ICT for Innovative Education and Science: Smart Environment for Networked Strategies

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Abstract – This research addresses the issues of information and communications technologies (ICT) support of Higher Education Institutions (HEIs) education and scientific activities management in innovation networks by indicating some strategies and approaches for ICT infrastructure management. The main issues and cases of ICT application in HEIs for technology transfer management thought the creation of smart environment of HEIs researches programs for business were considered. Empirically examining of these cases produced a more complete understanding of ICT-based HEI cooperative marketing networked strategies.

Keywords – innovation networks, smart environment, cooperative marketing, ICT, education.

I. INTRODUCTION

All sectors of the economy are undergoing a digital transformation, which will become a driver for changing existing educational institutions and creating new ones.

All new trends inexorably capture the educational market and change it. Trends in the implementation of digital technologies in educational and research activities are set by commercial organizations (private universities, business schools, corporate universities etc.). But public universities and institutions are starting to think more and more about digital transformation. It is important for them to prepare, compete with the wave of educational startups that emerged with the digital revolution. The formation of an online environment is an area that still requires serious investment from universities. But in the modern conditions the areas of information and communications technologies (ICT) application are expanded within the networked strategies. Modern trends do not even give clear idea of what the university will look like in 20 years, how the campuses or laboratories of universities will look like, how much education and research activities will move into the virtual reality.

In our study we will discuss a wide range of issues of an economic and organizational nature in order to understand what new university models look like now, what are the prospects and future steps needed to form modern university and create fundamentally new models of higher education based on ICT. This objective requires considering the limitations and possibilities of new university models as part of network strategies.

II. LITERATURE REVIEW

Modern innovation transformations require focus on universities, which are open to contestation concerning their role in public sphere and the politics of knowledge production.

Where universities are discussed, higher education is focused on, because this is undergoing an intense audit-driven neoliberal re-engineering [1]. It’s common knowledge that higher education, science and technology policy discourse is a key point of innovation system development [2]. Research activities have expanded research-intensive academic departments [3]. It relates to existing research on organization in academic leadership in many ways [4].

The paper [5] develops an analytical framework for analyzing the factors of global flows in higher education. Here we can note that attention would be primarily given to issues if Industry 4.0 impacts on higher education, including the problems of rapid learning and innovations development. Therefore one of the most striking features of this problem is re-assembling knowledge production in university [6]. Industry 4.0 revolution causes the transformation of social and economic systems [7] and higher education institutions (HEIs) can be considered as a source of innovations. Research [8] deals with the problem of education space that supports the learning needs of students. In the same in study [9] particular attention is given to distance education. It is clear from these observations that higher education should be based on innovation management and cooperative marketing. A number of key issues arise from the statement.

For instance, in research [10] a diverse aspects of universities influence on the development of the society is considered. E.g. it includes countless smart city and community initiatives. These cases bring together city planning, industry, universities and citizens to improve the urban life of individuals and organizations with the integrated use of versatile information, digital and communication technologies. Within these issues the quality management system in universities, which comprehensively covers education, research and social collaboration activities, and which can ensure the universities’ successful partnership in smart city projects, were studied. In [11] an analysis of three challenges to
established understandings of higher education: digitalization, commodification and precarity were proposed. Universities remain the most important organizations involved in developing knowledge and providing means of social mobility.

The study [12] aims to identify and analyze factors that determine the implementation of Information and Digital Technologies of smart manufacturing. Digitalization enables an administrative solutions, data security systems, research data storage and learning resources, as well as opportunities for better collaboration [13].

From these facts, we may conclude that digitalization provides opportunities for the exchange of accumulated experience and knowledge, which allows different stakeholders to learn more and make more informed decisions. ICT support of higher education institutions participation in innovation networks [14; 15], including international networks [16] is important issue. Examples of such ICT support can be found in nanoinformatics [17] application for R&D and industrial analysis.

The given points confirm the idea that strategies and approaches for ICT infrastructure management substantiation is a complex task, proposed by authors in previous studies [18]. Therefore the objective of this study is to consider the issues of ICT support of cooperative marketing in innovation networks by indicating some strategies for ICT infrastructure management.

III. UNIVERSITIES NETWORKED STRATEGIES SMART ENVIRONMENT LEVELS

Based on experience of leading universities and business schools [19], it is possible to form a conceptual model of smart environment for universities networked strategies, which consists of five levels.

The first level is the most important and is represented by scientific and pedagogical workers, students, industry and academic partners of the university, graduates and applicants. The first level is, in fact, the internal and external stakeholders of the university.

The second level is represented by basic information services. Their task is to create a single information space for digital interaction within the university using flexible tools. Examples of such services are video screens for lectures and seminars, wireless communications throughout the university, cloud storage for storing and exchanging data, professional printing, etc.

The third level includes services that greatly facilitate the lives of students and teachers in a modern university. For foreign teachers and students, they are already an obligatory element of the university; a number of services in most universities are still at the initial stage of implementation.

The fourth level is the most resource-intensive in terms of implementation, but at the same time it allows the university to get the highest added value. It consists of services such as digital marketing, research project management, procurement management, interaction with applicants and students.

The fifth level consists of digital technologies, which are highly likely to be widely used in the university environment (virtual reality, network labs etc.).

Advanced levels of smart environment for its development require appropriate infrastructure, and smart environment.

IV. ICT-BASED INNOVATION EDUCATION ISSUES

According to modern innovation policy approach, to ensure the educational services competitiveness, HEIs should implement appropriate quality assurance procedures, develop innovation management policies, standards of practice-oriented educational programs, form and implement a strategy for continually improving the quality of education through R&D interaction with business and society. At the same time, the innovation management in modern HEI should include the digitization the main directions of innovation activity.

