Evolution of universities in innovation digitalizing economy

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Abstract. The study aims to analyze the transformation of universities into the innovation actors and their role in the national innovation system development. We described the concepts of university role in modern society.

Introduction

The beginning of the third millennium has confirmed the fact that science and technical progress have turned into main source of economic growth. Permanent innovation activity has become a basis of modern economic progress. Technological, economic and social changes have been accelerating and leading to new type of economic development. Of course, the role of new knowledge producers has been increasing at this stage.

Universities are historically regarded as knowledge producers and distributors. In western countries, since the XIXth century, universities used to be both educational and research institutions, in which big part of R&D was concentrated. In post-socialist countries, different system of science organization was formed, which included university, academic and industrial sectors of science. However, nowadays, the role of universities in retention of Russian scientific potential and production of new knowledge for industry is continually growing.

The objective of this research was to analyze the transformation of universities into innovation actors, along with their experience in innovation management at the period of transition to knowledge-based economy (KBE) and digital economy.

1. Materials and methods

Relevant theories of knowledge production can be classified conventionally into two main groups: those arguing that there has been a shift in knowledge production to greater university contribution to industry and social needs, and those portraying necessity of changing “Mode 1” and “social contract” between academic researchers and the state.

However, all scholars agreed in recognizing main socio-economic and technological changes that have become the drivers in transformation of university role. In western countries, these changes are as follows: globalization; the growing role of knowledge and

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information in socio-economic development when knowledge becomes one of the major factors of well-being and competitiveness; changes on labor market when knowledge-intensive technologies require new high-skilled workers, which causes mass demand on professional higher education; increasing pressure on universities to meet societal needs, particularly those of industry and government.

Nevertheless, scholars differently interpret the impact of these changes on university behavior. We have analyzed these theories with respect to their major points in order to clarify changes in both university practices and their theoretical interpretation.

Mode 1 involves new knowledge being produced primarily within individual disciplines, mainly at universities and other academic institutions. There is little direct connection to societal needs, and the results of research are transferred to users at the end of the project (Martin and Etzkowitz 2000, Leydesdorff, 2012) [1].

Contrary to the above, Mode 2 (Gibbons et al. 1994, 2011) [2] generally involves multidisciplinary or transdisciplinary research carried out in a growing variety of institutions (not just universities or academic research institutions) and with a blurring of the boundaries between the traditional sectors (industry, university, etc.). Knowledge is increasingly being produced “in the context of application” - in other words, with societal needs having a direct influence from an early stage and with relatively explicit social accountability for the funding received by researchers from the government.

In post-war period, social contract as one of the knowledge production models has solved the main task to provide rapid scientific and technological progress of developed countries, first of all USA. In the beginning of the XXIst century, many authors (J.Duderstadt 1999; R.Florida, 1999; D.Guston, 2000; R.Frodeman and C.Mitcham, 2000) [1,2,3,4] proposed an idea to tie public research closer to industrial needs and to decrease public funding.

One of the most arguable models of knowledge production among scrutinized in this publication was Triple Helix model (H. Etzkowitz et al.) [5,6]. This model developed the hypothesis of the ‘third mission of university”, which was the consequence of two factors: first, societal needs of knowledge-based society, and, second, lack of public funding of the universities, (although, in fact, the latter is the former). This theory presumed the transformation of traditional university into “entrepreneurial university”. The entrepreneurial university encompasses a ‘third-mission' of economic development in addition to research and teaching (Etzkowitz and Leydesdorff, 1999, 2000; Etzkowitz, Ranga et al., 2008, 2012) [7,8]. Some authors argue that such shift arises from both internal development of the university and external influences on academic structures associated with emergence of ‘knowledge-based' innovation.

The triple helix model attempts to account for a new configuration of institutional forces emerging within innovation systems. In a knowledge-based economy, the university becomes a key element of the innovation system both as human capital provider and as seedbed of new firms. Three institutional spheres (public, private and academic), that formerly operated at arm’s length in laissez-faire societies, are increasingly interwoven with a spiral pattern of linkages emerging at various stages of the innovation and industrial policy-making processes.

