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Introducing the open innovation model in Polish biopharmaceutical companies: major drivers and barriers

1. Introduction

Innovation is one of the most important determinants of commercial success. It is virtually impossible for a company to maintain its competitive advantage without entering into collaborative partnerships. Companies are looking for new solutions to survive the crisis, develop their products and get them to market faster and more effectively, and stimulate economic development. This is particularly noticeable in the biopharmaceutical industry. However, the global development of this sector is very diverse. Many biopharmaceutical companies in Central and Eastern Europe (CEE), including Poland, have consistently failed to achieve a high level of competitiveness. This is mainly due to the shortages in financing and to insufficient collaboration between the key stakeholders.

There is a dearth of Polish literature on open innovation practices in the biopharmaceutical industry. The few studies that touch upon the problems facing Polish SMEs in the biopharmaceutical industry include the works of Kozierkiewicz (2020), Lewandowska (2018), Kozarkiewicz and Baster (2017), Puślecki and Staszków (2014), Bojewska (2009), Skowronek-Mielczarek (2013), Wach (2013), Lisowska and Ropęga (2016) and Micek (2014). The present paper is an attempt to rectify this deficiency.

The primary objective of the present study is to identify the open innovation model (i.e. the inbound and outbound open innovation practices) adopted by Polish biopharmaceutical SMEs. In particular, the following research questions are addressed: *1) What actions do Polish SMEs take in order to obtain external knowledge*

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in their innovation processes? 2) What is the role of cognitive, social, organizational, institutional and cultural factors in the selection of innovative partners? 3) What are the main drivers and benefits of engaging in open innovation processes? 4) What are the main barriers to, and challenges facing, open innovation cooperation with other enterprises and institutional partners?

Qualitative survey research and quantitative study methods are applied. The qualitative method enables the various innovation practices within Polish SMEs, along with the major drivers of, and barriers to, open innovation to be analysed. The data are provided by the Central Statistical Office (CSO), and enable the general development of, as well as the R&D collaboration trends in, the biotechnology and biopharma industries to be analysed.

The article is divided into seven sections. The introduction is followed by a review of the key literature on 'open innovation', including that which discusses the major barriers to adopting open innovation model. Sections 3 and 4 present the general trends in open innovation and R&D collaboration in the biopharmaceutical industry in the OECD. Section 5 presents a detailed discussion of innovation collaboration trends in the Polish biopharmaceutical sector. Section 6 discusses the applied research methodology and qualitative research findings. Finally, Section 7 section presents the conclusions, and discusses research limitations and the main implications for future research.

2. 'Open innovation' and the open innovation cooperation model: a subject literature review

The term 'open innovation', as initially proposed by Chesbrough (2006), denotes the 'purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation'. According to Chesbrough (2006), open innovation is 'a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model'. According to Tidd (2014), firms adopting open innovation 'acquire valuable resources from external firms and share internal resources for new product and service development'. In the open innovation environment defined by Dahlander and Gann (2010), firms can implement outbound and inbound movements. Firms which implement outbound movements 'commercialize their inventions and technologies through selling or licensing out resources developed in other organizations'. Whereas firms which implement inbound movements 'license-in and acquire expertise from outside'.

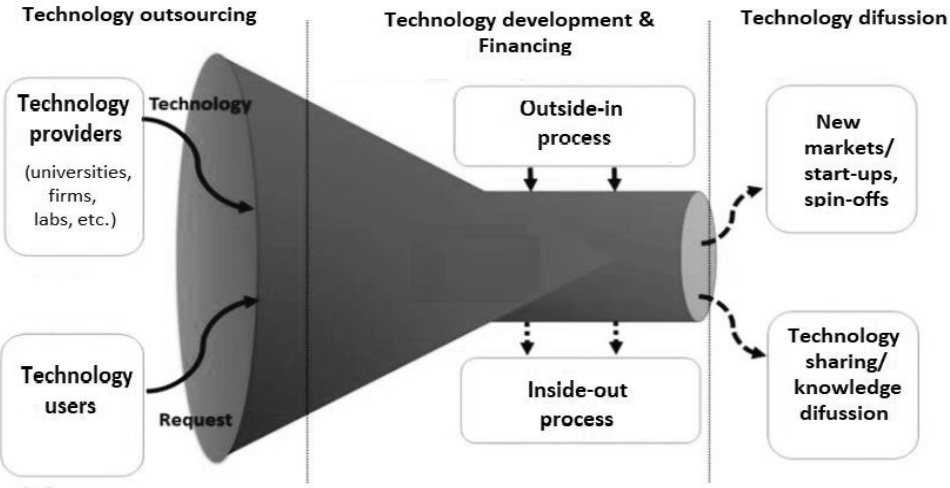
The above 'open innovation' definitions all have both innovation cooperation and R&D collaboration in common. This means that firms can adopt different open innovation strategies, at various levels of openness, according to their own requirements and those of the projects being implemented. For the purpose of this study, open innovation cooperation is defined as 'cooperation based on the

mutual exchange of knowledge, technical solutions and licences', and R&D collaboration as the common R&D and other related initiatives, e.g. traineeships. Furthermore, effective R&D collaboration enables barriers to the adoption of open innovation practices to be overcome. Common barriers include cognitive, organizational, cultural and institutional differences between collaborating partners. Cognitive similarity or proximity is linked to the ways in which various actors perceive, interpret, and evaluate new knowledge. Breschi et al. (2003) and Krafft et al. (2014) perceive cognitive proximity as being similar to technological proximity, whereas Broekel (2015) associate the latter with the degree of overlap in the knowledge bases of the collaborating partners. The innovative process is not only technical or economic; it is also social in so far as it concerns an awareness of the attitudes and views of individuals and groups. There is a substantial body of literature testifying to the increasing role of social networks in improving innovation (Runiewicz-Wardyn, 2020; Maskell, Mallberg 1999; Ziemiański, 2018; Etzkowitz, Leydesdorff, 2000). Finally, problems may also arise due to insufficient knowledge absorption capacity, excessive bureaucracy, a lack of resources, and/or free-rider behaviour (de Vrande et al., 2009).

Open innovation cooperation can be especially useful to SMEs by improving performance, helping to gain competitive advantage, and shortening the odds of survival (primarily by overcoming the limitations of their internal resources) (Hakaki et al., 2015). An open innovation strategy enables a company to receive external resources (accessed through its external relationships) in the form of R&D collaborations, managerial ties, and strategic alliances. The main drivers behind any (closed or open) innovation co-operation model can be classified into three groups: technological (new knowledge and competencies); economic (sales growth); and market (a stronger position and higher quality products and services). Innovation leads to new or improved products and services. Open innovation can be implemented by SMEs in a variety of ways, including innovation for the user, building innovation ecosystems, crowdsourcing, or by forming joint development alliances. More generally, they can be divided into inside-out, outside-in and coupled processes (Hakaki et al., 2021). In the inside-out movement, companies can engage in various open innovation practices in order to better deploy their internal knowledge. Technologies that do not fit their current market or business model may still be valuable to other firms, segments or markets, and it may be possible to transfer them there. This open innovation process has been implied in many companies, e.g. P&G, Philips and Nokia (Ebersberger et al., 2011; Pinarello et al., 2021). Diagram I illustrates the open innovation model.

Diagram 1

Open innovation model



Source: own elaboration based on Lee and Mwebaza (2020).

In the outside-in process, also known as technology exploration, external sources of innovation are used to enhance current technological developments. This refers to those activities that allow companies to acquire new knowledge and technologies outside their organizational boundaries, i.e. via joint innovative initiatives with customers, suppliers, competitors, universities, and/or business organizations. Therefore, industry clusters, with their highly developed network of collaborating partners, seem to be naturally predisposed to foster open innovation. Forms related to this technology exploitation in a cluster context include customer involvement, external network capitalization, external participation, R&D outsourcing, and IP licensing (de Vrande et al., 2009). The main barrier to implementing the open innovation model is that SMEs have insufficient internal resources (especially during the first stage of innovation cooperation). Other barriers include unrealistic expectations on the part of potential partners, ownership and management of intellectual property, and organizational barriers.

