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Article

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Scientific Papers of the University of Pardubice, Series D: Faculty of Economics and Administration

Provided in Cooperation with:

Faculty of Economics and Administration, University of Pardubice

Suggested Citation: Peterková, Jindra; Czerná, Katarzyna; Zimmermannova, Jarmila (2022) : Innovation ecosystem in selected regions of the Czech Republic and Poland, Scientific Papers of the University of Pardubice, Series D: Faculty of Economics and Administration, ISSN 1804-8048, University of Pardubice, Pardubice, Vol. 30, Iss. 1, pp. 1-14, <https://doi.org/10.46585/sp30011550>

This Version is available at:

<https://hdl.handle.net/10419/334773>

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Innovation Ecosystem in Selected Regions of the Czech Republic and Poland: Specifics of Infrastructure Supporting Innovative Entrepreneurship

Scientific Papers of the University of Pardubice, Series D: Faculty of Economics and Administration 2022, 30(1), 1550.
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DOI: 10.46585/sp30011550
editorial.upce.cz/SciPap

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Abstract

There are no official statistics in the Czech Republic and Poland mapping the number of start-ups, spin-offs, and organizations supporting innovative businesses. The paper defines the specifics of innovation ecosystem in selected regions of the CZ Moravian-Silesian Region and PL Silesian Voivodeship. Similar economic and socio-cultural developments characterize chosen regions. Hypotheses are defined whose statistical significance is evaluated through the Pearson Chi-Square test. The results are estimated separately for the Moravian-Silesian Region and Silesian Voivodeship and focus on identifying the ownership of organizations, the nature of services provided, and the average annual occupancy of clients in the business phase financing business support programs and possible cooperation between organization. Using the hierarchical cluster analysis with the Ward method, the authors described four clusters. Based on the results obtained from the solution, a general model of the innovation ecosystem supporting innovative entrepreneurship is defined.

Keywords

Innovation Ecosystem; Coworking; Start-Up; Business Incubator; Science and Technology Park

JEL Classification

M1, M2, O3

Introduction

The current world of business is changing dramatically. Its perspectives are increasingly associated with new scientific knowledge, applications, and rapid technology transfers globally. Various forms of innovative companies contribute to transferring the results of research and development into industrial life (Peterková, Wozniaková & Stefanovová, 2014; Peterková & Wozniaková, 2015; Adler, Florida, King & Mellander, 2019).

According to Švejda (2007), innovative business is associated with the projection of advanced knowledge into the business activities, allowing to achieve an added measure of products that have a higher quality and a price more acceptable than that offered by competitors. Innovative entrepreneurship forms include small to medium-sized firms, known as start-ups or spin-offs that do not have enough capital but are expected to achieve high profits after overcoming initial barriers. In knowledge economy a firm's knowledge and innovation activities to be closely intertwined (Guckenbiehl, Corral de Zubielqui & Lindsay, 2021).

Pomerol (2018) points out that the number of these innovative firms started to grow after the economic crisis, and the most significant increase occurred between 2006-2010. It appears that the conditions for the start-up, spin-off firms, and infrastructure supporting innovation businesses regarding similar economic and cultural developments are equal in the Czech Republic and Poland, especially in the border regions of the Moravian-Silesian Region (CZ) and Silesian Voivodeship (PL). Comparison of both areas enables to obtain information on possible differences in the functioning of innovation ecosystem and provides scope for potential cooperation.

Most Czech and Polish start-ups concentrate on software and application, while only a small percentage of companies are active in future industries such as healthcare, biotechnology, or robotics (Beauchamp, Kowalczyk,

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et al., 2016; Peterková & Wozniaková, 2016; Hrtúsová & Novák, 2017). Concomitantly, Staszkievicz & Havlíková (2016) emphasizes that most of the Czech start-ups (28%) focus on software for big data analytics (SaaS - Software as a Service), followed by the providing web services (21%) and the providing of mobile software services (17%). Following Beauchamp, Kowalczyk, et al. (2016), Polish start-ups are also the most active producers of powerful data analytics software; the second position is selling to small and medium-sized companies (B2B), and the third is that of analyzing large corporations as sales sources.

The number of start-up companies in the Czech Republic is predicted based on the database of StartupJobs.cz portal and field surveys. Hrtúsová & Novák (2017) indicate that there are 2000 start-ups in the Czech Republic, Staszkievicz & Havlíková (2016) add that the most significant number of start-ups concentrates in Prague (60%), followed by Brno (15.3%) and Ostrava (4%). In Poland, the number of start-up companies is based on the field survey and the database of the foundation StartupPoland. In Poland, the number of start-up firms is estimated at 2,700, with Warsaw (25%), Wrocław (12%), and Krakow (7%) identifying as three main start-up centers (Beauchamp, Kowalczyk, et al., 2016). The number of spin-off companies in the Czech Republic and Poland is not monitored.

The launch of start-up and spin-off businesses is difficult, especially infrastructure supporting innovation businesses should help with this phase. The authors of the article define innovation ecosystem as a support system created by organizations that provide services that help businesses, students, and researchers start developing their business. These organizations include science and technology parks (science park, technology park, business, and innovation center), incubators (business incubator, craft incubator, and technological incubator), and co-working centers. There are no official statistics of existing organizations in the Czech Republic and Poland, which belong to the innovation ecosystem supporting business development.

Staszkievicz & Havlíková (2016) say that 51 business incubators are working in the Czech Republic, of which 23 are privately owned, 21 are owned by the public, and seven are combined. Simultaneously, 15 science and technology parks and more than 80 co-working centers operate in the Czech Republic.

Based on the survey, 76 science and technology parks, 80 business incubators (23 technological incubators, 37 business incubators, and 20 academic incubators) were identified in Poland. It also appeared that 260 co-working centers operate there (Beauchamp, Kowalczyk, et al., 2016).