The main idea of Etzkowitz et al. is that Triple Helix theory implies an enhanced role of the university in technological innovations in increasingly knowledge-based societies. It seems to us, these changes in university role and activities are especially important during the transition to new economic order. We agree with Etzkowitz and Ranga (2012) [8], Rodrigues and Melo (2012) [9] on practical implementation of Triple Helix concept, which can be successfully utilized to motivate regional actors to collaborate across institutional and organizational boundaries, to legitimize policy efforts and to improve coherence among different sectors influencing innovation.

As Carayannis and Campbell (Carayannis and Campbell, 2009, 2012, 2013) [10,11]
stated, the innovative Triple Helix model was followed by the Quadruple Helix. This model added the “fourth helix” of “media-based and culture-based public and civil society” as integrative part for innovations; by doing this, that model involves the society and its cultural background in the process of knowledge creation and production.

As the fifth helix in the enhanced model of innovation represents the “natural environment,” currently ongoing transformation from the “Quadruple Helix” to the “Quintuple Helix” makes it clear that a sustainable development will be a definite part of the creation and production of innovations and knowledge (Carayannis and Campbell 2010, 2012) [11,12]. It extends and expands substantially the triple helix model of innovation economics as the framework introduces civil society and the environment as pillars and focal points of policy and practice. In particular, civil society emphasizes the role of bottom-up initiatives complementing top-down government, university and industry policies and practices, and the environment emphasizes the sustainability priorities and exigencies that need to inform and moderate top-down policies and practices as well as bottom-up initiatives. The quintuple helix views the natural environments of society and the economy as drivers for knowledge production and innovation, thus defining opportunities for the knowledge society and knowledge economy. The quintuple helix can be described in terms of the models of knowledge that it extends the five subsystems (helices) it incorporates, and the steps involved in the circulation of knowledge [11].

In addition, the “Quintuple Helix” as improved model of innovation shows, that in the twenty-first century, the creation and production of knowledge and innovation must be “transdisciplinary” and “interdisciplinary” at the same time. This is especially needed to work against the dangers resulting from the climate change and destruction of the environment. The described complex changes in the models, and the development of innovative models, should make clear that currently given complexity in the areas of work and research requires an academic entrepreneur. (E.G. Carayannis (ed.), 2013) [11].

Table 1. Theories of university role in the modern society

|                | Mode 1        | Mode 2        | Social contract | Triple Helix     | Quadruple Helix | Quintuple Helix |
|----------------|---------------|---------------|-----------------|------------------|-----------------|-----------------|
| **Actors**     | Academy (university) | Academy and practitioners | Universitiy, government | Universitiy, industry, government | Universitiy, industry, governmeent, civil society | Universitiy, industry, governmeent, civil society, environment |
| **Driving forces** | Academic community driven | Practice driven | Governmennt needs | Social needs | Social needs | Social and environmental needs |
| **Focus**      | Disciplinaary focus | Transdisciplinary | Mostly disciplinary | Interdisciplinary | Interdisciplinary | Interdisciplinary |
| **Organizational structure** | Hierarchical, stable knowledgge | Heterarchical and transient structures | Usually stable academic structures | Flexible, transmittiing structure | Flexible, transmittiing structure | Flexible, transmittiing structure |
| **res** | structures networks, feedback, recursive effects | networks, feedback, recursive effects | networks, feedback, recursive effects |
|----------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|
| **Instru** | Quality through internal consistency and peer review | Appeal to temporary and heterogeneous set of practitioners in specific context | Quality through peer review and social assessment |
| **ments (methods) of achieving quality** | Quality through alliances between scientists, practitioners and officials | Quality through alliances between scientists, practitioners, officials, media, civil society structures, culture | Quality through alliances between scientists, practitioners, officials, media, civil society structures, culture and ecologists |
| **Work organization** | Individual research work | Team work, group creativity, actors' networks | Individual / group research work |
| | Networks of actors involved | Networks of actors involved, social networks | Networks of actors involved, social networks |
| **Sphere of application (action)** | Science sector - universities, research institutes & laboratories | Applied research institutions, government laboratories, universities (especially technical) | Universities, R&D institutions, government programs |
| | Universiti es, public (official, government) bodies, R&D institutions, industry, business | Universiti es, government bodies, R&D institutions, industry, business, media, culture, civil society | Universiti es, government bodies, R&D institutions, industry, business, media, culture, civil society, environment |
| **Commercialization of results** | No, disclosed knowledge, priority of discovery | Closed knowledge, commercialization of results | Depends on situation |
| | Commercia lization or public program funding | Depends on situation | Depends on situation |
| **Preconditions of emergence** | Separate parallel development of science | Emergence of knowledge-based industries | Government needs |
| | Increasing pressure of social needs (above all) | The same and growing impact of civil | The same and growing impact of dangers |
and industry
growing demand on mass higher education, rising competition within education services market.
society needs and involving for environment

