

INFORMATION ECOLOGY IN FORMATION AND TRANSFORMATION OF ENTREPRENEURIAL ACTIVITIES

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1. Introduction

The pace of socio-economic development of countries and regions is largely determined by entrepreneurial activities. Entrepreneurs run various types of businesses with varying innovation level in different economic areas [14].

The choice of the company's type, areas of activities and innovation level is associated with searching and processing information. At the same time, information and communication technologies, codified and tacit knowledge of entrepreneurs, their cognitive abilities are used. The uncertainty of the external environment, lack of relevant information, presence of subjective preferences and expectations complicate the choice.

Potential entrepreneurs are faced with the goal of designing or redesigning their own business based on a variety of the existing or promising activities and forms of their implementation. At the same time, there are also a large number of economically comparable (Pareto efficient) combinations of business organization. Thus, there arises a need for intellectual and volitional efforts in making decisions on the degree of necessity and possibility of obtaining the desired result under uncertainty. Entrepreneurs make an intelligent choice if they: i) recognize the existence of other alternatives, i.e., availability of opportunity cost; ii) understand the insufficiency of the available information and personal knowledge for an unambiguous orientation in the situation, i.e., the need to increase transaction costs. A potential entrepreneur can: i)

refuse to take further actions; ii) delay the choice until the last critical moment and make the choice spontaneous; iii) continue collecting the necessary additional information; iv) reduce the level of uncertainty to subjective rationality with respect to more general motivational and cognitive goals.

With subjective rationality, decisions include not so much formal logical criteria as assessments of the entrepreneur's ability to act under uncertainty and skills to actualize all their intellectual and personal potential. Possible ways to solve the problem include conducting an axiology (value) assessment of information or formation of a stable personal ontology (a set of coherent knowledge). Both methods reflect either an accumulated experience or mental models obtained in the course of training. The methodological framework for the axiological analysis of intellectual choice is the theory of expectation and theory of planned behavior [13].

Any entrepreneurial activity begins with an idea. For increasing the rationality of choice and evaluating an entrepreneurial idea as well as for transforming it and choosing forms of its implementation, a potential entrepreneur searches and processes additional information. During these processes, large databases, "contaminated" with irrelevant, unreliable and even inadequate information, are examined. Such information overload negatively affects the entrepreneur's ability to concentrate. There are risks of over-saturation, misperception or abandonment of a further search [9]. The situational theory of problem solving (STOPS) considers information pollution as an obstacle in addressing a problematic situation (constraint recognition). The STOPS allows to assess the variable of Situational Motivation in Problem Solving [21].

To address the pollution problem, information ecology is applied. This concept implies optimizing the volume of information provided due to improving the level of its readiness for the entrepreneur's perception. It suggests the minimum amount of data provided ensuring their integrity, perceptibility, and interpretability [16]. By the intentional goal we mean a cognitive model of the desired and achieved result of the entrepreneur's activity in relation to the complex of internal motivations encouraging them to act [32]. The desirability of the results suggests the existence of a system of preferences, regulatory parameters and value judgments [5].

The greatest amount of information needs to be collected and processed when choosing innovative development. The main sources of information in the innovation process are universities and government agencies. The main consumers are entrepreneurs, who, from the general flow of data, need to single out those related to their area of interest. As a result, the Triple Helix information space is created. The structuring of this space, its transformation into a comfortable environment for innovation activities of entrepreneurs and society as a whole is of scientific and practical interest.

2. Theoretical and methodological background of the study

The normative context of the entrepreneur's intellectual choice is the external socio-economic situation. The architectonics of solving development problems by means of entrepreneurship has the form of a pyramid (Figure 1).

