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FACTORS OF COLLABORATION BETWEEN SMALL AND MEDIUM-SIZED ENTERPRISES (SMES) AND RESEARCH ENTITIES IN POLAND – THE PATH TO SUCCESS

Abstract

Objectives: The article aims to identify factors influencing the success of cooperation between small and medium-sized enterprises and research entities. We adopted the implementation of significant international innovations as a measure of success.

Material and methods: The study included 106 SMEs from the southeastern part of the Wielkopolska province. The first stage of the research involved the quantitative analysis of the impact of collaboration between SMEs and research entities on innovation activity. This analysis utilized nonparametric gamma rank correlation and the chi-square test of independence with Yates' correction. The second stage comprised qualitative case study of five companies that have achieved the best results in implementing innovation. The focus was on examining the factors influenced the success of collaboration efforts.

Results: The research confirmed the positive relationship between collaboration with research entities and the results of SMEs' innovation activity. Examining selected enterprises allowed us to identify factors contributing to the successful cooperation between SMEs and research entities. These factors include enterprise size and age, R&D activity, technology modernity, internationalization, obtaining subsidies from EU funds, informal contacts with research institutions, collaboration with the business environment and use of patent protection.

Conclusions: The study revealed the collective impact of various factors on implementation of internationally significant innovations that were previously considered individually. The findings indicate a set of factors that should be regarded as cooperation with a research entity to be effective. The work sheds new light on the necessity of a comprehensive approach to shaping the conditions for collaboration between SMEs and research entities.

Keywords: *innovation, success, small and medium-sized enterprises, university-industry collaboration, research entities*

Introduction

University-Industry collaboration is an important source of knowledge and new technological achievements reinforcing regions' economic and innovative competitiveness (Bishop et al., 2011; Rasmussen, Wright, 2015).

Numerous studies have been conducted on the subject of collaboration between large enterprises and research entities (Borges et al., 2022; Skute et al., 2017, Sjoo, Hellstorm, 2019). The research related to the University – Industry connection focuses on various aspects of collaboration, including its channels and mechanisms, barriers to collaboration, and factors influencing its

success (Masarenhas et al., 2018; Nsanzumuhire, Groot, 2020; Rybnicek, Koeningsgruber, 2019; Pereira, Franco, 2022). These phenomena are examined from the perspective of an enterprise and research entity.

Numerous authors' research results confirm that large enterprises are more likely to engage in collaborative relationships with research entities in comparison to small enterprises (Fontana et al., 2006; Levy et al., 2009; Veugelers, Cassiman, 2005) mainly due to high intensity of research activities within the development department (Fontana et al., 2006, Isaksen, Karlsen, 2010).

Small and medium-sized enterprises play a pivotal role in both developed and developing countries. They serve as significant sources of employment, innovation, and contribute to the reduction of inequalities (Manzoor et al., 2019). Small and medium-sized enterprises are not accustomed to engaging in research and development activities. However, the establishment of cooperative alliances has been identified as a pivotal factor in enhancing their competitive advantage and ensuring their survival (Martin et al., 2019).

The subject of studies on collaboration between small and medium-sized enterprises and research entities has been the environmental drivers of collaboration, such as regional politics and access to public resources (Gordon, Jack, 2010; Johnston, Huggins, 2018). The extant research has examined the barriers to collaboration development, including communication issues and a lack of financial resources (de Morales Silva et al., 2020; Collier et al., 2011). Other studies have identified geographical proximity and training programmes as significant determiners of collaboration (Maietta, 2015). Some publications refer to collaboration strategy, sustainable development, commercialization of research results, networking and business development, as well as to various forms of contacts (Bjerregaard, 2009; Padilla-Malendez et al., 2013; Corral de Zubielqui et al., 2015; Johnston, Huggins, 2017). There is no research on factors influencing the collaboration success of small and medium-sized enterprises with research entities (Rybnicek, Königsgruber, 2019). This constitutes the fundamental rationale for choosing this research problem.

The aim of this research is to identify the factors that influence the successful collaboration between small and medium-sized enterprises and research entities. The implementation of innovation on the international scale has been regarded as a measure of success. The identification of these factors has been

presented on the background of forms and intensity of collaboration between small and medium-sized enterprises and research entities.