| Stimuli of development | New knowledge search | Demand from practice (needs of application) | Political needs | Pressure of social needs, lack of university funding | Pressure of social needs, lack of university funding |
|------------------------|----------------------|---------------------------------------------|-----------------|-----------------------------------------------------|-----------------------------------------------------|

Results

The digitalization of many social, economic and production processes has becoming the main line of development over last decade. It led to new model of university – “University 4.0.”, “digital university”.

“The most common misconception of the “digital university” is that it is simply a university that offers online learning and courses. But it is much more than that. A true digital university is one that embraces the digital age from back to front, inside out, and beginning to end. A digital university is one in which lecturers teach students about the latest digital trends whilst using that very technology to deliver the most up-to-date insights. It is one in which PhD students openly seek out digital technology to support new, unknown, and untested ideas and innovations. It is a university in which students play with the latest technology and imagine working in the most digital workplaces” (Hoare, 2016) [13].

A digital university is a way of organizing education in modern era. It is the sum of methodological approaches, infrastructure and digital technologies, which transforms the form and content of the educational process and will be able to support education, scientific and administrative activities in accordance with the frame of the electronic economy. Unlike a traditional university, digital university operates on the base of "big data", with total automation of economic, financial and administrative activities, the introduction of electronic services and digital resources that allow joint research projects with scientists from other organizations and countries.

The educational process using digital technologies provides not only the direct transfer of information, for example, during online lectures, but also controls the its understanding. Therefore, for example, through the analysis of various data, a teaching plan for each student can be formed.
The new role of universities in the knowledge society and digital economy is manifested in the fact that:

- the contribution of modern universities to the innovative development of the country is increasingly determined by the university intellectual property;
- modern universities are the social institutions that best solve the problem of transferring knowledge into intellectual capital through the using resources of globality, openness, dynamism, a constant influx of active youth;
- modern universities are not only R&D executors, but actively creators of technologies and technology companies;
- universities are becoming leaders and centers for the creation of new hi-tech industries.

At the same time, number of experts note many universities cannot use the advantages of digitalization effectively. In British Public Research Center Report, common reasons of this situation are identified [14]:

- Understanding that universities have a new breed of customers that they need to engage with, and competitors that they need to compete with, in new and different ways
- An inability to simultaneously evolve existing ways of working whilst adding new techniques, tools and capabilities
- A culture that inhibits the rapid development and release of new technology
- A lack of trust in digital services and cloud technologies, or concerns about their reliability, security and resilience.

Another major inhibitor to digital uptake in universities is digital literacy.

In addition, university IT departments who need to support digital initiatives are not always well equipped to do so. Inflexible policies, aging infrastructure and inexperience working with digital agencies can delay or prevent new digital initiatives from taking shape.

However, digitalization of higher education and development of "University 4.0." model go fast.

Conclusions

"University 4.0" is a public institute that implements the function of a providing knowledge about the future. University 4.0 is becoming a leader in the development of high-tech industries. Thus, "University 4.0" is able to display effectively the function of capitalizing its own knowledge. When modern universities are moving to "University 4.0", more and more value is produced on the university campus, and is not transferred to the economy in the form of "semi-finished products": specialists and general knowledge.

The transformation of universities to "University 4.0" has a positive impact on increasing their contribution to the economic and social development through improving the quality of education, matching the competencies of graduates with the requirements of business structures, increasing competitiveness in the international educational market, the formation of sustainable income flows and less dependence from budget financing.

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