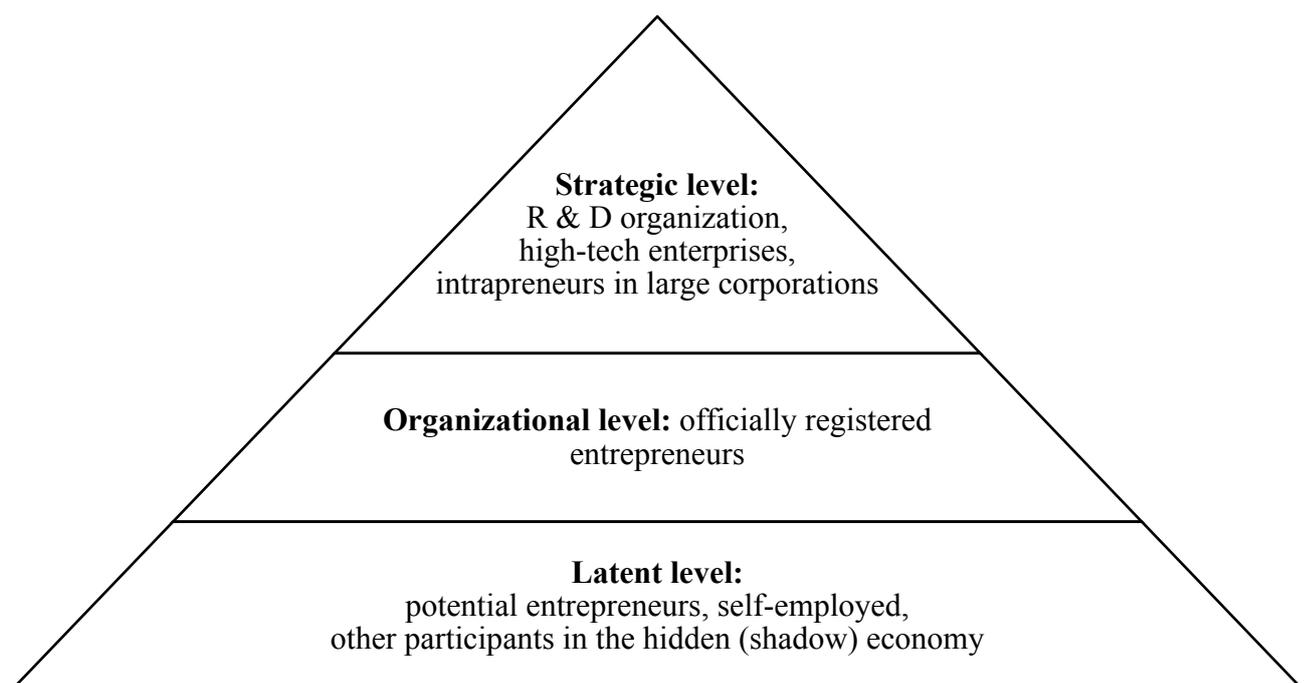


Figure 1. Architectonics of solving social problems through entrepreneurship (Developed by the author)

The lower (latent) level is occupied by: i) potential entrepreneurs, who are looking for opportunities to solve their problems through entrepreneurship; ii) self-employed, who use their skills and abilities to earn income in a narrow market niche

without formalization; iii) other participants in the hidden (shadow) economy. The latent layer is the quantitatively largest and qualitatively heterogeneous one. For its study, expert assessments are applied, the most common being the GEM and World Bank methodologies.

Officially registered entrepreneurs are located at the middle (organizational) level. There is a significant variety of types of entrepreneurial activities – from freelancers and sole proprietors to medium-sized enterprises and networks. For their study national and regional statistical data are used.

At the upper (strategic) level, there placed R & D organizations, small and medium-sized high-tech enterprises and intrapreneurs in large corporations. Here, a diversity in research directions is observed. For the study, data from international and national organizations are used. The most common methodologies employed include the tools developed by the World Economic Forum (WEF), the World Intellectual Property Organization (WIPO), and the Organization of Economic Development Countries (OECD).

The top of the pyramid presents the socio-economic effects of entrepreneurship. They reflect the degree to which the final results of entrepreneurial processes satisfy the needs and interests of stakeholders. In general, these are the needs and interests of entrepreneurs themselves, market structures interacting with them, state institutions, and society as a consumer of goods and services.