Empirical research was performed in Wielkolposkie Voivodship, an area distinguished by a high level of entrepreneurship. In comparison to the European Union, Poland is characterized by its comparatively low level of innovativeness, coupled with a relatively high dynamics of economic development. The obtained results provide a framework for understanding the factors of strengthening cooperation between SMEs and research entities at a similar stage of development.

The extant research results concerning collaboration between small and medium sized enterprises relate to research performed, in the majority of cases, in highly developed European countries in which collaboration between small and medium-sized enterprises and universities is stimulated by regional development and based on university formal programmes (Pereira, Franco, 2022). There is an absence of research conducted in dynamically developing countries of Central Europe.

Literature review

The vast majority of research results, regardless of the economic development of the country, concern the collaboration between universities and large enterprises. The willingness of large enterprises to cooperate with research entities is related to the size of an enterprise, R&D expenditures, technological advancement level of an enterprise, as well as open research strategy. Open research strategy relates to gaining knowledge on innovations for enterprises not only from universities but also from customers, suppliers, competition and Chamber of Trade and Commerce (Cohen et al., 2002; Laursen, Salter, 2004). Larger enterprises are more likely to cooperate with research entities, as they possess a more profound comprehension of the collaboration strategy (Jang et al., 2017; Alunurm et al., 2020).

Research which took into account internal and external factors influencing collaboration were performed in Brazil on a sector level (de Morales Silva et al., 2018). Internal factors influencing collaboration between universities and industry

included: the size of enterprise, own and external research and development sector, product and process innovations. External factors included the character of market, economic risk, innovation cost as well as state contributions. The findings of the aforementioned studies indicated that the main determinants influencing cooperation between science and industry are the size of an enterprise, external R&D expenditure, as well as product innovations.

Similar research on factors influencing collaboration of enterprises with national and foreign research entities was carried out using data from the 2012-2014 Community Innovation Survey (CIS) (Figueiredo, 2022). This study proved that the enterprise size, innovation activity and the amount of export are significant factors influencing collaboration, regardless of the location of the research entity. On the other hand, enterprises that use public funds cooperate with research entities from the same country.

In Poland research aimed at identification of success factors together with innovation implementation to a large enterprise were performed. Jakubiak and Chrapowicki (2017) used a case study method and stated that prior contacts between enterprises and universities, interest in collaboration and conviction concerning mutual benefits are of great importance.

In contrast, other research based on data from Community Innovation Survey concern factors influencing decision about engagement in cooperative R&D activity of industrial companies as well as the impact of this decision on economic performance of an enterprise (de Sousa et al., 2015). The main determinant of the decision to collaborate, especially in high technology companies, is applicability of joint research for an enterprise. Other factors include the desire to share the financial costs and risk of research work, as well as the potential side effects that may arise from collaboration. The success of collaboration is measured by the high number of new products implemented by enterprises, as well as incomes increase. The effect of collaboration applies both to high technology and low technology companies.

The vast majority of cited studies focus on high technology companies since they most often cooperate with universities. Low technology enterprises may also be interested in establishing contact with R&D sector. According to Maietta's (2015) studies, R&D collaboration of low technology enterprises exerts a significant influence on the implementation of process innovations.

On contrary, product innovations are positively influenced by geographical proximity of universities. University curriculums, in the areas useful for local companies, encourage research-development collaboration. Mikhailow and Puffal (2023) proved that innovative, low technology companies oriented at research and development are beneficiaries of collaboration.

Intentionally selected research results show that the most important factors determining the willingness of large enterprises to cooperate with universities, are organizational factors, such as the size of enterprise, external and internal expenditures on research and development activity, financial grants and the amount of export. The success of collaboration is measured by the number of new products, processes or incomes (Kaufman, Tödtling, 2001). Also well educated staff is an essential factor for making the decision about collaboration with a research entity (Giuliani, Arza, 2009).