3. Open innovation in the biopharmaceutical industry

The COVID-19 pandemic has left its mark on the global innovation landscape, especially in the healthcare and biotechnology sectors. Pharmaceutical and IT companies have redoubled their investments in innovation (WIPO, 2021). Some 62% of pharmaceutical and biotechnology companies reported an increase in R&D expenditure (WIPO, 2021). Strong partnerships and collaborative relationship are key to developing solutions for global healthcare challenges. The biophar-

maceutical industry includes firms that carry out the R&D, manufacturing and commercialisation of biopharmaceutical products (usually involving live organisms, see Bianchi et al., 2011). Moreover, it is characterized by very high failure rates of new drug candidates, and by the long timespans required to complete the R&D process (Nigro et al., 2015). As a result, it is also characterized by a long, uncertain, expensive, and strategic R&D function. The modes of cooperation and collaboration in the industry therefore change frequently and significantly (Malik, 2012). Moreover, the shortening technological cycles and the rise of technological convergence in the biopharma industry, combined with the rapidly changing business environment (with start-ups and the predominance of big companies), have increased the necessity of pooling resources and expertise.

Biopharmaceutical companies can implement inbound and outbound open innovation to obtain external knowledge. Inbound open innovation (technology exploration) includes alliances with other biotech firms, pharmaceutical companies, universities (the process by which biopharmaceutical companies establish partnerships - without equity involvement) and in-licensing (the process by which biopharmaceutical firms acquire the rights to use a specific candidate – typically from another biotech firm). Outbound open innovation (technology exploitation) includes alliances (the process by which a biopharmaceutical firm partners with another company in order to access complementary assets) and out-licensing (the process by which biopharmaceutical firms license out, generally to big pharmaceutical companies, the rights to use a new candidate they have discovered and developed) (Bianchi et al., 2011). Open innovation in the biopharmaceutical sector is beset with many challenges. Major challenges include limited internal knowledge resources, and the time, cost and effort required to establish relationships and networks with external technology providers. Knowledge resources are widely dispersed, sophisticated, and rapidly become obsolete in the biopharmaceutical sector. Network-level resources and network diversity are therefore crucial to innovation. Numerous empirical studies show that biopharmaceutical firms place greater emphasis on leveraging external knowledge, licensing, and changing their R&D models from inhouse to the open innovation paradigm (Malik, 2012; Schuhmacher, 2018; Dankhar et al., 2012; Staton 2015; Caroll, 2015; Sagonovsky, 2017). The result is that the proportion of externally sourced R&D assets has increased over recent years. This trend has coincided with major downsizing in the R&D departments of e.g. Merck, AstraZeneca, and Pfizer. For example, Seger (2013), having analysed the biotechnology clustered firms in Belgium, concludes that despite their small size and relative immaturity, new biotechnology firms are able to adopt innovative business models by providing R&D services to larger firms and openly working with them through open innovation.

Other studies emphasize the demotivating effects of low levels of trust and organizational, social and cultural proximities between partners, and the lack of mechanisms to stimulate cooperation in innovation (Kozierkiewicz, 2020; Stanisławski, Trębska, 2017; Lobacz et al, 2016).

On the basis of the extant literature, the present study addresses the following four hypotheses, which have been additionally tested in the context of Polish

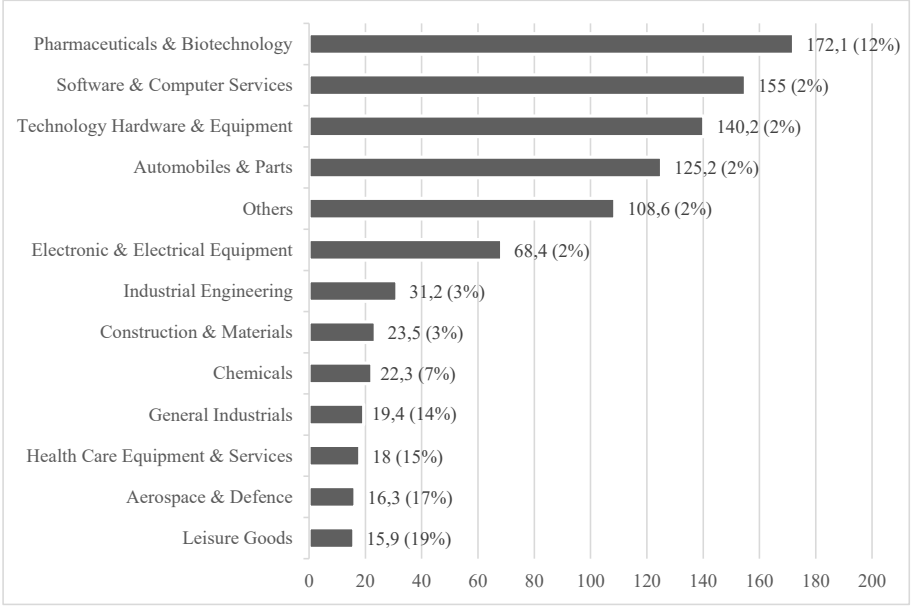
biopharmaceutical SMEs: *(i) Limited internal knowledge and R&D sources, along with increasing competition, stimulate biopharmaceutical SMEs towards greater openness in the innovation co-operation; (ii) Technological and cognitive proximities of potential partners are the key factors that induce biopharmaceutical SMEs to engage in open innovation cooperation; (iii) Organizational, social and cultural proximities between partners motivate SMEs to engage in open innovation co-operation; and (iv) Physical proximity between partners promotes open innovation cooperation (through the synergistic effects of mutual learning).*

4. Changing dynamics in the biopharmaceutical industry

The biopharmaceutical sector is one of the fastest-growing high-tech sectors in the world. The number of firms active in biotechnology increased by 14% in 9 years (2011–2019) in the OECD. The research-based biopharmaceutical industry spent USD 172 billion globally on biopharmaceutical R&D in 2020 (Figure 1).

Figure 1

R&D spending by main industrial sector of activity (EUR bn) in 2020 (source: Own elaboration based on Interactive R&D Scoreboard 2021).

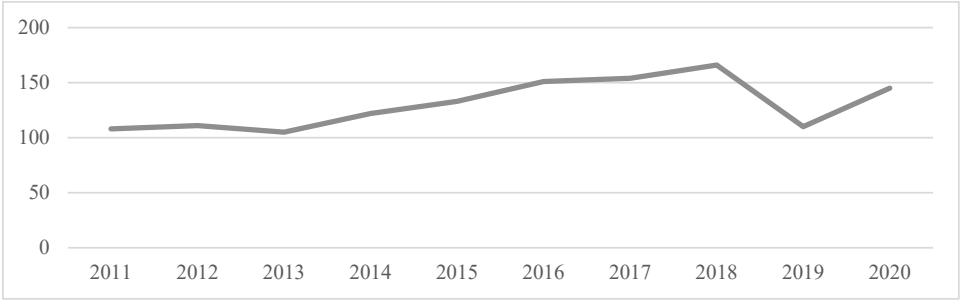


By the R&D spending the biopharmaceutical industry is 10.5 times greater than the aerospace and defence industries, 7.7 times greater than the chemical industry, and 1.1 times greater than the software and computer services industry.

Further evidence of the size of the biopharmaceutical industry can be found in Europe. From 2012 to 2021, the number of listed biotech and pharmaceutical companies in the EU Industrial Research and Development Scoreboard increased by more than 34% (Figure 2).

Figure 2

Number of firms active in biotechnology in the EU in 2011–2020 (source: Own elaboration based on EU data – EU Industrial R&D Investment Scoreboard).