The information circulating at each level of entrepreneurship differs in type, form and method of transmission, semantic and pragmatic context. Based on the Triple Helix methodology, we can single out the types of information provided to entrepreneurs by universities and government agencies.

Universities carry out research and pedagogical activities. As a result of research activities, academic and applied information emerges. Part of the academic information remains in the scientific environment and serves as a basis for the development of fundamental knowledge. The other part of this information goes in the form of joint R & D mainly to the strategic level of entrepreneurship. The middle (production and sales) level receives information about the applied research carried out by universities.

At the same level, employees spinoffs and spillovers of knowledge they accumulated while working at universities are implemented. Moreover, spinoffs and spillovers transfer not only codified but also tacit personal knowledge [25]. The distribution of spinoffs and spillovers by levels of entrepreneurship can be considered uniform. However, this assumption needs to be refined in further studies. The same can be said about university graduates, who, based on a number of signs, can be classified as knowledge spillovers. Such signs, in particular, include the fact that the knowledge of graduates enters the business environment almost free of charge.

To the lower (potential and informal) level of entrepreneurship, most of the information goes indirectly: either in an unaccentuated and generalized form or in an objectified form. Objectified information is knowledge that is actualized in high-tech devices and the ways they are used. Individual entrepreneurs are required to acquire skills of their practical use. Potential entrepreneurs receive the necessary information either from public, but not structured, sources, e.g., the Internet, or from relatives, partners, friends. A low degree of completeness, adequacy and reliability of such information are prerequisites for the deterioration of information ecology [31]. The situation becomes more complicated if a potential entrepreneur does not have a personal full-fledged knowledge base in the required subject area [34]. The problem is, in particular, as follows. A university scientist publishes laboratory results. If a prototype is obtained, this does not yet guarantee a successful industrial product development. In economic and social studies, even the most representative samples may not meet the conditions of the local markets in which small enterprises operate. Unintentional errors and inconsistencies are possible.

For the entrepreneurship environment, government agencies serve as sources of regulatory information, including that about measures to support entrepreneurship and actualized information in the form of their real actions. The discrepancy between official and actual information increases uncertainty in entrepreneurial decision-making [17]. The ecology of government information is negatively affected by its internal inconsistency and complexity of perception. Morris et al. [24] note that government information has an insufficient focus on the layer of potential

entrepreneurs. This is especially true for the self-employed and micro-enterprises with low incomes as well as small enterprises operating in local markets.

The Triple Helix denotes the relationship between university, industry, and government [10]. In this sense, the Triple Helix can be considered as a basic model for explaining knowledge production and utilization in the knowledge economy [2, 22]. At the same time, other sources of information are widely used in forming and reforming entrepreneurial activities. The Quadruple Helix and Quintuple Helix were designed as innovation system frameworks for a more broad and accurate description of the complex informational context of entrepreneurship. Thus, the analytical architecture is extended with the Triple Helix built in the Quadruple Helix, and the Quadruple Helix built in the Quintuple Helix (Table 1).

Table 1.

Comparative characteristics of the Triple, Quadruple and Quintuple innovation helix framework

№	Name of the innovation model	Components	Features	Advantages	Disadvantages
1	Triple Helix	university, industry, government	The model denotes trilateral networks and hybrid organizations of university-industry-government relations to provide the infrastructure needed for innovation and economic development.	It emphasizes the coexistence and co-development of different modes of knowledge and innovation along with mutual cross-learning between knowledge modes and interdisciplinary and transdisciplinary knowledge.	It does not focus on the social component.
2	Quadruple Helix	university, industry, government, public	The model is based on culture and media, comprises the public and civil society.	It includes sociological concepts (such as art, creative industries, culture, lifestyle, media and values) and is important for the smart co-evolution of	It does not take into consideration the ecological component.