Acs and Plumer (2005) stated that large enterprises are more constrained, rigidly structured and lack the flexibility to take advantage of the opportunities offered by universities. As a result, small enterprises should pass the knowledge filter, and thus becoming privileged users of knowledge created by universities (Acs, Plummer, 2005).

Against this background, the research on determiners of collaboration between small and medium-sized enterprises and universities is rather modest. This opinion has been verified by Rybnicek and Königsgruber (2019) in their article concerning a review of literature regarding factors influencing the success of collaboration between universities and industry. The authors highlighted an absence of research including micro, small and medium-sized enterprises.

The article of Fontana et al. (2006) belongs to the most crucial publications on small and medium-sized enterprises and universities collaboration. The authors studied factors determining collaboration with research entities in two aspects: the willingness to initiate joint research and development projects and collaboration intensity. The eagerness to cooperate depends on the size of an enterprise. Agostini and Nosella (2019) emphasized that the enterprise's size is an important factor characterizing different forms of collaboration and influencing enterprise's output. On the other hand, the intensity of collaboration (measured by the number of research and development projects)

in cooperative relations depends on signalizing own competences as well as on the network of dependencies while knowledge creation (Fontana et al., 2006).

Personal and informal relations between managers and scientists are factors influencing successful innovation in U – SME relation (Padilla-Melendez et al., 2013). Previous experiences of entrepreneurs with research entities and scientists are of great importance because they might initiate contact with researchers whom entrepreneurs trust (Bjerregaard, 2009; Trzmielak et al., 2016). Trust is a fundamental aspect reinforcing the choice of a partner for collaboration. Entrepreneur often gains trust while making use of more informal contacts (Johnston and Huggins, 2018; Collier et al., 2011; Trzmielak et al., 2016).

Access to European grants connected with implemented EU programmes has been identified as a significant motivator for collaboration of small and medium-sized enterprises with a research entities (Grimaldi, von Tunzelmann, 2002).

Geographical proximity is one of the factors determining the choice of research entity by small enterprises. It has been demonstrated that smaller companies are more likely to chose research entities located in close proximity as a cooperation partner (Johnston, Huggins, 2017).

Bjeregaard (2009) examined the relations between Danish SME and research entities in long and short term and stated that the collaboration success, expressed by the implementation of R&D practices, affects the company's position on the market and is a source of new contacts. On the other hand, research conducted among 375 enterprises from Spain, Portugal and France demonstrate that innovative companies exhibit a more proactive attitude towards R&D collaboration (Fernandez-Lopez et al., 2019). According to quoted authors, small, independent enterprises are most interested in collaboration with research entities. Moreover, these authors stipulated that factors connected with certain country's specifics also have an impact on collaboration.

The extant research on factors influencing the success of collaboration between small and medium-sized enterprises and universities refers to single aspects. A holistic approach is conspicuously absent.

Methodology

Research area

The research was performed in Poland in the south-eastern part of Wielkopolskie Voivodship. In terms of the innovativeness of the economy, Poland is located on a distant position among EU countries. Effective collaboration between universities and industry is one of factors influencing innovativeness. The intensity of collaboration is illustrated by indicators of expenditures incurred by business in order to realize research in universities. Poland, with an indicator of EUR 2.20 per capita, falls far behind Germany, the leader, with EUR 31 per capita (Geodecki, Hausner, 2023, p. 10). Also according to the Community Innovation Survey, only 5% of Polish companies established R&D collaboration with research entities in 2018. The highest indicators among EU countries are presented by Denmark (18%) and Finland (15%). In 2016-2021 there was an increase of R&D expenditures, but mainly in large and foreign-owned enterprises (Geodecki, Hausner, 2023). In Poland, as in other EU countries, micro, small and medium-sized enterprises constitute the vast majority of all enterprises (98%). According to the report of the entrepreneurship survey (GEM) in Poland in 2022, the transfer of knowledge and new technologies from universities and research entities to small enterprises remained insufficient (PARP, 2023).

