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Stimulants of and Barriers to Co-operation between Entrepreneurs and Research Entities Engaging in Innovative Projects

Stymulanty i bariery współpracy przedsiębiorców z jednostkami badawczymi w zakresie realizacji projektów innowacyjnych

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ABSTRACT

Objective: The aim of this paper is to identify the most important factors supporting and hindering co-operation between entrepreneurs and research entities engaging in innovative projects. Co-operation is aimed at generating technical, IT, or process innovations, while the most common partners of choice for entrepreneurs are research entities that are part of universities. Decisions concerning such co-operation should be based on three key factors: analysis of the company's potential, forecasting of future possible outcomes and information on funding opportunities. These assumptions are the basis for diagnosing the barriers that lead to the abandonment of co-operation. Factors that facilitate such co-operation are also identified.

Research Design & Methods: A survey was conducted among business entities engaged in manufacturing and service activities with high and medium-high technologies from the Lower Silesian Voivodship. The most important factors limiting and supporting the propensity for research collaboration were then analysed with the use of descriptive statistics and statistical inference (Fisher's test).

Findings: The research identifies barriers that should be neutralised in order to develop research co-operation between enterprises and universities. Paths to facilitating co-operation that could be developed by local and central authorities are also indicated.

Implications/Recommendations: An uncomplicated model co-operation agreement binding both parties in partnership should be developed. Attitudes in academia towards co-operation with business need to be radically changed, because researchers are primarily motivated to publish high-scoring publications in reputable journals instead of co-operating with business. Unlike researchers, entrepreneurs' main motivation is to quickly generate cash flow. Neither side focuses on developing unique high-end innovations in co-operation with one another. There is a lack of commercialisation-oriented interaction between research entities and business. Statistical studies reveal a need for research entities to embrace the principles of business. Helping them do so will allow for the development of effective research co-operation.

Contribution: The article is intended to broaden the knowledge of the current state of co-operation between entrepreneurs and scientific institutions and to lay out recommendations for developing research co-operation.

Article type: original article.

Keywords: research and development activities, commercialisation of R&D, co-operation between research institutions and business, innovation.

JEL Classification: M13, O31, O32.

STRESZCZENIE

Cel: Celem artykułu jest rozpoznanie najważniejszych czynników ułatwiających i utrudniających współpracę przedsiębiorców z jednostkami badawczymi w zakresie realizacji projektów innowacyjnych. Współpraca ta jest ukierunkowana na tworzenie innowacji technicznych, informatycznych lub procesowych. Najczęściej wybieranymi partnerami przedsiębiorców są jednostki badawcze, które wchodzą w skład uczelni wyższych. Decyzja ta powinna opierać się na trzech kluczowych czynnikach: analizie potencjału przedsiębiorstwa, prognozie przyszłych możliwych wyników oraz informacjach o możliwościach pozyskiwania finansowania. Tak sformułowane założenia są podstawą do zidentyfikowania barier, przez które współpraca nie jest podejmowana. Konieczne jest również wskazanie stymulantów ułatwiających współpracę.

Metodyka badań: Przeprowadzono badanie ankietowe wśród podmiotów reprezentujących działalności wytwórcze i usługowe z zakresu wysokich i średniowysokich technologii z województwa dolnośląskiego. Następnie, wykorzystując narzędzia statystyki opisowej oraz wnioskowanie statystyczne (test Fishera), przeanalizowano najważniejsze czynniki zmniejszające i zwiększające skłonność do podjęcia współpracy badawczej.

Wyniki badań: Przeprowadzone badania pozwalają na identyfikację barier, które powinny zostać zneutralizowane w celu zapewnienia rozwoju współpracy badawczej przedsiębiorstw

z uczelniami wyższymi. Wskazane zostały sposoby stymulowania współpracy, które powinny być ulepszone przez władze lokalne i centralne.

