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Towards Building Open Innovation Ecosystem in Poland: Challenges and Opportunities

Summary: Nowadays rapidly changing businesses environment (with start-ups and predominance of big companies), shortening technological cycles and accelerating technological convergence raise the need to combine competences with others. An *open innovation* based Quadruple helix interlinkages ecosystem seems to be appropriate method to boost innovation capabilities in companies, sectors and the whole regions. The research paper aims to discuss the opportunities and challenges related to adapting open innovation models in Polish enterprises. The concept of *open innovation* and promotion of clusters are important elements of economic policy of the industrial competitiveness of Poland and Europe 2020 strategy. Yet, despite increasing expenditure on innovation in Polish enterprises, innovation collaboration among Triple Helix stakeholders as well as the role of clusters are not growing significantly. In 2016–2018, such collaboration was undertaken only by 36% of innovation-active industrial enterprises, over 40% of which were big companies. Moreover, the share of industrial enterprises collaborating under a cluster initiative in the total number of enterprises amounted only to 3.5%. One of the sectors, where innovative activity was most often undertaken biotech and pharmaceutical related industry (biopharma) (56.2%). The industry faces a high-cost of R&D, limited commercialization and constant technological change. Thus, there is a growing attention for open innovation and external partnership. The study shows that in Poland, *open innovation* collaboration within the biopharma industry is still in the infancy. Among the financial, legal, institutional barriers socio-cultural factors have had large effects on the behaviour of firms with respect to their engagement in open innovation practices.

Keywords: open innovation, ecosystem, Quadruple helix, Poland, biopharma industry

W kierunku otwartych ekosystemów innowacji w Polsce: szanse i wyzwania

Streszczenie: W dobie dzisiejszej szybko zmieniające się otoczenie biznesowe (ze start-upami i przewagą dużych firm), skracanie się cykli technologicznych i przyśpieszenie konwergencji technologicznej powoduje potrzebę łączenia kompetencji oraz potencjału innowacyjnego firm i jednostek badawczo-rozwojowych. Ekosystem oparty na modelu poczwórnej helisy – Quadruple Helix (QH) lub otwartych innowacjach sprzyja zwiększeniu zdolności innowacyjnych w przedsiębiorstwach, sektorach i całych regionach. Opracowanie ma na celu omówienie możliwości i wyzwań związanych z adaptacją

modeli otwartych innowacji w polskich przedsiębiorstwach. Koncepcja otwartych innowacji i promocji klastrów to ważne elementy polityki gospodarczej, konkurencyjności przemysłowej Polski i strategii Europa 2020. Jednak pomimo rosnących nakładów na innowacje w polskich przedsiębiorstwach, współpraca pomiędzy przedstawicielami QH, a także rola klastrów nie rośnie znacząco. W latach 2016-2018 taką współpracę podjęło jedynie 36 proc. innowacyjnych przedsiębiorstw przemysłowych, z których ponad 40 proc. stanowiły duże firmy (GUS, 2020). Ponadto udział przedsiębiorstw przemysłowych współpracujących w ramach inicjatywy klastrowej w ogólnej liczbie przedsiębiorstw wyniósł tylko 3,5 proc. Jeden z sektorów, w którym działalność innowacyjną najczęściej podejmowano to sektor branży biotechnologicznej i farmaceutycznej (56,2 proc.). Branża zmaga się z wysokimi kosztami badań i rozwoju, ograniczoną komercjalizacją i ciągłymi zmianami technologicznymi. Dlatego rośnie zainteresowanie otwartymi innowacjami i partnerstwem zewnętrznym. Badanie pokazuje, że w Polsce współpraca w formie otwartych innowacji w branży biotechnologicznej i biofarmaceutycznej jest wciąż w fazie zalążkowej. Wśród najważniejszych czynników, które miały wpływ na słabe zaangażowanie przedstawicieli firm oraz jednostek badawczo-rozwojowych w otwarte praktyki innowacyjne należy zaliczyć czynniki finansowe, prawno-instytucjonalne oraz społeczno-kulturowe.