The substantial decrease of the number of firms in the EU ranking in 2019 is due to Brexit. In 2019, UK companies accounted for over 32% of all biotech and pharmaceutical companies in the ranking (54 UK companies were listed). In 2020, the number of biotech and pharmaceutical companies listed increased by more than 32% compared to 2019. On an annualized basis, this is the highest growth in the analysed period. This is a consequence of the COVID-19 pandemic and increased interest in the biotechnology sector.

The biotechnological and pharmaceutical sectors are an example of sectors positively affected by the crisis (including ICT services). In 2020, R&D spending in the industry grew by 6.5% over the previous year, thereby consolidating its position as the top R&D investing sector. These numbers clearly demonstrate the significant contribution the biopharmaceutical sector makes to the world economy. Moreover, the need to stop the COVID-19 pandemic fostered the speed and diversity of innovation. In addition to partnerships within the industry, biopharmaceutical companies develop alliances with universities or research institutes, as well as their more frequent cross-industry alliances and public-private partnerships. These new multiparty alliances have required even greater competencies and skills on the part of alliance managers as well as appropriate alliance management tools. Horizon 2020 project on coronavirus diagnostics and treatments in the European Union (the EU's research and innovation programme) is an example of such an alliance.

The COVID-19 pandemic has shown that strong partnerships are key to developing solutions to global healthcare challenges. The collaboration between different partners in the healthcare sector, including the biopharmaceutical sec-

tor, is fostered by the Venture Centre of Excellence (VCoE) programme. This is the first innovation platform of its kind in the Life Science sector in Europe, and commenced operations at the end of 2020. This pan-European, open-innovation programme was jointly designed by the European Institute of Innovation and Technology (EIT) and the European Investment Fund. The European Commission announced its support for this programme during the annual HealthTech Innovation Days (HTID®) event in October 2020 (European Commission announces support for the Venture Centre of Excellence programme, 2020). It additionally pledged to contribute EUR 150 mln from the European Fund for Strategic Investment to this programme. Companies in the programme receive support to fundraise and have key access to services provided by EIT Health in support of their Series A and B funding (Venture Centre of Excellence: access to finance and strategic connection, 2021). This can be especially helpful for companies in CEE (including Poland), where there is a clear financing shortfall between seed funding and series A and B funding.

5. The Polish biopharmaceutical sector

Biopharmaceutical innovation in Poland does not have a long history. This is the result of the highly unstable macroeconomic and political environment that hindered the country's development throughout most of the 20th century. Biopharmaceutical companies first began to operate in Poland at the beginning of the 21st century. In the first phase of development, the biopharmaceutical sector had a very hard time raising funds and getting research grants. Polish companies also suffered from a lack of research infrastructure, capital and, above all, orders. Therefore, they started to bootstrap. Obtaining access to affordable state-of-the-art biotech infrastructure was their biggest challenge when starting up (Deshmukh et al., 2020). The establishment of Technology Parks in selected major cities across Poland in the first decade of the 21st century provided essential infrastructure and the biopharmaceutical market began to grow steadily.

Biotechnology companies developing new drugs and treatment tools are becoming increasingly common in Poland. Polish biotechnology is fostered by funds supporting science and various research grants. It is one of twelve priority industries identified in the Strategy for Responsible Development.

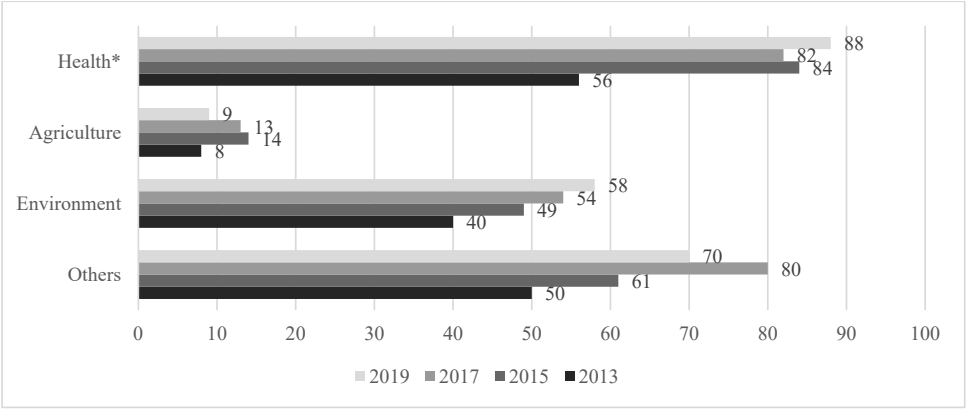
In 2017, medical engineering technologies, including medical biotechnologies, were included among the 'First Speed Programmes' earmarked for additional government support ((Strategy for Responsible Development for the period up to 2020 (including the perspective up to 2030)). In addition, medical biotechnology was included in the list of National Smart Specializations, i.e. priority industries in the area of research, development and innovation. This ensured an increase in added value and competitiveness of the economy on foreign markets (National Smart Specializations, 2021). Further evidence that the biotechnology sector is at the centre of government strategies was the establishment of the Warsaw Health Innovation Hub (WHIH) at the Medical Research Agency in June 2021. As of 14

July 2021, WHIH stated on its website[1] that the hub's main aim was to foster the development of biotechnology and innovative solutions, using public and private sector capacity. It is a unique platform, not only in Poland, but also in Central and Eastern Europe, when it comes to partnerships between the public and private sectors in the biotechnology market. Priorities are set by the Hub council. They will be defined jointly by the public partners, pharmaceutical companies, WHIH member companies, and developed on the basis of analyses conducted by the Polish healthcare sector.

Poland has seen the rise of a national biotech industry over the past decade. The biopharmaceutical sector is a key component of the Polish biotechnology sector. According to CSO data for 2013–2019, the number of healthcare-related biotechnology enterprises (including biopharmaceutical enterprises) has been growing quite robustly in recent years. The number of biotechnological enterprises involved in products and services related to health and medical care has increased by 57%. This was the biggest increase recorded in the group of biotechnological firms (Figure 3).

Figure 3

Number of biotechnology firms by main areas of biotechnology applications (*Human health, Veterinary health; source: own elaboration based on CSO data).



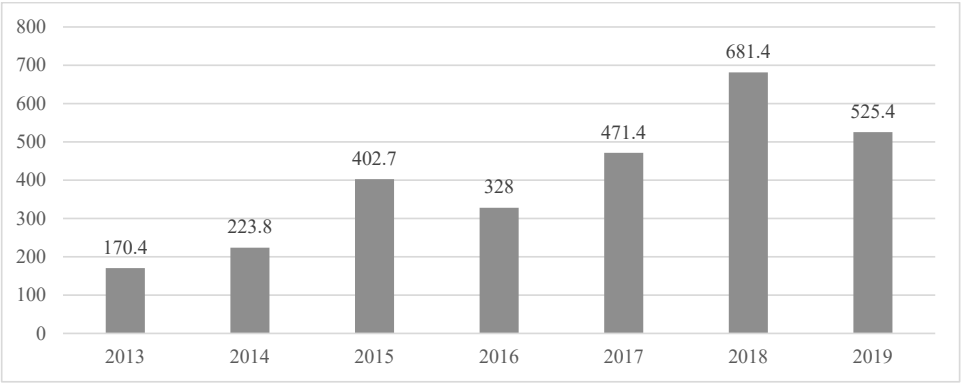
Another important indicator of the development of healthcare and medical related biotechnology industry in Poland is intramural expenditure (Figure 4). Intramural expenditure incurred on biotechnological activities related to health applications has increased by 208.3% – from 170.4 mln PLN in 2013 to 525.4 mln PLN in 2019. The enterprises spent most in 2018 (PLN 681.4 mln). Although the statistics clearly show an upward trend in this area of the industry, expenditure actually decreased by 23% in 2019. It is worth adding that biotechnology R&D expenditure increased by 6.5% in 2019. However, this increase in expenditure

[1] https://whih.abm.gov.pl/whe/about-us/about-whih/70,about-WHIH.html

may have been more pronounced, as the COVID-19 pandemic strongly drove the popularity of biotechnology, along with all healthcare-related businesses.

