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THE QUADRUPLE HELIX ELEMENTS OF THE INNOVATION SYSTEM IN AP VOJVODINA

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Abstract: *Since the regional innovation performance is tightly related with the effectiveness of implemented open innovation strategies, government should provide support to joint innovation programs, collaboration and networking in specific regions. Building upon the triple helix model, civil society is seen as the fourth important actor in addition to industry, government and academia, that is crucial for fostering regional innovation. This paper gives an overview of the situation in the AP Vojvodina in the light of the Quadruple Helix model and identifies its elements in this region, such as business incubators, science and technological parks, clusters and associations of inventors.*

Key Words: *Open Innovation, AP Vojvodina, Quadruple Helix Model*

1. INTRODUCTION

Open Innovation assumes that enterprises can and should use external ideas as well as internal ideas, and internal and external paths to market, to discover and realize innovative opportunities [1]. The main characteristic of open innovation is that the innovation process not necessarily takes place within the boundaries of the firm. Instead, the innovation process is distributed among a larger number of actors.

A change that comes with the current movement towards open innovation is the ability to collaborate with many. Surowiecki calls this the “wisdom of crowds” [2]. The assumption is that the collective intelligence of a larger group of people exceeds that of a few, both in terms of ideas and knowledge. A problem here is how to organize the collective intelligence – to create structure out of the information chaos that would otherwise exist. A central problem arising from this kind of reasoning is how the knowledge and ideas of many can be aggregated and synthesized. Related to the wisdom of crowds and community based innovation are ideas around mass collaboration. A difference between crowd sourcing and mass collaboration as defined in the current literature is the centre of the innovation process. In the first case, the firm or the product is in focus, and people are given assignments to support in the process of innovation. There is a clear sender and a clear receiver of the assignment, in most cases the firm. The mass collaboration examples rather take the form of self-organizing, bottom-up driven movements, where the idea is the carrier and focus of the organization. Users typically take on different tasks in the organization such as moderators of forums, as co-developers of the technical

platforms, or as censors of the material submitted by other community members. The differences between crowd sourcing and mass collaboration are not discrete. Rather, we may see a continuum between the top-down and bottom-up driven solutions. Since the foundation of innovations are ideas and it is people who develop, carry, react to, and modify ideas, it is critical to study what motivates or enables individual innovative behaviour.

Von Hippel [3] identifies the users as sources of innovation. Users are a group of R&D-performers that is often overlooked, and it seems that they do represent a relevant part of private enterprises’ R&D-expenditures. Users are the network partner where enterprises increasingly collaborate with. Interaction with users can provide missing external inputs into the learning process which the enterprise itself cannot (easily) provide [3]. More recently, enterprises facilitate users to co-develop products or technologies, such as in open source software [4]. Enterprises may benefit from user-initiated innovations by actively collaborating with them, i.e. by decreasing the need to generate and evaluate ideas or concepts, by reducing R&D and commercialization costs and by accelerating the involvement of customers into their own product development and commercialization process. Enterprises may also proactively support their users to further develop their products by offering toolkits and other materials to trigger their innovative efforts. They may also be active in creating and supporting communities of users to identify and exploit new opportunities. Henkel [4] argues that enterprises (adopting open source strategies) may make their technology available to the public in order to elicit development collaboration, but without any contractual guarantees of obtaining it.

Governments should account for the fact that most user innovations are developed to solve specific problems, not to conquer a new market and other economic benefits. Besides, in comparison with traditional R&D activities user innovations tend to be developed more closely to the market. This implies that traditional support mechanisms such as financial incentives will probably not work as they must be anticipated to disturb market processes. Government support should focus on suitable external conditions, e.g. support technology platforms, user communities, and repositories for intellectual commons, which can be facilitated by investments in strong ICT infrastructures [5]. Policies should also account for the fact that most users innovate because they are intrinsically

motivated to do so. Policies can account for this intrinsic motivation by offering recognition and fame, for example via awards and open competitions.