It appears that there are no official statistics in the Czech Republic and Poland mapping the number of start-ups, spin-offs, and organizations supporting innovative entrepreneurship, including monitoring their activities. Only studies mapping the number of start-up and spin-off companies, including organizations supporting innovative business, are available. Regular information and insights from the operations of these organizations are inadequate. Problems encountered by the organization are not specified. In Czech and foreign literature, the characteristic features and activities of science and technology parks, business incubators, craft incubators, innovation centers, co-working centers, and innovative entrepreneurship forms are defined. The question arises whether these specific activities differentiate infrastructure organizations even in real business practice.

The paper aims to map the specificities of innovation ecosystem supporting innovative entrepreneurship in selected regions of the Czech Republic and Poland, in the Moravian-Silesian Region and the Silesian Voivodeship. For this purpose, a research survey is carried out through a questionnaire on a selected innovation ecosystem sample, which contains 22 organizations. Subsequently, a hierarchical clustering analysis using the Ward method is realized, and sample analyzes are performed using the Pearson Chi-Square test in SPSS software. Simultaneously, the definition of the content of activities of individual types of infrastructure in real business practice is verified. The article contains a theoretical background, focused on defining the basic concepts related to the innovation ecosystem supporting entrepreneurship launching and development, the research methodology describing the used methods and the particular steps of the solution, followed by empirical research, the actual implementation of the study and the results, including the conclusions.

Theoretical Background

When defining a start-up firm, we can meet various definitions in literature and practice. According to Duda (2013) and Kohler (2016), the start-up firm is a newly emerging company that puts the business subject to an innovative idea. It means that a start-up company delivers a new product or produces it on the latest technological procedures basis or provides services in a way that no one else knows. Similarly, Peterková (2011) points out that the start-up firm can be perceived as a new business entity that offers unique products, uses new production directions, or makes new markets available to suppliers or customers. Several studies emphasize the need to cope with uncertainty (Ries, 2011; Guzman & Stern, 2016; Cho, Bonn & Kang, 2016; Aboen et al., 2017). Start-ups, in this understanding, continuously increase uncertainty in doing business in two ways. On the one hand, through the introduction of new technologies, products, and services, on the other, through the accumulation of capital resulting from the temporary monopoly position gained by technological success.

Damodaran (2012) defines a start-up company as a "young business" and emphasizes the need for market testing

of its offer, which is related to finding a market opportunity, business model including a marketing strategy (Picken, 2017). Following Wisseman (2005), a start-up can be characterized as a subject existing under certain market conditions less than a year that develops its product but does not sell it commercially. Based on this, it is an enterprise employing up to 49 employees. It is essential for start-ups at the beginning of the business to focus on the development, not just on the outcome. At the same time, the success of the start-up firm is related to the "start-up feeling." This is the enthusiasm that entrepreneurs throw into a business. It appears that 44% of start-ups globally end up in the third year of their lifecycle, with the main reasons for failure being the lack of market demand, lack of finances, and improper people (CB insight, 2014; Hrtúsová & Novák, 2017). Financial and insurance start-ups are considered the most successful in the world.

Orłowski (2013) points out that innovations, not only of the product and technology type but also of the entrepreneurial model, are essential for the stable functioning and development of start-up companies in a global environment. The development of start-up companies is helped by a well-functioning start-up environment linked to the country's high export activity, high level of investment in research and development, high level of professional activities, strong e-commerce position, and intense urbanization. Based on the results of the Visegrad Startup report 2016/2017, the Czech Republic is a leader in the Global Innovation Index and has the most substantial ranking in the Visegrad countries (V4: Poland, Slovakia, Czech Republic, Hungary) in many registered patents (Hrtúsová & Novák, 2017, Crass et al., 2019). On the contrary, the environment's weakness is low venture capital investment and a small number of Startup Weekends. Compared to the V4 start-up environment, Poland has an excellent placement within the Doing Business Index and the most significant number of Startup Weekends organized. The weaknesses include the lowest rankings in the Global Innovation Index and low patenting activity.

Unlike the start-up of the company, the spin-off firm is founded to utilize and develop the university's intellectual property, in the form of a product or service applicable to the customers or entrepreneurs (Miranda, Chamorro & Rubio, 2017). In harmony with this view, Poláček & Attl (2006) defines the spin-off as a firm that rises by using intangible assets as capital stock in a newly rising corporation (e.g., university know-how). Shane (2004) perceives spin-offs as a newly established firm that partially uses some universities' intellectual assets. It can be divided into two groups: the spin-offs that make up academic college staff who are her employees or students and spin-offs made up of college graduates (Kislingerová, 2011). There are also no statistics for spin-offs, and their number is smaller than start-ups.

The launch of start-up and spin-off businesses is difficult, and their viability requires support through infrastructure that supports them in phases of launching and further development. This ecosystem includes particularly business incubators, science and technology parks, innovation centers, and co-working centers (Chrzanowski & Zawada, 2019, Popkova et. al., 2020). According to The Commonwealth Department of Industry in Australia, a business incubator is a device designed to help emerging businesses, providing space, advice, and services to make the company well-established and profitable (Bergek & Norrman, 2008). Fukugawa (2017) claims that Incubators can be understood as technology transfer organizations because they focus on the commercialization of undeveloped inventions mostly held by universities and large R&D companies. Goals are achieved by supporting start-up and spin-off companies. The incubation period is usually one to three years, during which time an enterprise can be transformed into an established business entity and become part of a broader business community (Dewrsb, 2001; Pattnaik et al., 2020). Nair & Blomquist (2018) imply that the business incubator supports the process of launching a start-up or innovative companies. Simultaneously, it is the incubator that decides to select suitable entrepreneurs for admission to the incubation program.

