# SPIRAL MODELS OF COMMERCIALIZATION OF KNOWLEDGE INTO INNOVATIONS AND THE NECESSITY OF REINDUSTRIALIZATION

**Srđan Milićević**
Metropolitan University in Belgrade, Faculty of Management, Republic of Serbia,
srdjan.milicevic@metropolitan.ac.rs
**Slobodan Cvetanović**
Educons University in Sremska Kamenica, Republic of Serbia, prof.cvet@gmail.com
**Dragan Turanjanin**
Toplica Academy of Applied Studies, Department of Business School Blace, Republic of Serbia
turanjanindragan@leave.com

**Abstract**: Knowledge and innovations have the greatest importance in the development of society, since the very beginnings of human civilization. With globalization and the technological revolution during the last few decades, knowledge has become a key resource for the economic growth and development of both nations and individual economic entities. Both developed and developing countries strive to raise the level of their own readiness for the development of the knowledge economy as much as possible. By promoting knowledge as the most important production resource, the world economy is rapidly transforming into an economy of knowledge and innovation. Accordingly, innovation has become a key condition for both global and local competitiveness of the organization.
Innovations represent the commercialization of knowledge, turning ideas and research into added value of products, processes or services. Innovation occurs in order to create better performance, but the process is not exclusively automatic and always positive in nature. The innovation process should be carefully planned and clearly directed towards obtaining a positive final result. Large investments in research and development activities and other elements of the innovation process do not necessarily result in successful innovations. Innovation efforts and activities can be misdirected, and there is a possibility that good ideas will not be realized due to the creation of a bottleneck in some part of the innovation process.
The innovation process is composed of different activities that interact with each other according to a clear order of execution: gathering information about the problem, research (general or applied), ideas and development, finding solutions. The basic stages of the innovation process are identifying an idea or problem (focusing), modeling innovation (invention), evaluating alternatives, making decisions and implementing the innovation. In the changed conditions of the economy, finding effective models of knowledge production and its commercial valorization into innovations gains importance. In this connection, the paper places special emphasis on the apostrophizing of the logic of spiral models in the creation and commercial valorization of knowledge.
The conclusion was reached that these models have undoubtedly contributed to world economic development, but that with the emergence of the economic crisis caused by the Covid19 virus and, somewhat later, war events on Ukrainian soil, innovation in the service sector is growing compared to the improvement of innovation in the real sector. Many aspects of the valorization of knowledge into innovations dominantly in the service sector, characteristic of the period of globalization, with the change of geopolitical conditions in the world, starting with the emergence of the global crisis caused by the Covid19 virus, and especially with the outbreak of the war conflict in Ukraine, have been called into question until today. As a result, the economic theories that support it have largely lost their relevance.
**Keywords:** knowledge, innovations, helix models, reindustrialization

## 1. INTRODUCTION

Knowledge has become the main driving force of the economic and social development of countries around the world. The knowledge economy is based on the generation and adoption of new knowledge achieved through research, investment in education and the adoption of best practices, as well as openness to social, economic and cultural innovation (Powell, & Snellman, 2004).
In recent years, economic theory concerning the knowledge economy has been the subject of intensive research. Industries whose development is based on knowledge and innovation are significantly different from traditional industries. Their products tend to have short life cycles, narrow windows of opportunity and difficulty accessing global markets quickly. Consequently, high-tech industries are characterized by high research intensity, and also often by high capital intensity. Their cost structures are dominated by development and marketing costs instead of material and production costs.

Converting knowledge into economic and social benefits requires good innovation systems, including highly qualified staff and efficient technology transfer (TT) and venture capital. However, what is equally important and perhaps even more important than the creation of new high-tech industries is to maintain and improve the performance and competitiveness of traditional industries by providing them with access to high technology and knowledge.

In the knowledge economy, knowledge is a product developed by intellectual effort. The key concept of the knowledge economy is that knowledge and education are treated in the following two ways: 1) as a product and service, innovative and intellectual in nature, which is exchanged for a certain higher value; 2) as production assets, and as such can be defined as follows: production and services based on activities with intensive application of knowledge that contribute to the accelerated pace of technical-technological and scientific progress, as well as the rapid obsolescence of "new" technologies. A key component of the knowledge economy is a greater reliance on intellectual abilities, rather than physical labor and natural resources, combined with efforts to integrate improvements at every stage of the production process, from research and development laboratories, through the production process, to communication with clients. These changes are reflected in the increasing relative share of intangible (non-material) capital in the gross domestic product (Powell, & Snellman, 2004).