Open innovation is almost by definition related to the establishment of ties of innovating enterprises with others. Networks allow enterprises to rapidly fill in specific knowledge needs without having to spend enormous amounts of time and money to develop that knowledge internally or acquire it through vertical integration. Enterprises are working more and more as part of broader networks to create customer value [6]. Relevant network partners include customers, competitors, suppliers, consultants, engineers, industrial associations, universities and other public research organizations, governments and non-profit intermediary organizations [7]. Regional clusters are important as the effect of networks on innovation is magnified by geographic proximity. The effectiveness of Open Innovation strategies of organizations is believed to be strongly related to the presence of regional innovation systems. These regional differences can also explain why some regions are much more successful in attracting multinationals ensuring a steady flow of knowledge workers and related business activity. Examples are Silicon Valley, Helsinki's and San Diego's telecommunications clusters, biotechnology in Boston, and ICT clusters in Cambridge, to mention only a few [6]. Governments may therefore initiate developmental programs to support innovation, networking, collaboration and joint research programs in particular sectors and regions.

In that light the external network management is one of the roles in innovation management which have become more important. Policies should be developed to trigger and help individual enterprises to assess and improve their network management skills and competences. It enables enterprises to find and benefit from external sources, to enter into alliances, to in-source or outsource technological knowledge, and to start up new ventures. In order to do this, enterprises require a number of skills. They need strategic-alliance-forming skills and models for collaboration. They also need the capacity to manage the internal organization in such a way that it is suitable for Open Innovation and to manage their employees so that they are able to innovate with other parties. Governments can play a role by fostering knowledge development and competences in these areas, by providing information, and by popularizing models and best practices. They may also finance consultancy organizations which provide enterprises with advice and information. Go-betweens may be found at both public and private organizations, including banks, industry associations, knowledge transfer agencies, lawyers or private consultants. They may be the same organizations as those providing consultancy services to develop enterprises' networking skills. Governments can actively fund go-betweens and define the conditions for their activities.

2. DIMENSIONS OF THE INNOVATION SYSTEM: FROM THE TRIPLE TO QUADRUPLE HELIX MODEL

Looking from an innovation system perspective, Etzkowitz and Leydesdorff [8] have launched the concept of the triple helix. The triple helix is a spiral model of

innovation that captures multiple reciprocal relationships at different points in the process of knowledge capitalization.

The triple helix denotes the university-industry-government relationship as one of relatively equal, yet interdependent, institutional spheres which overlap and take the role of the other [9]. Triple-Helix is a model which describes the crossing of three worlds; academia, business and government (Fig. 1.).

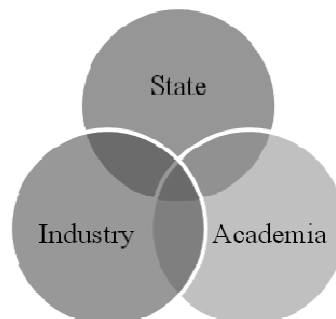


Fig. 1. *Triple Helix Model* [9]

In the model, the business segment operates as the locus of production; government as the source of contractual relations that guarantee stable interactions and exchange; the university as a source of new knowledge and technology, the generative principle of knowledge-based economies. The model was developed in the mid-1990s and has often been used to explain the inner workings of regional innovation systems and clusters.

The world in the 21st century is dynamic and is in continuous flux, due to globalisation and hyper competition. These are trends which will not be reversed. The traditional Triple-Helix model does not consider entrepreneurs and place managers, irrespective of their sectors. The consequence is that individual resourceful persons and brilliance of ideas are not addressed. The first missing link can be described in terms of an absence of "context management" in trying to find the common denominators between the highly institutionalized stakeholders in the classical Triple Helix model. The second Triple-Helix dilemma is the missing link to strong individuals who are resourceful, not in their capacity as legitimised role players in either of the three Triple-Helix organisations, but rather as resourceful individuals who are less well organised and normally not appointed by at least the classical institutions [10].