Wnioski: Z badań wynika, że wskazane jest opracowanie nieskomplikowanego wzoru umowy o współpracy, która będzie wiązała obie strony partnerstwa. Należy radykalnie zmienić nastawienie środowiska akademickiego do współpracy z przedstawicielami biznesu, ponieważ główną motywacją naukowców jest przygotowanie wysoko punktowanej publikacji w renomowanym czasopiśmie, a nie współpraca z biznesem. W przeciwieństwie do naukowców główną motywacją przedsiębiorców jest szybkie generowanie przepływów pieniężnych. Żadna ze stron nie koncentruje się na wykorzystaniu współpracy do opracowywania unikalnych innowacji wysokiej klasy. Brakuje zorientowanej na komercjalizację interakcji pomiędzy jednostkami naukowymi a biznesem. Badania statystyczne wskazują na potrzebę przyjęcia przez jednostki badawcze zasad biznesu. Pozwoli to na rozwój efektywnej współpracy badawczej.

Wkład w rozwój dyscypliny: Poszerzenie wiedzy na temat obecnego stanu współpracy przedsiębiorców z jednostkami naukowymi oraz wskazanie rekomendacji, które powinny być podstawą rozwoju współpracy badawczej.

Typ artykułu: oryginalny artykuł naukowy.

Słowa kluczowe: działalność badawczo-rozwojowa, komercjalizacja, współpraca jednostek naukowych z biznesem, innowacyjność.

1. Introduction

Gaining competitive advantage on the market depends on numerous factors. One is the implementation of unique solutions (e.g. technological and process solutions, etc.), widely referred to as innovations (Vargo, Akaka & Wieland 2020, p. 527; Lee & Trimi 2021, p. 19). Today, it would be difficult to identify market leaders that do not continuously implement new solutions. However, developing new intellectual property components is no simple task, and often requires significant expenditures and highly specialised personnel (Godina *et al.* 2020, p. 7; Roh, Lee & Yang 2021, p. 9). Still, due to the increased risk, following such a blueprint does not always contribute to project success.

Innovations can be acquired by co-operating with businesses and research centres (universities) (Raposo, Fernandes & Veiga 2022, p. 91). Researchers conduct basic and applied research, both of which can be used practically in the conduct of business. There are many programmes to support such co-operation, though participating in them does not necessarily result in financial aid being used at a satisfactory level (Opršal *et al.* 2021, p. 299). The reasons for that should not be found in resentment, lack of trust, or other psychological barriers. Bureaucratic barriers and legal problems, such as drafting a co-operation agreement and securing the interests of both parties, are other commonly highlighted problems (Shyrokykh 2022, p. 4).

Against this backdrop, it seems necessary to examine why, despite non-refundable funds, entrepreneurs choose to co-operate with research centres to only a limited extent. Accordingly, we pose the following research questions:

1. To what extent have entrepreneurs and research centres co-operated? How can that co-operation be evaluated?

2. What are the barriers to co-operation between entrepreneurs and research centres?

3. What are the proposals for improvements and plans for co-operation between entrepreneurs and research centres?

4. Is there a correlation between the barriers and the needs of those collaborating or expressing a desire to collaborate with research centres?

The purpose of the paper is to identify the most important factors supporting and hindering co-operation between entrepreneurs and research centres in the implementation of innovation projects. The paper consists of four sections. The first presents a brief review of the literature on generating partnerships aimed at creating innovation. The second section explains the methodology to be used and the survey research undertaken. The survey research was conducted on a representative group of Lower Silesian companies. The main theme of the research was the factors limiting and supporting development-oriented co-operation. The third section presents the results of the research and the last section offers conclusions and suggestions for further research work.

2. Literature Review

The development of scientific research significantly boosts innovation among local entrepreneurs, especially those working with modern technology. However, knowledge alone does not guarantee the production of diverse business innovations (Hájek & Stejskal 2018). Companies that engage in knowledge-intensive production usually co-operate with universities and research institutes (Szücs 2018). Therefore, managers should navigate companies towards knowledge-rich networks and participate in them. It is often impossible to transfer the results of theoretical work to enterprises. Thus, it is necessary to seek various forms of public support. A proper understanding of such correlations facilitates the effective spread of knowledge and the development of innovation processes. Research has shown (Medda 2020) that close contact between researchers and entrepreneurs gives rise to both product and process innovations.