It is worth to emphasize that the choice of Wielkopolska region as a research area was intentional. Wielkopolskie voivodship is located on a second place in an entrepreneurship ranking published by PARP in 2020 (PARP, 2020). According to the mentioned ranking, Wielkopolskie voivodship is on the first place due to the number of small economically active enterprises per 1000 inhabitants and due to the number of employees in small enterprises per 1000 inhabitants, as well as on the second place in Poland due to other 9 variables, including revenue per employee in a small enterprise and capital expenditures per micro company. The Regional Innovation Scoreboard results confirm good position of Wielkopolska among innovative regions. According to data published in 2021 concerning innovativeness indicators, Wielkopolska improved its indicators by 16.5% in comparison to year 2014 (European Commission, 2021).

Sample and data collection

Empirical data has been collected in the form of surveys conducted in 2023 with an intentionally selected group of 106 entrepreneurs, management team members or individuals with knowledge concerning innovation activity of a certain enterprise. The survey was carried out by a group of well-instructed students from Calisia University. Based on the available information and their own knowledge, the interviewers selected manufacturing or production-service companies whose activity could potentially be connected with innovations. The surveys were conducted using a questionnaire containing questions related to various aspects of innovation activity of small and medium-sized enterprises, including collaboration with research entities. The temporal scope of the research covered the years 2020-2022.

Method

The collected material has been processed using quantitative and qualitative methods in two stages. In the first stage, descriptive statistics were used to provide a general diagnosis of the collaboration between the surveyed enterprises and research entities. The influence of such collaboration on innovation activity of studied companies was also analyzed. Nonparametric correlation of gamma rank, Chi-square test with Yates correction and Pearson's contingency coefficient were employed in order to perform this research. Nonparametric correlation coefficients enable to define correlations between variables measured in the ordinal scale. On the other hand, Chi-square test is used to verify correlations between variables in a nominal scale. Pearson's contingency coefficient additionally allows to define the strength of such correlation (Stanisz, 2006; King, Minium, 2009).

The second stage of research was of qualitative character and involved case studied of five enterprises which achieved the best innovation results while cooperating with research entities. It means that they implemented new products on an international scale. The implementation of product innovation on an international scale was regarded as a measure of collaboration success with research entities (Kaufman, Tődtling, 2001).

The aim of the analysis was to identify the factors influencing the success of collaboration between small and medium-sized enterprises and research entities.

Results

Research sample characteristics

The enterprises included in this study represented a wide range of production and production-service sectors. The largest group comprised entities from the food industry (21.7%), the metal industry (17.9%), the wood industry (including packaging production) (16.0%), the plastics processing industry (7.5%), and the furniture industry (5.7%). According to the OECD classification, these enterprises most often performed activity perceived as medium-low or low technology.

The structure of the surveyed enterprises in term of their size, organizational and legal form and selected aspects of innovation activity is presented in Table 1.

Table 1. *The structure of researched enterprises N=106*

Category	Groups	Frequency	Per cent
Size (number of employees)	Micro (0-9 employees)	21	19.8
	Small (10-49 employees)	54	50.9
	Medium-sized (50-249 employees)	31	29.2
Organizational and legal form	Sole proprietorship	51	48.1
	Limited Liability Company	29	27.4
	Registered partnership	11	10.4
	General partnership	7	6.6
	Other	8	7.5
Product innovativeness	At least one new product in years 2020-2022	45	42.5
	Lack of innovations in years 2020-2022	61	57.5
Process innovativeness	At least one new process in years 2020-2022	76	71.7
	Lack of process innovations in years 2020-2022	30	28.3
Own R&D activity	Performed permanently	10	9.4
	Performed ad hoc	28	26.4
	Not performed	68	64.2

Source: own study.

More than 70% of the surveyed enterprises implemented at least one process innovation in years 2020-2022. Achievements in the field of product innovations were distinctly worse. They were implemented only by less than half of the interviewed in the same period of time. It is also worth emphasizing that these innovations were usually novelty only in the scale of the implementing company. Products being a novelty in the national scale were implemented by 13.2% of the companies, and products being a novelty in an international scale were presented

only by 5.7% of the enterprises. More than 35% of companies were engaged in R&D works, although in majority of cases such activity was only of ad hoc nature.

The innovation activity of the surveyed enterprises should be assessed rather positively, bearing in mind the relatively low level of technological advancement achieved.