The emergence and affirmation of spiral models of creation and commercial valorization of innovations coincides in time with the flourishing of neoliberal attitudes in economic theory and the rise of globalization as the supreme principle of world economic development. Treated in this light, the spiral models of commercialization of knowledge into innovations have undoubtedly made a significant contribution to improving the innovation of individual countries, that is, companies. Innovations, knowledge and entrepreneurship represent a key determinant of economic growth and improving the competitiveness of companies and countries.

Enterprise innovation means the ability to produce and commercially valorize goods and services based on the use of new knowledge and skills. Improving innovation is a key condition for the economic progress of companies as well as nations, while innovation policy is the most important instrument of economic development strategies and improving the competitiveness of companies in the global knowledge economy. In today's conditions, it is possible to ensure a satisfactory development performance of the company, as well as a respectable competitive position on the world market, only under the assumption of satisfactory innovativeness of its economy.

## 2. KNOWLEDGE AS A PRODUCTION FACTOR

Knowledge is a set of ideas, experiences, intuition, skills and learning that are used in the creation of new value. The goal is to direct knowledge towards increasing productivity. The greatest competition between companies and countries takes place precisely in the area of acquisition and market valorization of new solutions based on knowledge.

When managing knowledge as a resource, a distinction must be made between data and information. In fact, information represents data of importance for each specific user of that data. What information the observer will extract from the data depends on his perceptions, that is, his prior knowledge (or semantic capacity). The parallel with classic resources is that data is raw material, and information is a semi-product, the level of processing of which depends on the semantic level. Discovering and interpreting the context information schemas leads to the final product.

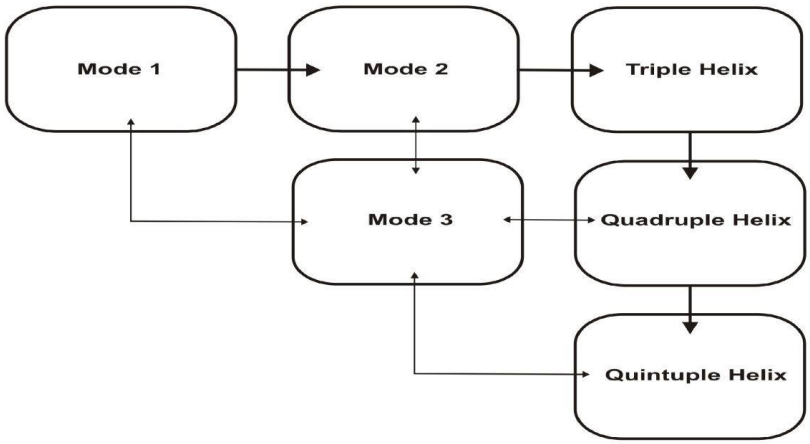
The embodiment of information into knowledge implies its efficient flow, as well as the fact that senders and receivers of information share the same coding scheme. Knowledge must also have a certain contextual level within which it can be interpreted. Effective use of knowledge implies the required level of: a) flow of knowledge (diffuseness), b) context of knowledge, as well as c) codification of knowledge.

Knowledge is usually divided into explicit knowledge and tacit knowledge. In the methodological sense, this difference is very significant, especially when analyzing the mutual influence of these two components of knowledge through the very process of its creation (Nonanka, 1991). Explicit knowledge is preserved in books and is obtained through the process of education. In today's economic conditions, knowledge increasingly takes on a digitized form, which enables its relatively quick adoption by interested subjects. Implicit or tacit knowledge is the result of many years of experience and accumulated skills. Since it is personalized, it is not easy to get hold of, which is why it often remains underutilized. The transfer of implicit knowledge to explicit knowledge is, in principle, a complex and mostly expensive process. Knowledge is the main catalyst of the innovation process. Seen in this light, the innovation process is a meta-process of the knowledge flow management process.

## 3. SPIRAL MODELS OF CREATION AND CAPITALIZATION OF KNOWLEDGE INTO INNOVATIONS

One of the key goals of the development policies of countries in this century is to achieve the most efficient commercialization of knowledge into innovations and ensure the country's transition to a knowledge economy as quickly as possible. Seen in this light, innovation represents a direct link between the creation and adoption of knowledge and its commercialization. Figure 1 shows the basic models of creation and commercialization of knowledge into innovations.