In recent literature it can be found many approaches that can be named as the Quadruple Helix model. Even though the Quadruple Helix theory exists, as a concept it is not very well-established and widely used in innovation research and in innovation policy. Quadruple Helix is not a very well-established and widely used concept in innovation research and in innovation policy. The concept does not have a well-established definition either. A clear springboard for this concept is of course the Triple Helix concept. Triple Helix describes spiral-shaped innovation cooperation between firms, universities and public organizations. The concept tries to capture the multiple reciprocal relationships of different innovation actors at different points of innovation process. Quadruple Helix adds another helix and actor group to the Triple Helix innovation cooperation model. Common to all Quadruple Helix type of innovation conceptions is they all have included some fourth group of

actors into Triple Helix model. This fourth helix according many authors [11] [12] [13] are the users. Accordingly Quadruple Helix can be seen as describing innovation cooperation between firms, universities, public organizations and users. Based on the above a group of authors have formed a general definition of the Quadruple Helix innovation model [11]: it is an innovation cooperation model or innovation environment in which users, firms, universities and public authorities cooperate in order to produce innovations. These innovations can be anything that is considered useful for innovation cooperation partners; they can be, for example, technological, social, product, service, commercial and non-commercial innovations.

In recent years, in addition to enterprises, government, and knowledge institutions “civil society” has come to be recognized as yet another important actor, giving rise to a new set of quadruple helix models of innovation [11]. In contrast to the top-down triple helix meta-models, quadruple helix models recognize that non-expert citizens acting as users or consumers actively participate in the co-

production of new knowledge and new products. As yet, there is no universally accepted definition of the quadruple helix concept [12].

Based on some innovation research literature [13] the User Community is named as the fourth helix of Quadruple Helix. Depending on the context, the user can be understood very broadly: businesses, organizations, civil society associations, lead users, professional users, consumers, employees, residents, citizens and hobbyists. According to the analytical review of innovation literature [14] there are three perspectives from which to look at user involvement in the development process. In the first approach, users remain an external source of information and new insights. Data about users are used as a base of the design. Secondly, users are involved actively in the development process. The third approach puts the users in the front seat of the car and lets them drive it in order to facilitate new products and services.

Table 1. provides a synoptic view of the Quadruple Helix types, corresponding goals and roles, practices and skills needed in innovation promotion for public authorities.

Table 1. *Synoptic view of the Quadruple Helix types, corresponding goals and roles, practices and skills needed in innovation promotion [11]*

QH type	Goal of innovation activity	Type of innovation	Role of public authorities	Key skills, practices and tools needed for public authorities
<i>Triple Helix + users model</i>	Produce commercially successful high-tech products and services	High-tech and radical innovations	Support high-tech firms, university research, financing	Contacts to research, project and financing skills and tools
<i>Firm-centred living lab model</i>	Produce products and services for firms and their clients	Commercially exploitable technological and social innovations, public sector innovations, incremental and radical	Supporting development and networking of LL actors, support user involvement, develop public services	Product development, learning network and dialogue forum building skills and tools
<i>Public-sector-centred living labs</i>	Produce products and services relevant for public authorities and users of public services	Public sector innovations; commercially exploitable technological and social innovations	Support user/citizen involvement, public sector development, promote LL, provide information on users. Offer dialogue forums to users and forums to participate in decision making	Learning network and information infrastructure building for regional/local organizations
<i>Citizen-centred Quadruple Helix</i>	Produce products and services relevant for citizens	Innovations relevant for citizens	Offer information, training and tools needed by citizens in their innovation activities	Facilitation, individual capability and community building

Ernest J. Wilson [15] underlines that in the context of innovative clusters it is critical to involve resourceful persons, not as representatives, but as resourceful entrepreneurs. He focuses on talented people who are open minded and capable to combine complex and

disparate factors, irrespective of their heritage or birthplace. He calls these persons “quad leaders”, which have been used as the forth corner in the Quadruple Helix model. He also stress that collaboration between the public and private sectors is the most visible ingredient of a successful quad system. But the variety and quality of the stakeholders

involved can make all the difference. In his interviews with quad leaders - senior executives and startup entrepreneurs alike - the same skills, talents, and attitudes are repeatedly mentioned. These attributes include: synthesis, perspective; communication skills; intellectual curiosity; empathy; substantive knowledge; cross-sector experience. The wider the range of experiences, the deeper the empathy and the more finely honed an individual's skills of cross-border communication and negotiation are likely to be [15].