Słowa kluczowe: otwarte innowacje, ekosystem, poczwórna helisa, Polska, przemysł biofarmaceutyczny

JEL: 031, 032, 033

Numerous financial programs, aiming to promote business and university research sectors co-operation and induce pro-innovation attitudes among Polish entrepreneurs have not translated into an increase in the level of innovativeness of the Polish economy and its regions (Bukowski, et al., 2012; Runiewicz-Wardyn, 2016; Weresa, 2018). This makes us pose the questions about the reasons for such state and the capacity of the current innovation system in creating and supporting innovations. Among the features characterizing Polish innovations, one should point that Polish enterprises tend to adapt innovative solutions rather than generate them. The level of innovative awareness and cooperation between Triple Helix (academia-industry-government) actors is low.

Open innovation is a complex function, in which both tangible factors such as R&D investments, infrastructure, knowledge acquisition and competence development, along with the intangible factors such as social and cognitive skills play role. The following study contributes to the emerging debate on the topic of open innovation ecosystems by sharing insights and knowledge on the open innovation practices in Polish enterprises as well as contributing with better understanding the challenges of open innovation collaboration, especially in the socio-behavioral context. It contributes to fill the gap that can be observed in the Polish and international literature on innovation theories and policies by incorporating evolutionary, behaviour, cognitive and social insights into the analysis of the innovation ecosystem Triple Helix networks.

The study applies descriptive data analysis method as well as discusses the qualitative research findings based on the case study of biopharma industry. In terms of the first one the data comes from the GUS studies in the Polish enterprises in the years 2012-15

and 2016–2018 (GUS, 2020). In case of to the qualitative method the study presents the interview survey findings based on research studies of Runiewicz-Wardyn (2020), Kozierkiewicz (2020), Sznyk and Karasek (2016), Trzmielak (2013) and others.

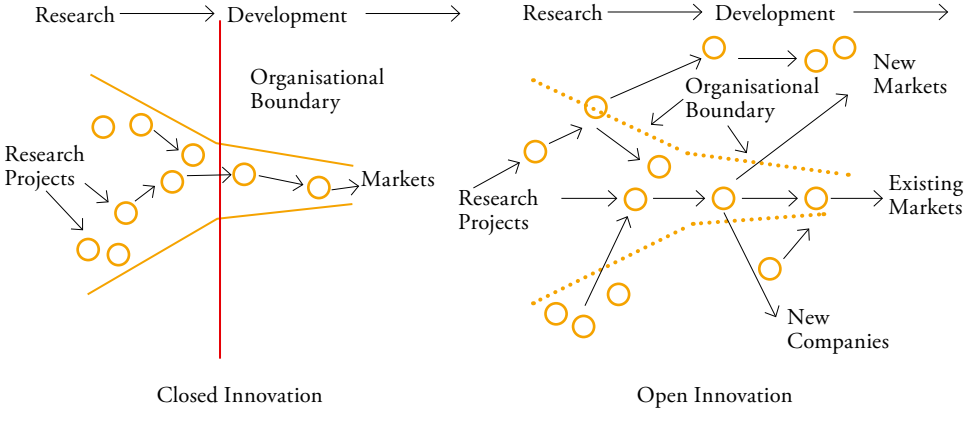
The paper is divided into four sections. The introduction is followed by the presentation of the theoretical framework of open innovations and open innovation ecosystem (section 1 and 2). The third section discusses the open innovation practices in Polish enterprises. The fourth section discusses the open innovation practices using the example of the biopharma industry. The paper ends with the research conclusions and policy implications.

Open innovations – conceptual framework

Innovation is the process that transforms new creative ideas into a new value. The capacity to innovate is therefore an ability of continuously transform knowledge and ideas into new products, processes and systems, both for the benefit of the organization as well as its socio-economic environment. Various approaches, methods and concepts are used for managing and advancing this interactive innovation process. Many recent studies have focused on the 'open innovation models' as the predominant way to increase the interaction external partners (e.g. Chesbrough, 2003; Laursen, Salter, 2006). The concept of 'open innovation' popularised by Henry Chesbough (2003) is defined as *the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation*. Closed innovation process is internally focused whereas open innovation includes externally focused elements within the organization`s innovation model. It is therefore a two-way process in which companies and other related organizations have an *inbound process* in which they bring in ideas, technologies, or other resources needed to develop their own business or research capacity and an *outbound process* in which they out-license or sell their own ideas, technologies, and other resources (Krause, et al., 2012). In sum, open innovation is a more than a simple correlation between R&D inputs and innovative output of single organization. In the open innovation model, enterprises can initiate and nurture innovations within the their own organisational boundaries, while at the same time bring ideas to the market and to benefit from external knowledge (De Jong, et al., 2008), see Figure 1.