The business incubator is also described as a facility providing favorable conditions to help manage new businesses' growth (Tanakov, 2020). In the meantime, a business incubator is defined as a private company or a publicly established and managed institution that allows new and emerging companies at a time when these companies are the most vulnerable: at the beginning of their business (Phan, Siegel & Wright, 2005; Hrtúsová & Novák, 2017). A specific incubator type is a craft incubator that combines a business incubator and a creative studio's functions. It stimulates creative ideas and promotes its commercial use. One of the first business incubators in Europe was founded in France (Cambridge Science Park and Sophia Antipolis) in 1960. According to Lalkala & Bishop (1996), incubators exist in developed Western countries and developing countries such as Turkey, Nigeria, and Brazil. Konečný et al. (2001) define four types of business incubators according to their owner: 1. Public and non-profit incubators aimed at supporting the development of the region's economy. Government or non-profit institutions fund them. 2. University incubators designed to implement university research and learning objectives. They operate at universities. 3. Private incubators designed to transfer knowledge from some industries to business life. are created by entrepreneurs using equity or equity participation in these incubators. 4. Hybrid public and private incubators, where new ideas are transformed into natural forms using state funds and other sources of finance such as non-profit agencies and the private sector. Business incubators are mainly funded by public funds and have strong links with authorities at a regional and local level (Hackett & Dilts, 2004; van Stel et al., 2019). In the Czech Republic and Poland, business incubators began to emerge mainly from 2004 (both countries became part of the European Union), given the possibility of using the Structural Funds. There are differences in the number of incubators within each territorial unit and the services provided in each country.

Another tool to support innovation and entrepreneurship is Science and Technology Parks. Veber et al. (2016) claim that it provides partnerships or mediates contacts between new knowledge builders and the business sector to facilitate the emergence and development of innovative enterprises. The term "science and technology park" has been used in the Czech Republic since 1990 for all kinds of parks. In Poland, the term for science and technology parks has been used since 2002. Their founders can be public institutions, especially at a local and regional level, universities, research institutions, and business entities. Science and Technology Parks are profiled into three essential types of science parks: technology parks, business, and innovation centers. Recently, the creation of co-working centers, which mean shared workspaces, is becoming popular. Independent individuals use them as their business place (Gandini, 2015; Bouncken & Reuschl 2016; Cunningam et al., 2019). Co-working is a collaborative and flexible working style based on mutual trust and the sharing of core values and goals. Many authors also emphasize the idea of self-employment in the collective (Spinuzzi, 2012; Fuzi, 2015).

Besides, the creation of the questionnaire was based on consultations with a representative of the management of the Business Incubator VŠB-TUO, the founder of VŠB-TUO, where the authors of the article work (at one of the faculties). Also, surveys conducted by UBI Global since 2014 meant inspiration. UBI Global is an international research firm founded in 2013 in Stockholm to improve business incubators and accelerators' programs and increase their overall efficiency. UBI Global specializes in benchmarking, and indexing incubators and accelerators linked to universities or are privately-, publicly-, or corporate-run. All participants will receive their scorecard (and customized scorecard) based on the comparison test.

Research objective, methodology and data

Empirical survey

The mapping of innovation ecosystem supporting the emergence and development of entrepreneurship is carried out by empirical research and by sample surveys on a selected sample of 22 organizations. Selected organizations represent the innovation ecosystem supporting innovative businesses in the Moravian-Silesian Region (CZ) and the Silesian Voivodeship (PL).

The Moravian-Silesian Region is one of the 14 territorial self-governing units in the Czech Republic (Czech Statistical Office, 2020). It has an area of 5 428 km² with a population of 1 213 000. It belongs to the third most populous region in the Czech Republic, which corresponds to a population density of 224 inhabitants per km². The hard coal deposits have been destined for the mining and metallurgical industry. Despite the downturn in heavy industry and mineral extraction, more than a third of 550.9 thousand employed in the national economy currently works in the industrial sectors. In recent years, heavy industry has been replaced by manufacturing industries, and services are developing. The number of business units in the region is 256 871 of the total number of economic entities in the Czech Republic, i.e. 2 889 422 (Czech Statistical Office, 2019). The Moravian-Silesian Region borders the Silesian Voivodeship.

The Silesian Voivodeship is one of the 16 territorial self-governing units in Poland with an area of 12 333 km² with a total population of 4,559,200. It is the most populous voivodeship with a population density of 370 inhabitants per km². Silesian Voivodeship is associated with the tradition of the mining and metallurgical industries. Within Poland, there are most people employed in the industry field (488.7 thousand). In addition to large industrial enterprises, small specialized businesses are being deployed in Silesian Voivodeship services (especially ICT) or medicine. Another priority area is energy. In total, there are 467 thousand business units (Polish Statistical Office, 2020).

The selection of regions for individual countries is not random but is targeted. The Czech Republic and Poland are among the countries of the former Eastern bloc with comparable economic, cultural development, and shared history, including problems associated with implementing innovative entrepreneurship and its support. Simultaneously, the selected regions of the Moravian-Silesian Region for the Czech Republic and the Silesian Voivodeship for the PL have a similar industrial character and are border regions. These are regions where many companies operate in the industry (according to CZNACE section B + C + D + E), while they operate mostly in the manufacturing industry. At the same time, selected regions have been associated with the heavy industry for many years and with companies' activities in the field of mining and quarrying and metallurgy and foundry. Both regions have undergone industrial restructuring and are trying to change the industry's nature by supporting innovative entrepreneurship through the created infrastructure (science and technology parks, business incubators, and coworking centers). According to the CZSO data for 2019, the Moravian-Silesian Region is the second largest region out of 14 regions in the Czech Republic in terms of the number of business entities and revenues from selling products and services of an industrial nature. According to the Polish Statistical Office, the Silesian Voivodeship has the first place out of all voivodeships in the PL concerning the number of business entities and revenues from selling products and services of an industrial nature.

The empirical survey was carried out on the interview questioning basis through a prepared questionnaire, which contained a total of 20 questions. The questions in the questionnaire were based on consultations with an employee of the Innovation Support Centre of the VŠB-TUO, who has many years of practical experience with the functioning of an innovation centre. It was also based on international studies (World Benchmark Study), which aims to identify

common features and best practices of innovation centres around the world. The survey has been conducted by UBI Global since 2014. UBI Global that specializes in benchmarking and indexing university business incubation programs.

