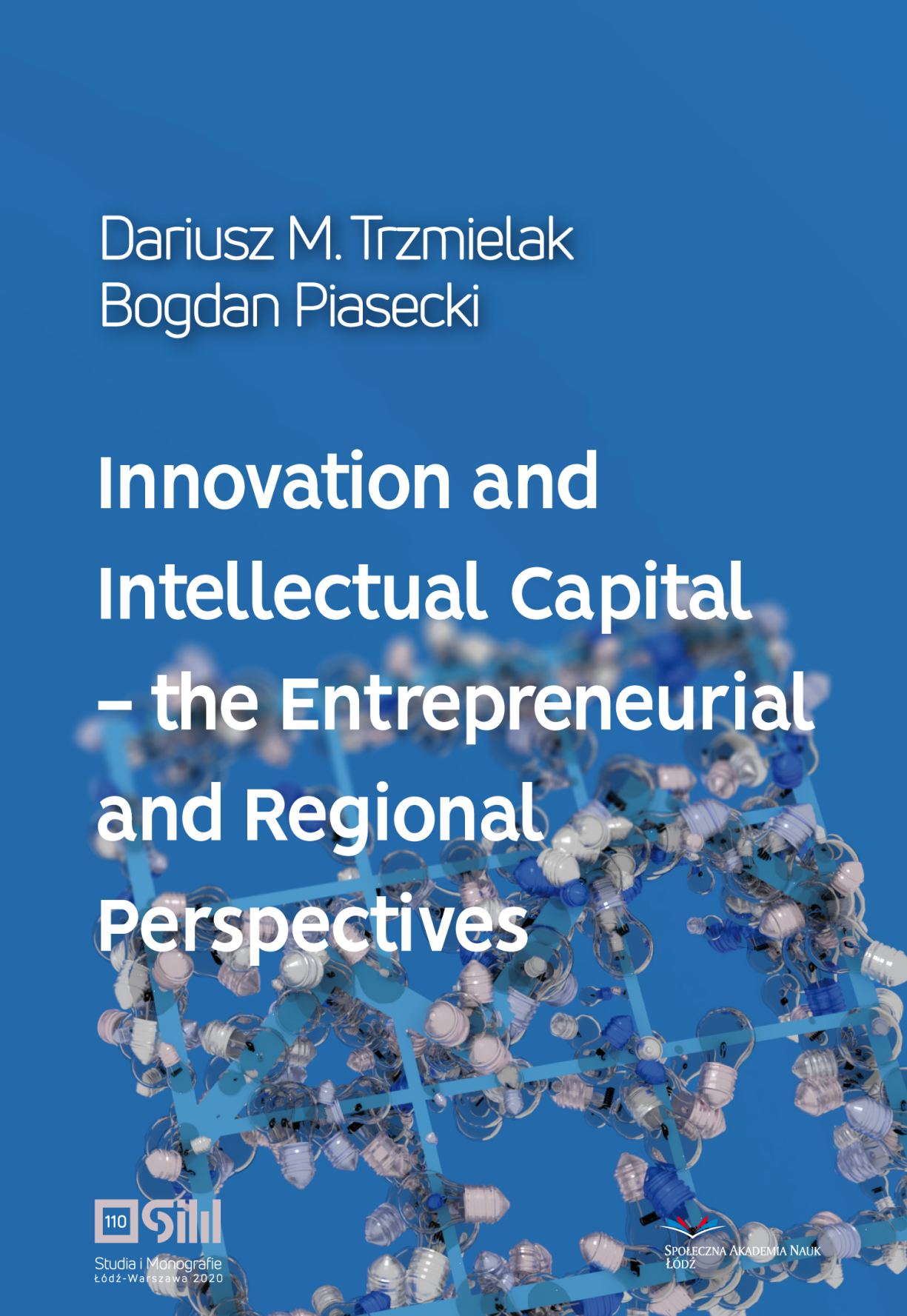
Dariusz M. Trzmielak
Bogdan Piasecki

Innovation and Intellectual Capital – the Entrepreneurial and Regional Perspectives

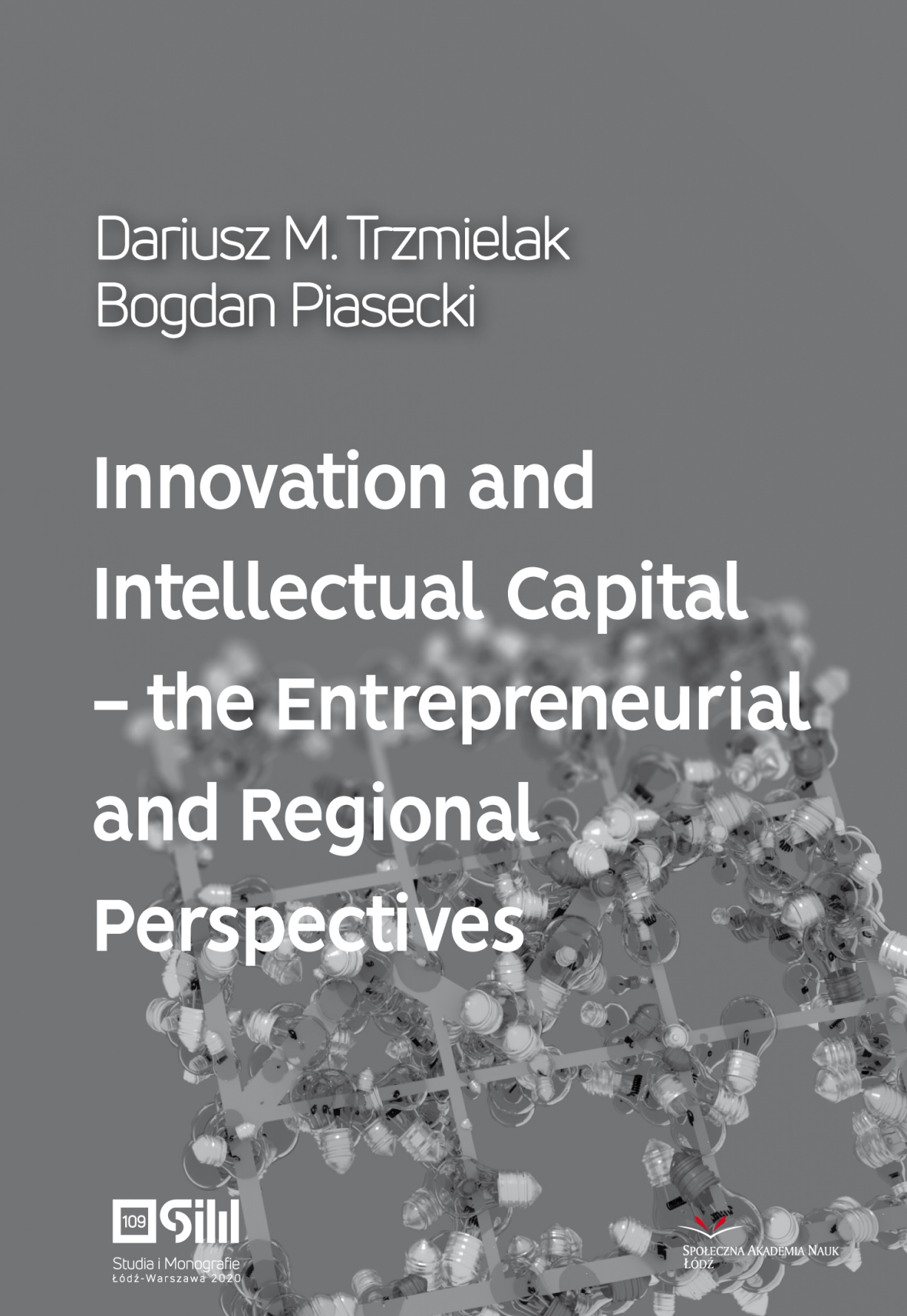


110 SiM
Studia i Monografie
Łódź-Warszawa 2020

Społeczna Akademia Nauk
Łódź

Dariusz M. Trzmielak
Bogdan Piasecki

Innovation and Intellectual Capital – the Entrepreneurial and Regional Perspectives



109
Studia i Monografie
Łódź-Warszawa 2020

Społeczna Akademia Nauk
Łódź

Review: Prof. dr hab. Krystyna Poznańska

Editors: Dariusz M. Trzmielak, Bogdan Piasecki
Adjustment: Zbigniew Pyszka, Dominika Więzik

Typesetting: Małgorzata Pająk
Cover design: Marcin Szadkowski

WYDAWNICTWO
SPOŁECZNEJ AKADEMII NAUK

Studia i Monografie no. 110
2020

ISBN: 978-83-64971-87-7

The Monograph is a periodic SOOIPP scientific publication – SOOIPP Annual 2019/2020.