№	Name of the innovation model	Components	Features	Advantages	Disadvantages
				regional innovations and institutional arrangements, i.e. regional innovation systems.	
3	Quintuple Helix	university, industry, government, public, environment	The model visualizes the collective interaction and exchange of knowledge in a country through five subsystems (helices): education system, economic system, natural environment, media-based and culture-based public (also civil society), and the political system.	It takes into consideration socio-ecological interactions, which means that it can be applied in an interdisciplinary and transdisciplinary way for sustainable development; has been applied to the quality of democracy, including in innovative systems; international cooperation; regional ecosystems; smart specialization and living labs; climate change, and sustainable development, as well as to innovative diplomacy, extension of science diplomacy.	No disadvantages were identified. Natural environment is considered as an additional sector or as an overarching sector that comprises the four other sectors.

The concept of the Quadruple and Quintuple innovation helix framework was co-developed by E. G. Carayannis and D. F. J. Campbell, with the quadruple helix described in 2009 [4, 27] and the quintuple helix – in 2010 [4, 12]. Various authors around the same time were exploring the concept of the Quadruple Helix [1]. The Quadruple Helix Model, developed by E. G. Carayannis and D. F. J. Campbell, incorporates public via the concept of media-based democracy [29], emphasizing that when a political system (government) elaborates innovation policies to develop the economy, it must adequately communicate them to the public and civil society via the media to obtain public support for the new strategies or policies [4]. In the case of industry involved in R & D, the framework emphasizes that companies' strategies for public relations have to negotiate "reality construction" by the media.

The Quadruple Helix adds as the fourth helix to media-based and culture-based public arts, artistic research, art-based innovation, knowledge democracy, and the civil society, referring to a democratic knowledge society and economic actors, such as creators, inventors, innovators, and entrepreneurs. According to E. G. Carayannis and D. F. J. Campbell, “The Quadruple Helix innovation model can be seen as a model that integrates the dimension of democracy or the context of democracy to promote knowledge, knowledge production and innovation” [23, p. 14].

The Quintuple Helix is the fifth helix or dimension in the ecological perspective of the natural environment of society and economy [3, p. 62], which emphasizes how democracy (knowledge democracy) and the environment (natural, social, information) matter for social-economic development.

The Quadruple and Quintuple innovation helix framework has been applied to projects and policies sponsored by the European Union, including the EU-MACS (EUropean MArketplace for Climate Services) project, a follow-up project of the European Research and Innovation Roadmap for Climate Services and a new paradigm Open Innovation 2.0 (OI2) based on the European Commission’s strategy for the Digital Single Market, supporting open innovation.

The socio-economic development of society and its components, such as entrepreneurship and innovation, are too complex processes to be described by several determinants. In particular, commonly used approaches pay little attention to market information. More precisely, a set of information from markets interacting with entrepreneurship, such as the labor market, innovation market, market for innovative products, market for educational services, etc.

In the study, we intend to compile an innovation helix framework, using the example of V. N. Karazin Kharkiv National University, and conduct an analysis of partnerships of Ukrainian higher education institutions to support social change, transformation and impact.

3. Institutionalization of the Multi Helix information space

In this study, we will consider institutionalization as the process of emergence and development of formal and informal rules for the exchange of information, knowledge, and intellectual property rights between ecosystem actors in the Multi Helix space. Such rules have social, economic and legal grounds. Their conventional (generally recognized) legitimacy improves the ecology of the Multi Helix information space and reduces transaction costs for the actors of its ecosystem [28]. According to H. Collins [7], the use of information technologies without consideration for the social and economic context and understanding of the semantic content of information by its providers deteriorates the quality of the decisions made.

The value of information is manifested when it contributes to the consumer interests, is relevant to their goals and fits into their research or business plans. The same facts and artifacts evoke different associations in heterogeneous actors of the Multi Helix ecosystem and, accordingly, have a different semantic connotation. When interacting, these actors must either find an information intermediary or in an evolutionary way develop rules for semantic understanding [18]. In any case, in the information space of the Multi Helix, a rule of reaching consensus on common interests should emerge. Lack of common interests or a consensus of interests destroys the information space of the Multi Helix.