Open innovation can take such forms as licenses, patents, purchase of know-how, implementation of R&D contracts, cooperation with universities in the introduction

Figure 1 **Closed innovation vs. open innovation process**



Source: Rahman and Ramos (2010).

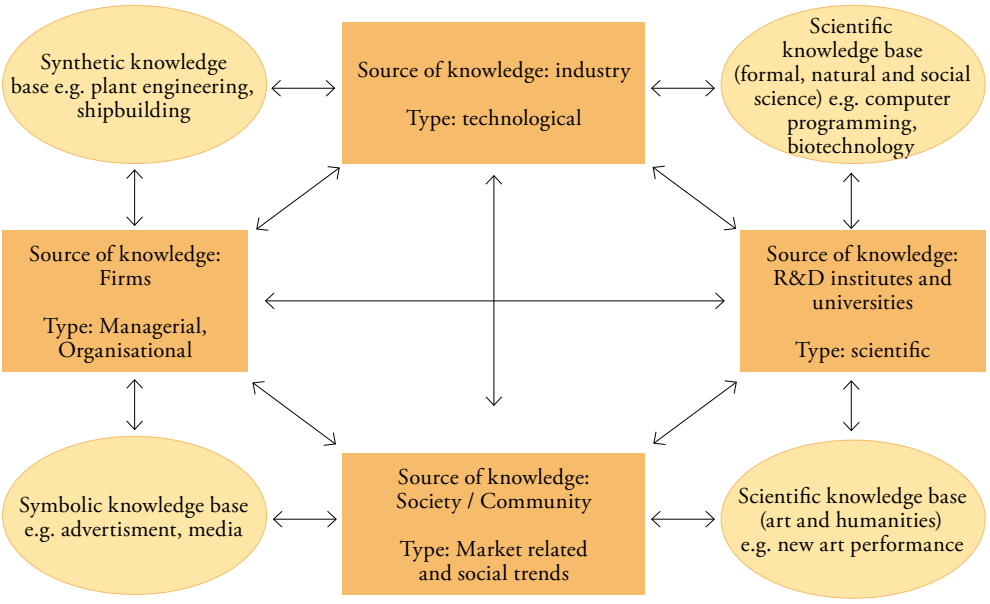
and implementation of new solutions or purchase of university spin-offs, etc. As a result, firms and research institutions introducing open innovation practices leverage better their innovative potential (research and learning processes), team productivity and stimulate innovations, technological advancement in the fields that are at early growth of their technology cycles, technological converge with other industries or that may have high potential to solve critical societal challenges.

Interactive model of the innovation in the open innovation ecosystem (OIE)

Development, adoption, implementation and diffusion of innovations are based on links established between various related entities. The Triple Helix (TH) – university-industry-government – interlinkages approach to innovation systems is widely accepted, especially in public sector. Recently, there has been an attempt to enrich this approach with new concept of innovation ecosystem based on the Quadruple Helix (QH), which is grounded on the idea that innovation is the outcome of interactive and transdisciplinary process involving *all stakeholders as active players in creating and experimenting new ways of doing things and creating new services and products* (Open Innovation 2.0, EC, 2018). Indeed, the rapidly growing and increasingly complex research and innovation processes require a large variety of knowledge types and sources. Nonaka and Takeuchi (1995), as well as Lundvall and Borrás (1998), pointed out that the knowledge creation and exploitation processes require a dynamic interplay of various types of knowledge and the transformation of tacit and codified forms of knowledge as well as a strong interaction between people within organizations and among them. Figure 2 highlights knowledge creation and shows that the process of innovation is the result of interaction between various actors and types of knowledge involved in this process.

In addition, within the context of emerging technologies, especially in the communication and social media, consumers, user communities and firms use their new power to share their opinions and interact in innovation process (Cova&Dalli,

Figure 2 **The interactive model of the innovation process in Quadruple Helix framework**



Source: own elaboration (Runiewicz-Wardyn, 2013).