Quantitative research results

Collaboration with research entities was declared by 33 enterprises from all studied group, which is 31.1%. 52 cases of such practices were identified on the basis of information gathered from respondents (average indicator is 1.58 of such connections for a company declaring collaboration). Enterprises cooperated with only one research entity in vast majority of cases (21 companies). In 7 cases there was collaboration with 2 research entities, and in 3 cases with 3 institutions. 2 enterprises declared collaboration with 4 research institutions.

Taking into consideration type of research entities, the studied companies performed:

- 34 cases of collaboration with universities,
- 12 cases of collaboration with research institutes (including Łukasiewicz Research Network),
- 6 cases of collaboration with other R&D entities.

The researched companies' contacts most often referred to research entities form the following voivodships: wielkopolskie, łódzkie, śląskie and dolnośląskie. Most often indicated entities are Poznań University of Technology, Poznań University of Life Sciences, Poznań Institute of Technology – Łukasiewicz Research Network, Wrocław University of Technology, Łódź University of Technology and Warsaw University of Life Sciences.

It is worth emphasizing that only a small number of identified cases of collaboration concerned research projects carried out jointly by the aforementioned companies and research entities. Contacts with research institutions were often connected with receiving expertise and certification, ordering research and development works, consulting services, information exchange and employee training. Purchase of ready to use solutions offered by research entities was very rare (Table 2).

Table 2. *Forms of collaboration with research entities*

Form of collaboration	Connections N=52		Enterprises N=33	
	Frequency	Per cent	Frequency	Per cent
Expertise and certification	12	23.1	8	24.2
Outsourcing research and development works	9	17.3	8	24.2
Technological advisory services	8	15.4	8	24.2
Information exchange	8	15.4	8	24.2
Joint research projects	8	15.4	7	21.2
Employee training	7	13.5	6	18.2
Sharing research equipment	4	7.7	3	9.1
Purchase of license and R&D works results	1	1.9	1	3.0
Other	1	1.9	1	3.0

Source: own study.

One element of this research involved assessing the impact of collaboration with research entities on the innovation activity of enterprises. Comparative analysis of innovation activity level of enterprises cooperating and not cooperating with research institutions was performed for this purpose. The results are presented in Table 3 and Table 4.

Table 3. *Innovation activity of enterprises cooperating and not cooperating with research entities according to the type of innovation*

Specification	Collaborating enterprises (n=33)		Not collaborating enterprises (n=73)	
	Frequency	Per cent	Frequency	Per cent
Implementing new product on an enterprise scale	20	60.6	22	30.1
Implementing new product on a national scale	10	30.3	4	5.5
Implementing new product on an international scale	5	15.2	1	1.4
Implementing new process	27	81.8	49	67.1

Source: own study.

Table 4. *Innovation activity of enterprises cooperating and not cooperating with research entities according to average number of implemented innovations*

Specification	Cooperating enterprises (n=33)	Not cooperating enterprises (n=73)
Average number of new products on an enterprise scale	1.88	1.00
Average number of new products on a national scale	0.73	0.08
Average number of new products on an international scale	0.24	0.01
Average number of new processes	2.15	1.34

Source: own study.

In case of companies cooperating with research institutions, higher percentage of enterprises implementing certain kinds of innovations was noticed. These enterprises were also characterized by a higher number of implemented innovations in all analyzed categories.

In order to confirm statistical relevance of the observed differences between both groups of enterprises, nonparametric correlation of Gamma rank and Chi-square test with Yates correction were used. The results of performed calculations are presented in Table 5 and Table 6.

Table 5. *Collaboration with research entities and innovation activity of the researched enterprises (correlation of Gamma rank)*

Innovativeness measure	N	Gamma	Z	p
Implementing new product on an enterprise scale	106	0.478	4.301	**<0.001**
Implementing new product on a national scale	106	0.699	4.607	**<0.001**
Implementing new product on an international scale	106	0.869	4.418	**<0.001**
Implementing new process	106	0.312	2.758	**0.006**

Source: own study.