STOWARZYSZENIE ORGANIZATORÓW
OŚRODKÓW INNOWACJI
I PRZEDSIĘBIORCZOŚCI W POLSCE

Wydawnictwo Społecznej Akademii Nauk
Kilińskiego 109
90-011 Łódź
tel. (42) 664 22 39
(42) 676 25 29 w. 339

Contents

Authors

Maciej Banacki | University of Lodz, Faculty of Management
Chapter 7

Robert Blażlak | Lodz University of Technology, Faculty of Management and Production Engineering
Chapter 2

Paweł Głodek | University of Lodz, Faculty od Management
Chapter 6

Andrzej H Jasiński | University of Warsaw, Faculty of Management
Chapter 1

Katarzyna Łobacz | University of Szczecin, Faculty of Economics, Finance and Management
Chapter 6

Renata Lisowska | University of Lodz, Faculty of Management
Chapter 5

Aleksandra Nowakowska | University of Lodz, Faculty of Economics and Sociology
Chapter 8

Bogdan Piasecki | University of Social Sciences, Faculty of Management
Chapter 9

Anna Rogut | University of Social Sciences, Faculty of Management
Chapter 9

Edward Stawasz | University of Lodz, Faculty of Management
Chapter 4, 5

Grzegorz Szymański | Lodz University of Technology, Faculty of Management and Production Engineering
Chapter 2

Dariusz M. Trzmielak | University of Lodz, Faculty of Management
Chapter 3, 7

Introduction

Today, one of the most basic and necessary conditions for the regional development is the pace of its innovative achievement, which impacts naturally the creation of the national wealth. In this book we bring together a range of expert's perspectives of a topic of the regional importance: "Innovation and intellectual capital – the entrepreneurial and regional perspectives". The subjects matter, still prevailing, refers to the innovation models, clusters, start-ups, business consulting, human resources, business advice process, adoption of innovation territorial capital and relation between science, economy and technology. The validity of this theme arises from the dynamic advancement of the European Union economy. This process has forced especially small and medium size companies operating in the market to notice the increasing role of innovation and intellectual capital in fostering entrepreneurship. It determines the socio-economic development of state and its region. In that spirit we shall briefly see the issues in the terms of the development of innovativeness and the intellectual capital of enterprises.

The work consists of 9 chapters. The first includes an introduction to innovation in small firms. The section presents the models of innovation process and how small firms find themselves among various type of the innovation process. The aim of the second chapter is to attempt to analyse the cluster's position as a stimulator of the development of enterprises' innovativeness, in the light of the market research as well as publicly available statistical data. It connects to the first part describing the possibilities of small firms innovation processes that are taking place in the clusters, and the most suitable for the open innovation model and the network model.

The innovations in the small businesses continue in the next section. The difference is that the activity in the market of the small companies is assessed in their activity in incubators and science and technology parks. Its content clarifies the rules for building innovative enterprises – start-ups or spin-offs. We describe the

start-ups market in the Central Europe at the examples of Poland, Czech Republic, Slovakia and Hungary. Further, it is explained how to identify the key factors for start-up development. The innovation means also the increase of competiveness of the firms. The aim of the presented paper is to assess the dependency between the innovativeness of micro and small enterprises using business advice services and their competitiveness. Next three sections present the dependency between the innovativeness and the competitiveness of micro and small enterprises, taking into account the scale and age of the enterprises and the experience of managers, effective management of human resources in the micro and small enterprises. The indicated analysis confirms the importance of the entrepreneur's attitude and actions for the effectiveness of the advisory process. In particular it plays a key role in the process of choosing the adviser, defining and redefining the area of consulting and the scope of entrepreneur participation in the advisory activities.

The last part of the monograph refers to innovation and intellectual capital in the regions. Three chapters focus on the diffusion of innovation and an effective use of knowledge and technological resources, the role of territorial capital in building smart regional specialization and the maps of relation between science, economy and technology. Adoption of innovation, territorialisation of smart regional specializations and the maps of relations in the national and international regions highlight the links between the dynamics of changes in innovation capacity of regions and identifies the most promising scientific and the economic potential of firms and their regions.

The subject matter is currently prevailing for academics, local government officials and representatives of companies, especially small and medium-sized firms. It refers to innovation and intellectual capital in the range of the entrepreneurial and regional perspectives. The book is addressed to scientists, managers from the fields of industry and to the public sector. Publishing the monograph will certainly expand the potential range of readership in both Poland and beyond its borders.

Dariusz M. Trzmielak
Bogdan Piasecki

Chapter 1

Models of the Innovation Process and a Small Firm

Abstract: The main aim of this chapter is to try to answer the following question: How can a small innovative firm find itself among various types of the innovation process? After analyzing the latest models of the process, recommendations for small firms are formulated. Such enterprises, usually operating in a given region, should be interested especially in the network model of innovation and the open innovation model. As a final result of this study, the concept of Partnership for Innovation is presented as an organizational model.
Key words: innovation, innovation process, small firm, innovative enterprise

1. Introduction

Small firm is a specific kind of economic entity. Many small firms rise as innovative entities. At the same time there are many small, but not innovative firms. Many of them would like to become innovative. But they do not know how to do it, as the world of modern innovation is differentiated and quite complicated.

That is why a purpose of this paper is to try to answer a question: *How can a small firm find itself among various types of the innovation process?* In other word, which type or types of modern innovation processes can be recommended to small entrepreneurs?

Among different categories of innovation, technical innovations are of particular interest to us, as they are manifestations of technological progress. This is why we will concentrate on technological innovation.

2. Models of innovation process

To skilfully manage the innovation process its internal mechanism should be understood correctly. It turns out, that in practice those processes have different paths. One, universal model does not exist.[1] In literature different models of innovation process are found.

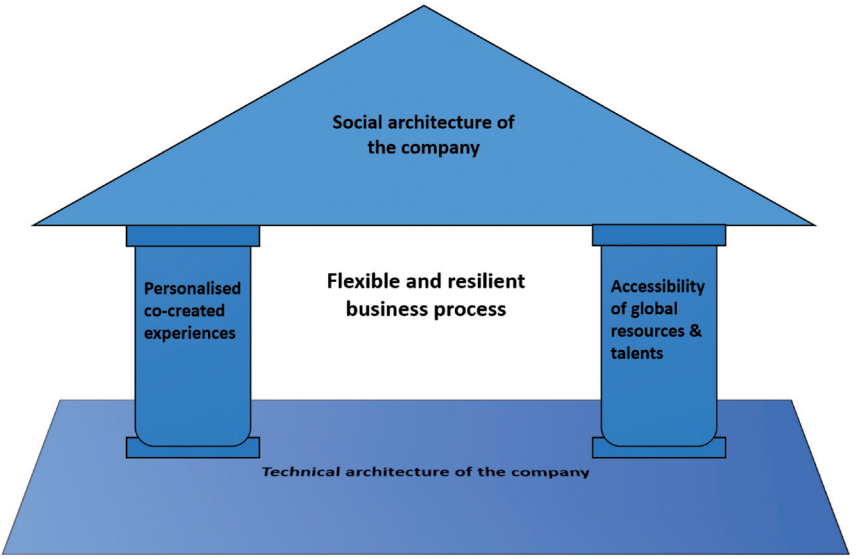
Historically, first models of innovative activities were linked to two most important sources of ideas for innovation. They will be called: (a) model of innovation "pushed" by the science – in other words a supply model, and (b) model of innovation pulled by demand – in other words: a demand model. Later on also further models appeared, such as: (c) model of connected chain by Klein and Rosenberg [1986], or (d) interactive model of Rothwell and Zegveld [1994]. Those and other, older models of innovation were widely popularized in polish literature.

Those models accurately reflected reality of their times. Today, however, they became obsolete, as economic reality is much more complex, complicated and diverse. In the following sections of this paper, we will describe various approaches to modern innovation process, that appeared in world literature in XXI century.

Model of innovation building. In face of such phenomena as growing competition and globalization of economy, a fundamental transformation of business is taking place, which in turn leads to radical change of what a firm is and how it creates value. As a result of such transformation, a new "building" of innovation is created (see Fig. 1), which rests on two pillars [Prahalad, Krishnan 2010]: (1) experience of a single consumer at given time, co-created by the firm, and (2) resources and talents available globally.

[1] Model is understood as a simplified image of reality (economic).

Figure 1. Model of a new building of innovation



Source: Prahalad, Krishnan 2010, p. 13.

The concept of a new building of innovation is an integrated package including creation of innovation and values, where technical and organizational innovations are equally important.

The attention is focused on central position of the consumer and access to resources, and not on their ownership. In the new, current era the key element for the company to succeed is the ability to introduce and improve flexible and transparent business processes, which allows make constant changes in choosing resources in the best interest of the consumer.

In the **network model** innovation is seen as a process with involvement of many participants, which requires high level of integration both inside and outside the company. The process is more and more facilitated by contacts based on information and communication technologies. The basis of the cooperation is the network.

Creation and management of the network becomes an overriding requirement [Tidd, Bessant 2011][2].

[2] This concept is based in so called model of fifth generation according to Rothwell's classification [1994], which presented somehow a forecast of how the innovation mechanism will look like in the XXI century.

The network model of innovation postulates:

- increase of the meaning of horizontal connections (with key clients, main suppliers, as well as intermediaries; sometimes even with competitors),
- mutual learning based on the quick flow of knowledge,
- significant role of network resources, effects and alliances – so called knowledge alliances,
- integration of knowledge resources, contacts and interactions in the innovation environment.

Brzeziński [2015, p. 159] in this context uses an expression „a model focused on harmonization of the complex organizational networks". Harmonization of single processes and subprocesses in innovative activities takes place both inside the network's links, as well as between the participants and partners in the innovation network. What becomes important is the "play" on non-material resources within the attitudes of innovative participating entities.

One of such entities can play the role of so called network integrator,[3] that is of the integrating cell with outstanding key competences in the chain of collaborators. Network connections facilitate innovative activities.

Open innovation model means that the firm cooperates broadly within its environment, and in that cooperation, part of innovative activities is carried out outside the firm. It is presumed that [Chesbrough 2003]:

- the firm is not able to employ all the best specialists, that is why it should seek partners from different environments and industries,
- research and development works are very important (R&D),
- the firm does not have to start the research itself, to be able to benefit from its results – it can use external ideas,
- what is more important than being first, is to build an effective business model,
- success can be achieved with the combination of internal and external ideas,
- benefits can be drawn from using intellectual property outside the firm[4], and also external knowledge can be utilized, as long as it facilitates company's operations.