3. INNOVATION ENVIRONMENT IN AP VOJVODINA AS AN ELEMENT OF QUADRUPLE HELIX MODEL

If we analyze the situation in the AP Vojvodina in the light of the Quadruple Helix model it is necessary to identify the elements that could be use as the sources of innovation that currently exist in its innovation environment.

Based on the analysis of the present situation of the innovation potential in the Province the elements of the fourth helix could be: structures/services established at the University of Novi Sad, such as business incubators, science and technological parks, as well as clusters and associations of inventors.

3.1. University of Novi Sad

Leading role in scientific and research activities in Vojvodina has the University of Novi Sad (UNS). It was founded on 28 June 1960. Today it comprises 15 faculties located in the four major towns of the Autonomous Province of Vojvodina: Novi Sad, Subotica, Zrenjanin, and Sombor. The University of Novi Sad is now the second largest among six state universities in Serbia.

The following structures/services are established at the University of Novi Sad with the aim to support knowledge transfer, research and innovation [16]:

- EEN – Enterprise Europe Network (CIP project) – University in Novi Sad, Financed by Competitiveness and Innovation Framework Programme;
- Business Incubator Novi Sad – Faculty of Engineering (aka Technical Sciences) of the University in Novi Sad;
- The Best Technology Innovation Competition – Faculty of Engineering (aka Technical Sciences) of the University of Novi Sad, with support from Ministry of Education, Science and Technological Development of the Republic of Serbia;
- UNESCO Chair for Entrepreneurial Studies (UCES) - University in Novi Sad;
- Science and Technology park of the University in Novi Sad, part at the Faculty of Engineering (aka Technical Sciences);
- Center for competitiveness and clusters – Faculty of Engineering (aka Technical Sciences) of the University in Novi Sad;
- Center for Development in Financial Sector - Faculty of Engineering (aka Technical Sciences) of the University in Novi Sad;
- The University Center for Intellectual property (IP Center) - Faculty of Engineering (aka Technical Sciences) of the University in Novi Sad;
- Numerous projects realized at the University of Novi Sad: IPA (COMPLEXIM, ECORYS, COMP-COMP,

MORDIC), TEMPUS (S&T Park, KNOWTS) and others.

Business Incubator Novi Sad is founded by Municipality of Novi Sad, Vojvodina Investment promotion fond, Faculty of engineering and public company Informatika. The main goal [16] of this institution is to provide business help to young entrepreneurs with good ideas. Most of the companies in Business incubator are from ICT cluster of Vojvodina.

The Best Technology Innovation Competition (BTI) (<http://www.inovacija.org/>) [16]. is one of the ways by which the Faculty of Engineering (or Faculty of Technical Sciences), the University in Novi Sad, has started educational process of high-tech would-be and existing entrepreneurs in Serbia in order to change current entrepreneurial knowledge and innovative culture. Since 2005 it has gained a continual support from Ministry of Science of the Republic of Serbia and Serbian Chamber of Commerce. Thus BTI has become national open competition for inventors, small high-tech entrepreneurs, researchers, etc.

The mission of BTI Competition is promotion of innovativeness, education of its participants how to enter into the market and strives to ensure media promotion and financial support. In order to fulfil its mission, Organizational Board of BTI each year delivers significant number of promotional and educational trainings in high-tech area. Taking into account a few-years experience in creating and realization of business and marketing trainings of researchers in high-tech area, it is noticed a large number of obstacles/problems which enables them to successfully enter into the market with theirs high/level research and scientific work.

For the last three years, the following results of this educational program that has been achieved:

- over 1900 innovators, researchers and company representatives attended educational program for innovative business, created and held by young, innovative professionals from the University of Novi Sad in 42 cities in Republic of Serbia and Republic of Srpska;
- 164 promotional and educational trainings (43 promotional, 121 educational trainings);
- over 35 new registered innovative high-tech companies;
- 282 teams (more than 846 people) finished their Business Plan.

