

INTER-ORGANIZATIONAL COOPERATION IN THE INNOVATIVE ACTIVITIES OF INDUSTRIAL ENTERPRISES IN POLAND – IN THE CONTEXT OF OPEN INNOVATION

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Purpose: Inter-organizational cooperation of industrial enterprises aligns with the assumptions of the Open Innovation paradigm. The study aims to identify and assess the structure of partners in inter-organizational cooperation within the innovative activities of industrial enterprises in Poland in 2016-2024, and to identify key partner groups in innovative processes.

Design/methodology/approach: The analysis was based on literature review and examination of selected secondary research findings. The basic research method is desk research, i.e. the analysis of existing documents.

Findings: Based on the analysis of the structure of partners involved in inter-organizational cooperation of industrial enterprises in 2016-2024, a group of dominant partners in this period was identified, and the role of universities in this structure was determined. The findings also revealed a shift in the partner group structure starting in 2017-2019.

Research limitations/ implications: A limitation of the study is the exclusion of industrial micro-enterprises, as well as the specificity of the desk research method.

Practical implications: The results of the study indicate that managers should focus on management factors supporting the intensification of inter-organizational cooperation, including the patterns of cooperation with universities.

Social implications: The implementation of recommendations by managers should have a positive impact on the development of inter-organizational cooperation in innovative activities.

Originality/value: The study results have significant scholarly value, highlighting the dominant patterns of cooperation between industrial enterprises in Poland and enterprises outside their own group, as well as the relatively low share of enterprises cooperating with universities in innovative activities. Recommendations aimed at increasing the scale of cooperation in coupled Open Innovation processes were formulated.

Keywords: Open Innovation, cooperation, industrial enterprises.

Category of the paper: general review; research paper.

1. Introduction

Poland has consistently ranked among the lowest-performing European Union (EU) member states in terms of innovation. In the 2025 European Innovation Scoreboard (EIS) Poland was classified as an ‘emerging innovator’, ranking 23rd among 27 countries (European Commission, 2025). The EIS ranking takes into account a number of criteria, such as the “innovators” indicator, which reflects the outcomes of firms’ innovative activities in terms of introducing product and business process innovations. One factor supporting the effectiveness of innovative activities is inter-organizational cooperation, recognized as one of the basic dimensions of innovative activity of enterprises (OECD/Eurostat, 2018). Enterprises are increasingly moving away from the traditional closed innovation model, based solely on their own research and development resources, towards knowledge flows between organizations, which is in line with the popular Open Innovation paradigm.

The present study focuses on inter-organizational cooperation in the innovative activity of industrial enterprises in Poland. The group of industrial enterprises was selected because of the EU's strategic assumption that industry plays a key role in the ongoing ecological and digital transformation (European Council, 2026). Consequently, in order to maintain the innovation activity and face the digitalization and sustainability challenges associated with the new regulatory framework, companies need to collaborate (Peiró-Signes et al., 2024).

The following research questions were posed: which inter-organizational cooperation partners dominate in the innovative activities of industrial enterprises in Poland in the period 2016-2024? What is the role of universities within the structure of partners involved in this cooperation? Has the structure of partners in this cooperation changed in the analyzed period?

The study aims to identify and assess the structure of partners in inter-organizational cooperation in the innovative activities of industrial enterprises in Poland in 2016-2024, and to determine which groups of partners play a key role.

The considerations and analyses were based on literature review and examination of selected secondary research findings. The basic research method is desk research. The study utilizes the results of selected secondary research published by Statistics Poland.

In the process of pursuing the study’s stated objectives the author presented the Open Innovation paradigm, the concept of innovative activity of enterprises, and various aspects of inter-organizational cooperation.

2. The Open Innovation paradigm

The Open Innovation (OI) paradigm aims to open up innovation processes implemented within the organization, with the goal of increasing the innovation and competitiveness of enterprises. The paradigm is based on the assumption that in their innovative activities enterprises should not rely solely on their own knowledge resources, but should also take advantage of external resources. Henry Chesbrough, the creator of the Open Innovation concept, defines it as:

- the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation (Chesbrough, 2006).
- a distributed innovation process based on purposefully managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model (Chesbrough, Bogers, 2014).