This model assumes openness of the innovation process on both sides: not only does the company derive the necessary knowledge form outside, but it also shares its knowledge with the environment. The heart of this model is utilization

[3] Such integrator is also called a network coordinator or orchestrator.

[4] It means non-material goods, such as scientific works and creations, as well as inventions and other technological solutions.

of relatively cheap and accessible scientific and technical information, as well as connections and interactions with other entities and people from outside the company.

Basing innovation on the open model allows entrepreneurs achieve numerous benefits, such as: lowering costs of obtaining new knowledge, access to missing knowledge resources, shortening the time of innovation project's implementation. This model, however, has certain flows. The firm can be subjected to uncontrolled leakages of knowledge to the competition, and violation of rights to their inventions and other scientific and technical achievements. That is why the fundamental condition is the protection of intellectual property rights of the company.

User-driven innovation model is related to the before mentioned demand-driven innovation model and is based on good understanding of the real needs of the users, and more systematic involvement of the users in innovative activities. This concept means a process of using the knowledge of future users – not only consumers – to create new products, processes or services [NIC 2008][5]. According to this model, innovation process consists of five following phases [FORA 2005]:

1. Identification od needs and expectations of future users of innovation.
2. Creation of new ideas and designing the solutions.
3. Estimation and analysis of technical potential and production capabilities.
4. Estimation of market absorption.
5. Implementation, here understood as introduction of new product to the market.

As it can be seen, this concept takes a lot from marketing experience. And what is more, it can be treated as an exemplification of open innovation model.

Design thinking is an approach based on particular sensitivity of the novelty creator and his methods of working. It is a process focused on the man and is based on the observation, quick learning, visualization of ideas and fast prototyping, which at the same time uses results of business analysis [Brown 2008], even without the need to curry out the research. According to this model, there are three basic forces „feeding" a business model: (1) thorough understanding of the future user, (2) visualization of the concept of the new product, and (3) strategic industrial design. This concept in turn, takes a lot from the concept of user-driven innovation.

[5] In Polish literature *user-driven innovation* (UDI) is called a demand approach to innovation, or directly a demand innovation, which is not a correct expression.

Literature also presents different model of innovation mechanisms, e.g. **hourglass innovation model** [Griffin, Price, Vojak 2012]. The upper half of the hourglass shows the moment of ideas creation, the neck is the moment of the creation of the invention and its approval; while the lower half is the implementation phase. Here various options of implementation and variants of the new product are generated, and multiple come backs to the aspects that were discussed or approved earlier take place.

Lately, both in the national and world literature, attention is paid to the growing role of knowledge in the innovation processes. The significant dependence between innovation processes and knowledge growth was reflected in e.g. a **spiral process model of innovation**, which includes three subprocesses: knowledge creation, introduction of innovation and learning [Merx-Chermin, Nijhof 2005].

3. Multi-process innovation model

Nowadays innovation process is, in fact, a collection of many highly complicated and complex processes, which results from following reasons [Jasiński 2014, p. 23]:

1. Innovation „stands on two legs" – and while one leg is still in the R&D area, the other one is already in the production phase, and at the crossing between both areas a transfer (flow) of new knowledge takes place.

2. Sometimes there is no continuity between R&D and production implementation, e.g. when results of research project undertaken from the initiative of a scientific entity, "are shelved" (for the time being, or permanently).

3. Particular processes (fragmentary) can take place in different time and different places of national or even international economy, e.g. within the open innovation.

4. Before mentioned globalization of innovation processes is in progress, which causes breaking up of close relation between fragmentary processes. For example, American company IBM has R&D centres in 9 locations, and only three in the USA.

5. Participants (subjects) of the innovation process are also very diverse: production and other firms, scientific entities, various institutions, as well as domestic households – e.g. in case of innovation carried out by a user.

6. Networking character of many firms and institutions, and of cooperation between them contributes to the dismembering of the innovation process.

7. More and more often innovation process is no longer a closed, solid process, where the beginning and the end are easily identified. For example, in case of open innovation it is difficult to decide when or where the process had started. Sometimes in does not result in commercialization, as immediately after implementation and trial sales it can turn out, that some "corrections" are needed, which requires additional research and development.

8. That is why a complex process model was developed, actually a multi-process innovation model [Jasiński 2014, pp. 24–25]. It is made up of a set of processes, where – from the point of view of the firm – following processes can be named:

Ideas + R&D + Transfer + Implementation + Commercialization + Diffusion

It should be explained here, that:

- first of all, these are not phases (stages) of the innovation process, but rather processes that together make up the modern innovative activity;
- second of all, not always there is a place for such sequence of phases. For example, during scientific research, there can appear, almost accidently, an idea for a new product that was not taken into consideration earlier;
- thirdly, some processes, e.g. "Ideas" and "R&D", can take place simultaneously;
- fourthly, innovation can, but does not have to, be based on an invention that was created during research and development works;
- fifthly, implementation and commercialization are parts of transforming research results in practical solutions;
- sixthly, operations that together make up the technology transfer (knowledge) and diffusion of innovation are not typical works that are a part of the innovation process, but they accompany the process;
- seventh, in case of a particular innovation process, all the phases do not have to appear, some can be completely absent. For example:
  - if a new scientific-technical solution is a result of research and development carried out inside the firm, technology transfer will not take place;
  - if the company bought a technical license, which is a manifestation of a transfer, then there will be no idea generation nor scientific research; in best case certain complementary developmental works (post-license) may be needed;
  - if we deal with a process innovation, there will be no commercialization process, as the method / technology of production usually stays in the company, unless it will offer the sale of the method/technology / or license to other companies;

– sometimes diffusion of innovation does not have to take place, and it does not take place, and diffusion is understood here as dissemination of given innovation among producers / manufacturers;

- eighth, the only process that has to take place is implementation, because it decides whether the innovation (technical) will take place.

Concluding, the conventional approach, which assumes that innovation process is understood as orderly sequence of events that make up subsequent phases that together constitute solid, logical entirety, is no longer sufficient. Today, the innovation if more often a result of a collection of various processes, and not a one innovation process that is carried put in few stages. Each of these partial processes produces certain value.

It produces serious complications for organization and management of these processes, because in the process model it can be seen that the subject of management is not a single process within the frame of an innovation project, but few different processes are being managed in different places and by different subjects or persons. Each process is different in its nature, and thus it calls for different management styles and different financial structure.

4. Specifics of a small firm, including regional system of innovation

We assume that a small company is an entity employing less than 49 workers[6]. A small company is not a miniature of a big company; it is a different type of economic unit. It is basically a private entity run by its founder-owner; it is often a family enterprise acting on the local market, and it often has to cooperate with other economic entities or institutions that usually do not have a long-term development strategy.

Small company has many assets such as, for example friendly atmosphere, quick exchange of internal information, low bureaucracy, direct contacts of management with employees as well as with clients, suppliers, contractors and R&D institutions. However, a small company also has its weaknesses. When it comes to weaknesses from the viewpoint of innovative activities, what often can be seen includes: week external communication, inadequate managerial skills, insufficient financial means, small economy of scale and necessity to employ external experts. That is why, among others, small company is often an "apple of the eye" on the innovation policy in many countries.

[6] Among this kind of companies there are also micro-firms employing up to 9 employees.

Tidd and Bessant [2011, pp. 814–815] classify companies according to their approach to innovation, into four types:

- type 1: they do not know what and how to change,
- type 2: they are aware that they should change, but they do not know what means are needed, and where,
- type 3: they are aware that they should change and have some skills to generate and absorb technology,
- type 4: are technologically able to generate and absorb innovation.

Small company, as every other, can be innovative or not. According to the *Oslo Manual* [OECD 2005], an innovative firm is a firm that has introduced at least one innovation (technological) in the last three years, and it should be an innovation at national scale. We are not interested here in innovative companies (of type 4), and those which want to be innovative (type 3 – according to those Authors).

For the company to be innovative, it should have following features [Jasiński 1992, p. 25]: it carries out broad R&D works or purchases projects of new products or technological processes; designates quite large amounts of financing to those means; systematically implements new scientific and technological solutions; represents high share of novelties in the production volume; constantly introduces innovations to the market.

It should be noticed, that small companies can be divided also into:

1. already existing and new (start-ups and spin-offs).
2. based on new/high technology (FONT) and others.
3. industrial and service-providing – such classification is used by Main Statistical Office in periodic studies of innovative activities of economic entities.

Today the role of small firms, which together with middle size enterprises create so called sector of small and medium enterprises[7] (SME), in technological progress is much more significant than 50 years ago, though – in the global scale – those firms are not dominant, contrary to big and large-scale corporations. However, the role of the small and medium enterprises in building and functioning of the regional innovation system (RIS) is unique. RIS includes following types of entities: (1) firms (production, services, agricultural), (2) entities of the science / R&D sector, and (3) regional authorities (local bodies of national administration, units of local self-governments and public agencies of regional and local development)

The role of small and medium firms in the regional innovation system results from three fundamental reasons:

[7] This sector also includes micro-firms (employing up to 9 employees).

1. RIS is created thanks to SME.
2. RIS is the main domain for activities of existing SME.
3. RIS should stimulate creation of new SME.

Companies – as we know – do not create innovations in isolation; relations between firms and other organizations are identified as important for shaping innovative processes in the region. That is why the role of the cooperation of firms not only with the two, before mentioned, main actors on regional innovation scene, but also with other entities (suppliers, customers, sometimes even competitors) is so very important. Such cooperation results in creation of so called industrial clusters, where the cluster is – generally speaking – a territorial concentration of independent, usually small firms that cooperate and at the same time compete with each other.