***Figure 1. Models of creation and commercial valorization of knowledge into innovations***




Source: https://handwiki.org/wiki/Finance:Quadruple_and_quintuple_innovation_helix_(Q2IH)_framework, accessed, March 9, 2024

*In Model 1*, universities and institutes have a central place in the research process. They are the key sources of their knowledge and therefore the most important generators of innovation in companies. Innovation comes to the center of science and technology policy, and efforts are concentrated on building national innovation systems whose efficiency and effectiveness are reflected in the successful commercialization of the results of research and development activities in the production process and the service sector.

*Model 2* implies the partnership of the research and production sectors. Scientific research gains its importance only in cooperation with the economy. The attention of industry and state administration is shifting from scientific research activities to product and process development, and scientific excellence complements and competes with management and managerial abilities that transform the results of research and development activities into innovations.

*Model 3* is in the function of further development of transdisciplinary application of multidisciplinary knowledge. It enables the coexistence of different paradigms of knowledge with a focus on the processes of commercialization of that knowledge into innovations. In recent decades, there has been a change in the dominant model of knowledge valorization into innovation. In this light, a particularly valuable example of an approach that systematizes the key characteristics of the interaction between universities, industry and the state is the *Triple helix model*. To the greatest extent, it removes the shortcomings of Model 1 and Model 2, which are related to excessive diffusion, unacceptable conceptual heterogeneity, as well as to the very low visibility of individual innovators.

*The triple helix model* is a non-linear and dynamic model that focuses on the mutual connections between the economy, science (university) and the state in the process of commercializing knowledge into innovation. In essence, the model reflects the change up to that time, in the governing relations between science (university), industry and the state in a knowledge-based society. This model starts from the assumption that there is: a) a competent, autonomous, responsible and, above all, entrepreneurially oriented university and similar scientific institutes, b) an entrepreneurial, productive and innovative economy, c) an efficient, transparent, responsible and innovative state administration.

*The triple helix model* represents a holistic approach to the creation of knowledge and its transformation into innovations based on the connection of various organizations and disciplines. As a form of system networking, it seeks to promote rapid learning through closeness and collaboration between the main actors. Each actor in the system should study the innovation process according to their own interest. This basic model of innovation is

analytically different from the national innovation system that views the firm as having a leading role in the innovation process, while the Triple Helix model considers three closely related spheres that have equal importance in the national innovation network. In fact, the model includes trilateral relations between industry, government and universities in the process of knowledge capitalization. In the knowledge economy, the creation of the knowledge base depends on the synergies achieved between the three main actors in the economy: the academic community, the business world and the government. Each actor can be associated with a certain element of the economy: universities are responsible for creating novelties, business firms create economic wealth, and the government is responsible for managing interactions between actors, but is also responsible for respecting social rules, i.e. legality in work.

The roles of the actors of the Triple helix model can overlap - eg universities can become more oriented towards entrepreneurship through the creation of spin-offs, companies can become more involved in research and become closer to the academic community, and the state can intervene in the creation of knowledge (through the financing of scientific research programs) and its application. This movement between roles is shown as Triple Helix or DNA, from where the name of the concept or model originates.

The triple helix model encourages actors to work in an open space for the circulation of aspirations, knowledge and innovation. This open space of circulation is a novelty that requires a deep understanding and its internalization as a personal and collective value, where cooperation is the source of sustainable success. Such an approach has enabled, over the last thirty years, the Triple Helix to develop into a widely accepted conceptual framework that brings together the knowledge, consensus and innovation of the three main social actors: university - government - economy and contributed to its transformation from an intuitive guide for policy makers and researchers , into a model of social organization that requires further work to reveal the relationships between the main actors. At the same time, one should always keep in mind that this concept is based on three key social processes: learning, communication and cooperation (Cai, & Etzkowitz, 2020).

The success of this model requires the internal entrepreneurial transformation of each actor of the concept, as well as the ability for both the state and the economy and the university to learn how to learn from each other. In other words, it means that they have to cooperate in the most difficult way. In fact, the key innovation brought by the Triple Helix concept is based on two important assumptions: the openness of the system enables the presence of the principle of equifinality, i.e. that some final state can be realized regardless of the initial conditions if there are innovative approaches in defining the problem and searching for solutions. It is also a source of hope, because if everything depended only on initial stakes, then the poor would always be poor, and the rich would always be rich. The balance between differentiation and integration – an open space for the circulation of intentions and knowledge leads to invention and innovation, with participants acting on the principle of solidarity and cooperation. Due to the enormous synergistic potential realized through the cooperation of all actors, the Triple Helix model is also called a sleeping giant by some authors. In order for that sleeping giant to wake up, each actor must be trained for effective interactions, which means that if one of the actors is extremely weak, then the entire Triple Helix model falls apart.