This Competition is an excellent example of how University should have an active, responsible role in the processes of gaining support from state institutions on one side, and developing innovative entrepreneurial ways of thinking and acting in society on the other. It has proved to be a very good way for reinforcing the entrepreneurial way of commercializing innovations, providing financial and educational support.

Additional direct and indirect results are: changed climate at the University of Novi Sad, which can be seen through startup a lot of spin-out companies, that are not direct result of the competition but show changed climate and readiness of university researchers to become entrepreneurs and test their knowledge in real life, as well as starting-up consultancy for high-tech companies Konekta

consulting founded by Organizational team from Faculty of Engineering, as a direct result of the Competition.

UNESCO Chair for Entrepreneurial Studies (UCES) was established at the University of Novi Sad in 2006, as a part of UNITWIN programme with the aim to promote and encourage education, research and exchange of academic staff and to create a platform for information exchange in all the most important UNESCO activities. UCES aims to become a centre of excellence in teaching and research in the field of entrepreneurship and tends to work on capacity building at different levels: professional and personal development of both students and teachers; development and promotion of entrepreneurial culture among students and young staff as well as in the wider environment; investment in educational and research resources; development of career guidance services for students; enhancement of the university - alumni relationships by involving alumni in teaching and research projects as learning resource as well as funding source. Together with the UNESCO Chair for Entrepreneurship Studies at the University "J.J.Strossmayer" in Osijek, Croatia, UCES is the only Chair of that kind in the region of South - East Europe. It is also a part of European network of UNESCO Chairs in Entrepreneurship under the leadership of the UNESCO Chair on Entrepreneurship and Intercultural Management at the University of Applied Sciences in Gelsenkirchen, Germany.

Centre for Competitiveness and Cluster Development is founded in 2007. It is formed by the Faculty of Engineering (or Faculty of Technical Sciences) in June 2007, with the aim to actively participate in the programs of promoting the competitiveness of the industry in the Republic of Serbia. Strategic goal of the Centre is to create environment which can support creation of added value strengthening the material products and services sector, raising the competitiveness of companies, promotion and introduction of all forms of quality management systems, securing of full functionality of cluster networking, and influence positively on their sustainability.

The mission of the *University Center for Intellectual property (IP Center)* which is to educate and inform academic, research, business and student society at Novi Sad and Vojvodina in order to promote the role of intellectual property and raise awareness about importance of IP in knowledge based society. Overall goal of the IP Center is to help in IP protection, mainly through writing patent documentation and tracking procedures, as well as to support transfer and commercialization of the knowledge developed through research and creative work at the University of Novi Sad. Consultations between researchers from the University interested in protecting their knowledge developed through research and creative work at the University of Novi Sad in form of intellectual property and IP Center experts about potential invention, procedures and possibilities of applying. If an idea is attractive and promising, the next step is to suggest the inventor to prepare detailed invention disclosure. IP Center representative and inventor are signing the document for confidentiality of invention which contains invention disclosure [16].

3.2. Clusters

Provincial Secretariat for Economy, Employment and Gender Equality has recognized clustering as one of the strategic measures for economic development of the

province. Strategic guidance to support clusters are related to following areas: development of innovation; business sustainability; internalization of cooperation and networking; regional specialization; new skills and creation of new jobs. Priority areas are: the efficient use of arable land, food-processing facilities, infrastructure and logistics, metals and textile area and development of modern advanced technologies and ICT. Currently there are 18 clusters and the most important are [16]: Vojvodina ICT Cluster (VOICT), Vojvodina metal cluster (VMC) and Creative industries cluster of Vojvodina (CICV).

Vojvodina ICT Cluster is a business association founded through a bottom-up initiative of ICT companies and several supporting institutions. It is a fast-growing organization, strongest in its field in Serbia. It provides a single point of contact with the best companies in Serbia, with the total workforce of 1,700 experienced IT professionals. Over 90% of of the members' businesses are tied to foreign markets – EU, North America and Middle East. Vojvodina ICT Cluster gives institutional support to this trend, mobilizing players from the triple helix business–education–government. Strategic objective of Vojvodina ICT Cluster is to increase visibility of Serbian ICT and put Novi Sad on the regional and European map as the hotbed for ICT in this part of the world. Activities toward this objective include further strengthening of the association, its positioning as the most relevant Serbian ICT institution within the country and abroad, building ever stronger network of international contacts, creating new business opportunities for the members, compiling and delivering sets of services to members and third parties, lobbying for improvement of business environment in Serbia, and popularization of ICT both in terms of generating more ICT.