For example, in a university laboratory, a scientist has developed a technology for obtaining an innovative product. In order for the product to acquire economic value (become a commodity), it is necessary to scale up the laboratory equipment to an industrial unit. This implies the involvement of designers and equipment manufacturers. It is necessary to mount the equipment, connect it to power supply networks and adjust; train maintenance personnel; launch the production; and carry out the trial operation. Furthermore, it also requires searching for suppliers of raw materials, product distributors, and consumers. The innovation ecosystem is growing and needs professional management. Given all the difficulties and uncertainties, up to 90 % of all patents do not reach the commercialization stage. Less than half of the commercialized ones are successful in the market and only a few of them become breakthrough technologies. On the one hand, this is explained by the objective need for

redundant information for the internal development of a subject area of science. The scientific logic does not coincide with the economic logic of mandatory payback. On the other hand, unsuccessful commercialization cannot serve as a reason to deny the truth of the facts obtained by scientists.

The likelihood of a successful commercialization will increase if: equipment designers are aware of the exact characteristics of the technology (temperature, pressure, environment aggressivity, etc.) in advance; marketers understand operational advantages and disadvantages of the potential product; entrepreneurs can estimate its possible purchase / sales volume. The university scientist does not know part of this information and does not disclose the rest of it because it can result in their losing the intellectual property. According to the actor-networking theory, an initiator of a multilateral evolutionary communication process should appear. During this process of information exchange, formal / informal communication rules and a common understanding of tasks and terminology are formed, and the distribution of roles and responsibilities is carried out [26]. To some extent, this is informational syntax and semantics in making intelligent decisions. At the same time, the Triple Helix information space will evolve, with the appearance of nodes uniting heterogeneous flows of information. This is factual information from university scientists and engineers (what works and how) and pragmatic information from entrepreneurs and government (who needs it and why). Further development of these nodes (business ideas), first, occurs through mutual adaptation and attraction of additional, detailed information. A further materialization and commercialization of a business idea leads to the expansion of the network of ecosystem participants and the emergence of the Multi Helix information space. Society and the market evaluate how much the new product is needed.

At the beginning of the innovation network formation, the initiator is autonomous and intentionally self-determined. Their self-determined behavior is conditioned by: i) stimuli from the external context, including the need for prompt response to situational circumstances, social norms, formal requirements; ii) intrinsic motivation, including the degree of attractiveness of the result, belief in a high

probability of achieving it, ambitiousness; iii) volitional attitudes, including action propensity, behavioral self-control, and self-efficacy; iv) involvement in joint activities, including partner, scientific or public ones. In addition to psychological determination, the initiator requires communication skills and project thinking to make an intellectual choice.

The first phase of the actor-networking theory is problematization. The initiator perceives and formulates the problem and then conveys (transfers) their understanding to other partners. In the information space, the problem situation is described by quantitative and qualitative parameters as well as significant links and relationships between them. The perception of the problem occurs through the filters of the personal codified and tacit knowledge of the initiator as well as their intentional self-determination. The personal knowledge and motivators personify the perception of the problem and its formulation, which will require their joint coordination with other ecosystem actors in the future.

The perception should be systemic, i.e., provide a reasoned concept of how the available information will help achieve intentional goals; determine what thematic information needs to be supplemented and expanded; as well as show the existing inconsistencies and contradictions. The formulation of the problem should take into consideration the main barriers to technology transfer and commercialization [19]. A particular focus should be on the absorptive capacity, which decreases with each level of entrepreneurship. Absorptive capacity is highlighted among the multiple barriers, since it is directly related to information ecology. A weak degree of absorptive capacity distorts the uniformity of the Multi Helix information space for its actors, increases the information asymmetry, and complicates the creation of an atmosphere of trust between partners.