The management of individual organizations took part in a questionnaire survey lasting one month (in 2020). The questionnaire was structured and focused on three areas: finding necessary information about organizations supporting entrepreneurship in the Moravian-Silesian Region and the Silesian Voivodeship, implementation of programs supporting the development of business activities of clients, and willingness to cooperate with other organizations supporting the development of business abroad. Thirteen organizations in the Moravian-Silesian Region attended the research. For the incompleteness of the data provided by two organizations, the obtained data are evaluated only in 11 organizations. In Silesian Voivodeship were approached 17 organizations, but only 11 organizations attended the survey. The total research sample was 22 organizations. The rate of return of the questionnaire is 73%. Concerning the organization's type of owner, the organizations were owned 45% by a private business entity, 30% by a university, and 25% by a public institution. Simultaneously, about the type of organization, the research sample consisted of 18.4% innovation centers, 32% business incubators, 4.5% craft incubators, 31.5% science and technology parks, and 13.6% coworking centers.

Cluster analysis

Cluster analysis refers to a set of methods designed to analyze multidimensional data to classify objects' plurality into several relatively homogeneous subsets, designated as clusters. Objects inside clusters should be as close as possible and objects belonging to different clusters as different as possible. The primary criterion for building clusters is the similarity between objects. For measurements of similarities, an appropriate correlation rate, distance measure, or association rate can be applied. Correlation and distance measurements are mainly used for ratio data, while association rates are more for enumeration (nominal) data. Distances between the Euclidean distance, the Euclidean square, the Manhattan distance (Hamming metric), the generalized Minkov Metric, the distance trajectory, and the Mahalanobis metric are standard. Common clustering methods include: nearest neighbor method - cluster pair is selected according to the smallest distance; farthest neighbor method - the cluster pair is chosen at the broadest reach; the average distance method - based on the average distance of all objects in the 1st cluster to all the objects in the 2nd cluster - and the Ward method - at each step, for each pair of deviations, the increment of the sum of the squares of the deviations resulting from their merger is computed, and then the clusters, which corresponds to the minimum value of this increment are combined. A binary tree, a dendrogram, can represent clustering with this method.

Ward's method is suitable for working with objects that have the same dimension of variables. Ward's minimum variance method is the most commonly used in management (Charry et al., 2016).

The cluster analysis included 22 organizations of analyzed innovation ecosystem aggregated by 12 Variables (owner, occupancy, rental, consultancy, rental and consultancy, students, research, others, pre-incubation phase, incubation phase, growth), see Table 1—the Euclidean metric calculated the distance (proximity) between the profiles. Bridging the objects were compared by Ward's method. Cluster analysis was performed using SPSS software.

Table 1. Characteristics of data entering cluster analyses.

Number	Organizations	Countries
1.	Podnikatelský inkubátor Steel IT	Czech Republic
2.	BIC Ostrava	Czech Republic
3.	Centrum buněčné terapie a diagnostiky a.s.	Czech Republic
4.	RVP Invest a.s.	Czech Republic
5.	Statutární město Karviná, Business Gate	Czech Republic
6.	FERRIT s.r.o.	Czech Republic
7.	Řemeslný inkubátor Ostrava z.s.	Czech Republic
8.	Centrum podpory inovací VŠB-TUO	Czech Republic
9.	Moravskoslezské inovační centrum	Czech Republic
10.	IdeaHub z.s.	Czech Republic
11.	Cowo Novo	Czech Republic
12.	Tarnogórski Inkubator Przedsiębiorczości	Poland
13.	Śląski Inkubator Przedsiębiorczości	Poland

14.	Twój StartUp Częstochowa	Poland
15.	Będziński Inkubator Przedsiębiorczości	Poland
16.	Bytomski Park Przemysłowy	Poland
17.	Żorski Park Przemysłowy	Poland
18.	Jaworznicki Park Przemysłowy	Poland
19.	PNT Technopark	Poland
20.	Akademickie Inkubatory Przedsiębiorczości	Poland
21.	Klub Przedsiębiorcy Przy Zamku Cieszyn	Poland
22.	BIELSCOWORKING	Poland

The selective analysis of the survey was carried out on the data obtained from the questionnaire survey basis. Selected areas of investigation for the Moravian-Silesian Region (CZ) and Silesian Voivodeship (PL) are listed; see Table 2.

Table 2. Selected investigation areas

Selected investigation areas	Owner					
	Private business unit		Public institution		University	
	PL	CZ	PL	CZ	PL	CZ
Providing services in the form of space renting and, at the same time, entrepreneurship support services	0 %	40 %	38.33 %	20 %	0 %	8.3 %
Clients are companies where students work	50 %	2.5 %	15 %	5.67 %	0 %	22.9 %
Clients are firms where researchers from the university operate	0 %	1.25 %	7.5 %	0.33 %	0 %	2.1 %
Clients are companies where private units operate	50 %	96.25 %	77.5 %	94 %	0 %	75 %
Number of companies that completed the program in the pre-incubation phase	0 %	50 %	0 %	10 %	0 %	65.9 %
Number of companies that completed the program in the incubation phase	65 %	25 %	0 %	23.33 %	0 %	34.1 %
Number of companies that completed the program in the growth phase	35 %	75 %	100 %	16.67 %	0 %	0 %

For this purpose, hypotheses were defined, the statistical significance of which was assessed separately in the research sample from the Moravian-Silesian Region and the Silesian Voivodeship. The hypotheses are:

H1: There is a difference with the types of owners of the organization (private owner, a public institution, university) concerning clients (company as a student, company as a researcher, firm as a private entity).

H2: There is a difference in organization owners' types concerning the number of companies that have completed the program in pre-incubation, incubation, and growth phases.

H3: There is a difference in the organization types for the average annual occupancy rate of the firms.

The established hypotheses do not verify theoretical assumptions, are based on an empirical study by UBI Global, and are primarily intended to provide new findings on the effect of the type of organization owner on existing client type, on the number of firms completing the program in each phase, and on average annual firm occupancy.

The defined hypotheses were evaluated using the Pearson Chi-Square test in SPSS software, particularly in a research sample for the Moravian-Silesian Region and the Silesian Voivodeship.

