failure is associated with weak innovative, technological and enterprises production capabilities, as well as a low management level[115].

[112] Zagainova A.A. Features of the development of the knowledge economy: theory and practice. *Polythematic Network Electronic Scientific Journal*. 2015. No. 113. P. 927-942.

[113] Mpango P. *Socio-Economic Transformation for Poverty Reduction: Eight Key Messages for Unlocking Tanzania's Potential*, REPOA Brief Number 37. 2013. 4 p.

[114] Lumpkin G.T., Dess G.G. Clarifying the entrepreneurial orientation construct and linking it to performance. *Academy of Management Review*. 1996. Vol. 2. Issue 1. P. 135-172.

[115] Salimyanova I.G., Pogoreltsev A.S. Categories of information support of innovative activity. *Innovative Activity*. 2016. No. 2(37). P. 53-60.

– Relationship failure: relationship problems relations between the innovation system subjects (absence or inadequate quality of relations, inability to realize technological opportunities; problems in the market structure).
– Failure of institutional structures: weak legal framework, insufficient protection of intellectual property rights, poor health and safety conditions.

Thus, in order to avoid a systemic failure, the state should support institutional structures associated with other entities, create advisory programs in the innovation policy field in order to improve coordination and synergy between system participants. This helps to develop a strategy corresponding to the activities nature of the innovation system subjects. Undoubtedly, the institutional mechanisms of bilateral relations differ significantly from those of trilateral or multilateral ones. For example, interactions between universities and industry can be expressed in various entities such as technology transfer offices (spin-offs), license agreements, and others. Thus, the solution to this problem lies in the institutional facilities network creation for the operational activities of the public and private sectors, which will accelerate the creation processes, storage, transfer and dissemination of knowledge and skills produced by innovations[116]. The state innovation policy in the support field of for national organizations related to research activities helps to cover the developing the fields costs of education, science, logistics and mediation in the production field and information use. All this stimulates and encourages economic entities to seek and implement innovations protected by various state support types, such as government purchases, tax incentives, subsidies, etc.[117].

In conclusion, we can say that the state is the subject that regulates and determines the institutional participants rest work areas in the national innovation system, while the industry is the main initiator of production and economic activity. As for universities, they play a leading role in organizing the knowledge creation process[118].

An analysis of the functional interaction mechanisms between the three subjects of the national innovation system makes it possible to identify the prerogative tasks of the knowledge economy.

– wealth creation in the economy;
– introduction of innovative production on a scientific and technological basis;
– development of appropriate institutional structures.

Thus, we can distinguish three subsystems in the knowledge economy: economic, academic and political. They work according to their own mechanisms, but under the close interaction condition in exact accordance with the triple helix

[116] Weber S., Bussell J. Will information technology reshape the North-South asymmetry of power in the global political economy? *Studies in Comparative International Development*. 2005. Vol. 40. Issue 2. P. 62-84.

[117] Babkin A.V., Chistyakova O.V. Digital Economy and Its Impact on the Competitiveness of Entrepreneurial Structures. *Journal of Entrepreneurship*. 2017. No. 8. P. 8-38.

[118] Nonaka I., Takeuchi H. *The Knowledge-creating company: How Japanese companies create the dynamics of innovation*, Oxford: Oxford University Press, 1995. 284 p.

model. Within the triple helix model framework, the relations between these entities represent a complex non-linear network interaction, in which the functional synergy between them at the geographical, technological and system levels has a significant impact on the form and development degree of the national innovation system structure[119].

Note that the functional relations perspective within the innovation system differs from the institutional one. Functional relations are constantly in development, while institutional ones serve as mechanisms for maintaining the entire system state. In this vein, it should be mentioned that all three main participants in the system do not always interact in every innovation event. There are many projects formed on bilateral cooperation, without the state participation. Based on the foregoing, an effective national innovation system is the result of managing the innovation process and intellectual resources through the creation of an appropriate institutional organization. At the heart of all processes of the national innovation system are three components:

- knowledge;
- innovation;
- welfare.

All functional relationships between the three subjects of the national innovation system are based on the actions of one or all three components. Therefore, based on the above analysis, we can present an analytical framework serving as a theoretical framework for a better understanding of the functional relationships between the subjects of the three-dimensional national innovation system. The presented scheme presents an analytical basis for the study of the subject's activities of the national innovation system, covering the linear process and non-linear creating innovations processes. It also includes all possible relationships between subjects within the national innovation system, both bilateral and multilateral.

Conclusions

In this research, the theoretical knowledge economy concept was presented, and, in particular, its differences from the industrial economy were shown through the main characteristics definition at the macro and micro levels. The key role played by knowledge in new sectors of the economy was also identified, and the knowledge role in the process of creating value in the economy was analyzed.

[119] Johnson B. *Institutional learning. National Innovation Systems: Towards a Theory of Innovation and Interactive Learning,* London: Pinter Publishers, 1992. 367 p.; Weber S., Bussell J. Will information technology reshape the North-South asymmetry of power in the global political economy? *Studies in Comparative International Development*. 2005. Vol. 40. Issue 2. P. 62-84.

This research has identified the main means and mechanisms for a successful transition to the knowledge economy. As a result, we found that the role of the state is considered central in the transition to the knowledge economy through innovation policies and strategies designed to take into account economic and social aspects in the transition process.

This research analyzes the stages in the NIS concept development, and establishes a fundamental difference between NIS and the knowledge economy. We found that the knowledge economy is a broader category than the national innovation system and has a broader geographical coverage, including diversified economic activities.

In addition, a number of factors and principles were proposed that play an important role in the formation and NIS development, its adaptation to the transition process requirements to the knowledge economy. In addition to the analysis and dynamics modeling of functional interaction between the subjects of the NIS. Where we found that there is a fundamental theoretical difference between the knowledge economy and the national innovation system.

So, the purpose of the study is achieved.

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Abstract

The task of the study is to scientifically comprehend the concepts of the knowledge economy and National Innovation System (NIS), which resulted in the formation of new theoretical and analytical approaches to the study of these aspects. The study considers the theoretical knowledge economy concept, and, in particular, shows its differences from the industrial economy through the definition of the main characteristics at the macro and micro levels. The key role played by knowledge in new economy sectors was also identified, and the knowledge role in the process of creating value in the economy was analyzed.

The main means and mechanisms for a successful transition to the knowledge economy were identified. As a result, we found that the role of the state is considered central in the transition to the knowledge economy through innovation policies and strategies designed to take into account economic and social aspects in the transition process.

The stages of development of the NIS concept were analyzed, and the fundamental difference between the NIS and the knowledge economy was established. We found that the knowledge economy is a broader category than the NIS and has a broader geographical coverage, including diversified economic activities.

In addition, a number of factors and principles were proposed that play an important role in the formation and development of the NIS, its adaptation to the requirements of the process of transition to the knowledge economy. In addition to the analysis and modeling of the dynamics of functional interaction between the subjects of the national innovation system.

In addition, the theoretical significance of the study lies in the development of methods for assessing and analyzing the effectiveness of national innovation systems, as well as in building an institutional framework for regulating interaction between NIS entities in different contexts.

This, in turn, will help future researchers understand how both the knowledge economy and the NIS work.

There are many characteristics that distinguish the knowledge economy from traditional forms of the economy, which explores the nature of production relations, productive forces and means of production. Thus, in the context of the knowledge economy, a new direction of political economy has emerged, in which various economic and social components operate.

Keywords: knowledge, knowledge economy, innovation system, national innovation system, disseminating knowledge, innovation system development.