According to the classical concept developed by W. Cohen and D. Levinthal [6], a priori knowledge and diversity of contacts create the firm's ability for absorption of new knowledge, i.e., recognition of valuable information in the general data flow, its interpretation, transformation, and application in commercial activities. In [6], the degree of absorptive capacity was associated primarily with R & D costs. Further

studies made a certain reassessment of the factors. Organizational procedures, the business culture of continuous staff training, mechanisms of social and economic integration began to be put forward [11]. This also concerns the ability to absorb and desorb knowledge using innovative mechanisms of the Triple Helix [8]. The recombination of the factors was the result of using different approaches to studying the phenomenon of absorptive capacity. There are at least three main approaches [20]. The first approach is technical and economic (rational). In instrumental terms, it is based on the search for effective ways of information selection, its interpretation, redistribution, and utilization [15]. With the second, socio-psychological approach (evolutionary one), the emphasis is on motivational factors, the ability of the individual to learn, and cultural values and norms. It assumes that information has no value until its associative relationship to intentional purposes is determined. In this study, the third approach, the process one, is applied. This approach uses the concept of bounded rationality in selecting and processing information at decision-making, proposed by H. Simon. The third approach also comprises the assumptions of the first two approaches. The combination of the factors used is situational and is determined in the process of solving the problem.

In the context of information ecology, based on the three approaches, a chain of conclusions can be drawn: i) the information space of the Multi Helix is used selectively; ii) the absorptive capacity of ecosystem actors is different; iii) there is an information asymmetry between the actors; iv) efficient network communication is required to increase the level of useful utilization of the Multi Helix information space. Moreover, the article [30] shows the need for a further research on increasing the cumulative absorptive and desorptive capacity of heterogeneous participants in multilateral innovation projects or integrated programs.

This problem is especially relevant for universities that interact with many partners in various multilateral innovation projects and programs. Section 4 will demonstrate the complexity of innovative interactions using the example of V. N. Karazin Kharkiv National University (Ukraine).

4. Description of the innovation model using the example of V. N. Karazin Kharkiv National University.

Currently, universities are becoming increasingly involved in solving social problems of a particular territory, both indirectly (through research and training / retraining of personnel) and directly (through a wide range of volunteer, charitable, educational, social and cultural activities). In view of this, in many cases they play the role of city-forming organizations, being at the center of the infrastructure that ensures the sustainable development of individual regions and cities, including the solution of social problems.

V. N. Karazin Kharkiv National University is the main social, educational and scientific center in Kharkiv (Ukraine). The university's motto is "Classics ahead of time". It has 9 sustainable development goals [33], directly related to components of the Quintuple innovation helix framework, namely:

1. No poverty – government, public.
2. Good health and well-being – public.
3. Quality education – university, industry.
4. Sustainable cities and communities – government, public.
5. Life on land – natural environment.
6. Peace, justice and strong institutions – government, public.
7. Partnership for the goals – university, industry, government, public, natural environment.
8. Gender equality – public.
9. Decent work and economic growth – university, public.

The seventh goal of sustainable development of V. N. Karazin Kharkiv National University – Partnership for the goals – combines all components of the Quintuple innovation helix framework: university, industry, government, public, natural environment (Figure 2).



Figure 2. Model of the sustainable development partnership of V. N. Karazin Kharkiv National University, combining all components of the Quintuple Helix

Let us consider each of the components in more detail, using the example of some projects implemented at V. N. Karazin Kharkiv National University.

1. University:

V. N. Karazin Kharkiv National University is a co-founder of the Eurasian Association of Universities, a member of the World Association of Universities, the European University Association, and the European Nuclear Education Network Association.

To deepen its educational, scientific and technical activities, V. N. Karazin Kharkiv National University cooperates with various organizations, for example, the National Research Foundation of Ukraine and the Ukrainian Center for Management of Education and Scientific Technologies.

The Karazin University implements a wide program of international cooperation, is an active member of the international community of leading European

and world universities from Austria, Poland, Latvia, Czech Republic, Iceland, Sweden, China, Germany, Turkey, Cyprus, and other countries.

2. Industry:

V. N. Karazin Kharkiv National University cooperates with employers (enterprises and research institutes) both in Ukraine and abroad.