The digital transformation of local industries is forcing the destruction of obsolete assets (Isaksen *et al.* 2021). Digital transformation can lead to various forms of innovation activities and to multifaceted development of regional economies. In order to be able to respond to the dynamic business environment, intense compe-

tition and changing customer expectations, it makes sense to perceive digital transformation as a continuous and ongoing process. Hence, it is important to regularly review and update one's portfolio of digital projects, so as to be ready to implement them at the right time and place (Cichosz, Wallenburg & Knemeyer 2020). It is not possible for a company to take the path of development without co-operating with innovation generators. Collaboration between businesses and universities is a source of success for many businesses (which, by the way, force the need to implement social innovations), as well as a generator of secondary problems (Oeij *et al.* 2019). Research (García-Quevedo, Segarra-Blasco & Teruel 2018) shows that many innovation projects are abandoned before completion, most commonly due to financial constraints. Furthermore, various mechanisms for financing innovation on a payback basis of one's own funds previously committed are also of key importance.

Universities play an important role in innovation ecosystems (Gontareva *et al.* 2022, p. 13). In addition to developing human capital and technological advances, universities and research centres are increasingly called upon to participate in economic development as industry partners. Unfortunately, flexible and entrepreneurial management of universities is difficult to implement (Chiarini, Belvedere & Grando 2020, p. 1387; Huber, Wainwright & Rentocchini 2020, p. 42).

Nevertheless, the literature offers suggestions on how universities can manage their innovation ecosystems. One proposal is to engage with entrepreneurs in local economies in order to launch new industries and generate innovation (Heaton, Siegel & Teece 2019). The multidimensional dynamics of the benefits of university-industry relations have been highlighted (Fischer *et al.* 2021). Much has been written about university-industry partnerships, but relatively little research has focused on the impact of such co-operation on a country's domestic problems. Universities need to lay the groundwork for long-term success at a time when public support for higher education appears to be in crisis (Heaton, Lewin & Teece 2020). The analysis of strategic management practices for innovation requires an evolutionary perspective and calls for new insights into the study of the effectiveness of university-enterprise partnerships in developing innovation. Policymakers should promote social programmes that increase the active participation of all actors involved in the entrepreneurship and innovation ecosystem, while university managers should understand the challenges and opportunities behind adopting an inclusive and social orientation.

Universities can contribute to knowledge-based regional development not only in their home regions, but also beyond them. In many countries, universities have established external institutes to promote the development of local entrepreneurship and technology transfer (Conlé *et al.* 2023). Understanding and identifying the drivers of innovation have been considered crucial for many years, as innova-

tion supports local competitiveness and economic growth (Canestrino, Carayannis & Magliocca 2022). In addition to teaching and research, the entrepreneurial and innovative activities that universities carry out have been aligned with the innovation systems policy framework, which has been the dominant innovation policy paradigm for several decades. However, innovation policy is being reformulated in response to the growing realisation that inequality, poverty, climate change, and environmental challenges persist. Additionally, despite significant public investment in science and technology, the situation is worsening and activities undertaken by universities are failing to fulfil their role (Parker & Lundgren 2022).

Studies of the incentives that can stimulate institutional change are being undertaken, as are others on how universities can become more entrepreneurial. In the process of enacting institutional change to help universities become entrepreneurial, it is necessary to introduce an individualised incentive system that could motivate researchers in their endeavours to contribute to this process (Staniulyte 2022). Some researchers (Rosli & Cacciolatti 2022) underscore the role that universities play in supporting the development of the local innovation base. Achieving a high level of local competitiveness is possible by taking advantage of the coordinating role of local knowledge centres (Dagnino, Picone & Ferrigno 2021, p. 99). Enhancing regional learning capabilities and upgrading the skills of employees will be key to the success of these approaches. However, there may be political implications of such an arrangement, including the threat that policymakers could shape the role of knowledge centres in coordinating regional efforts to apply knowledge-based solutions to the development of local innovative entrepreneurship.

Every development activity is subject to complex barriers, which vary depending on the process and type of innovation involved. They become interconnected throughout the implementation process (Cinar, Trott & Simms 2019). Entrepreneurs make decisions to implement innovations based on internal factors, including resources and capabilities, as well as external factors. Statistical analyses show that internal aspects are quite important as determinants of innovation (Kiefer, del Río González & Carrillo-Hermosilla 2019). In contrast, reliance on external innovation suppliers (most often researchers) is a barrier. The public-private way of funding innovation development hinders collaboration by adding additional bureaucracy and political control (Smith, Sochor & Karlsson 2019). This is a barrier that hinders the efficiency and speed of public institutions; furthermore, inter-organisational co-operation between public and private institutions is hampered by the built-in differences between them.