Let's go back now to the purpose of this chapter that was formulated earlier. What can be said to small companies that want to become and later stay innovative? Among innovation models that were presented, most of all network model of innovation and model of open innovation seem worth recommending. They represent such kind of innovation process, which allows – at least partially – recompense basic weaknesses of small firms, particularly the lack of own R&D facilities or cooperation with partners from their environment.

The model of open innovation makes it easier to, e.g. acquire information about new research projects as well as scientific and technological solutions (patented or not), and to share firms' own achievements with other companies.

The network model of innovation in turn, makes it easier to start partnerships, enter alliances, exchange scientific and technological information and generally facilitates communication with the market. Of course, both kinds of innovation process merge. When it comes to national literature, lately Stanisławski [2017] published a monography on open innovation in small and medium enterprises that is worth recommending.

5. Model od partnership for innovation

Researchers studying barriers in innovative activities of small and medium enterprises (SME), identified numerous barriers, among which the main obstacle **is weak cooperation** of those firms with research and development entities and support institutions. There are many such companies that feel simply alienated on the scene

of innovation[8]. At the same time, results of surveys conducted by the author of this paper show that, among other things, small and not innovative firms need more information, kind of guardianship from business support institutions (BSI), and attention from local administration.

In such situation **model of partnership for innovation** can be useful [Jasiński 2014, pp. 35–37]. Following partners should participate in such partnership.

In the world of innovation and value creation, the potential, future user of the innovation, e.g. consumer, becomes the most important participant of such partnership.

The innovation loop starts and ends with him. Fulfilment of the needs of this future, not present, user should be the main drive behind innovative activities, though sometimes it will have to be created. Thus starting the partnership calls for thorough market research.

The second participant of the partnership is the research-and-development institution that carries out scientific research and development work on new scientific and technological solutions.

The key participant of such partnership is, of course, the entrepreneur (production unit), which undertakes the effort of implementation and commercialization of the new solution. It can be a producer of both goods as well as services. Without him, there will be no innovation[9].

A much useful partner in the process turns out to be a professional intermediary, also often called a technology broker. In the Polish SME sector it is the broker who should be an animator of such partnership. It can be a person, economic entity or a non-governmental organization. We are talking about so called innovative activity support institutions (IASI); they bridge the two above described partners, i.e. R&D unit with the entrepreneur.

That is why, they are also often called a bridging institutions, as their field of activity is "attending to" the flows of knowledge – both in the creation of innovation (vertical technology transfer), and in the latter diffusion of the innovation (horizontal technology transfer).

The financial investor cannot be missing. Nowadays it is an incredibly important partner in innovative activity, mostly needed by small and medium firms,

[8] The concept of innovation stage relates to the model of Triple Helix [Etzkowitz, Leydesdorff 1995].
[9] It does happens, though relatively rarely, that implementation takes place in the R&D unit that created given solution.

especially in Poland, where the financing gap is quite aggravating. Such investor can bae a bank, Venture Capital fund, or a business angel etc.

Finally, a government or local government institution can be a partner in the innovative activity. It can be a government administrative body (central and / or local), e.g. the government, a minister, voivodship governor, or a local government unit (LGU), e.g. commune council, county council, voivodship council and their administrative bodies.

The model of partnership for innovation is imagined as a pentagon with one of the partners in central point, who can play such a role as the network integrator. It is not a typical innovation mechanism, but rather an organizational model.

6. Conclusion

There is no single, universal model of modern innovation. Nowadays innovation processes run along many different models. What is more, the innovation is more and more often a result of combining few processes together rather than of a one processes taking place in few phases. Therefore a classical approach, which says that innovation is understood as sequence of events that create a solid, ordered whole, is no longer valid.

Thus lately, the world of innovation has become very complicated. On the other hand, many new, unknown possibilities of participating in the global technological race have appeared. Innovation oriented companies – especially small ones – have to find their place in this new world, somehow "find something for themselves". Small firms can be advised to fit in with the innovation processes that are taking place, and the most suitable for them seem to be the open innovation model and network model.

Small companies often feel alienated on the innovation stage. That is why they seek allies. For them, a model of partnership for innovation is recommended, with participation of few types of participants, as in this model, small company have strategic partners in the innovation activities, who should act as allies.

Chapter 2

The Importance of Clusters in the Development of Innovativeness of Enterprises

Abstract: The concept of a cluster as an organisation having a significant impact on the management of an enterprise has taken a prominent place in the literature on the subject. It has been the subject of analyses since 1989. Currently, there are around 134 clusters in Poland, 16 of which are the National Key Clusters. However, the statistical data indicates that there is little interest in the cooperation among enterprises within such organisations. Therefore, the aim of the paper is to attempt to analyse cluster's position as a stimulator of the development of enterprises' innovativeness, in the light of own research as well as publicly available statistical data.
Key words: clusters, innovation, technology transfer

1. Introduction

The innovativeness of enterprises understood as the ability to implement and disseminate innovations is, on the one hand, the result of enterprises acquiring new solutions in the field of technology like assembly lines, know-how, patents (technology transfer). On the other hand, in the case of modifications and improvements to already existing solutions, the company could benefit from the creation and the impression of innovation from:

- own resources, including R&D departments,
- help of scientists employed in scientific and R&D units. Such assistance can take the form of a joint research grants, commissioning of research works, renting a laboratory,

- resources of other enterprises, organisations, as part of cooperation on the so-called open innovation markets.

The purpose of implementing new solutions (innovations) by the company should primarily be to obtain the desired competitive position by offering the company a better perceived value in the form of products or services. Unfortunately, not all enterprises have the necessary potential (resources) to enable them to implement innovations themselves. Thus, it seems that the phenomenon of cooperation or coopetition will be the best solution, a panacea, for obtaining the necessary resources. In this case, clusters together with their potential will constitute themselves as a natural set of partners for such type of cooperation.

Unfortunately, according to the Central Statistical Office in Poland (GUS) data from 2013 to 2016, in the range of enterprises employing from 10 to 249 employees cooperating with clusters rose from 5.3% of enterprises in 2013 to 10.1% of companies in 2016. Detailed data is presented in Table 1.

Table 1. The percentage of enterprises cooperating within cluster initiatives

	2013 [%]	2014 [%]	2015 [%]	2016 [%]
Poland	5.3	6.6	8.2	10.1

Source: Bank Danych Lokalnych, https://bdl.stat.gov.pl/BDL/dane/podgrup/tablica, access: 05.06.2018.

Moreover, according to the Central Statistical Office, the percentage of companies employing from 10 to 49 employees, cooperating in the area of innovation development ranged from 2% in 2013 to 3.2% in 2016. In the group of enterprises employing from 50 to 249 employees, the range was respectively from 10.6% in 2013 to 11% in 2016 [GUS 2018b]. Therefore, it seems appropriate to ask the question whether the functioning of an enterprise in the cluster structure makes sense from the point of view of its development through innovation. Hence, the main aim of the paper is to attempt to analyse the cluster's position as a stimulator of innovation development of enterprises, in the light of own research as well as generally available statistical data.

2. The concept of a cluster in literature

The most frequently quoted and economic life practice definition of a cluster is the definition by M.E. Porter from 1998, who defines the cluster as a geographical aggregation of interconnected companies, specialised suppliers, service providers, companies operating in related sectors and related institutions, in particular areas competing with each other but also cooperating [Porter 2001].

From the OECD point of view, the cluster can be described as a combined value-added network of independent companies, including specialized suppliers. In some cases, it is assumed that the cluster can also cover with its strategic scope entities such as universities, research and development units, highly specialised service or advisory, consulting, companies and purchasers [OECD 1999].

A. Sosnowska and S. Łobejko proposed the division of clusters (see Table 2) according to the following groups of criteria [Sosnowska, Łobejko 2007]:

- leading product groups,
- type of supported market,
- breakdown by stage of development.

Table 2. The typology of clusters

Distribution criterion	Cluster types
Stage of development	In this case, the following clusters are distinguished: embryonic, growth, mature and declining
The ability to create jobs	Clusters with increasing, stable and decreasing employment
Territorial reach	Depending on the location of the interconnected entities forming the cluster, local, regional, national and supranational clusters
Numbers of horizontal related sectors	Narrow or wide clusters
Number of stages of the production chain	Deep clusters – covering all stages of the production chain and shallow clusters – covering one or more stages of the production chain
Competitive position	World-leading, national or average or weak clusters
The importance of technology	Clusters of high, low or medium technology. In addition, some studies meet the division of high-or low-innovative clusters

Source: Sosnowska, Łobejko 2007, p. 8.

From the point of view of market practice and literature, the division of clusters presented by the OECD should be also mentioned [OECD 1999]:

1. Horizontal – a combination of companies operating in the same market, in the same sector, whose cooperation is limited to aspects such as research and development, common marketing and purchasing policies.

2. Vertical – characterized as an intersectoral network of differentiated but complementary links to its own offers and the capacity of companies that combine to use these resources or knowledge at the level of the individual chain links values.

From the point of view of the interaction of the cluster entities, as regards the possibility of increasing their level of innovation and competitiveness, the scope and strength of the linkages between companies, business environment institutions, R&D units and/or administration; it is also important to take action at the level of stimulating all types of links between organizations within the cluster and its environment, both in horizontal and vertical systems. The easier the way to identify such a kind of relation, the greater is the possibility for companies to acquire and use the latest solutions in terms of manufacturing technology, resources and knowledge.