In all considered cases, the achieved correlation values were positive and statistically significant. It means that enterprises cooperating with research entities implemented more product and process innovations than enterprises which did not engage in such collaboration. This correlation was the strongest in case of product innovations representing novelty at national and international levels.

Table 6. *Collaboration with research entities and innovation activity of the researched enterprises (Chi-square test with Yates correction and Pearson's contingency coefficient)*

Innovativeness measure	Yates χ^2	df	p	C
Implementing new product on an enterprise scale	9.926	1	**0.002**	0.311
Implementing new product on a national scale	7.720	1	**0.006**	0.288
Implementing new product on an international scale	6.435	1	**0.011**	0.279
Implementing new process	1.161	1	0.281	0.126

Source: own study.

The results of performed test allowed us to confirm a statistically significant correlation between collaboration of studied enterprises with research institutions and implementation of product innovations in all three discussed originality levels. However, this correlation has not been confirmed with regard to process innovations. The analysis of Pearson's contingency coefficient, whose values indicate a moderate strength of the aforementioned correlation, leads to similar conclusions.

An interesting supplement to the above discussed results may be the analysis of the sources of innovations used by both groups of enterprises (Table 7).

Table 7. *Sources of innovation in enterprises cooperating and not cooperating with research entities*

Source of innovation	Collaborating enterprises (n=33)		Not collaborating enterprises (n=73)	
	Frequency	Per cent	Frequency	Per cent
Employees' ideas	14	42.4	46	63.0
Own research and development works	17	51.5	11	15.1
Participation in trade show and exhibitions	14	42.4	28	38.4
Market research	11	33.3	13	17.8
Specialist literature	5	15.2	9	12.3
Observation of competitors	12	36.4	39	53.4
Information from business partners	10	30.3	38	52.1
Collaboration with research environment	5	15.2	1	1.4
License, R&D works results purchase	5	15.2	0	0.0

Source: own study.

Companies cooperating with research entities definitely more often indicated such sources of innovations as: own research and development works or market research. On the other hand, in case of enterprises which did not perform such collaboration, other sources became more important. These were workers' ideas, information from business partners or observation of competitors. Interestingly enough, collaboration with research environment was rarely mentioned as a source of innovation. It also applies to enterprises maintaining contact with research institutions (only 15.4% of indications). This result may demonstrate that research entities primarily support enterprises during the implementation phase of innovation, but are rarely perceived as a source of new ideas.

Qualitative research results – case study

The final phase of the research involved identification of factors determining collaboration in enterprises achieving the best results in the area of innovation implementation. Five companies that implemented product innovations on an international scale during the analyzed period were included in this stage of the research. A brief description of these enterprises is presented in Table 8.

Table 8. *Most innovative enterprises specification*

	Enterprise A	Enterprise B	Enterprise C	Enterprise D	Enterprise E
Business activity	industrial machines production	plastic processing industry	boilers and heaters production	concrete construction articles production	industrial machines production
Year of establishment	1957	2012	1999	1991	1952
Size of enterprise (employment)	medium (about 120 people)	medium (about 110 people)	micro (<10 people)	medium (about 120 people)	medium (about 120 people)
Entrepreneur's education	technical university	technical university	secondary education	technical university	technical university
Entrepreneur's experience in R&D	no	no	no	30 years	3 years
Own R&D activity	yes	yes	no	yes	yes
Intensity of collaboration with research entities	4 institutions (different forms of collaboration)	2 institutions (trainings and advisory services)	1 institution (ordering R&D works)	4 institutions (expertise and attestation)	3 institutions (different forms of collaboration)
Informal collaboration with researchers	yes (consulting)	yes (information exchange)	yes (networking)	yes (information exchange)	yes (support in R&D works)
Patent protection	yes	yes	yes	yes	yes
Applied technology level	distinguishing on a national scale	distinguishing on an international scale	standard	distinguishing on a national scale	distinguishing on a national scale
Cooperation with business environment institutions	yes (legal and tax advice, obtaining EU funds, training and seminars)	yes (legal and tax advice, obtaining EU funds, training and seminars)	yes (legal and tax advice, obtaining EU funds)	yes (legal and tax advice)	yes (business consulting, providing business information, training and seminars)
Grants form EU funds	several projects from Smart Growth Operational Programme and Regional Operational Programme	2 projects from Smart Growth Operational Programme	1 project from Regional Operational Programme	no	2 projects from Smart Growth Operational Programme
Export (main foreign markets)	40-50% of sales (USA, Germany)	30-40% of sales (Germany)	20-30% of sales (Germany, Austria)	no	30-40% of sales (Germany, France)

Source: own study.