The open innovation model distinguishes three basic open innovation processes: **centripetal, centrifugal and coupled** (Gassmann, Enkel, 2004). The centripetal process (inbound flow) is one where knowledge flows to the enterprise from other enterprises, suppliers, customers, users, as well as from universities and research units. The centrifugal process (outbound flow) is one where knowledge flows to the external environment from the enterprise, which consciously shares its solutions with other organizations. Coupled processes are based on the enterprise's **cooperation** with other organizations, including collaboration implemented within business associations, alliances, innovation networks, combining centripetal and centrifugal processes (Bigliardi, Galati, 2016). The author of the OI concept emphasizes that open innovation requires **collaboration** among distributed but interdependent actors who rely on each other's capabilities in value co-creation and value capture (Chesbrough et al., 2018). Although there are several definitions of open innovation, they all emphasize the importance of developing relationships and **collaboration** in order to create something new with the resources at hand (Arvaniti et al., 2022).

The adoption of the OI concept as a model of interactive innovation management in an enterprise should lead to an increase in its innovativeness, understood as the ability to systematically create and implement innovations, as well as absorb innovations. By sharing resources and collaborating with external partners, enterprises can develop their capabilities, take full advantage of patents and Intellectual Property, as well as reduce the risks and costs of innovation (Hong et al., 2019). However, researchers also emphasize that „collaborating with an external partner entails managerial complexities and additional challenges, that can lead to OI failures” (Cricelli et al., 2023). Among other things, analysts draw attention to partners' concerns resulting from lack of experience in technology transfer, possible conflicts concerning intellectual property rights, or difficulties in managing relationships. Eliminating these

limitations is therefore a challenge for managers basing innovation management on the concept of OI, while also including efforts to protect the sources of their own competitive advantage.

The development of digital technologies is driving a transformation of classic Open Innovation models into dynamic innovation ecosystems that integrate enterprises, academic institutions, technology suppliers, end users, and other stakeholders. Digital ecosystems use advanced technologies such as artificial intelligence, the Internet of Things (IoT), and blockchain to redefine traditional value chains.

A key role in these ecosystems is played by digital collaborative platforms that coordinate innovation processes, constituting “the main symbiotic interface for value co-creation within the innovation ecosystem” (Xing et al., 2024, p. 4). These platforms, “powered by deep technologies such as AI and IoT, promote transparency and collaboration across industrial actors” (Barile et al., 2026, p. 11).

Contemporary research focuses on data-driven innovation ecosystems and networks. In these models, data serves as the direct foundation of the innovation process (Rizk et al., 2022).

The latest international research shifts the focus towards complex structures in which industrial enterprises operate within multilateral cooperation networks (Türkcan, İnce Yenilmez, 2025). In this approach, the multi-directional flow of knowledge evolves towards a culture of co-creation, based on enhanced creativity and the use of collective intelligence.

3. Cooperation in the innovative activities of enterprises

Innovation activities include “all developmental, financial and commercial activities undertaken by a firm that are intended to result in an innovation for the firm” (OECD/Eurostat, Oslo Manual, 2018, p. 68). Companies can use the results of this activity solely for their own benefit or they can share the results with other organizations.

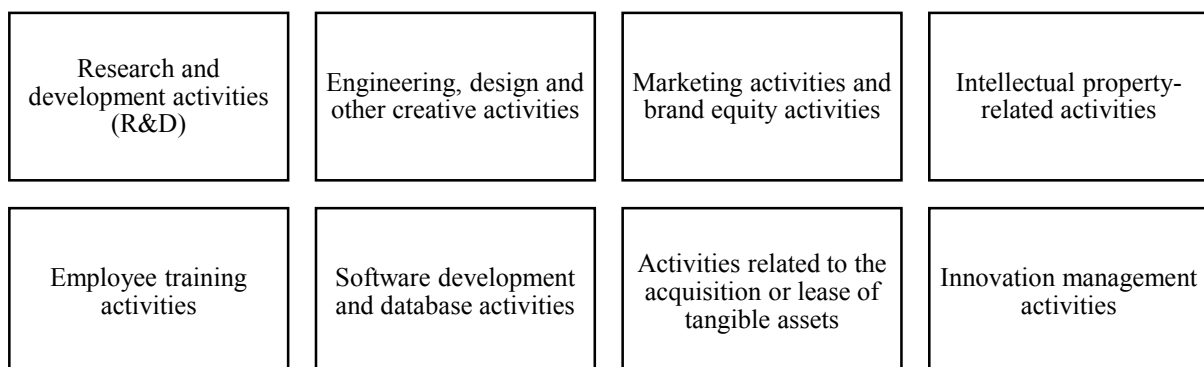


Figure 1. Areas of innovative activities of enterprises.

Source: OECD/Eurostat, Oslo Manual 2018.