There is also some reluctance to innovate, although companies are clearly aware of the need to do so. This problem can be explained in many ways. First, companies may see the current risks associated with innovation as being potentially costly, so they may wait for the economic situation to improve before setting out to inno-

vate. Negative past experiences can lead to the emergence of psychological barriers and excessive caution in developing and implementing innovations (Jakimowicz & Rzeczkowski 2019).

Although science has made significant progress in explaining the emergence of new development paths, a number of issues remain insufficiently explored. Research (Steen & Hansen 2018) has shown that the initial favourable context for creating innovation pathways has become more constrained. This process of creating innovation is susceptible to changes in external conditions that, for various reasons, have led to missed development opportunities.

3. Research Sample and Methods

For the present case, the appropriate research tool for collecting research data was a survey. In order for the research data to be representative, the population of the entities surveyed had to first be defined. Before the enterprises were drawn, they were divided into segments according to their size, and then the appropriate number of companies was chosen from each group. The structure of the sample approximates the structure of the entire population, so the sample is representative (Bartosińska & Jankiewicz-Siwiek 2006, p. 235). The survey was designed to cover entities representing manufacturing and servicing activities in high and medium-high technologies from Poland's Lower Silesian province. This assumption made it possible to survey entities that, by definition, should carry out research and development activities. The population size was determined using Statistics Poland data. The surveyed companies were divided into the following groups (according to number of employees): micro (0–9), small (10–49), medium (50–249), large (250 or more). Details are presented in Table 1.

Table 1. Data to Determine the Population

Company size	Number of entities	Rate (%)
Micro	20,380	97.34
Small	347	1.66
Medium	145	0.69
Large	64	0.31
Total	20,936	100

Source: the authors, based on the Statistics Poland data, i.e. national economy entities registered in the REGON (National Official Business Register), declaring business activity, as per the expected number of employees, provinces, and PKD (Polish Classification of Business Activity) 2007.

Based on the specified population size, the sample size was determined from the following formula:

$$N_{\min} = \frac{N}{1 + \frac{4d^2(N-1)}{z^2}},$$

where:

N – the size of the general population,

z – standard value read from the normal distribution tables for a given level of statistical relevance,

d – maximum estimation error.

The following assumptions were made: confidence level – 95%; fraction size – 0.5; maximum error – 5%. On this basis, a minimum sample size of approximately 350 business entities was determined. Details of the sample surveyed with the research tool are presented in Table 2. The structure of the sample drawn approximates the structure of the entire population. The percentage of companies in each segment of the sample is similar to the percentage of companies in each segment, but taking into account the entire population.

Table 2. Sample Size by Number of Employees

Company size	Number of entities	Rate (%)
Micro	309	88.28
Small	24	6.86
Medium	13	3.71
Large	4	0.31
Total	350	100

Source: the authors.

The questionnaire contained 21 questions on research and development activities and the evaluation of co-operation between enterprises and research centres. The questions were developed based on a review of the literature and relevant reports. The survey was anonymous. It included a metric that identified the company's size (based on employment, total assets, and annual turnover), number of years it had been operating, and the industry in which it operated. Due to the small number of enterprises other than microenterprises, this group was more widely represented in the survey than the structure found in the population, but these are not large discrepancies, so the survey should be considered representative.

In-depth interviews using CATI were conducted via telephone interviews with business representatives (mainly CFOs, board members/owners, accountants) between June and August 2022. The following section presents the results of the survey for entities that indicated that they engage in R&D activities. The purpose of the study was to identify the most important factors supporting and hindering co-operation between entrepreneurs and research entities in engaging in innovation

projects, and to examine the correlation between the barriers and the needs of entities co-operating or expressing a desire to co-operate with research entities. Out of 350 entities targeted by the survey, R&D was carried out by 86 entities. Table 3 contains the details and structure of the entities.

Table 3. Companies That Carry out Research and Development Activities by Company Size

Company size	Number of entities	Percentage	Rate in the sample (%)
Micro	69	80.23	22.33
Small	8	9.30	33.33
Medium	6	6.98	46.15
Large	3	3.49	75.00
Total	86	100	×

Source: the authors.

The analysis used statistical methods, including the Fischer's test at a statistical relevance level of 0.05. The test statistic in the Fischer test has an F distribution with a null hypothesis. Such a test is most often used when comparing statistical models that have been fitted to a dataset in order to identify the model that best fits the population from which the data was taken.

