

Digitalization of the University Technology Transfer Process

P. Karanikić*, H. Bezić** and S. Redzepagic***

* University of Rijeka, Department of Biotechnology, Rijeka, Croatia
pkaranikic@biotech.uniri.hr

** University of Rijeka, Faculty of Economics, Rijeka, Croatia
heri.bezic@efri.hr

*** University Cote d'Azur, Graduate School of Economics and Management, Nice, France
srdjan.redzepagic@univ-cotedazur.fr

Abstract - University technology transfer process is an important task for every university. Traditional technology transfer model identifies general steps needed for successful commercialization and transfer of scientific results developed at universities to the industry while technology transfer offices have a significant role not only in the implementation of university technology transfer process, but also in the overall technology transfer ecosystem. Digitalization and digital technologies impact the university technology transfer process and bring certain changes in the process. In this paper the steps of traditional university technology transfer model are identified and elaborated together with the role of technology transfer offices in the university technology transfer process. The impact of digitalization and implementation of digital technologies in certain aspects of the university technology transfer process is presented.

Keywords - university technology transfer process, technology transfer office, digitalization, digital technologies

I. INTRODUCTION

Universities today are becoming the sources of social and economic development through technology and knowledge transfer to the industry and society as a whole. Universities, beside their primary activities of teaching and research activities as a part of their traditional mission, are actively engaging in the co called “Third Mission”. From a general point of view, a Third Mission is an evolving phenomenon related to the concepts such as “entrepreneurial university”, “technology transfer” and “Triple Helix Model” [1]. On the other hand, this concept refers to the variety of activities performed by universities with the aim of transferring the knowledge and technology to particular organizations and society as a whole, and to promote entrepreneurial skills, innovation, and economic and social welfare.

Technology transfer process can be observed as a process that involves transferring of a knowledge base from one place to another. The main element in the process of technology transfer is technology itself. After the adoption of the Bayh-Dole Act in the United States in 1980, the motivation of universities to get involved in the technology transfer activities increased. Today, technology transfer is a global process. Universities have an important role in creation and bringing innovative

technologies to the market. Commercialization of universities’ scientific research results have a positive effect on economic growth, while technology transfer process generates revenues for universities (e.g. through IP licensing, collaboration agreements with the private sector, foundation of spin-off companies, etc.) and creates links between academia and industry. In the light of digitalization and digital economy, technology transfer process has become one of the main drivers of open innovation and covers all activities needed for efficient translation of scientific research results from academia to industry [2].

The aim of this paper is to analyze and describe relevant steps within the traditional university technology transfer process, to define the role and importance of technology transfer offices in implementation of university technology transfer process and to investigate how digitalization and digital technologies will impact the implementation of university technology transfer process in the digital economy.

II. UNIVERSITY TECHNOLOGY TRANSFER PROCESS

The purpose of university technology transfer is to transfer university research results from the university to the industry where the research results are transformed into the new products and services [3]. The university technology transfer process from scientific discovery (i.e. invention) to its commercialization is very complex, with many actions and steps. Often the results of these actions and steps are very hard to predict. There is an extent literature that depicts the traditional model of university technology transfer process as oversimplified. However, this model presents a basic model that continuously need to improve and consider the practical aspects of implementation of technology transfer activities and technological developments, especially digital technologies.

There are several steps in the traditional model of university technology transfer process [4]:

- University scientist makes a discovery;
- University scientist discloses the invention to the Technology Transfer Office (TTO);

- TTO evaluates the invention and decides whether or not to patent;
- Patent applications;
- Marketing of technology to firms/entrepreneurs;
- Negotiating licensing agreements/royalties, equity stake, etc.;
- Licensing of technology (existing companies adapt and use technology, or foundation of a spin-off and a start-up companies).

The traditional model of technology transfer process begins with a scientific discovery or improvement by a university scientist/researcher from any scientific discipline [5].

Disclosure of a scientific discovery made by the university scientist to the TTO is a second step in traditional technology transfer model. Disclosing the invention will depend on the formal and incentive structures of a particular university [6]. Evaluation of a commercial potential of the invention by the TTO is the third step in traditional technology transfer model. The TTO conducts the evaluation on several different levels: revenue potential, licensing potential, scientific field of invention, competitiveness and extensibility [4]. Based on the conducted evaluation the TTO will suggest to the university management to patent or not to patent the invention.