The Oslo Manual indicates eight types of activities that can be undertaken by firms in pursuit of innovation (Figure 1), either independently or in cooperation with other entities. Inter-organizational cooperation, which is consistent with the assumptions of the *Open Innovation* concept, is a desirable element of industrial enterprises' innovative activity. Contemporary researchers emphasize that it enables enterprises to create value and support innovation, which provides benefits through the pooling of resources, sharing risks and facilitating access to diverse specialized knowledge (Ozdemir et al., 2023). Collaboration requires coordinated efforts of different parties, aimed at solving a jointly defined problem, with the participation of all partners; it may involve formal agreements on the sharing of inputs, risks and potential benefits (OECD/Eurostat, Oslo Manual, 2018). The partners in inter-organizational cooperation pursued as part of firms' innovative activities include organizations from various sectors. The classification of partners is based on the **quadruple helix model**, promoting the inclusion of business, academic, public administration and social organizations in cooperation with enterprises (Cai, Lattu, 2022).

Forms of this cooperation include alliances, consortia, joint ventures and other partnership forms, including cluster organizations. In alliances and consortia, companies participate with other organizations in joint activities or pool their resources to achieve a common goal. Participants retain their separate legal status while agreements set out the rights and obligations of each participant. Consortia based on contractual relationships between participants do not need to be registered. Joint ventures arise when at least two enterprises invest equity capital in the creation of a third company, which is their joint property, and into which they can also bring their intellectual property rights.

4. Benefits of inter-organizational cooperation in innovative activities

Cooperation with partners is recognized as a factor that enhances the outcomes of innovative activities, provides a competitive advantage, and sustains the firm's growth and development (Acs et al., 2016; Franco, Haase, 2015). The benefits of collaboration depend on its form, as well as the technical level of the collaborating companies (Poznańska, 2016). Aspects of inter-organizational cooperation in the innovative activities of enterprises have been the subject of research efforts undertaken in recent years. For example, surveys and interviews conducted in 2013-2015 on a sample of 24 enterprises led to the following conclusions (Pałucha, 2016):

- the main objectives of cooperation in innovative activities included improving the quality of manufactured products and services, reducing costs, introducing new products to production and onto the market, building a strong competitive position,

- about 60% of the respondents pointed out that ongoing innovative collaboration allowed for the creation and implementation of new products that were the result of cooperation between enterprises themselves as well as enterprises' cooperation with R&D entities.

Moreover, the results of research conducted on a purposively selected sample of 48 enterprises from all over Poland, with a time range covering the years 2014-2016, basically confirmed the positive impact of inter-organizational cooperation on the outcomes of the surveyed enterprises' innovation activities. This research showed a statistically significant relationship between the degree of diversification of firms' external links and the level of novelty of innovations introduced, as well as between the number of links with external entities and the number of innovations introduced (Wściubiak, 2018).

The author's own research, carried out in 2014-2015 on a purposive sample of 180 innovative small and medium-sized industrial enterprises, aimed to determine the strategic factors of enterprise innovativeness. Using factor analysis and structural equation modeling it was shown that in the area of strategic organizational factors, the factor with the most significant positive impact on innovativeness of enterprises is "enterprise's active external cooperation" (Rojek, 2018).

It is worth noting the results of surveys of Turkish enterprises (N = 5863) conducted in the years 2006-2008. Researchers confirmed the benefits of inter-organizational cooperation, but pointed to the existence of optimal levels of breadth for both innovation objectives and cooperation in innovative activities (Temel et al., 2023).

5. Methods

The study aims to identify and assess the composition of partners in inter-organizational cooperation within the innovative activities of industrial enterprises in Poland in 2016-2024, and to determine which groups of partners are of primary importance.

The analyses are based on a comprehensive literature review and an examination of the findings of selected secondary sources. The basic research method is desk research. It is "especially useful for gaining a broad understanding of a subject, identifying trends, or gathering historical data" (Mangarin, Rodriguez, 2024, p. 849). The strengths of this research method include data accessibility and cost-effectiveness. One weakness lies in the fact that the reliability of secondary data cannot always be verified (Bednarowska, 2015). The use of the desk research method made it possible to conduct a long-term analysis of the structure of innovative cooperation partners of industrial enterprises in Poland. The author used the systematically collected, comparable statistical data from Statistics Poland, which constitute a robust foundation for analyzing trends in the area under investigation.

It should be emphasized, however, that the exclusive use of secondary statistical data is associated with certain research limitations. This data does not permit an in-depth interpretation of the quality of partner relationships or barriers to cooperation within the Open Innovation model. The lack of triangulation with qualitative methods, such as individual in-depth interviews, case studies or surveys, precludes a full explanation of the observed phenomena and the identification of factors affecting the choice of cooperation partners. The results of the analyses should be interpreted as an identification of trends and relationships occurring in inter-organizational cooperation of industrial enterprises.