3. The impact of the cluster on enterprise innovation

The above-mentioned concepts of the cluster assume that there is an interaction between its participants, aiming to increase the level of economic development of enterprises and other participants. On the other hand, this cooperation, particularly in the case of enterprises, should influence the dynamics of their innovation. Such assumptions are grounded in the attestation that by participating in a cluster the company obtains direct (through laboratory hire) and indirect (e.g. by outsourcing research) access to widely understood research infrastructures located at R&D institutions. Therefore, the transfer of knowledge and technology from scientific institutions and R&D centres (units) to enterprises should be a natural result of cooperation among cluster's participants.

This opinion is also shared by K. Kubiak, in his opinion the fundamental benefits of the company's operations in the cluster structures are primarily: faster access to market information, as well as less complex and costly access to new technologies and innovative solutions and increased possibilities of its implementation within a company, as well as easier and faster access to new knowledge [Kubiak 2017]. Therefore, cluster leaders must make every effort to move the centre of gravity to the offers services for business: from these low risky, offered in soft activities that do not require high financial outlay to such a range of services, which will directly include the support of enterprises in the process of development and implementation of processes and products innovation.

Therefore, the availability of research infrastructures, and thus the possibility of cooperation between companies and R&D is such an important factor in the cluster's innovation potential. Such cooperation could have many different forms, from carrying out research commissioned to cooperation in the framework of joint research initiatives, the creation of its own market for patents, know-how and the creation of spin-off companies or raising the level of employees' qualifications through training carried out by the R&D units [Świderek, Wiśniewska 2015]. The factor which encourages the concept of such cooperation may be both the desire to reduce research and development costs, the improvement of the product or the results of the research, as well as the extension of the range, access and use of new materials or new knowledge resources [Trzmielak, Grzegorczyk, Gregor 2016].

Moreover, the rank of access to the research and development infrastructure is underlined as one of the recommendations to clusters coordinators by Polish Agency for Enterprise Development (PARP). It is clear that each cluster leader should actively engage in the processes involved in creating innovation by the members of the cluster. This could be done by for example: sharing information, the mediation of the acquisition, implementation or sale of innovative technologies or the analysis of the requirements of cluster members on innovation and the implementation of innovation audits [PARP, *Wdrażanie standardów zarządzania…* 2017].

According to the authors of the report of the cluster inventory in Poland, out of 134 clusters surveyed only 33 had access or had their own research centres and 51 clusters declared to have specialised laboratories or access to such infrastructure [Buczyńska, Frączek, Kryjom 2016]. The same report shows the number of clusters whose residents possessed intangible property. The studies carried out by the authors showed that only 22 clusters had patent applications, 21 had trademarks, 19 – patents and 16 – utility models [Buczyńska, Frączek, Kryjom 2016].

The potential of clusters may also be evidenced by the results of recent benchmarking studies carried out on the sample of 39 clusters by PARP, which were published on the website of the Innovation Portal. The results of these studies indicate, *inter alia*, that [PARP, Innovation Portal 2018]:

- entrepreneurs account for more than 81% of cluster members (including 44.4% micro entrepreneurs, 49.7% small and medium and 5.9% large companies),
- the number of cluster members in the period 2012–2014 increased by approx. 41% (560 entities),

- more than 51% of the companies in the clusters declared to operate R&D, and 58% of the cluster's enterprises declared the implementation of innovation over the past two years,
- a differentiated level of implementation of innovations covered by legal protection was observed (10 out of 35 clusters introduced legal protection).

From the point of view of the issue discussed in the article, it is also interesting to analyse the potential of clusters in the field of biotechnology and nanotechnology carried out by the author. These analyses were the effect of the implementation of the project "The International Centre for Research on Innovative bio-based materials (ICRI-BioM)", co-financed by Horizon 2020. The analysis shown that industry clusters that have a high potential on the creation and implementation of broad sense of innovation. It is also worth to mention, that the aforementioned project focused on the analysis of the innovation of the biotechnology industry and, consequently, the possibility of establishing an independent research and development centre, a hub of innovation. At that time seven clusters in the field of bio and nanotechnology operated in the country's area, namely:

1. Polish Cluster of Biotechnology Linum.
2. Silesian Nano Cluster.
3. Cracovian Life Cluster.
4. Mazovia BioTechMed Cluster.
5. BioCeW Cluster.
6. Biotechnology Cluster BIOPARK.
7. NutruBioMed Cluster.

An analysis of the innovative potential of the abovementioned clusters revealed that the total capacity was 42 universities and research institutions, 17 hospitals and medical centres, 135 companies, 33 NGOs, which collectively have access to around 88 laboratories.

The potential of the clusters, which also translates into the innovation potential of the industry, is shown in Table 2.

Table 2. Analysis of the potential of clusters in the area of bio and nanotechnology

Cluster	R&D and Universities	Healthcare (MED)	Companies	NGOs	Access to laboratories	Local authorities
Polish Cluster of Biotechnology Linum	2	0	8	1	0	0
Silesian Nano Cluster	5	0	29	2	25	0
Mazovia BioTechMed Cluster	10	0	18	0	3	1
BioCeW Cluster	1	0	6	1	0	0
Biotechnology Cluster BIOPARK	3	3	12	3	0	0
NutruBioMed Cluster	9	0	40	6	40	0
Cracovian Life Cluster	12	14	22	20	20	3
Commitment to cluster initiatives in general	42	17	135	33	88	4

Source: own elaboration based on web pages of clusters and the POLON status system for October 2015.

Thus, it seems that the above-mentioned data clearly speak in favor of the functioning of enterprises in the cluster. Unfortunately, according to Szultka, many cluster initiatives (including the coordinators who represent them) are very weak in organizational and financial terms. One of the reasons for this is the small number of business entities involved in their development. This weakness is also caused by the formation in the regions of several cluster initiatives in a similar or even the same area of activity. This limits the possibility of implementing larger projects (among others due to limited financial resources or the lack of an appropriate scale of demand) and weakening the image of the initiative as a representative of the entire environment of a given specialization. Such initiatives should either merge with one another or work more closely in selected ventures [Szultka (ed.) 2012].

4. Analysis of the conducted research – Łódź region

The study was designed and carried out in 2015 on a group of 100 enterprises, from the Lodz region for the project ŁÓDZCY INTE-RIS-ARIUSZE – Benchmark parameterization of actors of the regional innovation system (RIS) as an opportunity to increase the synergy of the intellectual, institutional and infrastructural potential

of stakeholders Łódź regional innovation ecosystem; CBI Pro-Akademia. In this research 37 micro, 25 small, 35 medium and 3 large companies took part. In the last 7 years, within the framework of projects from various areas of European funds, they obtained respectively:

- up to 1.5 million PLN – 32%;
- between 1.5 and 3.0 million PLN – 26%;
- between 3 to 9 million PLN – 14%.

28% of the companies analysed did not obtain any funding from the European Union budget for development through innovation.

Moreover, the research shows that in the case of 60% of enterprises the most important from the point of view of the creating company's strategy, including development through innovations, is the information on the direction of technology development and the possibilities of obtaining this information (37%), also trends in costs and technology available in scientific units (36%). In addition, private advisory institutions, for eample consulting companies (46%) and PARP (17%), are the main sources of knowledge acquisition on the information necessary to develop the strategy and innovation. 37% of the companies obtained such information on their own, which significantly marginalized the technology offer of the Lodz University of Technology (3%). From the point of view of the issue of the impact of clusters on the innovativeness of enterprises, it is extremely important that the surveyed enterprises, in the last 7 years, did not cooperate with scientific and research institution like univeristies or public and privet Sciencific Center. As many as 78% of the surveyed enterprises were not able to document it in the form of an invoice for purchasing R&D services in the given time interval. What seems interesting, in terms of financing research works related to the development of new products or technologies, the surveyed enterprises primarily consider obtaining support funds from European Union funds, which recognize the cooperation of industry with scientific and R&D units as a key factor in obtaining support funds. And the demonstrated affiliation and cooperation with other entities within the special National Key Cluster is also a very important factor to obtain such financial support.

Unfortunately, the basic barrier to such cooperation is, according to the analyzed companies, the unreasonable cost of technology development and the ability of scientific and R&D institutions to adjust the time of its implementation to the expectations of these companies. Only the improvement of these two factors would strongly motivate companies to cooperate with scientific and R&D units. In the matter of optimizing the costs of technology development, it

would be justified for 66% of companies and in terms of adapting the time of its development and implementation to the expectations of enterprises in the case of 43% of enterprises.

5. Summary

Summing up the considerations regarding the potential impact of clusters on the innovativeness of enterprises, it should be stated that while it is irrefutable from the point of view of the literature, in terms of business practice, there is not necessarily a correlation between the level of innovation of a given enterprise and its functioning in the cluster structure. Two facts speak for it. The first of these is the fact that there is a great risk that the main purpose of some enterprises' accession to the cluster, especially the National Key Cluster, was and is only to find support for development through innovation from the European Union budget. The second one is the fact that the companies analyzed by the author have not cooperated for at least 7 years with any R&D and scientific institutions and that those institutions are not a source of new knowledge and technology for these enterprises. In other words, in a broader sense, a source of information necessary for creating the company's strategy is development through innovation.

This situation seems to be difficult because the fundamental rule of cluster existence is based on the cooperation of entities, member of a cluster, which, both directly and indirectly, results in increased the level of companies inovativeness and competitiveness. At this point, it is worth adding that all universities in Lodz, as well as their individual units are members of clusters operating in the province, as well as Polish Technology Platforms.