Results and discussion

Results of the Empirical Survey on Innovation Ecosystem in the Moravian-Silesian Region

Organizations supporting business development in Moravian-Silesian Region are owned mostly by a private business unit (4 organizations). A public institution owns three organizations, three are owned by a combined (public institution, university, private business unit), and a university owns only one organization. It was found that most of the organizations of infrastructure supporting innovative entrepreneurship provide the same services for entrepreneurs. Concerning the range of services offered by these organizations, it appears that there is no unambiguous definition of a bid characterizing the organization representing the particular type of innovation ecosystem.

For the sample of organizations surveyed, it appeared that the average annual occupancy rate by companies regarding the capacity offered by organizations is 58.8%. The main clients are companies that only rent space (49.16%), followed by companies that rent space and provide business support services (27.12%), and the least numerous are companies that only offer services that support business development (23.72%). From the structure of clients exclusively provided with space rent, 59% is a public institution as the owner, and 52.5% of the cases are private owners.

Current company structure or clients, which are provided with rent and services, form a broad range of companies with the character of private business units (85.45%), followed by companies where students are acting (9.99%) and firms employing researchers, the so-called spin-off firms (4.55%).

Organizations mostly provide for all clients' office space (13.33%), access to the market through partnerships (13.33%), and coaching and mentoring (11.67%). Other services are captured; see Table 3.

Table 3. Provided services

Services	Frequency	Percentage share	Rank
Office space (rent)	8	13.33 %	1.
Coaching and mentoring	7	11.67 %	3.
Access to finance	6	10 %	4.
Market access through partnership	8	13.33 %	2.
Human Resources	6	10 %	4.
Laboratories	5	8.33 %	5.
Intellectual property protection	5	8.33 %	5.
Law services	2	3.34 %	7.
Accounting and tax services	4	6.67 %	6.
Founding a company	5	8.33 %	5.
Others	4	6.67 %	6.

Note: As part of the questionnaire survey, the organizations involved in the research chose from the listed offer the services they use.

Among the main problems associated with their activities, the organization mainly mentioned ignorance and lack of clients, bureaucracy, the complexity of firms' access to subsidy programs, lack of business competencies, and lack of human resources.

The clients' occupancy has been finding out when entering an organization concerning phases of realized entrepreneurial activities for the past three years. The stages of the entrepreneurial activities in organizations included a pre-incubation step, which means the design and verification of the idea's viability. Then the incubation phase, in which the business starts as part of an existing business idea. In the growth phase, an established firm is looking for an opportunity for further development. Most of the clients were in the growth phase (46.36%), then in the incubation phase (27.36%), and finally in the pre-incubation phase (26.27%). At the same time, it identified how many companies have completed the program in the various stages of implementing business activities. At the pre-incubation phase, the program successfully ended 31.45% of companies, 24% of companies completed the incubation phase, and finally, 49.09% of companies were successful in the growth phase.

Programs supporting the clients' business development and provided by organizations are financed primarily from service charges (31.43%), renting space (22.86%), and state subsidies (20%).

It appeared that 81.82% of the organizations in innovation ecosystem supporting the development of the Moravian-Silesian Region businesses would benefit from cooperation with other similar organizations in the Silesian Voivodeship. Most of the organizations (9 companies) would appreciate especially cooperation in the field of joint projects supporting the development of business, then experience and information exchange on services provided in the area of business support (7 companies) and organization of joint seminars and competitions for start-up companies (5 companies).

Results of Empirical Survey on Innovation Ecosystem in the Silesian Voivodeship

Organizations conducive to business development in the Silesian Voivodeship are owned mostly by a public institution (6 organizations); in the case of 4 organizations, it is a combined owner. Only one organization is owned strictly by a private business unit. The questionnaire did not contain a response from a subject owned by the university only.

Given the capacity offered by the surveyed sample of organizations, the average annual occupancy is 81.18%.

Besides, it appeared that 56.85% of the cases clients of the company are using only rental services, 24.55% of the monitored companies offer rental space with accompanying services, and in 18.64% of cases, there is an offer, which contains only services that support the development of a business. It shows a specific rental specialization trend and the recent departure from providing additional services for start-up clients separately. From the structure of the clients who are only offered with space rent, 70% of them are privately owned. In 83.75% of cases, the ownership is combined.

From the point of view of the current structure of clients, which are provided simultaneously with the renting of premises and additional services supporting the development of business, the most significant number of private business units is represented (83.18%), the share of companies where the students work is 12.73%, followed by companies in which researchers operate, so-called spin-off companies (4.09%).

The organization actively provides for all clients, mostly with the rent of office space (31.41%), coaching, and mentoring (22.86%). The list of other services provided is also captured see Table 4.

Table 4. Provided services in the Silesian Voivodship.

Services	Frequency	Percentage share	Rank
Office space (rent)	11	31.43 %	1.
Coaching and mentoring	8	22.86 %	2.
Founding a company	6	11.43 %	3.
Law services	3	8.57 %	4.
Accounting and tax services	2	5.71 %	5.
Others	2	5.71 %	5.
Market access through partnership	1	2.86 %	6.
Laboratories	1	2.86 %	6.
Intellectual property protection	0	0 %	7.
Human Resources	0	0 %	7.

Note: As part of the questionnaire survey, the organizations involved in the research chose from the listed offer the services they use.

The main problems mentioned by organizations supporting business development include the lack of knowledge of business activity's basic principles in the Silesian Voivodeship. Furthermore, the surveyed organizations pointed to the problem of insufficient awareness of their organizations' existence (e.g., through specialized media or publicly available databases) or lack of support from local authorities.

For the comparison with results from the Moravian-Silesian Region, the clients' occupancy during the entry into the organization within the individual phases of the implemented entrepreneurial activities over the last three years has been mapped. Most of the sample clients were currently in the growth stage (43.19%), followed by the preincubation phase (33.28%), and then in the incubation phase were identifying 23.55% of monitored organizations. In completing the program at specific phases of the implementation of business activities, the success rate was 18.18% in the preincubation stage, 18.64% in the incubation phase, and finally 59.55% in the growth phase.

The programs provided by the studied organizations are sponsored by private units (40%), state and European subsidies (25.71%), and rental fees (25.71%). Service charges participate in 20%.