The author's analyses are based on literature review and an examination of the findings of selected secondary research. The basic research method is desk research. The analysis of aspects of inter-organizational cooperation in innovative activities relates to industrial enterprises in Poland, and in particular to innovation-active enterprises within that broader group. The research uses the results of cyclical surveys conducted by Statistics Poland, in particular those included in reports on innovative activities of enterprises in Poland. These surveys cover all medium-sized and large enterprises and 25% of small enterprises, excluding micro-enterprises. The survey results concerning the percentage of industrial enterprises cooperating in innovative activities, broken down by type of partner, are available in publications of Statistics Poland starting from the period 2016-2018. Therefore, the time range of the study covers the years 2016-2024.

For the purposes of surveys conducted by Statistics Poland, cooperation in innovative activities was defined as “active participation in joint projects with other enterprises or non-commercial institutions”, which does not include “ordering works from external contractors, without active participation in their implementation” (Statistics Poland, 2025, p. 79). The above definition of cooperation, referred to as “inter-organizational cooperation”, was adopted for the purposes of the present study.

Table 1.

Partners of inter-organizational cooperation in the innovative activities of enterprises

Partners of inter-organizational cooperation in the innovative activities of enterprises
Enterprises belonging to the same group of enterprises ¹
Enterprises outside the same group of enterprises, including: consulting companies (consultants), commercial laboratories, private research institutes and universities, suppliers of equipment, materials, components or software, customers, competitors, other enterprises
Universities
Public research institutes (including research institutes of the Polish Academy of Sciences)
Public sector entities (national and local government administration bodies, i.e. public offices, organizations, agencies, public schools and educational entities, health care facilities and other entities providing public services)
Non-profit organizations

Source: Statistics Poland, 2025.

¹ A group of enterprises means enterprises that are legally independent, but are economically interdependent due to links existing between them in terms of corporate control and/or ownership. (Statistics Poland, 2026).

As part of the study of inter-organizational cooperation in the innovative activities of industrial enterprises, partner organizations were categorized into groups (Table 1).

The findings were obtained using structure analysis, comparison of average values in the period 2016-2024 and assessment of changes over time.

6. Inter-organizational cooperation in the innovative activities of industrial enterprises in Poland: Results of a desk research study

Figure 2 presents the share of industrial enterprises that collaborated in innovative activities in individual years of the period 2016-2024, relative to the total number of industrial enterprises in Poland. This share reached 9.7% in 2024, marking an increase from the previous year (9.1%). This was the highest value recorded during the entire study period.

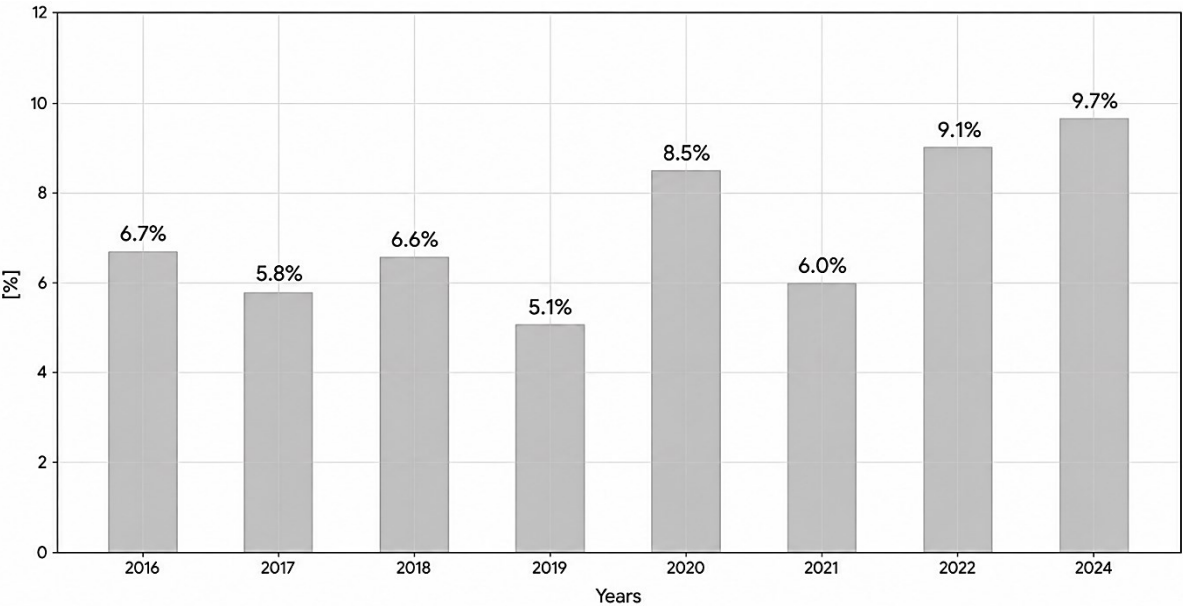


Figure 2. Industrial enterprises in Poland that cooperated in innovative activities (as % of total number of industrial enterprises).