In addition, it seems that the reasons for this state of affairs should also be seen in the fear of entrepreneurs of losing control, or even taking over their resources constituting a collection of intellectual property or market protection. Another reason may be the lack of experience in such cooperation, especially if it would concern the use of external resources in the process of company development and implementation of innovations.

Chapter 3

Innovation and Start-ups in the Polish Incubators and Science and Technology Parks – Central Europe Regional Perspective

Abstract: The basic condition of turning application research into intellectual value of economic significance is to build its market value. The market-based approach in conducting innovation is essential in the transfer and commercialization of technologies. The key role in the technology entrepreneurship is played by the start-ups as new based technology firms (NBTF).

In the first section of the chapter, the characteristics of innovative entrepreneurship is discussed. Its content clarifies the rules for building innovative enterprises – start-ups or spin-offs. In the second section, the author describes the start-ups market in the Central Europe on the examples of Poland, the Czech Republic, Slovakia and Hungary. Further, it is explained how to identify the key factors for start-up development. The second part is the background to main analysis prepared by the author. The third part of the article describes the market research conducted in Polish incubators and science and technology parks in 2017. The author pays particular attention to the types of innovation in the start-ups and indicates the correlation between product innovation and process innovation. The final investigation also found that among start-ups developing innovation there are European Union market oriented firms as well.

Key words: Innovation, start-ups, business support institutions

1. Introduction

The innovation is the effect of commercialization and the transfer of technology and knowledge, which may involve creating companies often called technology enterprises. The decision on the creation of a company should not result only from

technological competence or willingness to develop the technology in the new business entity. Further problems to be solved are the disparity between the projected return from the implementation of the technology (using the company's business) and the granted license and an acceptable level of business risk.

The meaning of innovation in enterprises can be can be referred to what Matusiak said, that in the first decade of the twenty first century companies used to achieve significant competitive advantage thanks to low labour costs. However, this situation will not last for long and that is why one of the key elements of companies' development should be building competences in the field of innovation [Matusiak 2006, pp. 331–341]. Rise in innovation, and in consequence of competitiveness, especially in micro, small and medium firms can be achieved through increase of investments for research and development, and resulting cooperation of companies with scientific and business support institutions [Trzmielak, Grzegorczyk, Gregor 2016, pp. 12–17].

The Ortega-Argilés, Piva, Vivarel [2011] study on the relationship between a firm's R&D expenditures and its productivity in 1990–2008 looking at sectoral characteristics found the positive link between R&D and productivity. The surveyed manufacturing firms in high-tech sectors achieved more in terms of productivity gains connected with research activities in comparison with their low-tech counterparts. R&D investments can result from direct or indirect commercialization. In the first case a company acquires new knowledge through its own research and development, or ideas and projects acquired from external sources [Lipczyński 2014, pp. 42–56] (such as research institutes, universities or innovative companies) or generates the knowledge in cooperation with other institutions. Indirect commercialization in turn, prompts companies or authors to open a new economic entity – a start-up or a joint-venture.

For more than 70 years science and technology parks have been present to create conditions that foster cooperation between science and business, using optimization of mechanisms of technology transfer and knowledge commercialization for creation and growth of innovative firms. When companies based on knowledge and R&D are clustered in a limited area together with providers of support and risk-financing services, effect of synergy can be achieved and innovative environment created. The key role of a science and technology park is to stimulate growth of innovative companies [*Strategiczne obszary…* 2011, pp. 15–22]. In narrower context we can talk about development of technological companies (NBTF).

So called technological companies are a special group of start-ups (NTBFs). Kondo [2007, p. 92] defines technological companies as firms that launch their

activity based on relations with academia. These companies, during incubation period, use technology, personnel, and even financial means of the scientific institutions for further operations. Based on this, we can say that these are academic companies. Benneworth and Charles [2005, pp. 537–557] are of the same opinion and stress that spin-off companies are new enterprises created to commercialize knowledge, technology or research results created at university. Their main role and determinant of development is innovativeness. Spin-off companies arise because they often enter new, niche sectors. Roberts and Malone [1996] give wider interpretation of companies generally called spin-offs, and add that these are companies that emerge not only from relations with academia, but also with R&D institutions and government labs. Spin-offs are created to implement results of research to industry [Trzmielak 2009, pp. 153–167].

We can distinguish three types of so-called new technology firms (NTBFs) created on the basis of the license transferred from the parent organization (so-called spin-offs) or contribution of intellectual property to the company [Trzmielak 2011]. Firms created e.g. by university graduates but unrelated through the license or patent with the parent entity are spin-outs. Spin-out firms can also be defined as organizations of the parent entity [Matusiak 2009, pp. 54–85] (e.g. through the participation of the parent entity representatives in the board of directors or the supervisory board). The self-contained organizational units created on the basis of the transfer of knowledge also with the transfer to the license management have been named by Isabelle spin-ins firms [Isabelle 2004, pp. 63–64].

A spin-off firm is often perceived by the founders as "semi-scientific" and "semi-business" [Kuhn 1988, pp. 587–596]. Hence, the role of the technology incubators and science and technology parks is to help with the adopting to the market principles which every start-up must meet [Trzmielak, Zehner 2011, pp. 102–108]. Along the integration function (creating networks of relations), promotion function (communication of the region with e.g. external investors, with entities interested in innovation development and in cooperation with innovative organizations), technology and science parks also play incubation function. In a, most often, separate part of the park suitable conditions are created (suitable offices and labs are opened, and pro-innovative services provided) to start companies based on knowledge and new technologies.

2. Start-ups in the Czech Republic, Hungary, Poland and Slovakia – background to the empirical analysis

The short analysis of the main innovation factors in start-up sector in the Czech Republic, Slovakia, Hungary and Poland will follow the discussion on the innovation of start-ups in the Polish incubators and science and technology parks. It gives background for understanding the situation in Poland. The SMEs differ across the EU-28. There were 53 SMEs per 1,000 inhabitants (of 15 years or above) in Poland in 2017. In Hungary this number was as low as 42. By comparison, in Czech Republic and Slovakia the number of SMEs per 1,000 inhabitants of 15 years or above was the highest, respectively 115 and 94 and exceeded Poland and Hungary by more than 100%. The variation among countries in the number of SMEs per 1,000 inhabitants (of 15 years or above) illustrates the differences between their economies. The factors which can explain the discrepancy between countries are as follows: the industrial structure of the economy, the public policies encouraging self-employment and the creation of enterprises, especially micro-enterprises, the level of entrepreneurship and the tax and innovation policy [*Annual Report…* 2018, p. 15].

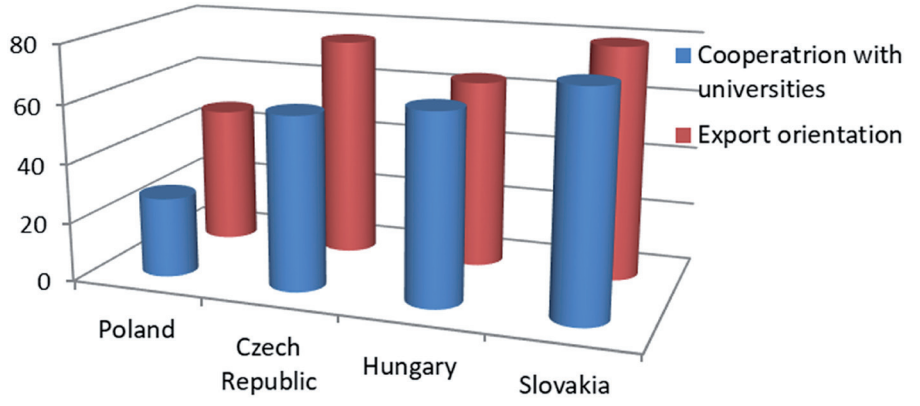
Assessing the start-ups situation on the market it should be noted that according to the OECD [Entrepreneurship at a Glance 2017; Becsky-Nagy 2013], the start-up rates still remain below pre-crisis levels in a few economies but numbers of new firm creations continue to recover. The cooperation with academia is one of the factors which is connected with innovation implementation by SMEs. The Beauchamp and Skala research [2017] found that one of four start-ups in Poland cooperate with a university. In the Czech Republic, Slovakia and Hungary, it is every second, two in three and three in four respectively. Just 3% in Slovakia and 14.2% of enterprises in Czech Republic were created as a university spin-off [SAPIE 2016, p. 36; Staszkiewicz, Havlíková 2016 p. 42].

The above data is surprising because according to the author of the research from years 2007–2009 all the countries of the "new" European Union were positioned at the lower level of cooperation with academia than others [Trzmielak 2015, pp. 189–206][1]. The positive developments in the economic and entrepreneurship fields first of all reinforce Czech start-ups and spin-offs, despite the fact that Poland has received the biggest amount of EU financial support.

[1] The multidimensional scaling analysis, in the area of cooperation with academia and venture capital funds consumption – Project financed by Polish National Scientific Agency 2007–2009.

At the same time the level of business funding consumption in Poland was the one of the lowest in "new" members of UE. Position of Poland in the profile of innovation development should be also perceived in the context of spending on the entire R&D sphere [PARP 2017b]. However, it should be noted that Poland had (in 2017) a higher level of R&D expenditure than in the period of 2007–2009. The four analysed countries have varied expenditures on R&D. Three of Visegrad members, including Poland, have R&D intensity at higher level than 1%. Only Slovakia has lower R&D expenditure than 1% [Eurostat 2019][2]. This European or global innovation area of SMEs activity would be confirmed also by the exporting orientation of SMEs goods and services. Start-ups from Poland and Hungary are less globally oriented than their Slovak and Czech Republic counterparts (Fig. 1)[3] [Beauchamp, Skala. 2017, pp. 14–15]. However the Hungarian start-up sector is flourishing in comparison with traditional small and medium sized businesses in the Hungarian economy. The start-up enterprises have a significant growth potential [Kállay et al. 2016].