When the decision on patenting the invention is positive, then the next step in the traditional model of university technology transfer is the patent application process. Since the patent protection of an invention is very expensive, TTOs must be very careful in deciding in which technologies (arising from inventions) a certain university should invest, due to the fact that most of the technology transfer offices have limited patenting budgets. It is very important to conduct a relevant evaluation of a commercial potential of particular invention since TTO will decide to patent an invention with a broad commercial potential.

Marketing of technology is the fourth step in the traditional model of university technology transfer. The role of a TTO is to market the technology to the industry, but also to manage the potential conflict of interest between themselves and industry on the one side, and between themselves and university scientists on another side [7]. Focus of the TTOs and industry actors is on the financial gains from patenting and licensing of technologies, while university scientists seek for visibility and reputation that will result from implementation of such activities [8]. It is very important that a TTO provides a balance between preservation of academic freedom, knowledge creation and diffusion, and promotion of economic development and interests of the industry on profit maximization, growth and competitiveness [9 - 11]. The technology marketing mode is defined based on the technology characteristics. This stage is very important in the overall technology transfer model because it provides the foundations for the future relationships between the university and the private (industrial) sector.

The fifth step in the traditional model of university technology transfer is the negotiation of the license agreements. Universities protect intellectual property rights on technologies created by the university scientists with the aim of licensing these technologies to an interested company [12]. In a typical license agreement, a licensee (interested company) will pay royalties to the licensor (university) for using the licensor's intellectual property. Licensing agreements are generating revenues for the university and these revenues can be used for additional funding of research activities.

Licensing of university technologies is the final step in the university technology transfer process. The license can be exclusive or non-exclusive [13] and companies usually seek for an exclusive license in order to keep the proprietary control over the licensed technologies. In a traditional university technology transfer process, the technology is licensed to the existing company, or to the new company – called a start-up or a spin-off company [4].

The traditional university technology transfer model is linear, quite inflexible and therefore limited. A certain degree of flexibility can be introduced by defining the various factors that will contribute to the technology transfer process such as: funding structures, research activities, the universities' legal environment and the institutional setting [14].

There is no “one-fit-all” model of university technology transfer process. The traditional technology transfer model presents a solid basis and identifies general steps for implementation of university technology transfer activities. This model requires certain adaptations for commercialization of technologies from various scientific disciplines. In addition, digitalization and implementation of various digital technologies will also require certain modifications in implementation of the university technology transfer process.

III. THE ROLE OF TECHNOLOGY TRANSFER OFFICES IN UNIVERSITY TECHNOLOGY TRANSFER PROCESS

The efficient implementation of university technology transfer process requires the establishment of the adequate technology transfer ecosystem. Many universities worldwide have in the past decades institutionalized the technology transfer process in order to stimulate the commercialization of university research results [15 – 17]. A developed and established technology transfer ecosystem at universities supports university technology transfer process [18] through university affiliated and connected intermediary organizations that directly support the technology transfer activities: technology transfer offices (TTOs), science parks, incubators and university venture funds [19]. Due to the increased focus of more and more universities on the university technology transfer, most universities have now established their TTOs [20].

There are three relevant actors involved in the university technology transfer process: university scientists, technology (result of a conducted research by university scientists) and technology transfer office with its relevant staff and infrastructure [21]. They all have

different motives to engage in the process of technology transfer. However, there is a common goal of all actors in this process – a successful commercialization of university intellectual property (IP) and generated revenue for the university. University scientists are the creators of a new knowledge, while technology transfer offices (TTOs) can be considered as guardians of the universities' IP rights generated by the university scientists. University TTOs are an important component not only in the university technology transfer process, but also in the overall technology transfer ecosystem. University TTOs act as facilitators of the technology transfer process and for this reason it is important to consider how they can be more effective.

The main role of TTOs is to bring the research results toward the industrial application [22, 23]. In order to be effective and successful in this process TTOs are conducting and are responsible for many different activities. Beside performing their main activities of invention disclosure, evaluation of the invention commercial potential, defining the university IP protection and management strategy, protection of an invention with the appropriate means of IP protection, and finding the best route for IP commercialization (e.g. licensing, setting up a spin-off or a start-up company, etc.), they also communicate and advise university researchers on technology transfer activities, organize trainings and workshops on the technology transfer and intellectual property rights topics, interact and network with industry partners, collect revenues from licensing of the university IP rights, etc.