Source: Statistics Poland, Local Data Bank.

Table 2 shows the data on the share of cooperating enterprises in the group of innovation-active industrial enterprises. Over the course of the entire analyzed period, i.e. from 2016 to 2024, this share first fluctuated around 25% in 2016-2018, and subsequently decreased. Starting from 2020, this share followed an upward trend, and reached 26.5% in the last analyzed period of 2022-2024. The 1.8-percentage points increase compared with the previous period represents a favorable shift (Table 2).

Table 2.

Innovative industrial enterprises in Poland that cooperated in innovative activities – percentage share

Period	2016-2018	2017-2019	2018-2020	2019-2021	2020-2022	2022-2024
Percentage share	25.4	23.4	23.6	22.7	24.7	26.5

Share – relative to the total number of innovative industrial enterprises [%].

Source: own compilation on the basis of: Statistics Poland, 2025; 2022; 2021; 2020; 2019.

The size of the enterprise undertaking inter-organizational cooperation is also of importance. In the years 2022-2024, the share of large innovation-active industrial enterprises that cooperated with entities from their environment in innovative activities was 51.1%. The percentage of small and medium-sized innovation-active industrial enterprises involved in such cooperation was lower and amounted to 19.4% and 29.4%, respectively (Statistics Poland, 2025). There was an increase in these shares compared to the previous period.

When it comes to the groups of partners that dominated in the inter-organizational cooperation of the surveyed enterprises in the period 2016-2024, the analysis of the data shown in Table 3 leads to the conclusion that **enterprises from outside a firm's own enterprise group** are – according to the results of cyclical surveys – the dominant group of cooperation partners of innovation-active industrial enterprises, starting from the years 2017-2019.

Table 3.

Innovation-active industrial enterprises that cooperated in innovative activities with individual organizations in 2016-2024 – structure [%]

Entity involved in inter-organizational cooperation	Period					
	2016-2018	2017-2019	2018-2020	2019-2021	2020-2022	2022-2024
Enterprises outside the firm's own enterprise group	22.5	67.6	67.4	70.6	71.8	73.4
Universities	47.7	55.6	39.1	50.5	38.7	33.5
Public research institutes	33.8	33.2	25.6	31.3	25.7	20.8
Enterprises belonging to the firm's own enterprise group	31.4	29.5	34.9	29.5	17.0	16.8
Public sector entities	11.9	10.7	8.6	11.0	10.4	9.1
Non-profit organizations	5.8	5.8	4.8	5.7	6.6	6.7

Share - relative to all innovation-active industrial enterprises that cooperated in innovative activities with partners headquartered in Poland [%].

Source: own compilation on the basis of: Statistics Poland, 2025; 2022; 2021; 2020; 2019.

Shares of firms involved in cooperation with partners from outside their own enterprise group, with headquarters in Poland, fluctuate around 70% in the period 2017-2022, with an upward trend starting from 2019. These values systematically increase, reaching 73.4% in the last reviewed period, i.e. in the years 2022-2024.

Starting from the period 2017-2019, **universities** have ranked second among partners in cooperation undertaken by innovative industrial enterprises in Poland. The percentage share in this case ranges from 55.6% to 33.5%, as recorded in the last studied period, reflecting a downward trend in recent years.

However, back in 2016-2018 – in light of the results of secondary research – universities were the dominant group of cooperation partners of industrial enterprises (accounting for 47.7% of responses), ahead of public research institutes (33.8%) and enterprises belonging to a firm's own enterprise group (31.4%). Enterprises outside the firm's own enterprise group only ranked fourth in the period 2016-2018, with a share of 22.5% (Table 3).

The shares of innovation-active industrial enterprises that cooperated with enterprises from outside their own group are shown below, along with an indication of entities with headquarters located outside Poland. The cooperation partners among these entities were primarily enterprises based in the EU and EFTA countries (Table 4).

Table 4.