Figure 1. Differences and similarities in export and start-ups cooperation with academia – chosen Central European countries analysis



Source: based on: Beauchamp, Skala 2017.

[2] R&D expenditure, according to Eurostat: Czech Republic – 1.79 of GDP, Hungary – 1.35 of GDP, Poland 1.03 of GDB and Slovakia – 0.88 of GDP.

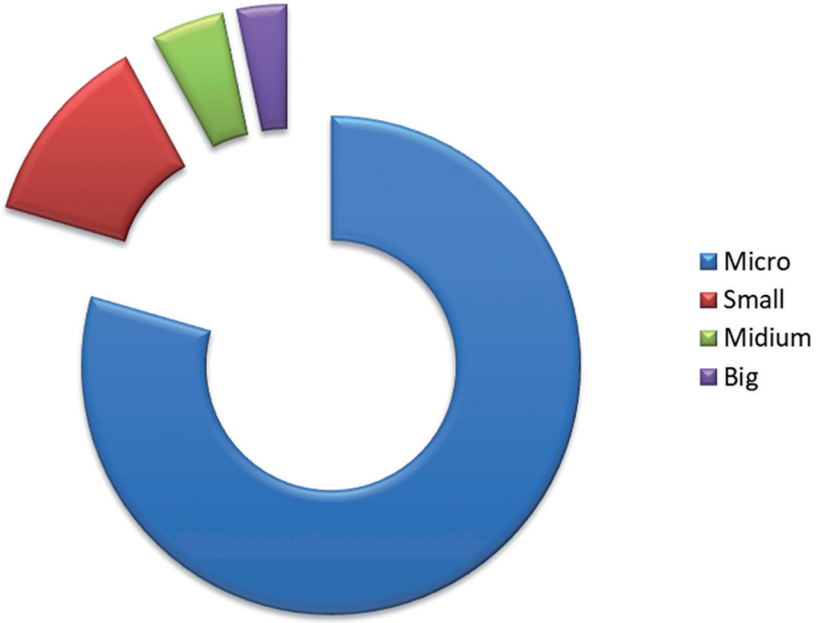
[3] 80% of Start-ups respondents from Slovakia indicated on global expert of their firms, respectively 75% of the Czech Republic, 64% of Hungary and 47 of Polish start-ups.

3. The micro and small firms innovation – the empirical analysis of Polish technology incubators and science and technology parks business clients

The analysis presented is based on the data available from Polish Business and Innovation Centers Association (PBICA)[4] survey conducted by the author and other members of the organization. A survey has been conducted to gather the insights and factors for the technology incubator and science and technology parks development and innovation policy recommendation. The analysis presented in this paper is only a part of the annual project. Nevertheless it reveals an interesting trend. The online questionnaire was sent to all business clients in the Polish technology incubators and science and technology parks and the organizers of the survey received 1564 responses but 243 responses included the answers on the type of innovation development. The data sample size, about 243 responses, is still a small set, making it questionable whether it is entirely representative of the communities covering more than 1560. Additionally, responses representing micro and small firms were submitted by the management of technology incubators and science and technology parks familiar with the organizer of the survey, the data may be biased towards organisations and people who may show more interest in the surveyed areas than normal. Generally, the survey focuses on the factors that impact the type of innovation implemented at the market, training policy, area of activity, sources of financing of products and services developments and development strategy for the next years. The data given by respondents constitutes crucial material for comparison of the opinions and activities of four type players on high-tech markets: micro, small, medium and big companies (Fig. 2). The micro and small firms dominated in the sample. Therefore, the analysis has taken into consideration only two first groups of respondents.

[4] Polish Business and Innovation Centers Association in Poland, www.sooipp.org.pl.

Figure 2. The sample characteristic



Source: PBICA survey conducted in 2017 in Polish science and technology parks and technology incubators, own analysis of data.

The changes on Polish market – micro, small and medium enterprises perspectives

Innovativeness of Polish companies in last years has changed, and it is shown in research of Polish Agency for Entrepreneurship Development [2017]. Assessment of global perspectives for transfer and commercialization prepared by the Institute of Innovation Creativity and Capital, which includes Poland, shows that innovation had been under development [Trzmielak 2009, pp. 239–269]. The level of development in the small and medium enterprises did not allow for the purchase of research results or new technologies (the New Connect stock market has functioned since 2007). Usually[5], SMEs considered the purchase of machinery and equipment to be more effective and the definite minority[6] recognized the effectiveness of joint research work with other companies or the validity of implementation of such [Mazurek, Owczarek 2007]. Lack of funds and the high cost of innovation were the

[5] Three out of five MSEs.
[6] Every tenth SMEs.

dominating barriers to implementation of innovation in the companies and on the market. Polish small and medium enterprises had to struggle with uncertain demand for innovation. The difficulty in finding cooperation partners for new product and technology implementation were one of the barriers that influenced the innovation activity of Polish SMEs [GUS 2020, p. 29].

Innovation activity of micro firms in the accession period was researched by Żołnierski [2005, pp. 33–39], who said that every third micro company introduces innovation, but they are mainly organizational innovations. Implementation of process innovations was declared by less than every tenth micro company, while new products are introduced to the market by less than every fifth studied company.

The analysis of innovation activities of micro and small firms in science and technology parks, and in technology incubators conducted by the author is accordant with the recommendations that were presented by Jasiński in the summary of his research [2005, p. 61].

The author, researching barriers for technology transfer on the market of investment and delivery goods, raises the need to create suitable support system for small and medium enterprises in the area of innovation and technology transfer. One of the elements of the technology transfer and knowledge commercialization system are innovations centres, including science and technology parks and technology incubators [Matusiak, Guliński 2010]. Effective development of the business support institutions plays its role in decreasing the number of unsuccessful start-ups. Ropęga in his research on failures of small companies identifies mistakes in management, particularly in the stage of working on the idea and in the growth stage. Most often an apparent growth results from wrong assessment of market potential and inappropriate development strategy [Ropęga 2013, pp. 142–159]. That is why it is important for technology incubators and technology and science parks to support first of all the development of innovation in micro and small enterprises.

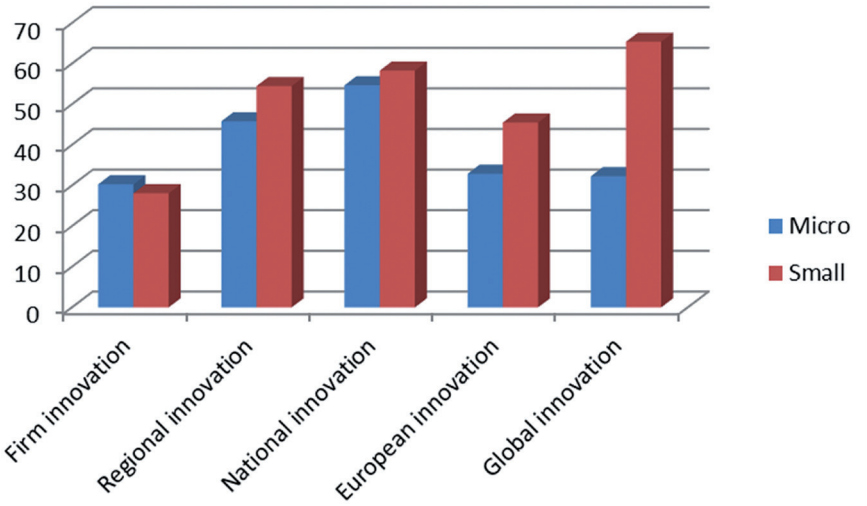
Innovation in Polish companies has changed in last few years, which is reflected in research of Polish Agency for Entrepreneurship Development [2017, pp. 7–17]. Micro and small enterprises are short-lived – 70% of micro firms and 81% of small firms survive their first year in business. Together with micro firms they have the slowest pace of revenue growth. On average, enterprises have been significantly reducing their investment expenditures. Unfortunately, most micro firms concentrate only on national market, but their revenue growth from export of goods and services is the highest when compared to other groups of companies. In the last six years export growth, in total, rose by 74%. Polish micro

companies are characterized by positive development trend: in last few years the number of micro companies has risen, as well as value of production, income, investment spending, number of the working and the unemployed. Micro firms are most cost effective and profitable. Polish small enterprises are more profitable and have bigger financial liquidity than medium and large enterprises, but show the smallest export growth in the last 6 years.

That is why it is important for technology incubators and science and technology parks to support, first of all, development of innovation in micro and small enterprises.

Results of the study from Polish Business and Innovation Centers Association (PBICA) on advance of innovation confirm the general trend of firms from micro and small enterprises' sector. Innovation growth cannot be recognized as satisfactory, in the examined organizations supporting innovation and entrepreneurship, as only one in every five firms said that it is working on innovations. Study results confirm that micro companies concentrate on national innovations, but in the case of small companies the biggest percentage of respondents referred to global innovations. They were higher than percentage of European innovations. Two in three small firms revealed that they are working on global innovations (Fig. 3).