Each of these activities requires relevant policies put in place, assured infrastructure and adequate and skilled TTO staff. Additionally, all these activities require many different operations in order to find the best business model for commercialization of technologies developed at universities. Moreover, the commercialization process for every specific technology should have a particular project-based approach, since different technologies have different characteristics and applications.

IV. UNIVERSITY TECHNOLOGY TRANSFER PROCESS AND DIGITALIZATION

Digitalization is one of the major trends in changing both the society and the ways of performing businesses, and its impact and importance is well recognized among organizations [24]. Many organizations implement various digital solutions in order to assure the transfer of knowledge, but also to improve the possibility of storing and dissemination of knowledge and information from various projects and individuals [25]. Understanding of the university technology transfer process is a prerequisite for further understanding and development of a university technology transfer model impacted by various digital technologies.

There is no doubt that digitalization has a positive effect on technology transfer activities, especially on information management, specific assessments, big data creation and activity routinization. The benefits of digitalization in the technology transfer process occur in better internal efficiency, consistency through elimination

of manual steps and better accuracy. Additionally, better real time view on operations and results, as well as better work satisfaction for employees through automation of routine work is enabled [26].

Today, there is abundant information important for efficient technology transfer activities available online, and digitalization enables technology managers to reach the state-of-the-art of any discovery and helps them in decision making on IP protection and marketing activities. Digitalization has also influenced the way how technology transfer information is planned, organized, coordinated and controlled: the information is now stored in secured platforms and is managed online. With digitalization, managing the information is easier and less expensive, but is also riskier [27].

Digital tools, artificial intelligence (AI) and big data analytics, can be used for the evaluation of scientific achievements in published scientific papers to derive relevant information on available scientific methods, and existing and future technological trends important for the overall technology transfer process. A technology transfer office as a facilitator of university technology transfer process manages a large amount of data. The ability of a particular TTO to manage, capture and analyze such various information requires strong commercialization, administrative and technical competences and skills by the TTO staff.

One of the most important activities within the university technology transfer process is the protection of university IP. A TTO, based on available information, decides on IP protection. IP rights protection and management is one of the most digitally advanced areas. Beside the fact that the process of IP application and protection is almost completely digitalized within the relevant national and international organizations (national intellectual property offices, World Intellectual Property Office - WIPO, European Patent Office - EPO, United States Patent and Trademark Office - USPTO, etc.), accessing the relevant market information, identification of suitable licenses and automated systems for marketing and licensing are available due to the development of digital tools such as blockchain.

An important aspect of digitalization of the IP rights protection and management is the implementation of AI in the freedom to operate (FTO) process. Freedom to operate search will provide relevant information for organizations to proceed with the research, development and/or commercial production, marketing or use of a new product or process with a minimal risk of infringing the unlicensed IP rights or tangible property rights of third parties. Since the IP protection and the IP rights litigation are expensive, it is very important to conduct an FTO search before making the commercialization decision. The FTO analysis must be organized, logical, methodical, meticulous, and carefully documented [28]. Scientific and patent digital databases (both freely available and paid) are important sources of information and an integral part of the FTO analysis. Examples of such databases are Current Contents, Thompson Reuters, Espacenet, Patentscope, Derwent, etc. The implementation of AI in FTO search process will help in the IP case law analysis, infringement

analysis, invalidity analysis and risk assessment analysis, and will increase the quality of commercialization decision making.

Blockchain technology is an important digital tool useful for the implementation of technology transfer process. In its basic form, the blockchain technology is an open ledger of information that can be used to record and track transactions, and which is exchanged and verified on a peer-to-peer network. Blockchain technology in the context of technology transfer process can be implemented in the form of “smart contracts” (e.g. license agreements, non-disclosure agreements, etc.) and used to establish and enforce IP rights by allowing the payment transactions in real time to the IP owners [29].