In the quadruple spiral model, the fourth spiral includes media, creative industry, culture, social values. It is often identified with the term creative class. The quadruple spiral model starts from the assumption that the university, the economy, the state and society function on the principles of open circulation of knowledge, the learning process, communication and mutual cooperation. Such spiral connections result in multiple relationships in the capitalization of knowledge into innovation. The quadruple spiral model had a pronounced impact on the organization of research and development at the regional level. The starting point of the model is the position that the market should function for the benefit of society. For its part, society should serve people. The role of individuals is of central importance.

Further development of the spiral model into existing models of knowledge production and its commercialization into innovations is represented by the *Quintuple helix model*. This model apostrophizes the way in which socio-ecological change can improve the production of knowledge and its commercialization into innovations. (Carayannis et al, 2012). This model includes five subsystems 1) educational system, 2) economic system, 3) natural environment, 4) public opinion (i.e. civil society) and 5) political system. In order to achieve the sustainability and development of the system, the model assumes that each of the five subsystems (spirals) has special and necessary resources that are necessary for their functioning and the creation of socially and scientifically relevant knowledge (https://handwiki.org).

The model of the five-fold helix has in a peculiar way absorbed the model of the triple and four-fold helix, indicating that knowledge possesses the qualities and functions of input and output for each subsystem considered individually. Entering as an input in one subsystem, knowledge comes out as an output in another subsystem, which further represents an input for the next subsystem, through continuous circulation and creation of innovations. In this way, the circulation of knowledge continuously acts in the direction of stimulating new knowledge and its commercialization into innovations. The model shows that investment in knowledge and promotion of knowledge

creation creates key impulses for innovation. By initiating small but continuous steps, through the synergistic potential of the model, a long-term and sustainable knowledge-based society is created, which exists in balance with nature. This risk is even greater in newer, more complex models that were created based on the idea of the triple helix and the need for its superstructure, i.e. redefinition. Here, we first mean the introduction of civil society as its fourth helix, which has already been largely initiated in scientific theories, which led to the Quadruple helix model. Also, the development of the Quintuple helix model is already underway, with the introduction of an additional element: the natural environment, which significantly expands the context of observing the older theory of the Quadruple helix model. There should be no doubt that in the future some even newer important element will be detected, which will lead to new models. All this indicates that the triple helix concept opened up new methodological directions for the analysis of such an important fact of contemporary and future life: knowledge and innovation, but also strengthened the theoretical and methodological basis of leading a quality industrial policy.

The highlighted spiral connections express multiple relationships in the capitalization of knowledge, i.e. hybridization of knowledge through the creation of new forms, which do not belong exclusively to the state, the business sector or the university, but arise at the intersections of their interaction. These can be different institutions or projects that arise through cooperation and require the ability to learn from each other, and communication in a constantly changing and open environment. Examples of such hybridizations are centers of excellence, technology parks, incubators, accelerators, open information exchange platforms, etc.

It should be borne in mind that the development of the theory of spiral models of creation and commercial valorization of knowledge in innovations, by introducing civil society as the fourth factor of the Quadruple helix model, does not replace the originally developed theory of the Triple helix model. Likewise, the development of the Quintuple helix model does not automatically replace the older theory of the Quadruple model, by introducing an additional building element of the natural environment, indicating the need for socioecological transition of the social and economic system in the XXI century. By introducing new factors into the theory of the Triple helix model, it makes the theory itself wider and the whole picture clearer, but it does not mean that it completely replaces it (Amaral, & Cai, 2022). Therefore, the subject of future research will be directed towards the monitoring and empirical research of further stages in the development of the helix theory - quintuple helix, hexable helix... - n-tuple helix model. The helix perspective of observation enables the study of the innovation system in an empirical mirror, showing to what extent certain relationships can be considered systematic and called a *system*. (Carayannis et al, 2022)

There are different interpretations of the helix model in empirical studies that apply them, but they sometimes deviate from the original theses of the model. A comparison of different spiral models shows that they are largely complementary to each other when analyzing innovation processes in contemporary society providing a basis for building potential synergy between them (Cai, & Lattu, 2021).