4. Research Findings

4.1. General Remarks

The survey resulted in responses that were analysed in detail. Among respondents that engaged in R&D, 31 said that they collaborate with scientific entities or research institutes. Nine respondents indicated that they had sought to co-operate but failed, or plan to co-operate in future. An important part of the survey was to assess the quality of co-operation with the research centres – a key element supporting the determination of barriers and the facilitation of co-operation.

4.2. Co-operation of Entrepreneurs with Research Centres – a Diagnosis

Co-operation with research entities was evaluated only by entities that declared they had co-operated with a research centre/institute.

Respondents that collaborate with a scientific entity or research institute rate this collaboration at an average of 4.1, which is close to the median of 4.0. As many as 77.42% of respondents rated it better (at least 4). The remaining respondents (7 entities, 22.58%) rated the co-operation less well (i.e. 3 at the most). No respondent rated the co-operation at 1, or "very poor." On the other hand, 12 respondents rated it at 5 ("very good") (38.71%). The results are presented in Figure 1.

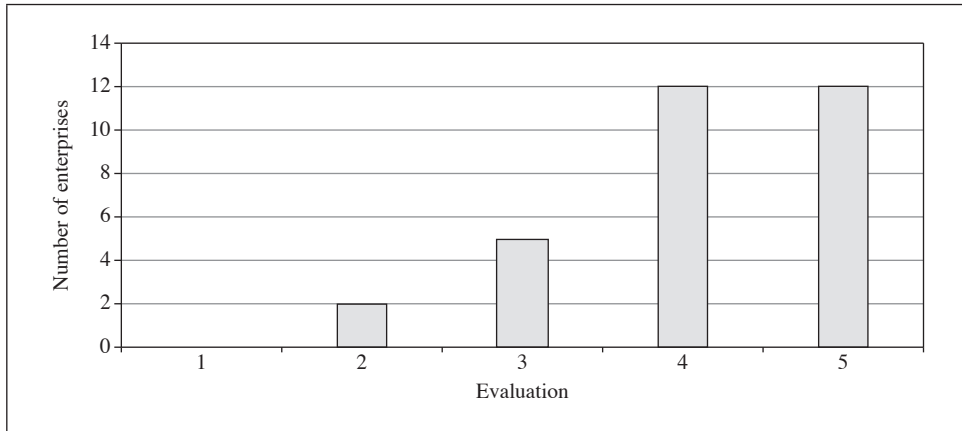


Fig. 1. Evaluation of Co-operation with Research Centres

Source: the authors.

The extent of co-operation with research centres was examined by means of a multiple-choice question test and was conducted only for entities that marked “yes” in response to the question, “When engaging in R&D projects, does your company co-operate with a scientific entity/research institute?”, i.e. organisations that co-operate with a scientific entity or research institute. Table 4 presents the results.

Table 4. Responses of the Entities Surveyed on the Scope of Co-operation

Response	Percentage
Ordering R&D services to be performed by a research entity	35.48
Outsourcing part of the work of an R&D project to a research entity	35.48
Joint R&D project	38.71
Expert analyses, evaluation analyses, opinions, consulting	61.29

Source: the authors.

More than half of the respondents (61.29%) engaging in R&D activities and additionally co-operating with a scientific entity or research institute in the course of that engagement indicated that the scope of their co-operation included expert analyses, evaluations, opinions, or consulting. Each of the other options was indicated by fewer respondents (less than 40%).

The analysis of the correlation between the evaluation of co-operation and the various scopes of co-operation with research entities was carried out only for those

entities that marked “yes” in response to the question: “When engaging in R&D projects, does your company co-operate with a scientific entity/research institute?”.

The question, “On a scale of 1 to 5, where 1 means very bad and 5 means very good, how would you rate your co-operation with the scientific entity?”, was recoded behind a zero-one variable. Two categories within this variable have emerged:

- “better” – ratings: 4 and 5,
- “worse” – ratings: 1, 2, and 3.

Fisher’s exact test was carried out for the variable that determines the evaluation of co-operation and different variants of the scope of co-operation. Each time, at the assumed statistical relevance level of 0.05, the null hypothesis, which meant that the variables were independent, had to be accepted. The analysis shows that there is no statistically relevant correlation between the rating (“better” or “worse”) and the various scopes of co-operation. It is not possible to think that the evaluation is “better”/“worse” when either of the options is chosen more often. The sample consisted of 31 respondents only, so enlarging the sample could yield different results.