Innovation-active industrial enterprises that cooperated in innovative activities with enterprises outside their own group in 2016-2024 - share [%]

Period	Country of the cooperating entity's headquarters		
	Poland	EU and EFTA countries	Other countries
2022-2024	73.4	28.1	10.3
2020-2022	71.8	28.0	12.2
2019-2021	70.6	31.2	14.4
2018-2020	67.4	27.1	10.7
2017-2019	67.6	34.6	14.6
2016-2018	22.5	6.7	2.6

Share – relative to the total number of innovation-active industrial enterprises that cooperated in innovative activities [%].

Source: own compilation on the basis of: Statistics Poland, 2025; 2022; 2021; 2020; 2019.

Detailed data on the recently examined period, i.e. 2022-2024, regarding partners in inter-organizational cooperation of industrial enterprises in Poland, including the country of the collaborating entity's headquarters, is presented in Table 5. The results of the latest research, on the period 2022-2024, show that innovation-active industrial enterprises most often cooperated with enterprises outside their own group of enterprises, with headquarters located in Poland (73.4%), in the EU and EFTA countries (28.1%), and in other countries (10.3%). The second most frequent cooperation partners were universities – mainly based in Poland (33.5%). The third most frequent cooperation partners were public research institutes in Poland (20.8% of responses), followed by enterprises from the company's own group (16.8%). In 2022-2024, public sector entities and non-profit organizations were identified as cooperation partners by 9.1% and 6.7% of the surveyed enterprises, respectively.

Table 5.

Innovation-active industrial enterprises that cooperated in innovative activities with individual organizations in 2022-2024 – structure [%]

Entity involved in inter-organizational cooperation	Country of the cooperating entity's headquarters		
	Poland	EU and EFTA countries	Other countries
Enterprises outside the firm's own enterprise group	73.4	28.1	10.3
Universities	33.5	3.1	0.5
Public research institutes	20.8	2.2	0.2

Cont. table 5.

Enterprises belonging to the firm's own enterprises group	16.8	18.5	6.0
Public sector entities	9.1	0.5	0.3
Non-profit organizations	6.7	0.7	0.4

Share – relative to the total number of innovation-active industrial enterprises that cooperated in innovative activities [%].

Source: own compilation on the basis of: Statistics Poland, 2025.

One limitation of the analyzes in question, based on the results of secondary research, is the exclusion of micro-enterprises, but also the sole consideration of the occurrence of inter-organizational cooperation, without taking into account its scope and intensity.

7. Discussion

An assessment of the state of inter-organizational cooperation in the innovative activities of industrial enterprises in Poland – carried out in the study using the desk research method, based on an analysis of the results of cyclical surveys of Statistics Poland² – shows that in the period 2022-2024, more than a quarter of the surveyed enterprises (26.5%) engaged in inter-organizational cooperation. Over the entire study period of 2016-2024, the share of cooperating enterprises initially fluctuated around 25% in the years 2016-2018, and then decreased, but subsequently exhibited an upward trend in recent years, marking a favorable shift.

In response to research questions concerning the period 2016-2024, it was determined that in the group of innovation-active industrial enterprises cooperating in innovative activities, the dominant cooperation partners are **enterprises from outside the firm's own enterprise group**, with headquarters in Poland. This trend has continued since 2017-2019, with the percentage share of this category of partners increasing annually and exceeding 73% in the years 2022-2024.

On the other hand, cooperation with **universities** in Poland, which have ranked second among cooperation partners in innovative activities starting from 2017-2019, is currently pursued by less than 34% of innovation-active industrial enterprises. In recent years, the share of this partner group has exhibited a noticeable downward trend (Figure 3).

There was a visible change in terms of the most-frequently chosen inter-organizational cooperation partners starting from 2017. The changes observed in the period of 2017-2019 have continued in subsequent years. Based on the research results it can be concluded that the structure of cooperation partners in industrial enterprises' innovative activities changed in the analyzed period.

² The surveys relate to all large enterprises and to 25% of SMEs, and exclude micro-enterprises, which is a limitation of the analysis.