2009). Just few examples worth mentioning, include the B2B, open source or crowdfunding platforms. The B2B systems facilitate the exchange of information and Internet based sales. The B2B and other platform-based services for healthcare and life sciences companies may offer new ways to improve the patient-customer experience and develop innovations based on data. Another example is the open source platforms and technologies, which allow developers learn new technologies, learn from each other and thus accelerate further innovation process in the industry. Last but not least prominent example of open innovation collaboration is crowdfunding platforms that allow entrepreneurs bring new products to market through broader conversation with large numbers of potential innovation backers.

While the rationale behind innovation system focuses on the investments into R&D infrastructure, the innovation ecosystem concept broadens attention to more intangible, qualitative interactions and relationships that affect innovation process. Notably, the QH approach builds on the emerging concept of open innovation ecosystem (OIE)' and widens the TH concept with one more helice – society and societal perspective (Carayannis and Campbell, 2019; Report by Committee of Regions, EC, 2016). The OIE concept refers to the system of heterogeneous group of actors (representatives of firms, universities, technology centres, development organizations, NGOs and broader community) that interact in order to boost the innovation capability of their communities (Fasnacht, 2018). For that purpose the research objective the concept of OIE is defined as a (complex) set of relationships, both formal and informal that foster and facilitate inter-exchange of new and exploitable knowledge between the Quadruple Helix actors (industry, academia, government and user community), and lead to the new collaborative (open) projects or partnerships.

The European Commission responded to the opportunities and challenges of OIE by introducing in 2006 Living Lab concept (led by the Finnish prime minister). The field of living labs is still at an early stage, but has already became an important component of knowledge exploitation and facilitation strategies in many regional innovation policies. There is no commonly accepted definition of LL in the international literature. The concept of LL is considered from organisation' perspective and can be defined as *a mechanism of maintaining its openness towards external partners and engaging in open collaborative innovation*. In the LL concept university acts as creative space for sharing technical skills and developing, testing, transferring and co-producing disruptive ideas through partnerships with companies, researchers, students, NGOs and other stakeholders.

Drivers and barriers of open innovation ecosystems in empirical studies

Given the still relatively new phenomenon of open innovation there still not many studies investigating open innovations from the perspective of the systemic interlinkages in the open innovation ecosystem. The studies by Cattacin and Zimmer (2016) and Arocena et al. (2017) provide some successful examples of learning integration and academia-industry collaboration in the context of university-based LLs initiatives in Sweden, Denmark, Italy, Germany and Spain, and at the cross-border Nordic-Baltic examples. More specifically, Arocena et al. (2017) bring example of role of Danish universities as drivers of local innovation, sustainable development and regional innovation policy consultants. The authors conclude that engaging students in collaborative knowledge creation with external partners (including SMEs) can be important driver for regional innovation. Zaphiris and Ioannou (2018) demonstrate how online net-

working sites and crowdsourcing platform allow students, faculty, and other staff create and evaluate ideas for innovative processes, services and products. Nevertheless, some earlier studies i.e. by Florida and Cohen (1999), Cohen and Noll (1994), Blumenthal et al. (1996), Brooks and Randazzese (1999) and others pointed to a possible detrimental impact of combining academic research and business-related activities and a lack of synergies between both activity realm. The conflicting nature of normative principles that guide academia and business sectors were at the base of these conflicts and concerns. This idea of conflicting nature has been also at the roots of the so-called *corporate manipulation thesis* (Mazza et al. 2008). There is however very few studies examining the structure, drivers and developments of university open innovation linkages with firms in the biopharma industries. The survey conducted by Florida and Cohen (1999) at the US university–industry research centres, suggested that research centres that valued the mission of improving industrial products and processes devoted relatively less R&D. Furthermore, studies by Cohen and Levinthal (1990) show that higher absorptive capacity of firms, driven by their active R&D activities, fosters their innovative potential development as well as higher ability to insource the external knowledge. On the other hand, intensive internal R&D activity, would supply companies with a lot of product ideas and new technologies, and the need for acquiring the external knowledge would decrease.

Moreover, legal, institutional and socio-cultural factors may have large effects on the behaviour of firms and research organizations with respect to their engagement in open innovation practices. The first one arises from IPR area and relates to the costs of IP protection and the procedure of claiming intellectual property. Following Chesbrough et al. (2006) strong IPR protection encourages disclosure and promotes efficient trade on markets for technology, whilst weak appropriability implies widespread existence of knowledge externalities (Malerba, Orsenigo, 1993). Consequently, weak appropriability of IP regime, each individual firm or research organization will have less incentive to conduct in-house R&D and the amount of research surplus may decrease as well.