Vojvodina metal cluster was created as an initiative of companies from metal sector in Vojvodina and that is the main strength and value of the cluster. The project is financed from the technical assistance of the European Union, the regional program of socio-economic program RDEPR2. The University of Novi Sad - Faculty of Engineering (or Faculty of Technical Sciences) is one of the partners and founders of this cluster. Guarantee for achieving the objectives of the VMC is support of local and provincial government of Vojvodina, the Serbian government through the Ministry of Economy and Regional Development, Chamber of Commerce, VIP Fund - Fund of Vojvodina Investment Promotion and the Regional Centres for Standardization and Certification. Companies from the metal sector are becoming members of the VMC on the basis of self-interest. By joining the VMC, all members are eligible to vote and have certain obligations.

Creative industries cluster of Vojvodina is founded in 2010 as a business model in creative economy. It [16] acts as generator of economic empowerment of small and medium-sized enterprises from the field of creative industry by documenting the economic impact and contribution of these industries to Vojvodina and Serbia. In collaboration with its partners, this cluster provides a central point for creative businesses to access business development opportunities, information, events and resources relating to: commercialisation and finance; education and training; research and technology; and industry knowledge and networks. It is dedicated to supporting the potential of Serbia's creative businesses and is supported by the

University of Novi Sad and Center for competitiveness and Cluster development as part of its commitment to supporting Vojvodina's creative industries. Therefore its aims are to improve networking and innovation in the cultural and creative industries sector in Vojvodina, and enhance the image and profile of creative industries at regional and international market. Its mission is to develop a regional framework for creating new products and services.

3.5. Associations of inventors

There are three organizations that develop invention at the territory of AP Vojvodina. These are: Peoples Technique of Vojvodina, Alliance of Inventors of Vojvodina and Association of Inventors and Innovators (API).

They organize inventors' activities in all working environments, carry out according to the needs of the inventors, the industry and all interested, provide necessary professional help to the individuals working environments and institutions concerning protection and use of the results of innovative work, encourage and create conditions for the development of all kinds of innovations, connect the authors of inventions and all kinds of innovations, connect them and their potential users who might be interested in the realization and distribution of inventions, encourage the work of young inventors and supervise their development, take part in the implementation and creation of the strategy of technological development and organize manifestations and exhibitions with aim of popularization of innovations (exp. Tesla fest in Novi Sad). Tesla fest (<http://www.teslafest.com/>) – international festival of innovation and patents is annually held in Novi Sad, Serbia. Many exhibitors from all over the world take this festival as a chance to present their patents, technological achievements, technical solutions, etc. Members of the Jury for the Tesla Fest are usually professors from the University of Novi Sad, Serbia.

4. CONCLUSION

From the perspective of the Quadruple Helix model this paper gives an overview of its elements in the AP Vojvodina, identifying business incubators, science and technological parks, clusters and associations of inventors as crucial actors in supporting regional innovation performance.

These elements represent the structures, established with the aim to support knowledge transfer, research and innovation in different ways. Business incubators are necessary to support young entrepreneurs, entrepreneurial studies and innovation competitions are crucial for development and promotion of entrepreneurial culture in the region, mainly among students, young researchers and teachers, and centres for competitiveness and intellectual property are important to build awareness about importance of innovation and related issues within academic, research, business and student society at Novi Sad and Vojvodina. On the other hand, clustering is seen as one of the strategic measures for economic development of the province and associations of inventors as invaluable providers of the necessary professional help concerning protection and use of the results of innovative work.

Having all these identified elements in mind, it can be concluded that AP Vojvodina has a strong potential to grow into a highly innovative region, based on the firm connections

among four helices – government, industry, academia and civil society.

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