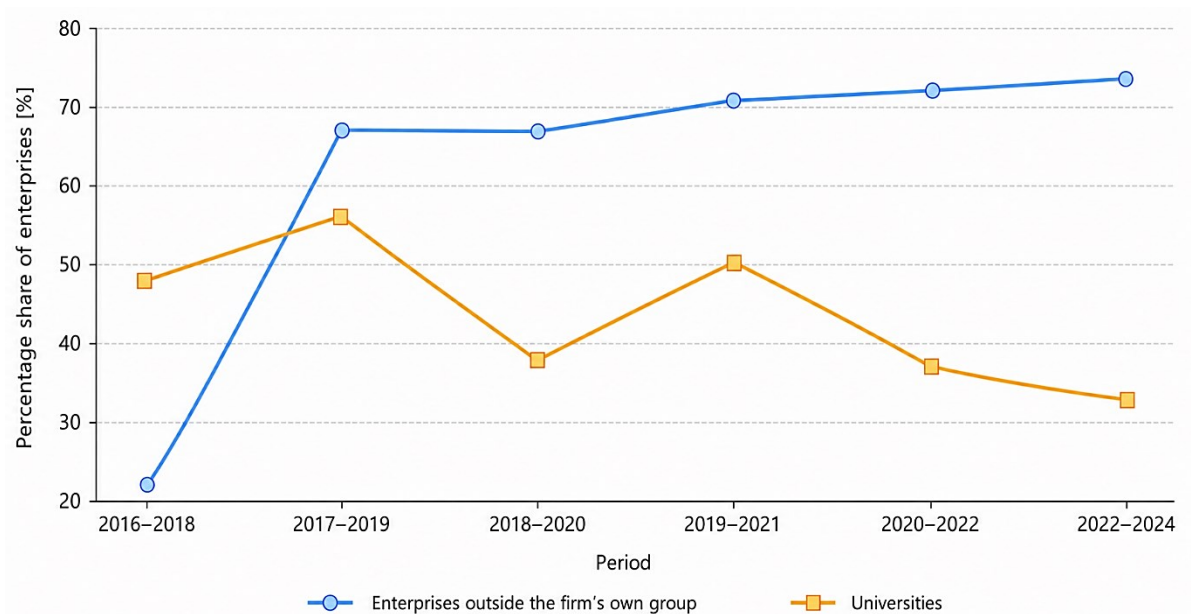


Figure 3. Industrial enterprises in Poland that cooperated in innovative activities – with selected groups of partners (as % of total number of industrial enterprises).

Source: own compilation on the basis of: Statistics Poland, 2025; 2023; 2022; 2021; 2020; 2019, using the Google Gemini application.

A noticeable change in the model of inter-organizational cooperation – towards more open market relations – may be viewed as a positive phenomenon, confirming the adoption of the Open Innovation paradigm by enterprises that cooperate with each other in the implementation of innovative projects and thus go beyond the boundaries of their own enterprise group. The results of the research and analyses provide a basis for further exploration of factors supporting continued increases in industrial enterprises' cooperation with market partners, in particular with universities, in the area of innovative activities.

On the other hand, the decreasing role of universities, whose share declined from 55.6% in 2017-2019 to 33.5% in 2022-2024, despite the theoretical emphasis on knowledge transfer and Open Innovation ecosystems, necessitates further investigation. The decline in the importance of universities as partners of inter-organizational cooperation of industrial enterprises regarding innovative activities may indicate that the academic sector has not sufficiently aligned its research output with the current needs of enterprises operating in the conditions of dynamic technological transformation. Enterprises may prefer to collaborate with partners that provide faster access to practical expertise and greater organizational flexibility, such as technology suppliers or consulting companies. The observed trend may also be a consequence of institutional barriers and the limited effectiveness of mechanisms for the commercialization of the results of scientific research.

8. Conclusions

Developing mechanisms to foster inter-organizational cooperation in the innovative activities of industrial enterprises remains a persistent challenge for both researchers and managers interested in increasing the innovativeness of managed enterprises.

From the point of view of the enterprise, the key element is managers' involvement in initiating and implementing inter-organizational cooperation with enterprises, supplemented by greater use of the potential offered by universities and other partners within the framework of the open innovation system. A strategic approach to innovation management, based on the Open Innovation concept, is recommended.

Researchers emphasize that understanding the goals, scope and levels of cooperation supports managerial decision-making in the practice of cooperation for innovation (Temel et al., 2023). One important aspect is the careful selection of partners from among the available options. According to researchers (Chrupała-Pniak et al., 2017; Fujiwara, Watanabe, 2017), this requires assessments based on various criteria, in order to ensure the potential partner is able to provide the firm with economic, cultural, socio-psychological benefits (trust, honesty and responsibility of the partner).

One factor crucial for increased inter-organizational cooperation is the development of **managerial competences**, including both negotiation skills in Open Innovation processes (Barchi, Greco, 2018) and organizational skills needed to effectively solve possible problems resulting from the implementation of open innovation, without disrupting the functioning of the organization (Lam et al., 2021). Cooperation involves the joint performance of tasks among partners and striving to achieve mutual benefits, but such actions require the **trust** and commitment of collaborating partners (Li et al., 2017). This increases the importance of fostering an **organizational culture** that supports not only the aforementioned processes of selecting partners or negotiations, but also the important of creating a climate that facilitates cooperation and mutual trust among partners from different backgrounds.