Last but not least, Dwyer, et al. (2005) suggest that social and cultural factors have an influence on the diffusion of innovations and open innovation practices. The positive attitude toward open innovation is not something obvious and natural. The studies of the collaborative innovation projects demonstrate that successful open innovation partnerships require a cultural, social and behavioural foundation (Herzog, Leker, 2010; Witzeman, et al., 2006). Chesbrough and Crowther's (2006) concluded that in order to conduct successful collaborative innovation firms must overcome *not-invented-here* syndrome. Whereas Herzog and Leker (2010) finds out that employees in open innovation units more readily accept ideas from the outside and are more open to risks. Several other studies by Dhanarag and Parkhe (2006), Zaphiris and Ioannou (2018), Harris and Lyon (2013) and Pomponi, et al. (2015) highlight that openness, interaction and communication does not always come naturally and is linked to the people`s beliefs, attitudes to open innovation and mutual *collaborative trust*. For example, people who do not contribute proactively to open innovation are often afraid of becoming too dependent on collaboration partners.

Open innovation practices in Polish companies

Cooperation with other entities in the form of open innovations can be particularly important for the Polish firms with insufficient funding for innovation activity investments. As after the survey data from Polish Statistical Polish (GUS, 2020) in-

Table 1 **The cooperation of enterprises for innovation in the years 2010-2015 and 2016-2019**

Indicators (%)	2010	2011	2012	2013	2014	2015	2016	2017	2018
Percentage of industrial enterprises incurring expenditure on innovation activities	29,6	29,8	28,8	29,6	29,5	30,0	31,1	30,9	31,1
Percentage of industrial enterprises that cooperated in the field of innovative activities	6,1	5,5	6,0	5,2	5,6	5,5	6,7	5,8	6,6
Share of industrial enterprises cooperating in clusters in the number of innovation active enterprises	4,0	7,4	7,2	5,3	6,6	8,2	10,1	8,7	21,0
Share of innovative enterprises in the total number of service enterprises	12,8	11,6	12,4	11,4	11,4	9,8	13,6	10,4	19,6
participation of service enterprises introducing new or improved products	7,9	6,4	7,0	5,8	6,8	4,8	6,9	5,4	9,6

Source: based on data from Polish Statistical Office (GUS, 2020), *Działalność innowacyjna przedsiębiorstw w latach 2013-2015 and 2016-2018.*

novative enterprises cooperate with each other within the local value networks, such as clusters, as well as in less formal ways, in the introduction of new products, services and processes. According to the GUS survey data, the percentage share of industrial enterprises from the small and medium-sized enterprises (SME) sector cooperating within the clusters in the years 2010–2015 increased from 4% in 2010 to 8.2% in 2015 (Table 1).

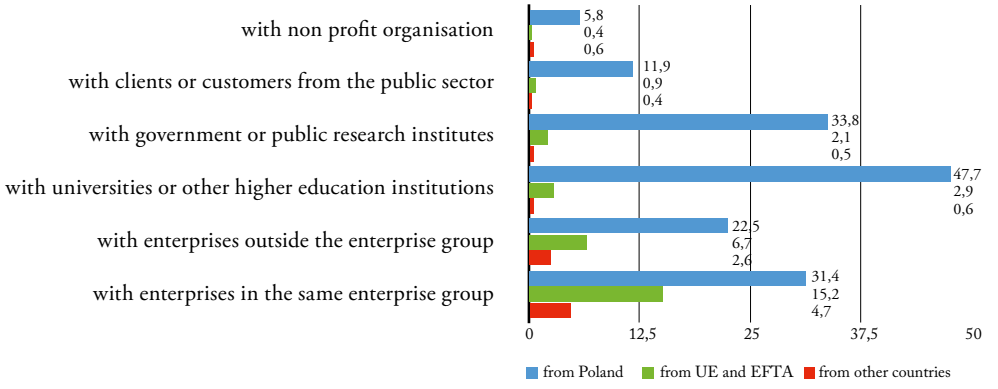
In the years 2016-2018, the share of enterprises cooperating under a cluster initiative in the total number of entities in industrial enterprises amounted to 3.5%, and in the services sector – 2.5%. Among the entities that cooperated within clusters in the years 2016-2018, the highest percentage of industrial and service enterprises were entities employing 250 persons or more.