## 4. COMMERCIALIZATION OF KNOWLEDGE INTO INNOVATIONS AND THE IMPERATIVE OF REINDUSTRIALIZATION

One of the major trends in the world economy during the last forty years is the growing participation of knowledge commercialized in innovations, on the one hand, and the increased participation of services in the creation of gross domestic product. This tendency was interpreted in economic science primarily as a consequence of the changing role of industry in the economy over time. Namely, empirical data show that the industry has the largest share (from 20 to 35%) in the gross domestic product in economies that are developing and create a medium level of income per inhabitant. Beyond that, consumption shifts to services, employment in the service sector exceeds employment in industrial production, and the share of industry in the creation of gross domestic product begins to decline analogous to the logic of an inverted U curve. As economies mature, industry becomes in fostering productivity growth, improving processes creation of knowledge and its commercialization in innovation and trade development. Also, the industry plays a key role in solving social challenges, such as reducing the consumption of energy and other resources per unit of final production, reducing the emission of gases that lead to greenhouse effects, etc.

The economic theory of globalization until the pandemic caused by the Covid 19 virus pointed to the position that the abandonment of production should not cause concern for the countries where such a phenomenon is most pronounced. In short, the process of deindustrialization is considered to be a logical manifestation of the development of the world economy. Rightfully, in this context, the question arises as to whether the events caused by the Covid 19 virus pandemic and the political and economic instability of international relations have called such a position into question. In short, the answer to this question, in our opinion, is positive. Obviously, a new economic theory is necessary that would explain the importance of re-establishing the balance between the service sector and the value of real, that is, industrial production. Being a service superpower, as many highly developed market economies were until recently, is not enough. Growing knowledge and solutions in the field of artificial intelligence

have caused many service industries to face huge disruptions. Nevertheless, with important exceptions such as life sciences and aerospace, the industrial sector of economically developed market economies is too small. The result of these circumstances is a fragmented labor market, low productivity and a high trade deficit of a large number of countries.

## 5. CONCLUSION

Regardless of which spiral model of knowledge creation and commercialization they had in mind, the fact is that they were in the function of improving the innovation of the economy and the growth of the gross domestic product of the largest number of market economies. This statement is based on the view that the potential for innovation and economic development in the knowledge society is found in the hybridization of elements from all elements of the helix in order to generate new institutional and social frameworks for the production, transfer and application of knowledge. The successful application of the helix model in practice represents the foundation of a favorable environment for the optimization of the use of knowledge and the creation of innovations, and thus the revival of economic flows, especially in the direction of more intensive reindustrialization.

## REFERENCESS

Amaral, M.G., & Cai, Y. (2022). The Tribology of the Helixes: Relations between Triple, Quadruple and Quintuple Helix Models. *Triple Helix Journal* 9(1)

Cai, Y., & Lattu, A. (2021). Triple Helix or Quadruple Helix: Which Model of Innovation to Choose for Empirical Studies? *Minerva, 60*, 257 – 280

Cai, Y., & Etzkowitz, H. (2020). Theorizing the Triple Helix model: Past, present, and future. *Triple Helix* 7(2–3): 189–226

Carayannis, E., Campbell, D., & Grigoroudis, E. (2022). Helix Trilogy: the Triple, Quadruple, and Quintuple Innovation Helices from a Theory, Policy, and Practice Set of. Perspectives. *Journal of the Knowledge Economy*, 13(3, 2272-2301.

Carayannis, E., Barth, T., & Campbell, D. (2012). The Quintuple Helix Innovation Model: Global Warming as a Challenge and Driver for Innovation. *Journal of Innovation and Entrepreneurship*, 1(2)

Cvetanović, S., & Nedić, V. (2021). *Inovacija kao razvojni resurs*. Niš: Ekonomski fakultet Univerziteta u Nišu.

Nonanka, I. (1991). The Knowledge-Creating Company. *Harvard Business Review*, 69: 96-104.

Powell, W., & Snellman, K. (2004). The Knowledge Economy. *Annual Review of Sociology*. 30(1), 199–220.

Leydesdorff, L., & Etzkowitz, H. (1998). The Triple Helix as a model for innovation studies, *Science and Public Policy*, 25 3), 195–203

https://handwiki.org/wiki/Finance:Quadruple_and_quintuple_innovation_helix_(Q2IH)_framework, accessed March 9, 2024