Management of formation and practical application of intellectual resources becomes a key task for HEIs in the framework of new role in development. Therefore, ICT tools that are involved in the creation of intellectual resources are largely decisive. Experience of number of leading world universities and expert’s reviews confirm that critical thinking and communicative skills are the two core competencies of Industry 4.0.

As a consequence, the role of the communication component of the HEIs interaction with its environment is growing, which forms relevant requests for educational strategies and can facilitate the application of various academic resources for the purposes of socio-economic development. In the context of the foregoing it is expedient to consider the peculiarities of strategic role of academic institutions, in particular in the context of educational and research missions. The analysis shows the practical absence of system processes in research and social missions, which leads to the loss of development potential and impairs the implementation of an educational component that is not related to practice.

For the purposes of ICT tools role analysis we consider the innovation networks. Today, innovative networks are actively involved in modern business processes, offering effective ways to implement complex projects. The growing number of multifunctional networks offers high availability, security and service quality for business processes. But at the same time business and public sector face with a number of challenges related to development of network infrastructure and introduction of ICTs, because digital transformation leads to a number of problems (especially security problems) and opportunities (formation of interaction synergy).

From an innovative point of view, we propose to consider the role of ICT within a systematic approach. In Stanford, the innovation system is defined as inter-organizational, political, economic, technological and non-military systems, through which a favorable environment for business development is formed, supported and developed. From this definition we can define four main components of innovation system:

1. Purposeful process: the innovation system is built
around the process of commercialization of innovations, which has a clear result in the form of innovative products in the market;
2. Subjects interacting with the process of commercialization of innovations;
3. Relationships between them;
4. An environment that provides resources for subjects of commercialization of innovations.

Therefore the strategic development of the HEIs networked-based innovation system is a factor that equally contributes to both increasing the scientific reputation and its financial sustainability, attracting students, new employees and innovative resources. To do this, we need to orient the system to specific commercial outcomes.

Specialized ICT offer the new platforms (applications) for interaction and integration the educational & research processes. Domestic and international R&D cooperation, which becomes effective through modern ICT tools, is crucial for solving modern research problems. In general, collaboration tools and services create new opportunities for future research challenges overcoming.

It can be accurately noted that individual ICT solutions, network infrastructure and scalable solutions will play major role in HEIs R&D and technology transfer. Such ICT can be considered as a key for educational processes reengineering. Thus, the higher education system digital transformation is important to maintain competitiveness in the era of Industry 4.0.

The role of innovation networks is growing significantly as future education reduces the distance between employer and employee, and the educational services market will increase its degree of flexibility. As a result, ICTs in innovation and education networks will participate in the following education and R&D areas:

- large corporations will be able to order certain competencies (projects) without mediation of specialized government or private firms, including project approach (learning in R&D projects);
- organizations that are in particular in need of collective intelligence and team building can enter the educational market themselves and offer specialized courses or services;
- carriers of new interactive educational technologies will be able to combine into the virtual professional communities and to form the community colleges with their own standards and teaching methods. Subsequently, these structures can compete with traditional universities;
- to implement a model of future education, a high-tech infrastructure is needed that will be developed based on up-to-date databases based on Big Data or cloud technologies;
- there are prototypes of stock exchanges for educational opportunities for joint and individual learning, platforms for educational content stores;
- mass attestation tests to determine the overall educational level will gradually lose relevance. They will be replaced with online evaluation and certification systems that allow for an external, verified assessment of the availability of individual competencies and skills.

In these conditions, the educational sector needs to achieve significant progress in digitization and the use of leading innovations in ICTs in new tasks solving (Fig. 1).

Thus, the role of ICT for the development of innovation and educational processes of modern universities can be defined in the following areas:

- creation of educational programs based on unified scientific-educational and innovative process with application of interdisciplinary problem-oriented and project-oriented educational technologies;
- organizational structure and project management methods, which are appropriate to the new task, have been developed;
- diversified sources of HEI funding and effective system of crowdsourcing;
- increase in the number of cooperation projects and practical oriented R&D and educational services;
- developed infrastructure of interaction of HEI with the external environment, which includes agents from the regional, national and international dimensions.

For development of smart environment appropriate for networked strategies purposes we propose to consider the elements of system design methodology [20; 21]. Among other things it includes a comprehensive analysis and evaluation of the customer’s task, goals and objectives of complex technical systems, the formation of a source data system for system design, the development of an interconnected system of criteria and indicators for innovation and its components. Rational Unified Process (RUP) model supports the basic principles of system
design and Model-Driven Systems Development (MDSD), which is used both for education and R&D.

Virtual reality technology, e.g. IC.IDO, also has significant potential, which, in combination with engineering systems for product design, is used both by large international corporations and medium and small companies to increase the competitiveness of products on the market. The IC.IDO system is a model of a real product with all its specific characteristics and behavior in real conditions, thereby providing the most accurate teaching aid for conducting trainings and advanced training courses for academic staff in applied areas of innovation management (e.g. [22; 23; 24]). Such methodological foundations can solve the problem of ICT support of universities R&D strategies.

V. CONCLUSION

In research it was concluded that universities should perceive the use of new educational technologies as a tool to increase their own competitiveness within the innovation networks. A general conclusion is made concerning that processes of testing and implementing such technologies develops the university’s digital educational system but at the same it requires individual strategy that should corresponds with R&D strategy.

As a result of models of ICT support of universities R&D strategies considering the main issues and cases of ICT application in universities for technology transfer management thought the creation of smart environment of HEIs researches programs for business were outlined.

Empirically examining of some cases has produced a more complete understanding of ICT-based university networked strategies. Discussion of the present findings has confirmed the smart environment for networked strategies of universities not only helps students to form unique competencies, but at the same time expands the creative opportunities for teachers and researchers.

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