The slight upward but unstable trend is noticeable in the indicator representing the percentage share of industrial enterprises that cooperated in the field of innovation activity in general of innovation active enterprises. This ratio was 6.1% in 2010, 5.5% in 2015 and to 6.6% in 2018.

Large enterprises had the biggest share in the innovation cooperation activities. In the years 2010-2018, some 6.4% of large industrial enterprises and 50.2% of service enterprises cooperated in the field of innovation activity. The relative share for the small enterprises was only 18.7 % of industrial enterprises and 17.7 % of service sector respectively. Moreover, the percentage of innovative active enterprises increases along with the increase in the level of technology advancement. The highest percentage of innovation-active enterprises was recorded in case of the high-tech enterprises (55.9%), and the lowest in the companies classified as low-tech (19.5%). There has been a significant increase in the latter trend compared to the period 2013-2015, when this indicator for high- and medium-high technology enterprises amounted to 37.7 % and 33.1% respectively.

According to the GUS report, Polish enterprises most often cooperated with enterprises belonging to the same group of professional activity (35.5% of service enterprises and 19.8% of industrial enterprises). On the other hand, the lowest level of cooperation occurred with foreign public R&D institutions (1% of service enterprises and 0.8% of industrial enterprises).

Figure 3 **Industrial enterprises, which led co-operation in innovative activity in the years 2016-2018 according partner institutions**



Source: based on data from Polish Statistical Office (GUS, 2020), *Działalność innowacyjna przedsiębiorstw w latach 2013-2015 and 2016-2018*.

Industrial and service enterprises that cooperated in the field of innovation most willingly cooperated with the Polish universities (47.7% and 46.4% respectively), as well as with enterprises belonging to their own group of enterprises from Poland (31.4% and 38,5% respectively). In industry as well as in services, the EU and EFTA countries were less popular as partner institutions. Similarly, Polish enterprises were least keen to cooperate with non-profit organizations, whereas in the case of partner institutions from other countries with public sector entities (Figure 3).

Over half of all enterprises interviewed in the years 2016-2018 declared that they considered scientific, technical and trade journals, followed by the participation in conferences, fairs and exhibitions (52.9% and 53.1%, respectively) as major source for their innovative activity (55.6% of industrial and 57.3% services enterprises) (Figure 4).

Summing up the survey findings, it can be assumed that the low level of innovativeness of the Polish economy is partially explained by a low level of collaborative and open innovation practices in the Polish enterprises. The relatively low investments in R&D activity and other financial constraints, should become a driving force behind the open innovation model in Polish and other transition economies enterprises. The further, more detailed analysis of barriers and opportunities related to the implementation of open innovation practices, requires more sectoral, industry or individual organizations case based approach.

Case study: Open innovations practices in the biopharma industry

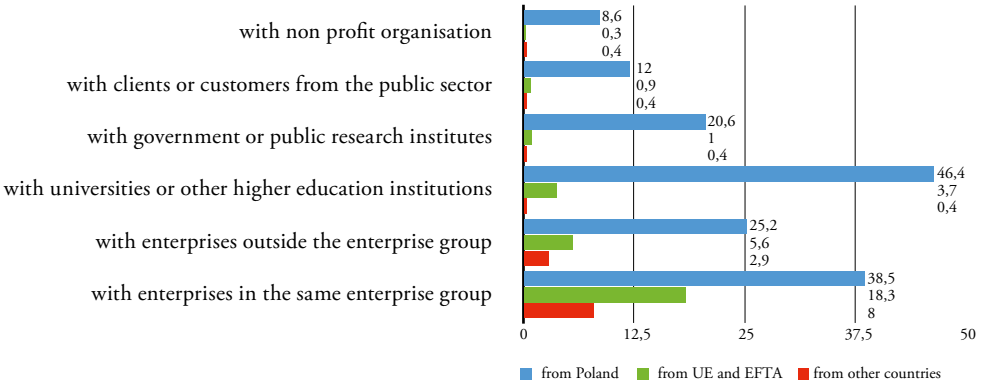
The biotechnology and biopharma industries are one of the fastest-growing high-tech sectors worldwide, characterised by intensive rise of new emerging technologies, advancing technological convergence, high R&D costs, high risks associated with science based technology investments and globalization of the R&D activities (Adner, 2016). Its beginnings dates late 60s and goes back to the San Francisco Bay Area, where first pioneers, like Herbert Boyer and Robert Swanson commercialized successfully the recombinant DNA technology (Zhang, 2005). The event led to the birth of the first biotechnology company in the world – Genentech. Two years later, Genentech scientists cloned human insulin, and a year after, the human growth hormone. These discoveries inspired other Bay Area scientists, venture capitalists and as a result many smaller