Several features common to the majority of the above entities can be identified on the basis of the quantitative analysis performed. These were most often medium-sized enterprises with a relatively long presence on the market, representing a medium-high or medium-low level of technological advancement. These entities are characterized by a high level of knowledge absorption from external sources, including science and research institutions. This can be deduced from the fact that they engage in their own R&D activity and use technology that stands out compared to other national enterprises.

It is worth emphasizing that the companies involved in the research maintained rather widespread network of contacts with scientific environment, usually cooperating with several different research institutions. All enterprises also maintained informal contacts with research workers. These contacts covered many areas, including information exchange, consultations, and support for research and development. The companies established these contacts in various ways. For one company, it resulted from previous research projects, while for another it was due to their membership of a supra-regional association promoting collaboration between science and business. Another company co-organised an industry conference attended by representatives of the scientific community.

Interestingly enough, despite almost all enterprise owners hold a university education, none of them had previous experience as an employee in research institutions. Only one person had considerable experience (about 30 years) as an R&D worker in industrial departments.

All companies also used legal instruments to protect intellectual property, particularly patents. In this way, companies not only protected their legal interests (protection against imitation of the solutions introduced), but also increased their recognition and prestige, becoming more readily visible and better perceived by the scientific community. The scientific community may also be more willing to cooperate with such companies, as they can hope to obtain joint patents in the future. Furthermore, based on the analysis of patent descriptions, researchers can obtain supplementary information about the company's activities, such as its technological potential.

Almost all enterprises stood out for the high level of their activity internationalization, performing a considerable sale on demanding foreign markets (for example in Germany). This can be attributed not only to the need to

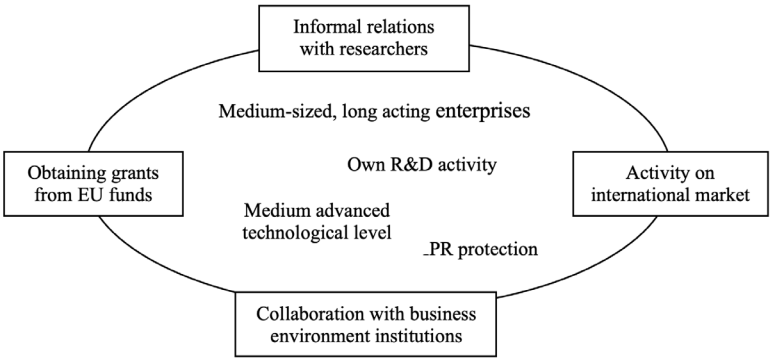
compete with strong competitors and meet clients' high requirements, but also to the opportunity to gain unique experience and access knowledge sources that are unavailable to most enterprises operating on the national market.

A significant distinctive feature of the analyzed enterprises was their high level of activity in obtaining grants for innovative activity from EU funds. These enterprises carried out numerous projects within Smart Growth Operational Programme and Regional Operational Programme, at the same time becoming highly attractive collaboration partners for research institutions It is noteworthy that many programmes supporting innovative enterprises in Poland offer significant preferences to projects realized in collaboration with research institutions.

All enterprises collaborated with business environment institutions such as business incubators, chambers of commerce and industry associations. They utilized the support services provided by these institutions, which included training, legal and tax advice and help in securing financial resources. These engagements could positively impact various aspects of the enterprise's activity such as increasing the likelihood of receiving EU funding, enhancing its networking capabilities, and facilitating successful partnership with other entities, including research institutions.

Qualitative research identified a model of enterprise predisposed to successfully cooperating with research entities.

Figure 1. *Model features of the enterprise that successfully collaborates with research entities*



Source: own work.