It is worth mentioning its partnership with Strikeplagiarism.com and Unicheck to maintain academic integrity. Strikeplagiarism.com is an anti-plagiarism Internet system designed to check the originality of texts submitted, in particular, by post-graduates and students before defending their qualification papers. The purpose of the service is to prevent copyright infringement and illegal use of someone else's intellectual property; create an anti-plagiarism network, covering the whole world, to protect the author's rights of researchers and students; collaborate with higher education institutions, government agencies, and publishing houses; support individuals who want to protect their intellectual property from plagiarism.

The mission of Unicheck is to improve the quality of education in Ukraine through the introduction of the principles of academic integrity in the university culture and to improve the academic motivation of students and teachers.

3. Government:

By the Order of the President of Ukraine, the Ministry of Education and Science of Ukraine, a Working Group of 93 participants, including the Karazin University, was established to elaborate a draft Strategy for the Development of Higher Education in Ukraine until 2031.

V. N. Karazin Kharkiv National University, along with nine other Ukrainian higher education institutions, was recommended by the Ministry of Education and Science of Ukraine for participation in a four-year Strengthening Academic Integrity in Ukraine Project (SAIUP), initiated by the American Councils for International Education in partnership with the Ministry of Education and Science and with the support of the US Embassy.

Its purpose is to convey the importance of academic integrity and the consequences of non-compliance with its postulates to the university community. Since

academic integrity means that in educational and research activities, students, faculty and researchers must adhere, above all, to the principles of honest work and study, which will become an integral part of a new academic culture in Ukraine's higher education institutions and a prerequisite for successful development of society.

The collaboration with regional and city councils should also be mentioned. For example, the Department for Innovative Development and Image Projects of Kharkiv City Council initiated the creation of the municipal school of social design and grant-making Open Grant School. The aim of the project is to develop the competence and skills in social design in representatives of public organizations who are willing and able to initiate and implement social innovation projects in various spheres of life in Kharkiv.

4. Public:

As concerns this component, it is worth mentioning the participation of V. N. Karazin Kharkiv National University in the project "Innovative University and Leadership" initiated by the Ukrainian-Polish Academic Forum, which is implemented with the assistance of the Union of Rectors of Higher Education Institutions of Ukraine and the international charitable foundation International Foundation for Education Policy Research with the support of the Ministry of Education and Science of Ukraine and the Ministry of Science and Higher Education in Poland. The project is divided into phases, the implementation of which began in 2014:

2014-2015 – Phase I, which implies training academic leaders who are willing and able to implement innovative changes in universities.

2015-2016 – Phase II – "Quality Assurance and Internationalization", which is aimed at training leaders who are willing and able to implement innovation technologies and higher education quality management systems and who focus on internationalization of higher education in Ukraine.

2017-2018 – Phase III – "Innovation and Stakeholder Relations", which involves training academic leaders who are willing and able to implement innovative educational and managerial technologies in the Ukrainian higher education system and

focus on building a dynamic structure of relations with the main stakeholders of higher education in Ukraine.

2018-2019 – Phase IV – “Communication Strategies and University-School Relationships”. The main idea of the project is to identify and train two groups of academic leaders who are willing and able to introduce modern communication technologies into the practices of Ukrainian higher education and those focused on studying and building new models of university relations with various educational institutions of secondary and vocational education.

2019-2020 – Phase V – “Interdisciplinarity and Intersectorality and University Development Strategies”, which was designed to train agents of change in the Ukrainian system of higher education.

2022-2023 – Phase VI – “Models of Academic Autonomy and the University in a Lifelong Education System”, which implies training two groups of academic leaders including those who are willing and able to contribute to the introduction of modern models of academic autonomy in the practices of Ukrainian higher education (Group K: October 9 – November 5, 2022) and those focused on studying the Polish practices in building university development programs in the life-long learning system (Group L: November 6 – December 3, 2022).

Representatives of V. N. Karazin Kharkiv National University participated in all events suggested by these phases.