Cooperation with organizations of a similar type in the Moravian-Silesian Region in the Czech Republic would welcome 72.73% of the surveyed organizations from the Silesian Voivodeship. This cooperation should include joint seminars on business support and collaborative projects to support businesses' development (both four companies) or the exchange of experience and information on business support services (3 firms).

Results from cluster analysis

A hierarchical clustering analysis, Ward's technique with Euclidean distance, was used to perform cluster analysis. A dendrogram generated by the Ward method was also used to define the final number of clusters. Clusters were identified through this analysis. The Ward's minimum variance method creates clusters that minimize variance within each cluster. For each cluster, the mean is calculated. In each cluster, the observations are compared to the mean for each variable. Observations and/or clusters are combined so that the variance within the final cluster solution is minimized. The process of clustering of individual innovation ecosystem organizations shows Table 5.

Table 5. Agglomeration Schedule - description of the clustering process based on minimal scattering analysis.

Stg.	Cluster Combined		Coef.	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	17	18	.000	0	0	2
2	16	17	.000	0	1	11
3	12	15	.189	0	0	7
4	5	9	.410	0	0	7
5	4	6	.974	0	0	15
6	13	14	1.729	0	0	14
7	5	12	2.875	4	3	10
8	2	8	4.109	0	0	13
9	1	20	6.739	0	0	12
10	5	11	9.630	7	0	11
11	5	16	13.407	10	2	19
12	1	7	17.376	9	0	20
13	2	22	21.923	8	0	15
14	3	13	28.061	0	6	17
15	2	4	35.940	13	5	18
16	10	19	45.321	0	0	20
17	3	21	55.824	14	0	18
18	2	3	73.603	15	17	19
19	2	5	97.728	18	11	21
20	1	10	125.785	12	16	21
21	1	2	168.000	20	19	0

Individual innovation ecosystem organizations were identified by the numbers as shown in the table. The entire clustering process displays the dendrogram in Figure 1.

Using the Ward method, four clusters of organizations of analyzed innovation ecosystem were created. The first cluster comprises organizations 17, 18, 16, 12, 15, 5, 9, 11, of which five are based in Poland and the Czech Republic. These organizations focus on rent rather than on advice; clients are not students or research workers. Still, other private companies, organizations focus on companies in growth.

The second cluster comprises organizations 4, 6, 2, 8, 22, of which one is based in Poland and 4 in the Czech Republic. These organizations associate with the same occupancy rate; clients are not students or researchers but other private companies, while innovation ecosystem organizations provide clients with advice and hiring simultaneously.

The third cluster comprises organizations 13, 14, 3, 21, of which three are based in Poland and one organization in the Czech Republic. The organizations combine the same occupancy rate by providing services to clients such as advice and hiring. Clients are not students or researchers but other private entities.

The fourth cluster comprises organizations 1, 20, 7, 10, 19, of which two are based in Poland and three in the Czech Republic. Organizations have a low percentage of companies that have completed the program.

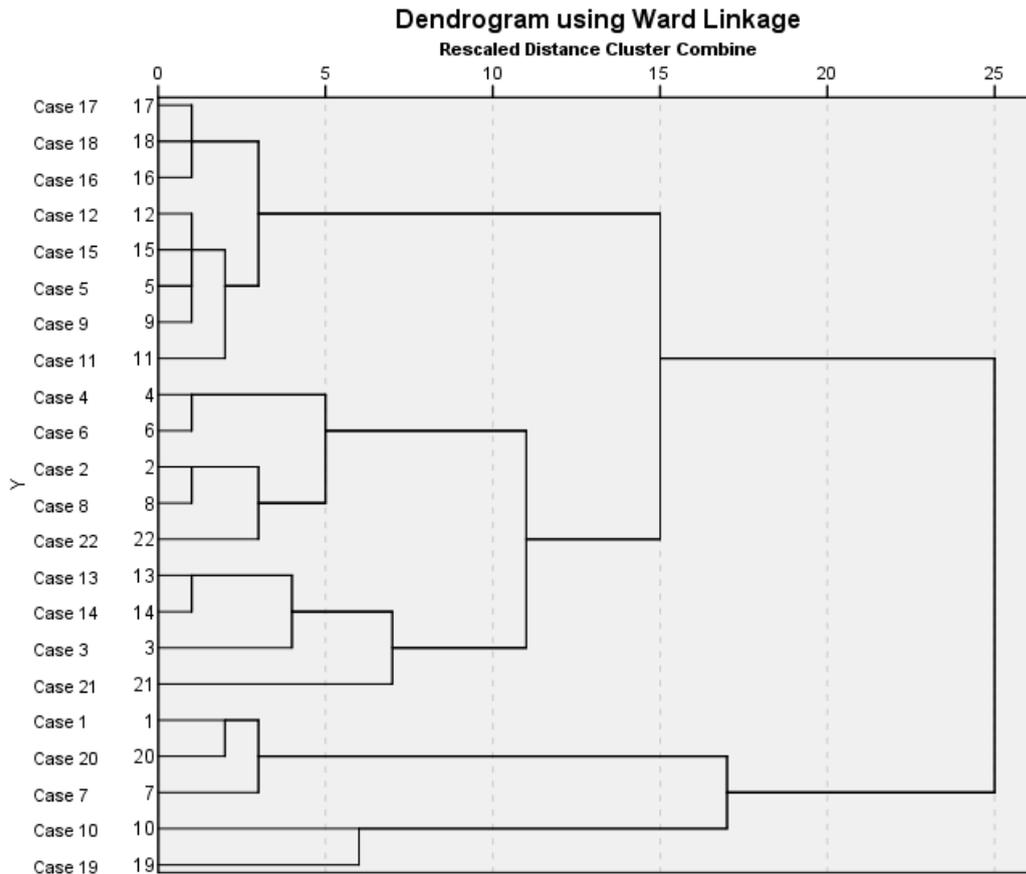


Fig. 1. Dendrogram.