In the era of digital transformation, it is important to adopt an innovative approach to the way inter-organizational cooperation is organized. For example, it is worth establishing a platform on which partners will cooperate (Jun, Kim, 2022). Inter-organizational cooperation should therefore be actively supported by solutions associated with the concept of Industry 4.0, such as the Internet of Things (IoT), artificial intelligence (AI), big data analytics or cyber-physical systems. Analysts recommend that in order to enhance firms' innovation effectiveness through OI practices, policies should be implemented to support firms in developing internal capabilities for processing data that arise from adopting Industry 4.0 technologies and exchanging such data with external parties (Kim, Park, 2024).

The results of the analyses presented in the study, indicating high and growing activity of industrial enterprises in cooperation with entities outside their own group and a simultaneous decline in cooperation with universities, shed new light on the determinants of digital transformation. The implementation of key technologies of Industry 4.0 naturally ties into the logic of Open Innovation, according to which enterprises deliberately cross organizational boundaries in order to acquire external knowledge and technological resources. This trend may indicate a shift towards deployment-oriented partnerships, aimed at rapid and scalable implementation of AI-based solutions, process automation, advanced robotics, or real-time data architecture. The IoT and Big Data technologies further strengthen these processes, increasing the importance of ongoing data exchange in value chains and requiring the integration of information sources within coherent digital ecosystems. In this approach, cooperation with specialized technology suppliers serves as a key element of open innovation ecosystems, which are typical for Industry 4.0.

At the same time, the rapid evolution of digital technologies and the pressure for swift market implementation (time-to-market) may explain why the share of cooperation between industrial enterprises and universities is almost 50% lower and continues to decline. In the context of Industry 4.0, traditional research and development cycles of academic entities may be perceived as less flexible compared to the ready-made, commercial digital ecosystems offered by enterprises from the high-tech sector. In this context, researchers point out that “engagement between scholars and managers remains ad hoc, such that much of the scholarship in OI is unknown to the managers, while many new management practices are not well known by academics” (Radziwon et al., 2024, p. 20).

One important element of this transformation, especially in the context of building innovation capabilities, is **cooperation with universities**. These entities possess current scientific knowledge, along with research and development facilities, which is why their active inclusion in cooperation in the area of innovative activities promotes knowledge transfer and efficient implementation of innovative solutions in business practice. This means that although universities do not constitute the dominant group in the quantitative structure of innovative cooperation partners of industrial enterprises in Poland, they can become a key partner in qualitative terms.

One major challenge is the development of systemic support mechanisms for greater participation of universities in the innovation ecosystem – both through appropriate financing mechanisms and the establishment of cooperation platforms and incentives for both sides of cooperation. The author’s recommendations include, among other things, establishing rules for the distribution of European funds for the economy in such a way as to mobilize enterprises participating in the grant competitions to utilize the obtained funds in inter-organizational cooperation with universities, as part of innovative activities.

It should be emphasized that the presented interpretations result from the analysis of the observed trends in the area of inter-organizational cooperation of industrial enterprises, rather than a direct measurement of the impact of individual technologies on the composition of cooperation partners. The applied desk research methodology yielded an analysis that serves as a foundation for future primary research in the analyzed problem area.

These findings provide a baseline for continued exploration of factors conducive to further strengthening of industrial enterprises' cooperation with market partners, in particular with universities, in the field of innovative activities, especially in the context of technology transfer, implementation projects and development of expertise in the era of Industry 4.0.

9. Summary

The article examines the cooperation of industrial enterprises in the context of the Open Innovation paradigm, focusing on the identification and analysis of the structure of cooperation partner groups of industrial enterprises in Poland in innovative activities in the years 2016-2024. The author bases the analysis on literature review and examination of secondary research findings, with particular emphasis on the available Statistics Poland research on the innovative activity of enterprises. Based on the analysis of the research results, it was found that in the structure of partners involved in inter-organizational cooperation in innovative activities of industrial enterprises in 2017-2024, enterprises from outside firms' own capital group dominate, while cooperation with universities occurs less frequently. This status has been observed since 2017-2019, while in the period 2016-2018 universities were the dominant group of cooperation partners. The article concludes with practical recommendations for managers with regard to factors supporting inter-organizational cooperation and calls for wider utilization of instruments available as part of funding programs that could stimulate cooperation with universities.

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