The evaluation of proposals for improving co-operation between science and business was carried out only for entities that marked “yes” in response to the question: “When engaging in R&D projects, does your company co-operate with a scientific entity/research institute?”, i.e. co-operating with a scientific entity or research institute.

An important element of the study was the preparation of ready-made scenarios for improvements that should be implemented. The scenarios proposed in the study are presented in Table 5.

Table 5. Scenarios for Improving Co-operation between Entrepreneurs and Research Entities

Proposal	Description of the improvement
Proposal 1	Co-operation exchanges, where entrepreneurs could present their problems to be solved and meet with scientists and researchers
Proposal 2	University should hire a business co-operation manager who knows the needs of business and is able to talk to researchers
Proposal 3	A model co-operation agreement should be developed that is not complicated and binds both parties in partnership
Proposal 4	Researchers should solve specific problems of entrepreneurs; for example, during internships in companies, where students would be involved, who would be trained to work in the company after their graduation
Proposal 5	Involvement of the university both in pre-implementation and implementation of new solutions on the market
Proposal 6	Clear proposal of commercial services offered by the scientific entity

Source: the authors.

These improvements have been evaluated by entrepreneurs who have started working with research entities.

Tables 6 and 7 present summaries of respondents' ratings for the suggested collaboration improvements, as well as the calculated averages and medians for each proposal.

Table 6. Statistics of Respondents' Evaluations

Specification	Proposal 1	Proposal 2	Proposal 3	Proposal 4	Proposal 5	Proposal 6
Average	3.68	3.42	4.35	3.52	3.65	4.16
Median	4	4	5	4	4	5

Source: the authors.

Table 7. Summary of Respondents' Ratings for Improvement Proposals (in %)

Specification	Rating 1	Rating 2	Rating 3	Rating 4	Rating 5
Proposal 1	6.45	9.68	22.58	32.26	29.03
Proposal 2	16.13	9.68	22.58	19.35	32.26
Proposal 3	3.23	3.23	9.68	22.58	61.28
Proposal 4	9.68	12.90	22.58	25.81	29.03
Proposal 5	6.45	19.35	12.90	25.81	35.49
Proposal 6	3.23	6.45	12.90	25.81	51.61

Source: the authors.

Proposal 3 (a model co-operation agreement should be developed that is not complicated and binds both parties in partnership) was rated the highest. The mean score for this variant was 4.35, and the median was 5. This improvement was marked 5, or "very good," by as many as 61.28% respondents. Only proposal 6 (clear proposal of commercial services offered by the scientific entity) received a mean score higher than 4 (4.16); and the median was 5. Slightly more than half of the respondents (51.61%) marked it 5 ("very good"). For the remaining proposals, the average score was less than 4, and the median was 4. Proposal 2 (the university should hire a business co-operation manager who knows the needs of business and is able to talk to researchers) was rated the lowest. The average of all rates was only 3.42. In this case, the largest percentage of respondents marked it 1, or "very bad". They accounted for 16.13% of all respondents co-operating with research entities.

Plans to co-operate with a research institute were surveyed using a multiple-choice question test among entities. To the question, "When carrying out R&D projects, does your company co-operate with a scientific entity/research institute?",

these entities indicated that they wanted to but had not succeeded, or would still like to co-operate.

The analysis shows that less than 80% of respondents who wanted to co-operate but had failed to do so or would like to co-operate indicated that they plan to co-operate with a research entity on expert analyses, expert evaluations, opinions, or consulting. Approximately 55% of respondents intend or intended to outsource some of the work in an R&D project to a scientific entity. The results are presented in Figure 2.