Results from sample surveys of the survey for the Moravian-Silesian Region and the Silesian Voivodeship

The Pearson Chi-Square test for the verification of hypotheses 1, 2, and three was carried out in the framework of the sample analysis of the survey, particularly for a sample of organizations in the Moravian-Silesian Region (11 organizations) and a selection of organizations in the Silesian Voivodeship (11 organizations).

Verification of hypothesis 1

Using the Pearson Chi-Square test, a sample of organizations in the Moravian-Silesian Region confirmed the difference between the types of owners of the organization concerning the firm as a researcher (Pearson Chi-Square test, which had a value of 25.57 with 15 degrees of freedom, meaning that 100 % had expected the count less than 5. The minimum expected count is 0.043). On the other hand, there was no confirmation of the difference in the types of owners of the organization concerning the firm as a student (Chi-Square test was performed which had a value of 16.42 with 12 degrees of freedom, meaning that 100% had expected the count less than 5. The minimum expected count is 0.172) and the company as a private subject (Chi-Square test was performed which had a value of 27.06 with 18 degrees of freedom, meaning that 100% had expected the count less than 5. The minimum expected count is 0.078).

For the sample from the Silesian Voivodeship, no distinction was identified between the types of owners of the organization for the firm as a student (Pearson Chi-Square test was performed which had a value of 7.72 with 6 degrees of freedom, meaning that 100% had expected the count less than 5. The minimum expected count is 0.259), a firm as a researcher (Pearson Chi-Square test was performed which had a value of 2.03 with 4 degrees of freedom, meaning that 100% had expected the count less than 5. The minimum expected count is 0.729) and the company as a private unit (Pearson Chi-Square test was performed which had a value of 5.58 with 4 degrees of freedom, meaning that 100% had expected the count less than 5. The minimum expected count is 0.232).

Verification of hypothesis 2

Using the Pearson Chi-Square test, the sample tested in the Moravian-Silesian Region confirmed a difference in the types of owners of the organization concerning the number of firms that had completed the program in the incubation phase (Pearson Chi-Square test was performed which had a value of 24.51 with 12 degrees of freedom, meaning that 100% had expected the count less than 5. The minimum expected count is 0.017). On the other hand, there was no difference in the type of owners of the organization about the number of companies that had completed the program in the pre-incubation phase (Pearson Chi-Square test was performed which had a value of 26.40 with 12 degrees of freedom, meaning that 100%. The minimum expected count is 0.009) and in the growth

phase (Pearson Chi-Square test was performed which had a value of 15.64 with 9 degrees of freedom, meaning that 100% had expected the count less than 5. The minimum expected count is 0.075).

The sample of organizations in the Silesian Voivodship did not confirm the difference in the types of owners of the organization concerning the number of companies that had completed the program in the incubation phase (Pearson Chi-Square test was performed which had a value of 6.41 with 4 degrees of freedom, meaning that 100% had expected the count less than 5. The minimum expected count is 0.170) and in the growth phase (Pearson Chi-Square test was performed which had a value of 7.33 with 12 degrees of freedom, meaning that 100% had expected the count less than 5. The minimum expected count is 0.291). On the contrary, it was confirmed that the type of owners of the organization varies concerning the number of companies that had completed the program in the pre-incubation phase (Pearson Chi-Square test which had a value of 12.83 with 4 degrees of freedom, meaning that 100% expect the count less than 5. The minimum expected count is 0.012).

Verification of hypothesis 3

The values from Person's Chi-Square test did not confirm differences between the types of owners of the organization for the average occupancy rate of the companies (Chi-Square test, which had a value of 29.70 with 21 degrees of freedom, meaning that 100% had expected the count less than 5. The minimum expected count is 0.098). In the case of the sample examined in the Silesian Voivods, the difference between the types of owners of the organization and the average occupancy was confirmed (Chi-Square test, which had a value of 22.00 with 12 degrees of freedom, meaning that 100% had expected the count less than 5. The minimum expected count is 0.038).

Discussion

It has been confirmed that there are no official statistics in the Czech Republic and Poland mapping the number of start-ups, spin-offs, and organizations supporting innovative entrepreneurship, including monitoring their activities. Based on studies that contain conclusions from the field survey, it is estimated that there are 2000 in the Czech Republic and 2700 in Poland, so-called start-up companies. About the number of start-ups per capita, there are more start-ups in the Czech Republic. The Czech and Polish start-ups are most active in the production of large data analytics software. Based on the available data from published studies regarding the number of science and technology parks, business incubators, and coworking centers, there is a more significant number of incubators and coworking centers per capita in the Czech Republic. At the same time, there is a more considerable number of science and technology parks per capita in Poland. Own empirical study based on data obtained from the selected sample of companies supporting innovative entrepreneurship (11 organizations in Moravian-Silesian Region and 11 organizations in Silesian Voivodeship) has shown that the organizations representing the innovation ecosystem are mostly privately owned in the Moravian-Silesian Region, while in the Silesian Voivodships organizations are owned by the public institutions.

Table 6. Specificities of innovation ecosystem supporting innovative entrepreneurship.

Selected specifics	Specifics in the Moravian-Silesian Region	Specifics in the Silesian Voivodeship
Dominant infrastructure owner	Private business unit	Public institution
Average annual occupancy rate	Up to 60 %	Over 60 %
Differences in services provided by organizations in infrastructure	No	No
Dominant provided service	Office space (rent)	Office space (rent)
Clients – office space	Public institution	Private business unit
Other clients' interests	Market access through partnership	Founding company
The highest occupancy of clients in individual phases of the entrepreneurial activities (preincubation, incubation, and growth)	Phase of growth	Phase of growth
Programs financing	Service charges + funds from renting	Private units' sponsoring + state and European subsidies
Fields of cooperation	Joint workshops, projects, exchange of experience	Joint workshops, projects, exchange of experience

No apparent differences in activity between science and technology parks, a business incubator and coworking center about the services provided were found in the sample from the Moravian-Silesian Region or even in Silesian Voivodeship. It was determined that similar services are offered to clients by all infrastructure types (science and

technology parks, a business incubator, coworking center). Simultaneously, it appeared that coworking centers are located in urban centers, on the other hand, science and technology parks and business incubators on the outskirts of towns. The average annual organizations' occupancy rate regarding Silesian Voivodeship's offered capacity is 22.38% higher than in the Moravian-Silesian Region. The Moravian-Silesian Region innovation ecosystem's main clients are companies owned by a public institution, but in the Silesian Voivodeship, these clients are owned by a private business unit. Both clients are provided mostly with space rental. The smallest is a group of clients with business support services only.