Figure 4

Medical and healthcare related intramural expenditure by biotechnology firms – mln PLN (source: own elaboration based on CSO data).



It should be noted that the biopharmaceutical sector became much more important to investors in Poland during the COVID-19 pandemic. The growing interest in the biotechnology market in Poland is evidenced by the number of pharmaceutical and biotechnology companies included in stock market indices and debuting – or preparing to debut – on the trading floor, as well as by their capitalization, which in many cases has multiplied between 2019 and 2021. The share of these companies in the mWIG40 index,[2] for example, increased during the year from over 1.5% to 4%. In the broad WIG index,[3] these companies had a 0.8% share a year ago compared with more than 1.5% today – an increase from 11 to 13 companies. Obviously, even though the weights have increased, it is still small at the WIG. This means that there is still a lot of room for this sector to find its place on the Polish stock exchange.

The biotechnology market is dominated by SMEs. It is important to note that, in Poland, small biotech companies do not often attempt to conduct their own clinical trials, obtain regulatory approval, and market drugs under their own brand name and distribution channels. This is all simply too difficult. The biggest problem facing the Polish biotechnology sector remains access to capital, and the dominant element is now grant funding. This slows the development of innovative biopharmaceutical products. Moreover, no VC fund invests in companies seek-

[2] mWIG40 is a price index that comprises 40 medium size companies listed on the WSE Main List (Warsaw Stock Exchange) and other markets, and which have a market capitalization of more than € 1 billion at the ranking date.

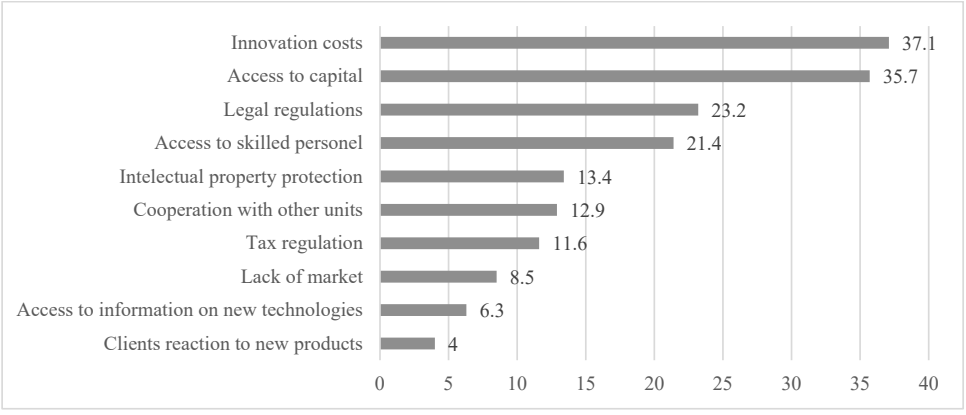
[3] WIG is the oldest index of the Warsaw Stock Exchange (WSE). It was introduced on the WSE's first trading session on 16 April 1991 (WSE is an acronym for Warszawski Indeks Giełdowy – Warsaw Stock Exchange Index).

ing to develop new drugs. Thus, biotech companies have no significant capital at the outset other than that contributed by the founders. Later, they receive funds through grants, subsidies and further contributions from shareholders. According to the Polish Economic Institute data, the total value of VC funding in Poland in 2019 amounted to 331 million dollars. By comparison, global biotech companies raised a total of 18.8 billion USD in venture capital funding in 2019 (Andrzejewska-Górecka et al., 2020).

According to the study 'Biotechnology in Poland: The Industry View', conducted in early 2016 by the consulting firm Deloitte, the biggest barrier to the development of the biotechnology industry is the difficulty of raising capital. The most popular and realistic way to commercialize the technologies developed by domestic biotech entrepreneurs is to enter into a licensing agreement with a global corporation. About 60% of Polish entrepreneurs participating in the survey consider access to financing, including public and EU funds, as the sector's greatest risk factor (Świerczyński et. al., 2016). CSO data confirm the existence of these barriers to the development of the biotechnology industry. In 2019, 57.1% of companies surveyed cited barriers to biotechnology R&D. Enterprises most often indicated the costs of innovation and obtaining funds as the main barriers (Figure 5).

Figure 5

Percentage of enterprises citing barriers to biotechnology R&D in 2019 (source: own elaboration based on CSO data).



The difficulty of obtaining financing means that, in most cases, the global success of Polish biopharmaceutical products depends being able to cooperate with giants, who have the resources to expand globally. Therefore, it is crucial that Polish biopharmaceutical companies work towards any innovation collaboration: open or closed. Unfortunately, nearly 13% of Polish biotechnology companies cited collaboration with other units as a barrier to biotechnology R&D in 2019 (see Figure 5).

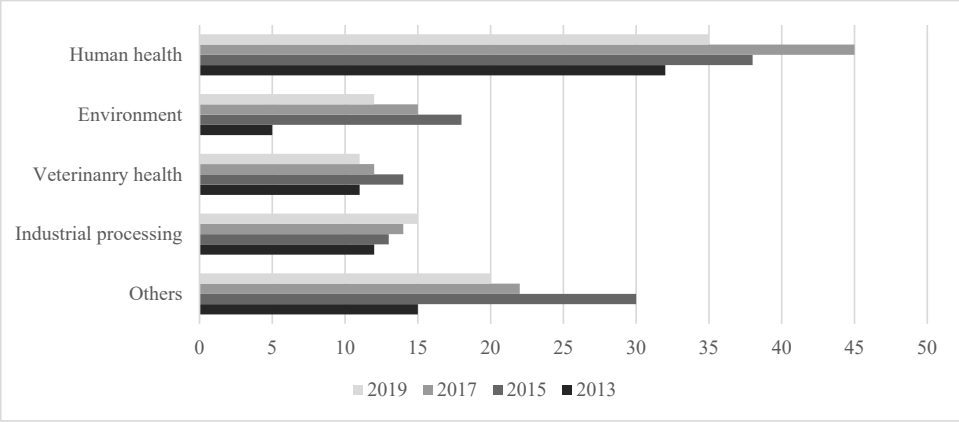
The most common way for a biotech company to commercialize a Polish product is to take the project to a certain stage of development and then sign a partnership agreement with a larger biotech or pharmaceutical company. An example of cooperation between a Polish biopharmaceutical company and a foreign entity is the Polish biopharmaceutical company Pure Biologics and Twist Bioscience Corporation, which is based in South San Francisco. The Pure Biologics and Twist Bioscience partnership aims to accelerate immuno-oncology drug discovery based on antibodies used by Pure Biologics. In November 2020, the largest ever partnership agreement was signed by a Polish biotech company. OncoArendi signed a partnership agreement with Galapagos to develop the asthma and pulmonary fibrosis drug – OATD-01 (Sprawozdanie Zarządu z Działalności Grupy Kapitałowej OncoArendi Therapeutics w I półroczu 2021 roku, 2021).

Increasing the intensity of work and development of Polish technology is an opportunity for companies in this sector to increase their competitiveness in the international arena. It is worth mentioning the huge success of Polish biotechnology related to the development and commercialization of an indigenous biopharmaceutical. The product is a recombinant human insulin sold under the trade name, Gensulin®. Gensulin® has been produced since 2001 by Bioton SA, a company established by the Institute Bioton SA. So far, Gensulin® is the only biopharmaceutical that has been developed and implemented in our country. The production of biosynthetic human insulin, Gensulin opened a new chapter not only in the history of Bioton, but also of the entire Polish pharmaceutical industry. Gensulin is the first Polish drug produced using genetic engineering. With the introduction of Gensulin, Bioton expanded the elite group of companies producing human insulin and it is in the world's top eight commercial manufacturers of recombinant human insulin (i.e. Novo Nordisk A/S, Sanofi S.A., Eli Lilly and Company, Julphar Gulf Pharmaceutical Industries, Bioton S.A., Biocon Limited, GanandLee Pharmaceuticals, Ltd. And Wanbang Biopharmaceuticals Co., Ltd.). It should be noted that the launch of Polish insulin production has reduced the cost of drug reimbursement by the state budget by about PLN 200 million annually. Thus, development of indigenous biopharmaceuticals may generate large savings for the treasury.