companies emerged (Zhang, 2005). Furthermore, the presence of Silicon Valley in the Bay Area provided a unique opportunity for biotechnology to merge with the IT sector. In the late 1980s, UC Berkeley's postdoctoral fellow and research scientist, Stephen Fodor, came up with the idea that semiconductor manufacturing techniques could be used to build vast amounts of biological data on a glass chip, which would facilitate the analysis of complex genetic information (Yi 2010; Zhang, 2005). Fodor founded Affymetrix, later on acquired by Thermo Fisher Scientific. Today Being historically rooted in both computer, IT, life sciences and media industry (more than 300 digital media companies operate in the Bay Area; they are, among others, YouTube, Electronic Arts, Zynga, Twitter, Dolby Laboratories, Pixar, Sony, Sega of America, Konami Digital Entertainment America, and PDI/DreamWorks SKG), the modern San Francisco Bay Area, cannot be considered a classical cluster in the sense of Michael Porter's early definition, but rather a *cluster of clusters* or *cluster of tech start-up innovations* (Runiewicz-Wardyn, 2020).

Open collaborative innovation practices, related to the external inter-organizational and interdisciplinary knowledge – other companies or research labs – became major driver of their innovations and development. Open innovations created new business opportunities for smaller companies through technology sourcing (license from universities or larger, technology-savvy companies) and technology co-development (with knowledge partners such as universities, research labs, and lead-customers). It is therefore impossible to consider biotechnology and biopharma industry development in isolation from the open innovation strategies.

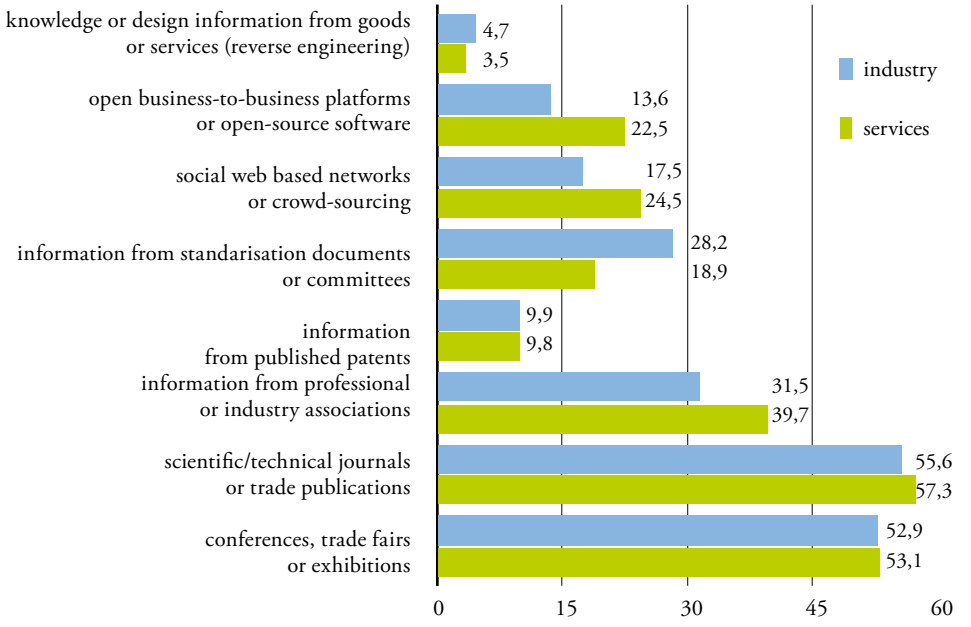
However, other studies show that positive externalities of open innovation is not something obvious and natural for all the firms and sectors. Studies by Steninger (2014) and Torkkeli, et al. (2009) emphasize that there is a cost for external sources of knowledge-lost control over technology and internal knowledge or under-investments in internal R&D assets. Moreover, Cohen & Levinthal (1990) noticed that organizations relying heavily on external partners in fact often neglect internal development of technological competencies, decrease absorptive capacity, and lower motivation of internal R&D staff. While Roper, et al. (2013) conclude that the social benefits of widespread adoption of openness in innovation may be considerably greater than the sum of the achieved by inter-firm externalities.