Given the above findings, it is possible to define the specifics of innovation ecosystem supporting innovative entrepreneurship in the Moravian-Silesian Region and the Silesian Voivodeship, see Table 6.

The specific features help better understand the innovation ecosystem in the Moravian-Silesian Region and the Silesian Voivodeship, thus cooperating in selected areas, for examples joint workshops, projects, exchange of experience. Despite the existing specifics of innovation ecosystem in the Moravian-Silesian Region and Silesian Voivodeship, it is possible to define a general model for the innovation infrastructure functioning.

Conclusion

The infrastructure represented by science and technology parks (science parks, technology parks, business and innovation centers), incubators (business, technology, and craft), and coworking centers plays an essential role in developing innovative entrepreneurship in Moravian-Silesian Region and Silesian Voivodeship.

A questionnaire survey in selected regions of the Czech Republic and Poland, analysis of the survey sample of organizations in innovation ecosystem supporting business development, and hierarchical cluster analysis were carried out. The questionnaire survey was evaluated using relative and absolute frequency.

The hierarchical clustering analysis was performed using the Ward method, and four clusters were identified. The hierarchical clustering analysis results showed that all organizations in innovation ecosystem supporting business development in the Moravian -Silesian Region and the Silesian Voivodeship do not differ in the range of services provided. There are no significant differences in each type of these organizations' services. Business incubators, science and technology parks, and coworking centers provide services with similar character. In the case of sample analysis, the hypotheses were verified using the Pearson Chi-square test.

Organizations representing infrastructure implement activities in the form of consulting and service provision. This results in output in the format of new viable proposals, newly created startups, the development of existing startups, and regions' actual development. A general model of innovation infrastructure functioning is shown in Figure 2. The research results show that future research should evaluate the benefits of start-up companies and their impact on life in the Moravian-Silesian Region and the Silesian Voivodeship.

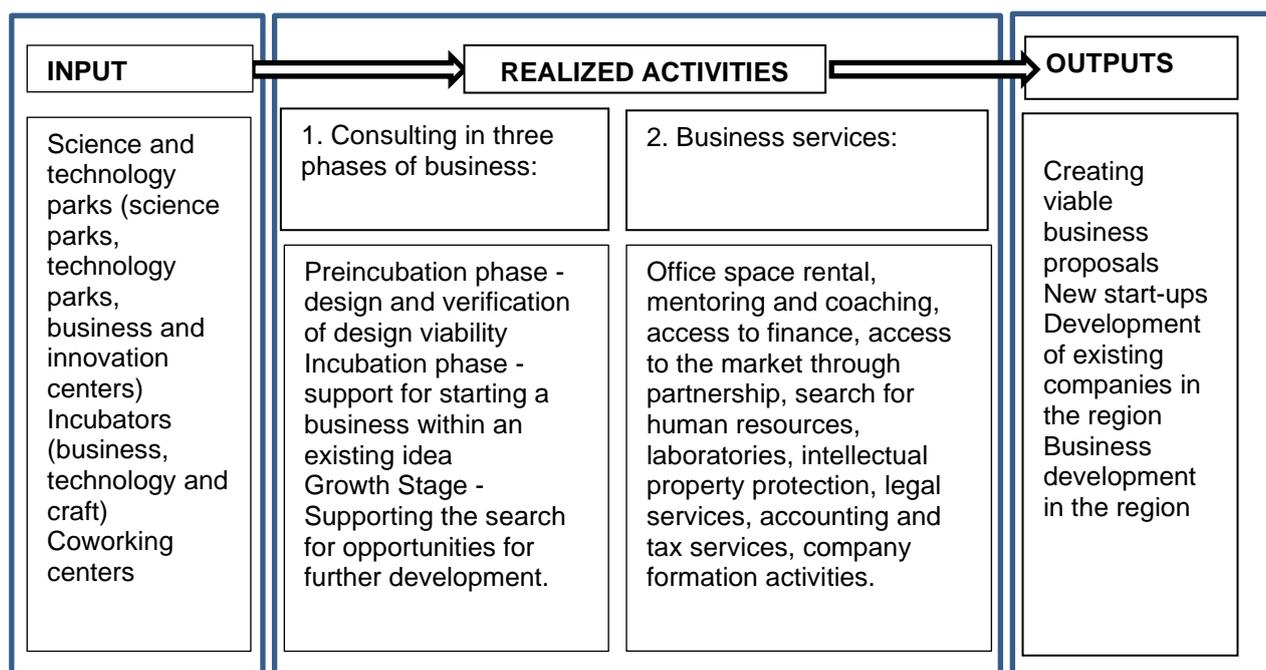


Figure 2. General model of innovation ecosystem supporting entrepreneurship.

The research results showed that the built innovation ecosystem supporting innovative entrepreneurship in MSK and the Silesian Voivodeship, primarily through the provision of advisory services and preferential leasing of

premises for business, helps create new or to develop existing business entities. This promotes entrepreneurship in the regions, particularly the support of start-ups using new technologies, which positively impacts entrepreneurship, the creation of high-tech enterprises, employment, investor input, and strengthening regions' competitiveness. This implies that an established and well-functioning infrastructure supporting innovative entrepreneurship helps to increase competitiveness in the areas. The limitation of the study is due to the sample size, although a total of 30 business support organisations were contacted for the Moravian-Silesian Region and Silesian Voivodeship, the results are obtained from 22 organisations.

Acknowledgement

This article was created with the financial support of the IGA project under Moravian Business College Olomouc, no: 1_2020/21 and Student Grant Competition EkF, VŠB-TU Ostrava within project SP2019/47 " Evaluation of Innovation Activities and Identification of Problems in Innovation Process in Selected Czech and Polish Enterprises".

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