In the process of developing innovative biopharmaceutical products, it is crucial for companies to collaborate with other partners (including scientific entities) and to carry out innovative research projects as part of this collaboration. Unfortunately, the low level of both innovation cooperation and collaboration in the biotechnology sector are significant problems in Poland. An example of the low level of collaboration in the biotechnology sector are the few enterprises participating in partnerships in biotechnology R&D related to health and medical care. The number of enterprises participating in such collaboration has remained unchanged for many years (Figure 6).

Figure 6

Number of enterprises participating in partner co-operation in biotechnology R&D by areas of biotechnology applications (source: own elaboration based on CSO data).

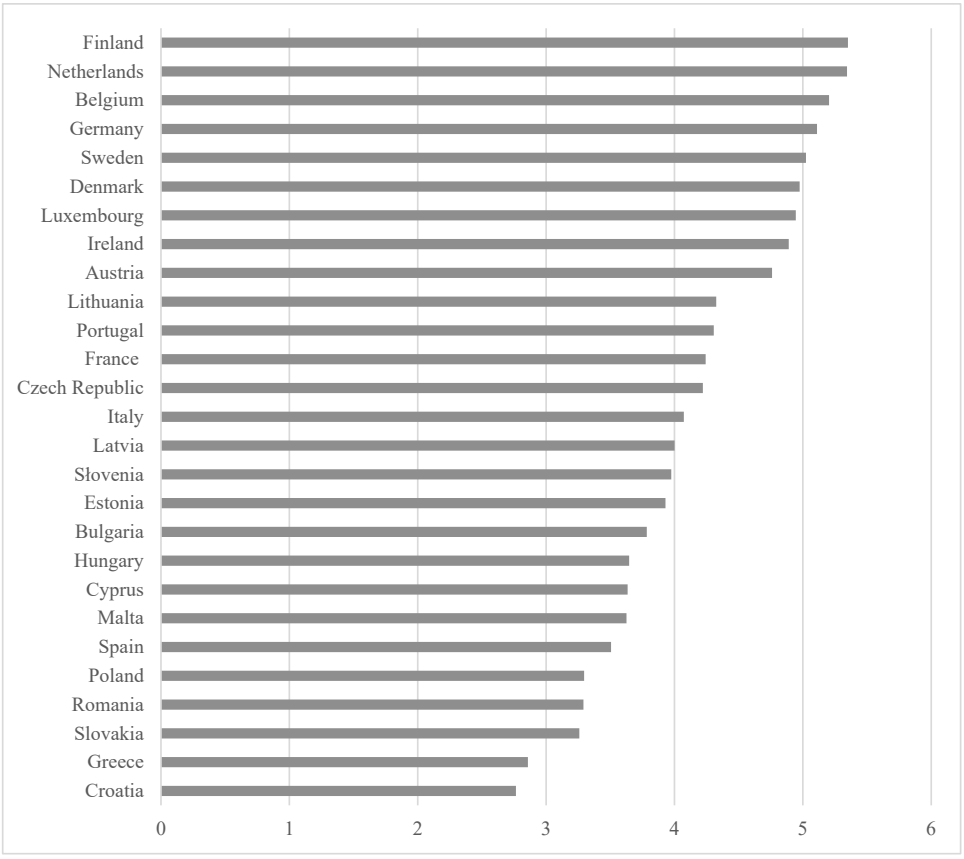


The number of enterprises participating in biotechnology R&D partnerships related to health and medical care in Poland only increased by 9.4% over a 7-year period. Moreover, the number of enterprises participating in such cooperation decreased by 22% in 2019.

Unfortunately, this low level of collaboration is not restricted to the biotechnology sector in Poland. Poland ranks near the bottom of EU countries involved in university-industry R&D collaboration (in the ranking of Global Innovation Index) (Figure 7). This collaboration was analysed by means of a survey based on the following question: 'To what extent do businesses and universities collaborate on R&D in your country?'.

Figure 7

University-industry R&D collaboration in EU in 2020 (source: Own elaboration on the basis of "Global Innovation Index 2021. Tracking Innovation through the COVID-19 crisis").

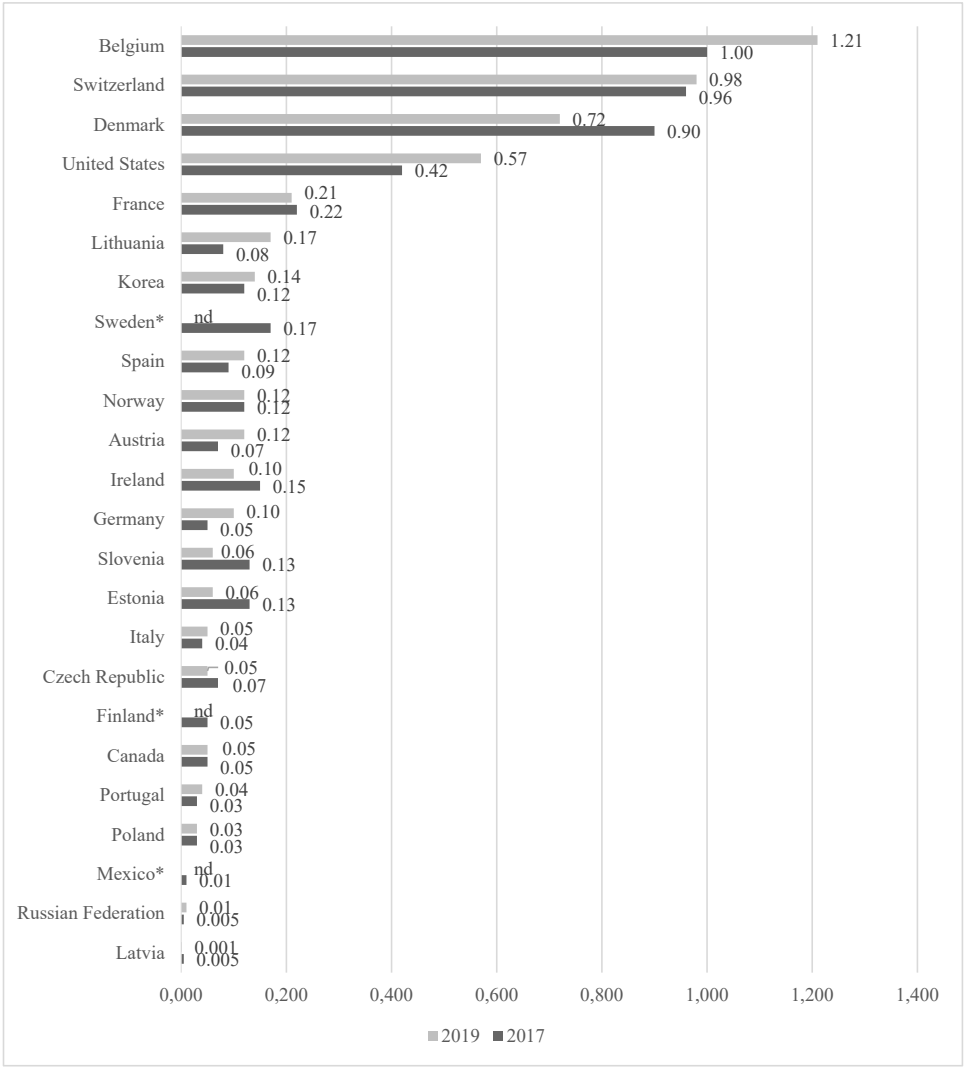


The low level of collaboration in the biotechnology sector was confirmed and proven in a scientific paper published by Krzysztof Szczygielski et al. (Szczygielski et al., 2022). The authors compared the performance of Polish companies that used biotechnology to those that did not in 2010–2016. The cooperation patterns of the biotechnology companies were examined. Their analysis showed that the biotechnology sector is not strongly embedded in the local business landscape, as biotechnology companies are much more likely to cooperate with R&D than with other companies, and that there is a low level of cooperation with clients.