Another aspect of implementation of blockchain technology in the technology transfer process are the blockchain-based platforms developed for scientists and investors where they can register and efficiently exchange early stage technologies. Scientists are allowed to upload relevant information on their technologies (invention disclosure documents, scientific data, IP data, list of inventors, etc.) and commercialization proposals. These data are then verified in the blockchain and investors can search the blockchain in order to identify the relevant technologies for their particular businesses [30].

An important aspect of knowledge creation is the ability to transform relevant data to information. Universities constantly generate new data and information as a result of their research and development activities that are important for implementation of technology transfer activities. Implementation of Big Data technology is enabling universities to collect, mine and exploit a large amount of data available from various internal and external sources [31]. Adequate knowledge management will help universities to transform the gathered data into useful knowledge.

Digitalization and implementation of different digital tools will lead to certain changes in the technology transfer process. The process will be more iterative and activities will be more flexible and intertwined. The positive effect of digitalization will also be manifested in the overall effectiveness of the technology transfer process.

V. CONCLUSION

Technology and knowledge transfer from universities to the industry has become one of the important directions for most universities. Commercialization of scientific results developed at universities generates additional revenues for universities and has a positive impact on economic development and growth.

A traditional model of university technology transfer identifies general steps of the technology transfer process with relevant activities within each of these steps. The implementation of digitalization and digital tools in the university technology transfer process will require certain modifications in the process, but will definitely improve the effectiveness of the overall technology transfer process.

A well developed and established university technology transfer ecosystem is a prerequisite for successful implementation of the university technology transfer process. Technology transfer offices are facilitators of the university technology transfer process and are an important component in the overall technology transfer ecosystem. Technology transfer offices are implementing and are responsible for almost all of the activities in the university technology transfer process.

The introduction of digitalization, digital technologies and tools affects the university technology transfer process and brings certain changes in the implementation of university technology transfer process. It is expected that these changes will be beneficial for the technology transfer process and will improve the overall effectiveness of the university technology transfer process.

There are some open considerations regarding the future development and implementation of digitalization on university technology transfer process. It is still unknown how is digitalization going to be helpful in closing the certain gaps between science and industry, and in what way the university technology transfer process together with TTOs will change and adapt due to these changes.

ACKNOWLEDGMENT

The publication of this work has been supported by University of Rijeka under the projects “Smart cities in function of development of national economy” (uniri-drustv-18-255-1424) and “Industry 4.0 and export competitiveness of the European Union” (uniri-drustv-18-281).

REFERENCES

- [1] Trencher, G., Yarime, M., McCormick, K.B., Doll, C.N.H., and Kraines, S.B. (2014). Beyond the third mission: exploring the emerging university function of co-creation for sustainability. *Sci. Public Policy* 41(2), pp. 151–179
- [2] Karanikic, P., Matulja, M., and Tijan, E. (2019). The role of university technology transfer process in Digital Economy. In 2019 42nd International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO), pp. 1419-1422
- [3] Hockaday, T. (2020). *University Technology Transfer: What it is and how to Do it*. JHU Press
- [4] Bradley, S., Hayter, C. S., and Link, A. (2013). Models and methods of university technology transfer. *Foundations and trends in Entrepreneurship*, 9(6)
- [5] Siegel, D. S., Waldman, D. A., Atwater, L. E., and Link, A. N. (2004). Toward a model of the effective transfer of scientific knowledge from academicians to practitioners: qualitative evidence from the commercialization of university technologies. *Journal of engineering and technology management*, 21(1-2), pp. 115-142
- [6] Debackere, K. and Veugelers, R. (2005). The role of academic technology transfer organizations in improving industry science links, *Research Policy*, 34(3), 321-342
- [7] Slaughter S. and Rhoades, G. (2004). *Academic capitalism and the new economy: markets, states and higher education*, Johns Hopkins University Press, Baltimore
- [8] Baycan, T. and Stough, R. R. (2012). Bridging knowledge to commercialization: The good, the bad, and the challenging, *Annals of Regional Science*, Special Issue Paper
- [9] Behrens T. R. and Gray, D. O. (2001). Unintended consequences of co-operative research: impact of industry sponsorship on