In the model approach (Figure 1), two sets of factors characterize companies that effectively cooperate with research institutions. The internal factors include objective features such as company size, durability, and technological advancement. Internal controllable factors include the company's own research and development activity, as well as its commitment to protecting intellectual property. The second group of features is related to the company's external activity and proves its openness to introducing modern solutions.

Discussion and conclusions

Discussion

The enterprises participating in this research maintained numerous contacts with research entities. In light of the findings of other studies (Bjerregaard, 2009; Fernández-López et al., 2019; Martin et al., 2019), this result appears to confirm the permanently increasing significance of university–industry collaboration, a trend that is also becoming more prevalent in small and medium-sized enterprises and more traditional business sectors. It is noteworthy that collaboration between enterprises and research institutions was related to various aspects, including expertise and certification, advisory services and information exchange, and that it only became joint research projects in some cases. This demonstrates that small and medium-sized enterprises have a wide range of options for shaping their relationships with research institutions, enabling them to adapt these contacts to the specific requirements of their innovation activity.

The results of the studies confirmed a positive correlation between collaboration with research entities and the innovation activity of small and medium-sized enterprises. Enterprises can access indispensible knowledge sources, unique competences and highly specialized research equipment, which make it easier to overcome barriers in innovation activity. The achieved results may also be partly the effect of greater tendency of innovative enterprises to cooperate with research institutions.

It is also worth noting that these results, to a great extent, match previous findings regarding large companies' collaboration with research entities. These factors include: the size of an enterprise (Jang et al., 2017), the company's

own R&D activity (de Morales Silva et al., 2018), the amount of export or public grants received (Figueiredo, 2022). Research confirmed also some previous findings concerning collaboration between small and medium-sized enterprises and research entities, particularly with regard to the importance of personal, informal relations of entrepreneurs and managers with research workers (Padilla-Melèndez et al., 2013).

Practical implications

The above results allow us to formulate some recommendations for business practice. Firstly, entrepreneurs and managers from small and medium-sized enterprises should recognize the importance of collaboration with research entities for a certain group of companies, particularly with regard to innovation activity. However, exploiting the full benefits of such collaboration demands a permanent increase in companies' internal potential, including through systematic technological modernization, human resources development, and conducting their own R&D activity. Entrepreneurs and managers should prioritize developing and maintaining personal contacts with research workers, which may be helpful in case of initiating more formalized collaboration with research entities.

Entrepreneurs and managers of companies applying for grants from EU funds should consider initiating or intensifying collaboration with research entities. This will not only increase their chances to receive grants, but also enable them to make better use of the support they receive. Collaboration with research entities ought to be of interest to enterprises expanding their activity to foreign markets.

Policy makers should take into account the aforementioned research findings when designing innovation policy instruments at regional and national levels, particularly with regard to grants from EU funds. These programmes should not only stimulate cooperation between business and research entities, but also give preference to companies that are most likely to succeed in such partnerships.

Limitations and further research

However, the research performed is not free from limitations. Firstly, they mainly focus on enterprises' product innovativeness, including distinction in the level of novelty of implemented solutions. This type of distinction has

not been applied to process innovations. Consequently, the achievements of companies that implemented new process innovations on a national or international scale may have been overlooked in this research. Secondly, the temporal scope of the research included a very specific period of pandemics and economic-political disturbances connected with Russian aggression on Ukraine. This enabled to capture the activity of researched enterprises in unfavorable external conditions, however, it cannot be excluded that decisions made during this period concerning implementation of innovations were fundamentally influenced by external factors. Thirdly, the research only covered small and medium-sized enterprises from one region: south-eastern Wielkopolska. Therefore, the results obtained may primarily reflect the local context in which these companies operate, including the specifics of the research institutions in their local area.

Further research should include small and medium-sized enterprises not only from other regions of Poland, but also from other countries in Central and Eastern Europe. Such research should also take into account enterprises' process innovativeness to a greater extent, especially with regard to the novelty of the implemented solutions and their role within the company's activity (e.g. manufacturing, logistics, distribution, marketing, etc.).

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