Figure 4 **Service enterprises, which led co-operation in innovative activity in the years 2016-2018 according partner institutions**



Source: based on data from Polish Statistical Office (GUS, 2020), *Działalność innowacyjna przedsiębiorstw w latach 2013-2015 and 2016-2018.*

Figure 5 **Enterprises which in the years 2016-2018 used knowledge by sources of its acquisition**



Source: based on data from Polish Statistical Office (GUS, 2020), *Działalność innowacyjna przedsiębiorstw w latach 2013-2015 and 2016-2018.*

The survey with representatives of the life several sciences clusters in the US and Europe by Runiewicz-Wardyn (2020) aimed to identify methods of collaboration, intensity of interactions and the role of social networks in R&D collaboration and innovative performance. The study showed that a strong entrepreneurship culture, history and social capital in the US clusters promote tight and dynamic innovation networks. In contrast, social capital formation, entrepreneurship and network dynamics in Europe (Cambridge-UK), Medicon Valley (Denmark-Sweden frontier) clusters` ecosystems have been initiated to the significant extent by the intermediary organizations and *star* scientists. Similar research survey conducted by Kozierkiewicz (2020) on a smaller sample of representatives of pharmaceutical and biotechnology sector in Poland during 2017-2018 show that even though life sciences stakeholders appreciate the role of social networks and collaboration within the Triple/Quadruple Helix innovation collaboration is hampered by low level of trust and the low level of organizational, social and cultural proximity between the scientists and business, little motivation and no mechanisms stimulating research co-operation, patenting, legislative gaps and excessive bureaucracy (in the scope of clinical trials), the lack of intermediary institutions brokering university-industry collaboration, as well as a high level of individualism and limited interdisciplinary cooperation, especially at the university level. Avoiding cooperation with universities was based on stereotypical notion that these were closed and ossified organizations with which cooperation is very difficult (Kozierkiewicz, 2020). Whereas scientists, motivated mainly by publications, tended to work in narrow teams of specialists in a given field, often feared that collaborating with a company or other institution would end in the loss of control over their innovation. Such organizational, social and cultural distinctions constituted a challenge to *open innovation* collaborations between university and industry partners in Poland.

Many Polish firms focus predominantly on publications as source of innovative potential and do not develop other forms of knowledge co-creation.

Conclusion and policy implications

Nowadays, rapidly changing businesses environment, shortening technological cycles and social challenges in life sciences (e.g.COVID-19 pandemic) raise the need to combine competences and research efforts. It is imperative that policy regulators, academia and business representatives start exploring the best collaborative innovation strategies. Open innovation and open science models, bring together researchers and experts from different disciplines to make a path for breakthrough innovations. In sum, executing an open innovation model may help Polish firms, to spur product development, speed time to market, reduce costs, and increase competitiveness. Yet, the transition from the traditional, closed R&D model, which stifles true innovation to an open and collaboration driven innovation model requires a greater social trust and cooperation-based attitude. Companies that adopt a cooperative, open innovation framework are likely to succeed. Nevertheless, understanding and yet stimulating transition from the traditionally closed and open innovation ecosystem requires holistic approach, taking from more than one fields, i.e. science and technology, economy, geography, sociology and psychology.

The research study findings reveal that most of the innovation active companies choose *closed innovation* or mixed of *closed and open innovation* collaboration model within the Triple Helix (i.e. investing into their internal R&D and avoiding cooperation with universities). The case of biotechnology and pharmaceutical industry discloses further challenges of Triple Helix stakeholders in Poland: the difficulty in finding innovation partners, lack of mutual trust, and a lack of institution of intermediary role, offering scientific advice or facilitating the open innovation collaboration, especially in the interdisciplinary cooperation. It is therefore crucial to understand the social and behavioural factors that foster or hinder the collaborative knowledge creation. In sum, the transition from *closed* to *open* innovation ecosystem in Poland requires not only financial support, R&D skills, but also higher investments into brokering links between and among Triple helix actors, to enhance trust, social capital and collaboration among possible partners.

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