This weak collaborative environment is a significant problem, as it saps the intensity of biotechnology R&D in Poland. According to the latest available OECD data, the R&D intensity of Poland's biotechnology sector is one of the lowest in the organisation (Figure 8).

Figure 8

Biotechnology R&D intensity in the business sector as a percentage of industry value added (*Finland – Available data 2015; Mexico – Available data 2016; Sweden – Available data 2015; source: own elaboration on the basis of OECD data).



It has to be emphasised that developing a cooperative and collaborative culture is crucial to overcoming barriers to innovation, especially open innovation. Truly collaborative relationships with external partners stimulate innovation. Developing these sorts of relationships in the biopharmaceutical industry can help the partners to them offer new innovations to patients much faster. This was especially important during the COVID-19 pandemic. Identifying the major drivers of, and

barriers to, open innovation cooperation and R&D collaboration is a vital first step to developing innovation in the Polish biopharmaceutical sector.

6. Open innovation survey results – the case of the Polish biopharma SMEs

Research methodology

The study employed the qualitative survey research method. This research methodology enabled a better understanding of the complex nature of innovation relationships and the open innovation environment, as well as identifying the major drivers of, and barriers to, open innovation. The qualitative research survey was conducted in conjunction with the online market research company, ARC Rynek i Opinia (from January to April 2021). The study was conducted using the CATI (computer assisted telephone interview) method. The respondents were managerial staff of SMEs (employing between 10 and 249 people) responsible for implementing innovations. Half the SMEs sampled employed fewer than 50 people. All the companies belonged to the 'Production of basic pharmaceutical substances and drugs and other pharmaceutical products', sector according to the Polish classification system, PKD (21) (CSO, 2021). The sample only represented a small share (18%) of the 110 SMEs in this sector (CSO, 2018). The sample mainly consisted of companies that produced drugs and other pharmaceutical products. Most of the surveyed companies were located in the Masovian Voivodeship. The research period covered the last 3 years. The surveyed companies are companies with mixed capital, i.e. both Polish and foreign.

The main objective of the study was to identify inbound and outbound open innovative practices and the major drivers of , and barriers to, engaging in open innovation collaboration, as seen by Polish biopharma SMEs. The questionnaire contained mixed (open and closed) questions structured in five parts: (1) the general structure of methods of conducting R&D; (2) factors influencing innovation collaboration, including the role of geographical proximity; (3) the advantages and drivers of entering into open innovation collaboration with other firms and academia; (4) the disadvantages and barriers to entering into open innovation with other firms and academia; and (5) future plans regarding open or closed innovation collaboration. A Likert rating scale was used to measure the opinions and attitudes of the respondents. Due to the COVID-19 pandemic, it took longer than planned to conduct the survey.

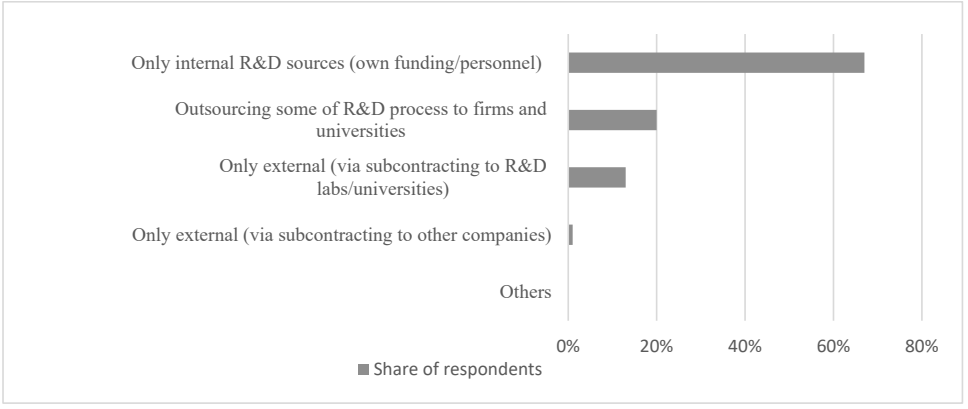
Open innovation survey findings

This section summarizes the survey results. As stated in the above literature review, the 'open innovation model' is based on the 'mutual exchange of knowledge, technical solutions and licenses' and aims at integrating external knowledge

resources into a firm's own innovative process. In terms of the first general part of the questionnaire, the representatives of the bigger share of the biopharmaceutical SMEs in Poland declared that their internal sources largely covered their innovation needs. Some 67% of respondents conducted their R&D activities internally (Figure 9).

Figure 9

Methods of conducting research and development (R&D) activities (source: research survey made by the author and ARC Rynek i Opinia, 2021).

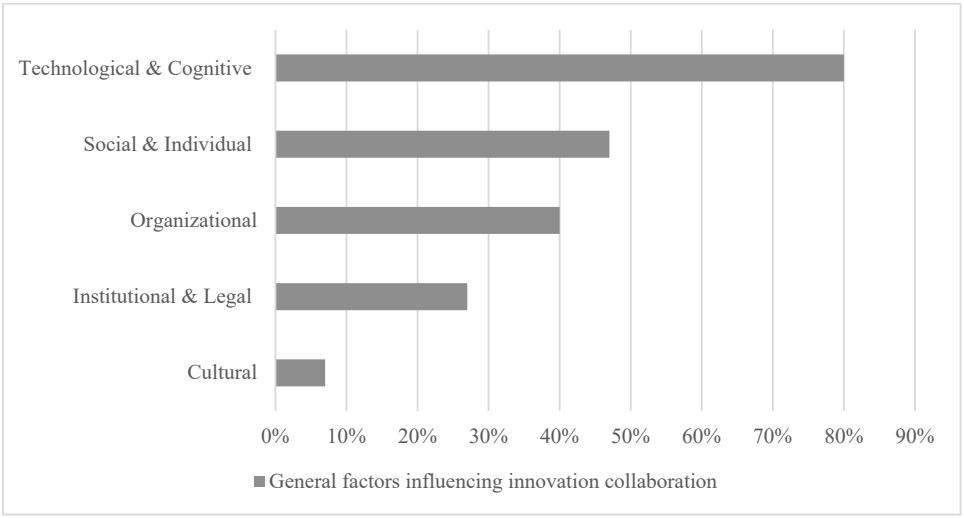


Only 20% of firms declared that they engaged in open innovative cooperation. The study also evidenced that at least some of the Polish biopharmaceutical firms outsource specific R&D tasks (covering both basic research as well as the late-stage development process) (20%) or subcontract them to other R&D organizations (this R&D outsourcing reflects common practice among many other biopharma companies around the world (see Pammolli et al., 2011; Mestre-Ferrandiz et al., 2012). R&D outsourcing can reduce costs and thus increase efficiency in the discovery and testing of new medicines (Schuhmacher et al., 2016).

According to 80% of the respondents, the key factors influencing the selection of partners for innovative cooperation are cognitive and technological factors (understood as the technological profile of firms) (Figure 10).

Figure 10

General factors influencing the selection of innovative partners (source: research survey made the author and ARC Rynek i Opinia, 2021).



Socio-individual factors can facilitate access to the exchange and transfer of knowledge and make it easier for people to engage in mutually beneficial collective actions. This is effected by lowering transaction costs and improving social learning. Some 46% of the respondents declared that socio-individual factors were important for the selection of innovative partners. Moreover, representatives of larger companies (over 50 employees) expressed more negative attitudes and displayed greater resistance to changes in their current R&D partnerships. They also found it harder to trust their partners when it came to sharing new knowledge and intellectual capital. This finding somewhat contradicts the general rule that open innovation is the preserve of larger organizations, and shows that it may be industry specific.