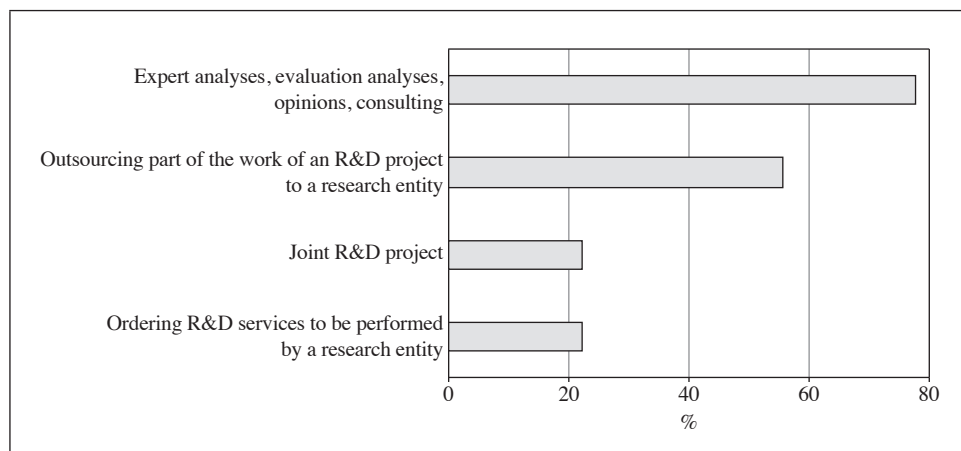


Fig. 2. Plans to Co-operate with a Scientific Entity

Source: the authors.

A key finding of this part of the research is that entrepreneurs are able to co-operate with research entities. However, they point to the need for improvements. The biggest challenge is overcoming legal barriers. An important finding from this part of the research is that entrepreneurs indicate the need for the research units to develop a transparent commercial offer.

4.3. Analysis of the Correlation between the Barriers and Needs of Entities Co-operating with Research Centres

Further statistical research focused on legal problems and the lack of commercial orientation among research entities. For each pair of options in the questions: “What barriers have you identified in your co-operation with the research entity?” and “What needs do you have with regard to co-operation with the research entity?”, Fisher’s exact test was carried out, with the null hypothesis stating that the characteristics were independent, and the alternative hypothesis indicating that there was

such a correlation. At the 0.05 level of statistical relevance, the correlation proved statistically relevant for only four barrier-need pairs. Only respondents who indicated that they worked with a scientific entity or research institute were surveyed. Detailed conclusions were obtained for the four barriers analysed. Key results include¹:

1. The problem of allocating intellectual property to the product being developed vs. the need for universities to adapt to market conditions. Respondents working with universities who did not observe a problem in the distribution of intellectual property to a product were more likely to express the need for universities to adapt to market conditions than those who identified such a barrier. The correlation was found to be statistically relevant.

2. Researchers can be ignorant of the market's needs and fail to adapt their projects to the needs of entrepreneurs vs. universities need to adapt to conditions on the market. Respondents working with universities who stated that researchers were unaware of market needs and their projects did not match the needs of entrepreneurs were more likely to report the need to adapt to market conditions than those who did not indicate such a barrier. The correlation was found to be statistically relevant.

3. Scientific entities may lack knowledge about commercial offerings vs. the scientific entity proposes solutions that could improve operations. Respondents working with universities who stated that the barrier was a lack of knowledge of the scientific entity's commercial offerings were more likely to report the need for the scientific entity to propose solutions that could improve their business than those who did not indicate such a barrier. The correlation was found to be statistically relevant.

4. Divergence of goals between science and business (science is interested in publications, business in generating cash from new solutions in the short term) vs. the need for research entities to adapt to the market conditions. Respondents working with universities who indicated this divergence of goals between science and business were more likely to express the need for universities to adapt to the market conditions than those who did not indicate such a barrier. The correlation was found to be statistically relevant.

The main conclusion of this part of the research is that research entities fail to understand the needs of the market. At the same time, entrepreneurs see researchers mainly as consultants who should provide solutions to technological problems. Research design is a complex process and the assumptions behind it vary considerably. A lack of knowledge of the needs of the economic environment and business representatives significantly hinders the preparation of an offer tailored to the needs of entrepreneurs.

¹ At the assumed statistical relevance level of 0.05, Fisher's exact test.

4.4. Analysis of the Correlation between the Barriers and Needs of Entities Co-operating or Wishing to Co-operate with Scientific Entities

In this part of the research, the limited (or even complete lack of) business awareness of researchers was examined. For each pair of variants of the corresponding questions on barriers and needs (according to the variants from the question, “When carrying out R&D projects, does your company co-operate with a scientific entity / research institute?”), exact Fisher’s test was carried out with the null hypothesis stating that the studied characteristics were independent, and the alternative hypothesis indicated that such a correlation occurred. At the 0.05 level of statistical relevance, the correlation proved statistically relevant for only four barrier-need pairs. The conclusions obtained require detailed discussion for each of the four barriers. Key results include²:

1. The problem of allocating intellectual property to the product being developed vs. the need for universities to adapt to market conditions. Respondents who did not observe a problem distributing intellectual property to the product being developed were more likely to express the need for the university to adapt to market conditions than those who did observe such a barrier. The correlation was found to be statistically relevant.