- climate for academic freedom and other graduate student outcome, *Research Policy*, 30(2), pp. 179-199
- [10] Van Dierdonck R. and Debackere, K. (1988). Academic entrepreneurship at Belgian universities, *R&D Management*, 18(4), pp. 341-353
- [11] Kumar, M. N. (2010). Ethical conflicts in commercialization of university research in the post-Bayh Dole era, *Ethics and Behavior*, 20(5), pp. 324-351.
- [12] Friedman, J. and Silberman, J. (2003). University technology transfer: do incentives, management, and location matter? *Journal of Technology Transfer*, 28(1), pp. 17-30
- [13] Lee, J. and Win H.N. (2004). 'Technology transfer between university research centers and industry in Singapore,' *Technovation*, 24(5), 433-442
- [14] Heinzl, J., Kor, A., Orange, G., and Kaufmann, H. (2008). Technology transfer model for Austrian higher education institutions, presented at the European and Mediterranean Conference on Information Systems, May 25-26, 2008
- [15] Ambos, T.C., Mäkelä, K., Birkinshaw, J., and D'Este, P. (2008). When does university research get commercialized? Creating ambidexterity in research institutions. *J. Manag. Stud.* 45, pp. 1424-1447
- [16] Colyvas, J.A. (2007). From divergent meanings to common practices: the early institutionalization of technology transfer in the life sciences at Stanford University. *Res. Policy* 36, pp. 456-476
- [17] Owen-Smith, J. (2003). From separate systems to a hybrid order: accumulative advantage across public and private science at Research One universities. *Res. Policy* 32, pp. 1081-1104
- [18] Siegel, D.S., Wright, M. (2007). Intellectual property: the assessment. *Oxf. Rev. Econ. Policy* 23, pp. 529-540
- [19] Huyghe, A., Knockaert, M., Wright, M., and Piva, E. (2014). Technology transfer offices as boundary spanners in the pre-spin-off process: the case of a hybrid model. *Small Bus. Econ.* 43, pp. 289-307
- [20] Friedman, J., Silberman, J. (2003). University technology transfer: do incentives, management, and location matter? *The Journal of technology transfer*, 28(1), pp. 17-30
- [21] Siegel D. S., Waldman D. A., and Link, A. (2003). Assessing the Impact of Organizational Practices on the Productivity of University Technology Transfer Offices: An Exploratory Study, *Research Policy*, vol. 32 (1) (pp. 27-48)
- [22] Barra, C., Zotti, R. (2018). The contribution of university, private and public sector resources to Italian regional innovation system (in)efficiency. *Journal of Technology Transfer*, 43, pp. 432-457
- [23] Hayter, C. S., Nelson, A. J., Zayed, S., and O'Connor, A. C. (2018). Conceptualizing academic entrepreneurship ecosystems: A review, analysis and extension of the literature. *Journal of Technology Transfer*, 43(4), 1039-1082
- [24] Larsson, A. (2018). Utilizing digitalization for improved knowledge transfer in Project-Based Organizations: A single case study of a management consulting firm
- [25] Swan, J., Scarbrough, H., and Newell, S. (2010). Why don't (or do) organizations learn from projects? *Management Learning*, 41(3), pp. 325-344
- [26] Parviainen, P., Tihinen, M., Kääriäinen, J., and Teppola, S. (2017). Tackling the digitalization challenge: how to benefit from digitalization in practice. *International Journal of Information Systems and Project Management*, 5 (1), pp. 63- 77
- [27] Gbadegeshin, S. A. (2019). The effect of digitalization on the commercialization process of high-Technology companies in the life sciences industry. *Technology Innovation Management Review*, 9(1)
- [28] Kowalski, S.P. (2007). Freedom to operate: the preparations. *Intellectual property management in health and agricultural innovation: a handbook of best practices*, pp.1901-1922.
- [29] Clark, B. (2018). Blockchain and IP Law: A Match made in Crypto Heaven, available at: https://www.wipo.int/wipo_magazine/en/2018/01/article_0005.html
- [30] Haag, T.A., Haag, R. (2018). Blockchain & Bio/Pharma R&D, Tech Transfer, and IP, available at: <https://www.acc.com/resource-library/blockchain-biopharma-rd-tech-transfer-and-ip>
- [31] Obitade, P.O. (2019). Big data analytics: a link between knowledge management capabilities and superior cyber protection. *J Big Data* 6, 71