Moreover, the current survey findings reveal that ae high proportion of respondents (40%) consider organizational factors as being of key importance to open innovation collaboration. In fact, knowledge spills over from both one to the other organization as well as across different units within the same organization. As researchers and other staff members move about the organization, they strengthen their organizational proximity, facilitating both intentional and accidental interaction.

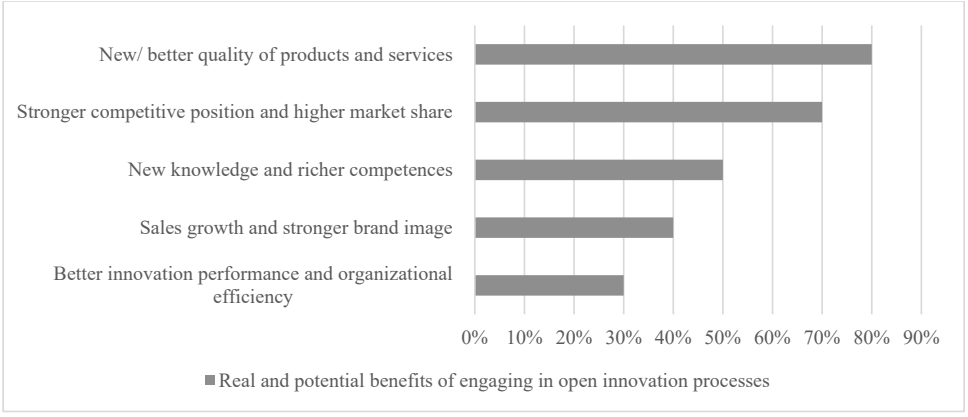
Furthermore, representatives of most of the surveyed companies (87%) agreed with the statement that physical proximity has a positive effect on initiating innovative interactions (both open and closed). For respondents who believed that physical proximity was beneficial for initiating innovative interactions, the national and EU levels of proximity were the most important for R&D cooperation (31% and 32% respectively). Furthermore, cooperation within the Polish

regions (voivodships) and with countries outside the EU was significant for 23% of companies (for both categories of proximity).

The potential drivers or benefits of open innovation cooperation are, in the eyes of the respondents, primarily new or better quality products and services (this was especially the view of large biopharmaceutical companies) – 80% of respondents (Figure 11).

Figure 11

Main drivers and benefits of engaging in open innovation processes (with other companies and universities) (source: research survey made by the author and ARC Rynek i Opinia, 2021).

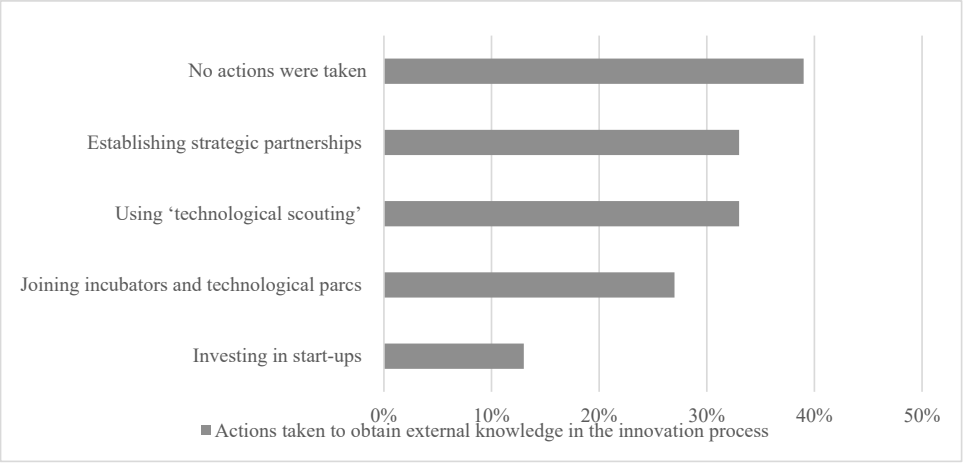


Some 70% of the respondents considered that engaging in open innovation would strengthen their competitive position and enable them to increase their market share, 40% declared that it increased sales growth and strengthened their brand image, and 50% considered that it would enable them to acquire new knowledge and expand their competencies. In sum, the survey findings show that biopharma firms in Poland believed that open innovation partnerships (with other firms and R&D organizations) had a significant impact on their survival and growth.

Despite their awareness of the many advantages brought about by open innovation collaboration, 38% of the surveyed companies declared that they were not taking any specific steps towards open innovation co-operation (Figure 12). Among those who conducted innovation collaboration, ‘establishing strategic partnerships’ and ‘technological scouting’ were cited as the most common actions taken to obtain external knowledge in the innovation process.

Figure 12

Actions taken to obtain external knowledge in the innovation process (source: research survey made by the author and ARC Rynek i Opinia, 2021).



Technological scouting has to do with a company's assessment of the potential to commercialise university research, and to do so if it finds it viable. It is therefore not surprising that it was mostly larger companies that engaged in technological scouting. On the other hand, some 27% of companies stated that they joined incubators and science & technology parks (STPs) in order to obtain new and external knowledge. Compared with the more than two-thirds of tobacco companies that develop their innovations by collaborating in clusters, pharmaceutical companies rarely do so (13.5%).

The main challenges and barriers hindering open innovation cooperation with other enterprises include insufficient resources and unrealistic expectations, followed by the difficulties in dividing intellectual property rights and managing intellectual property, and organizational barriers (Figure 13 below).

Insufficient resources and uncertain sales were considered the biggest barriers to introducing open innovation by Polish biopharmaceutical SMEs. The latter was cited by 33% of companies. A slightly smaller proportion of respondents (27%) found it challenging to establish clear and realistic expectations from their partners. This can lead to unrealistic expectations for innovation, e.g. quick generation of ideas, R&D insights, or new innovative products.

Another reason why Polish pharmaceutical SMEs lagged in implementing open innovation lie in their organizational mindset and administrative barriers. Seven percent of respondents stated that their company lacked the support and commitment of senior management in initiating greater openness to external ideas and sharing knowledge.

Triple Helix (industry-academia-government) open innovation collaboration, in the view of the respondents, has been hampered by rigid administrative and

organizational structures (40% of respondents), different socio-cultural values (33% of respondents), and lack of motivation (20% of respondents) for industry and academia to work together (Figure 14).

Figure 13

Main challenges and barriers hindering open innovation cooperation with other enterprises (source: research survey made by the author and ARC Rynek i Opinia, 2021).

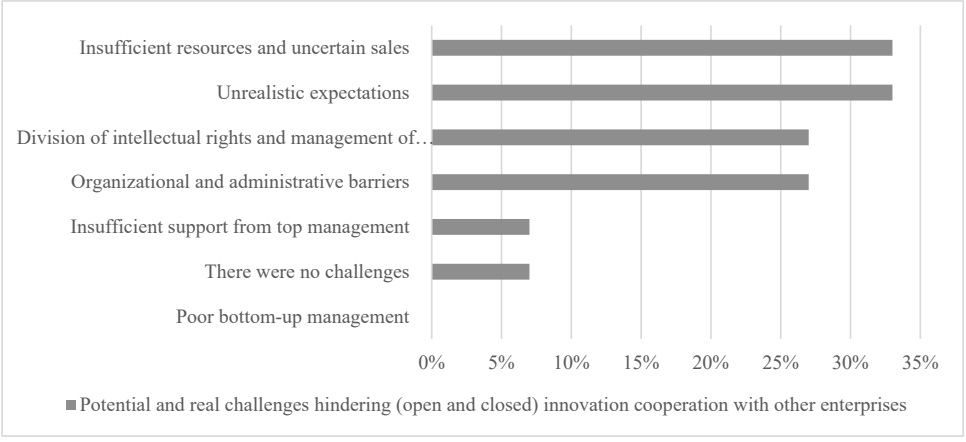
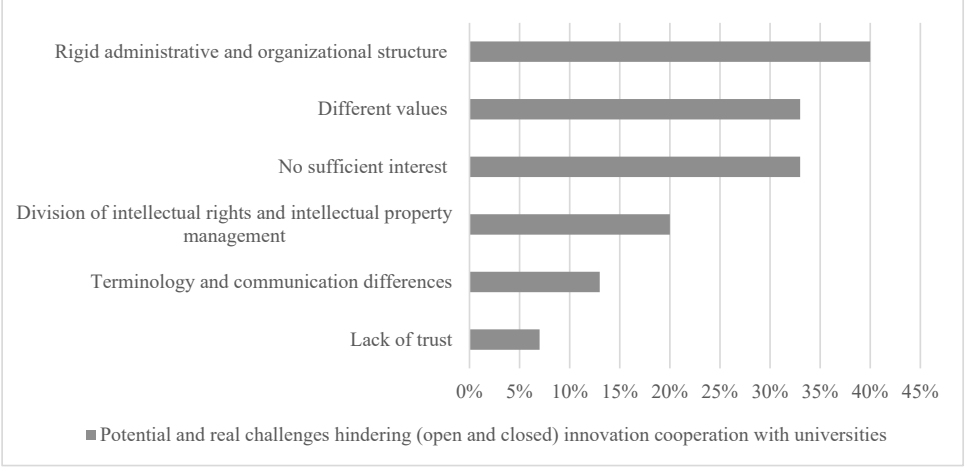