2. The problem in dividing intellectual property to the developed product vs. the need to be perceived as a customer rather than an applicant. Respondents who noted a problem in the distribution of intellectual property to the product being developed were more likely to express the need to be treated like a customer rather than an applicant than those who did not observe such a barrier. The correlation was found to be statistically relevant.

3. Researchers’ ignorance of market needs and failure to adapt their projects to the needs of entrepreneurs vs. the need for research entities to adapt to market conditions. Respondents who stated that researchers were unaware of the market needs and their projects did not match the needs of entrepreneurs were more likely to report the need to adapt to market conditions than those who did not indicate such a barrier. The correlation was found to be statistically relevant.

4. Divergence of goals between science and business (science is interested in publications, business in generating cash from new solutions in the short term) vs. the need for universities to adapt to market conditions. Respondents who observed this divergence of goals between science and business were more likely to express the need for universities to adapt to market conditions than those who did not.

This part of the research suggests there is a need for behavioural changes on the part of both researchers and administrative services. As the results indicate, research entities do not appreciate entrepreneurs as partners. Often entrepreneurs are treated

² At the assumed statistical relevance level of 0.05, Fisher’s exact test.

as applicants rather than customers who fund the research. At the same time, the approach of entrepreneurs is in need of improvement. Research procedures do not always allow the rapid development of a commercial solution that can generate positive cash flow in a short time.

5. Conclusions

The key finding of the survey is that Polish entrepreneurs are able to co-operate with research entities. In addition, researchers have competencies that are useful to entrepreneurs. A barrier to co-operation, however, is the lack of means of effectively collaborating. While small-scale entrepreneurs often lack the cash to fund long-term research, it is precisely time they need to comprehensively test innovative solutions. The quick production and sale of products can generate revenue, but it is not the imperative in research procedures. Thus, there is a need to seek long-term financing for innovation projects.

A lack of information on the willingness of entrepreneurs participating in the interviews to co-operate limited the formulation of full conclusions from the survey. Managers of small units often lack knowledge of the opportunities for co-operation with research entities. Another factor that limited the reliability of the answers provided may be a fear that entities pretending to be research organisations would aggressively promote their research services. This may have been the reason some chose the answer: “We do not co-operate and do not intend to co-operate”.

The research conducted allows us to draw the following conclusions:

1) a model co-operation agreement should be developed that is not complicated and binds both parties in partnership. This suggests there is a need for a standardised approach and the development of an uncomplicated agreement template;

2) attitudes in academia towards co-operation with business need to be radically changed. Researchers’ main motivation is to publish in reputable journals, not to co-operate with entrepreneurs;

3) unlike researchers, entrepreneurs’ main motivation is to quickly generate cash flow;

4) neither side focuses on developing unique high-end innovations;

5) there is a lack of commercialisation-oriented interaction between research entities and business. While entrepreneurs do not always know what research is being done at universities, researchers fail to comprehend the needs of entrepreneurs;

6) the results of the study show a significant correlation between researchers’ approach to business (far from market-oriented) and the expectations of entrepreneurs. Statistical studies reveal a need to for research entities to embrace the principles of business. This will allow for the development of effective research co-operation.

The research presented here is a preliminary solution for detecting barriers to co-operation between industry and academia. Combining research results and contextual information from entrepreneurs will help to develop ways of effectively co-operating. This preliminary research will be the basis for using a systemic approach to creating co-operation. Future work should focus on developing mechanisms for identifying business needs, which could in turn be used to design research. Preparing an own brand placement strategy for research entities will be another important step. A comprehensive commercial offerings developed by research entities will allow entrepreneurs to better reach researchers-innovators. The use of business-oriented and knowledge-based systems will allow enterprises to develop faster. A significant limitation of further research may be the reluctance of entrepreneurs to co-operate and disclose specific company secrets, potentially rendering future studies less representative.

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