The Karazin University implements many social projects, for example:

1. *The student volunteer research project “Kharkiv citizens on the ATO front”.*

The university community, like no one else, understand the significance and invaluableity of the feat performed by the military every day, because among the students and employees of the Karazin university there are many courageous fighters defending the national interests.

2. *The Karazin School of Leadership*, which was launched within the framework of the “Program for the Development of Leadership Potential of Ukrainian Universities” of the British Council and the Institute of Higher Education of the National Academy of Pedagogical Sciences of Ukraine. The project is aimed at

developing the leadership potential of the university, in particular, the formation of a personnel reserve.

3. *Student Internet Radio*. The project “Student Internet Radio ZIR” (Zovsim Inshe Radio / Completely Different Radio) was implemented in keeping with the best traditions, with the support of the Embassy of the United States of America. The radio tells about: the brightest announcements, events, author programs and interviews. It presents fresh podcasts every week.

5. *Natural environment:*

Regarding this component, it is worth mentioning the participation of V. N. Karazin Kharkiv National University in the projects of the International Visegrad Fund “Political and economic aspects of biodiversity conservation in the countries of the V4 countries”, Erasmus + Jean Monnet Module on European and International Environmental Law (EIEL). Besides, it involves various seminars on the topic of environmental protection, for example, the seminar “EU Environmental Policy Instruments for Ukraine”, and others.

This dimension also includes the establishment of a doctoral school on environmental policy, management, and technology and the arrangement of events related to improving the environmental situation, for example, planting trees on the Karazin University Foundation Day.

As part of the implementation of the sustainable development partnership model of V. N. Karazin Kharkiv National University, which combines all components of the Quintuple Helix, the following goals to support social change, transformation and impact have been achieved:

- development of effective models for interaction with business and community, citizens;

- maximization of job creation for graduates using relationships with employers;

- increasing participation in government and public initiatives;

- maintenance of academic integrity;

- maintenance of the mental health of the academic community, support personnel, university students;

building of mutually beneficial business partnerships to support the environment;

increasing students' involvement in the activities of the university, including volunteering and educational activities;

integration with all structures of society accompanying the development of human capital through life-long learning.

5. Conclusions

The method of innovation helix models is used in the innovation economy and knowledge theories, such as the knowledge society and knowledge economy. Each sector of the model is represented by a circle (helix), with the overlapping showing interactions. The relationships between the university (academia), industry and government are highlighted in the Triple Helix. The Quadruple Helix and Quintuple Helix were designed as an innovation system framework to more broadly and accurately describe the complexity and context of production and application of knowledge (innovation).

The Quadruple Helix adds as the fourth helix to media-based and culture-based public arts, artistic research, art-based innovation, knowledge democracy, and civil society, referring to a democratic knowledge society and economic actors, such as creators, inventors, innovators, and entrepreneurs.

The Quintuple Helix is the fifth helix or dimension in the ecological perspective of the natural environment of society and economy, which emphasizes how democracy and the environment influence the development of knowledge and innovation at the university.

Our study proposes an innovation helix framework, using the example of V. N. Karazin Kharkiv National University, and analyzes the partnerships of Ukrainian higher education institutions to support social change, transformation and impact.

V. N. Karazin Kharkiv National University is the main social and educational center in Kharkiv (Ukraine). The university's motto is "Classics ahead of time". It has

9 sustainable development goals directly related to components of the Quintuple innovation helix framework. The seventh goal of sustainable development of V. N. Karazin Kharkiv National University – Partnership for the goals – comprises all components of the Quintuple innovation helix framework: university, industry, government, public, natural environment.

The participation of the Karazin University in the project “Innovative University and Leadership” initiated by the Ukrainian-Polish Academic Forum has made it possible for the university to implement a series of micro-projects aimed at: ensuring a high quality and internationalization of higher education; introducing innovations and building a dynamic structure of relations with key stakeholders; developing modern communication technologies; forming university-school relations; providing interdisciplinarity; and elaborating a university development strategy to support social change, transformation and impact.

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