Figure 14

Main challenges and barriers hindering (open and closed) innovation cooperation with universities (source: research survey made by the author and ARC Rynek i Opinia, 2021).



The lack of motivation for two of the stakeholders to work together is predicated on the stereotypical notion that universities were closed and ossified organizations with which cooperation was very difficult. Moreover, university scientists, being primarily motivated by their academic career paths and highly cited publications, tend to work in narrow teams of specialists. They also often fear that collaborating with a company would result in losing control over their innovations. Some 20% of respondents claimed that the division of intellectual property rights, legal protection, and the management of intellectual property was one of the major challenges to innovation collaboration. The survey findings also emphasize the importance of cognitive and communication skills in open innovation collaboration between pharmaceutical companies and universities. Some 13% of respondents pointed to a lack of cognitive similarity (differences in terminology, technical vocabulary and communication codes) between these potential partners creates a barrier that hinders both closed and open innovation collaboration. Finally, 7% of respondents consider lack of trust to be a major impediment to both open and closed innovation collaboration.

7. Conclusions

The open innovation collaboration ecosystem is still in its initial stage in Poland. The present study shows that, although many pharmaceutical companies are aware of the advantages of open innovation cooperation, they do nothing about it. As for the first hypothesis that was addressed, viz. *Limited internal knowledge and R&D sources along with the increasing competition stimulate biopharmaceutical SMEs towards greater openness in the innovation co-operation,* the majority of the surveyed biopharmaceutical SMEs declared that their internal sources largely covered their innovation needs. They also stated that they conducted their R&D activities internally. This outcome is somewhat surprising given that Poland ranks near the bottom of the EU in intensity of R&D collaboration (including university-industry). With reference to the second hypothesis, viz. *Technological and cognitive proximities of potential partners are the key factors influencing the biopharmaceutical SMEs engagement in open innovation cooperation*, the study confirms that the chances of open innovation collaborations are much higher between firms that have a great deal of cognitive and technological overlap. This outcome suggests that intermediary (public and non-profit) institutions could act as brokers, encouraging and narrowing technological and cognitive distances at the local and regional levels. The third hypothesis, viz. *Organizational, social and cultural proximities between partners result in higher motivation of SMEs to engage in open innovation co-operation*, was partially confirmed. Differences in socio-cultural values are especially visible in the relationships between industry and university actors. The high level of individualism among scientists is not conducive to sharing the major direction/vision of common R&D projects. For open innovation to be successful, both a common vision and greater social communication skills are necessary. Finally, in regard to the fourth hypothesis viz. *Physical proximity*

between the collaborating partners promotes open innovation cooperation (through the synergistic effects of mutual learning), most of the respondents companies believed that physical proximity had a positive effect on initiating innovative interactions. This suggests that national and EU R&D frameworks, as well as various regional cluster initiatives, might act as open innovation intermediaries, thereby strengthening connections, social relations and flows of knowledge in the biopharmaceutical sector.

Research limitations and implications

The present study has several limitations resulting from its very small and unequally distributed (across time and space) sample of Polish biopharmaceutical firms. Further studies on issues related to monitoring the level of open innovation adopted by SMEs, and thus the level of willingness to cooperate with other organizations, are required. Several directions for future research stem from this study. Firstly, further surveys could help develop a more in-depth understanding of the drivers of, and the barriers to, innovation collaboration and innovation performance among Polish biopharmaceutical SMEs (especially evidence on open innovation practices and their impact on performance), the role of institutional and policy settings, especially in stimulating interactive innovation processes within the Quadruple helix (industry-government-academia-civil society institutions), collaboration, and cluster initiatives.

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INTRODUCING THE OPEN INNOVATION MODEL IN POLISH BIOPHARMACEUTICAL COMPANIES: MAJOR DRIVERS AND BARRIERS

Abstract

Innovation is one of the most critical determinants of economic success and one of the most important elements in building a competitive advantage. The COVID-19 pandemic has

led to the development of new strategic partnerships, including open innovation alliances, in the biopharmaceutical industry. The adoption of open innovation strategies has been a persistent trend, although these strategies vary considerably from one country to another. The lowest level of open cooperation and R&D collaboration in the biopharmaceutical industry can be observed in Central and Eastern Europe, including Poland. The main barriers to, and challenges facing, open innovation cooperation in the Polish biopharmaceutical sector, however, are not well understood. This study analyses the major drivers of, and barriers to, engaging in open innovation cooperation. A survey was conducted and established that open innovation cooperation and R&D collaboration do not necessarily suffer from a lack of financial resources, but are definitely dependent on such socio-behavioural factors as motivation for collaboration, value systems, and trust between partners.

Keywords: development, biopharmaceutical industry, open innovation strategies

JEL: O12, O31, O32

WPROWADZENIE MODELU OTWARTEJ INNOWACJI W POLSKICH FIRMACH BIOFARMACEUTYCZNYCH: GŁÓWNE SIŁY NAPĘDOWE I BARIERY

Streszczenie

Obecnie innowacyjność jest jednym z najważniejszych wyznaczników procesów gospodarczych i jednym z najważniejszych elementów budowania przewagi konkurencyjnej każdej firmy. W branży biofarmaceutycznej pandemia COVID-19 przyczyniła się do rozwoju nowych partnerstw strategicznych, w tym otwartych sojuszy innowacyjnych. Przyjmowanie strategii otwartych innowacji jest coraz bardziej powszechnym zjawiskiem, jednocześnie przynoszącym bardzo zróżnicowane efekty w różnych krajach. Najniższy poziom otwartej współpracy i współpracy badawczo-rozwojowej w branży biofarmaceutycznej można zaobserwować w krajach Europy Środkowo-Wschodniej, w tym w Polsce. Wciąż jednak niewiele wiadomo o głównych barierach i wyzwaniach utrudniających współpracę w zakresie otwartej innowacji w sektorze biofarmaceutycznym w Polsce. Niniejsze badanie analizuje główne siły napędowe i bariery w angażowaniu się we współpracę w zakresie otwartej innowacji. Przeprowadzając ankietę, autorzy stwierdzają, że współpraca w zakresie otwartej innowacyjności i współpracy badawczo-rozwojowej (zwłaszcza z uczelniami) nie zawsze cierpi na brak środków finansowych, ale zależy głównie od siły oddziaływania czynników społeczno-behawioralnych, tj. motywacji do podjęcia współpracy, systemu wartości oraz zaufania pomiędzy zaangażowanymi partnerami.

Słowa kluczowe: rozwój, przemysł biofarmaceutyczny, otwarte strategie innowacji

JEL: O12, O31, O32