Figure 3. Innovation implementation in micro and small firms – geographical analysis

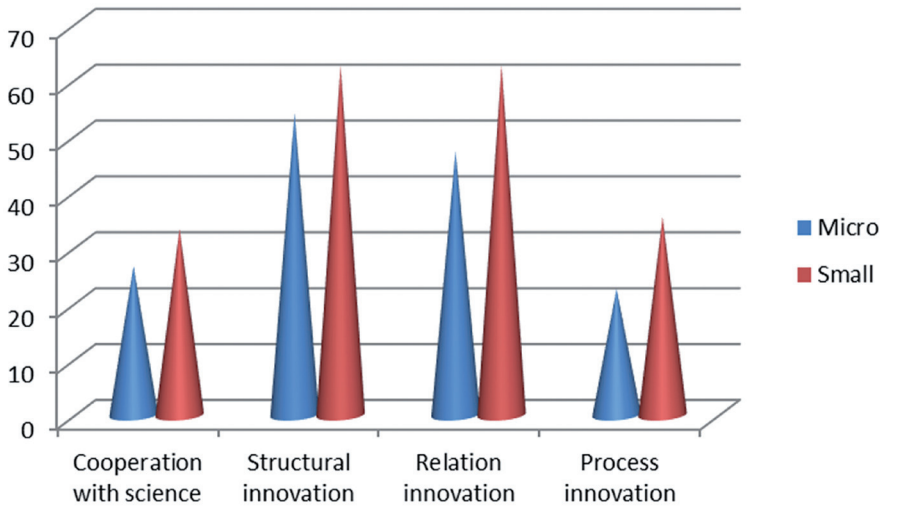


Source: PBICA survey conducted in 2017 in Polish science and technology parks and technology incubators, own analysis of data.

In the analysis of entrepreneurs' answers concerning development of relation, structural and process innovation, almost 60% of respondents from small companies indicated relation and structural innovations. Every third innovation under development was a process innovation. And in the group of micro companies, every second micro firm was developing relation and structural innovations, and every fifth one a process innovation.

When it comes to cooperation with scientific institutions every third and fourth small and micro company respectively, was cooperating with the science world. This result is accordant with statements of respondents concerning development of process Innovations (Fig. 4).

Figure 4. Innovation implementation in micro and small firms – type of innovation

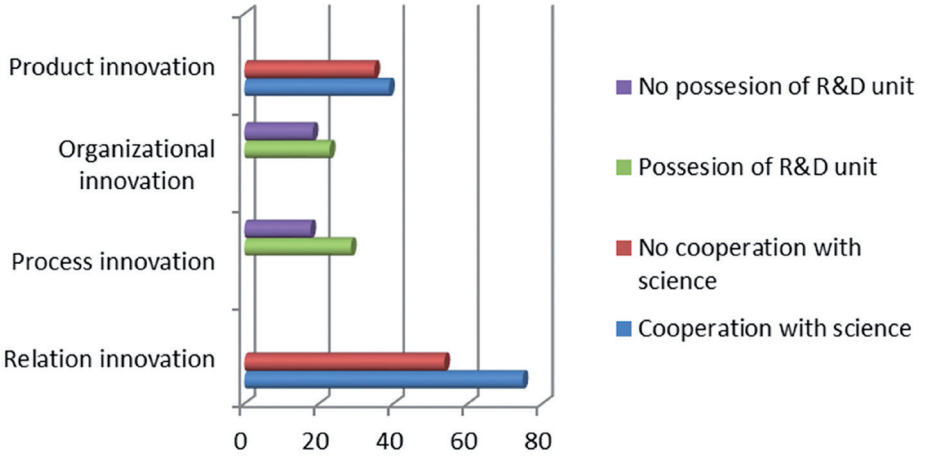


Source: PBICA survey conducted in 2017 in Polish science and technology parks and technology incubators, own analysis of data.

Also, another phenomenon of having an R&D department among researched groups of enterprises should be noted. Having an R&D department increases the number of process innovations. When analysing three variables at once: having an R&D department, cooperation with R&D institutions and process innovations, it can be concluded that process innovations depend on having access to either their own or external R&D department or unit. The relation innovation in the surveyed population depended significantly on the cooperation of the

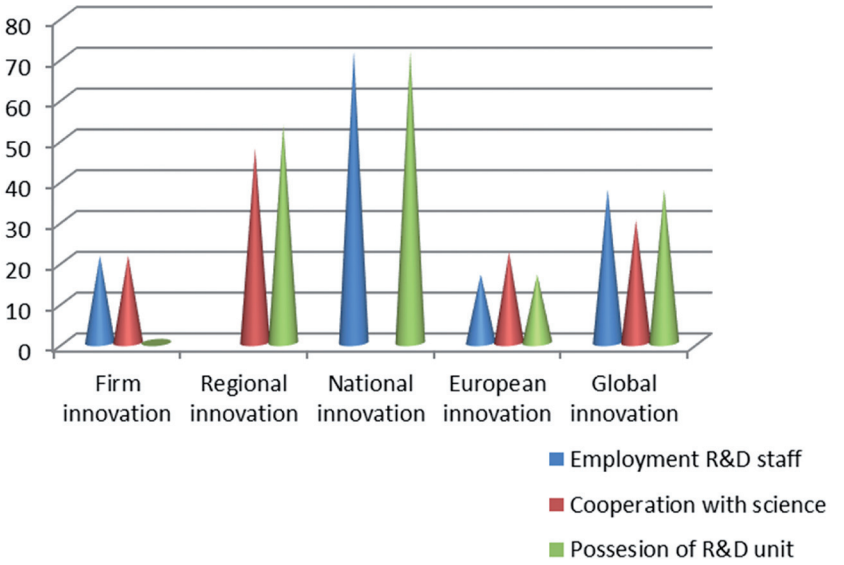
enterprises with science (Fig. 5). Most of the firms (74.7%) declared the cooperation with academia and the implementation of relation and regional innovations (47.5%) on the market. Additionally, the employment of R&D staff and the possession of R&D unit intensify, first of all, the activities in the implementation of national innovation. However, the R&D infrastructure, staff and cooperation with science effect weakly on European and global innovations (Fig. 6).

Figure 5. Innovation implementation in companies in science and technology parks and technology incubators – the analysis of influence of companies' cooperation with academia and possession of R&D units



Source: PBICA survey conducted in 2017 in Polish science and technology parks and technology incubators, own analysis of data.

Figure 6. Innovation implementation in companies in science and technology parks and technology incubators – the analysis of influence of companies cooperation with academia and possession of R&D units, geographical scope



Source: PBICA survey conducted in 2017 in Polish science and technology parks and technology incubators, own analysis of data.

Analysis of correlation between innovations according to the geographical division showed that it is strongest in case of global innovations and those in the European Union. There is innovation, but on the lowest level in case of innovations in companies and global ones (Tab. 1). Despite low value (which is logical as following the growth of the market for innovation companies can more strongly strive for creating a global innovation) the correlation between innovations according to geographical criterion can be interpreted as the awareness of the significance of global innovations in micro and small companies. Firms start with innovations in the firm – often relation innovations, and then, along with the company growth, national, European Union and global innovations appear.

Product innovation is correlated with process one. Development of products is related to the development of processes Product innovation has the highest value of correlation in combination with national innovations. Micro and small companies introduce innovations to national market in first instance (Tab. 2).

Table 1. Correlation of global innovation variable and firm, regional, national and European innovation variables

		Global innovation
Firm innovation	Pearson Correlation	.206*
	Bilateral significance	0.019
Regional innovation	Pearson Correlation	.489**
	Bilateral significance	0
National innovation	Pearson Correlation	.514**
	Bilateral significance	0
European innovation	Pearson Correlation	.831**
	Bilateral significance	0

Source: PBICA survey conducted in 2017 in Polish science and technology parks and technology incubators, own analysis of data.

**. Correlation is significant on the level of 0.01 – bilateral significant
**. Correlation is significant on the level of 0.05 – bilateral significant

Table 2. Correlation of product innovation variables and national, EU and global product innovation variables and process innovation variables

		National product innovation	European Union product innovation	global product innovation	Process innovation
Product innovation	Pearson Correlation	.765**	.619**	.400**	.455**
	Bilateral significance	0	0	0	0

Source: PBICA survey conducted in 2017 in Polish science and technology parks and technology incubators, own analysis of data.

4. Conclusion

In spite of the wide investment in the Polish innovation infrastructure – high-tech incubators and science and technology parks, there is no significant number of international (European and global), product or processes innovations. On the one hand, we can argue that science and technology parks and high-tech incubators have no relevant impact on micro and small firms' innovation implementation results. Business support organizations do not encourage effectively their clients to create synergies that might result in added value for Polish markets. Data on cooperation and export-orientation of micro and small enterprises with

universities in Poland, Czech Republic, Slovakia and Hungary presented in this article show that Polish enterprises look the weakest in the region among so called Visegrad countries. In consequence, relation innovations are dominant. Those of the researched companies that cooperate with the world of science introduce process innovations later on.

Chapter 4

Innovation and Competitiveness of Micro and Small-sized Enterprises in the Context Business Consulting

Abstract: The aim of the presented paper is to assess of dependency between the innovativeness of micro and small enterprises using business advice services and their competitiveness. The achievement of this objective required discussing factors of innovation and competitiveness (age and scale of enterprises, experience of managers) in micro and small enterprises, the role of business advice and the capacity to absorb knowledge in these enterprises. The second part of the paper presents the results of empirical research carried out using the CATI technique on a sample of 400 micro and small Polish innovative enterprises using business advice services. The research results confirm existence of dependency between the innovativeness and the competitiveness of micro and small enterprises, taking into account the scale and age of enterprises and the experience of managers. Improvement of competitiveness of enterprises as a result of introducing innovations requires the use of business advice as well as the capacity to absorb knowledge.
Key words: innovation, competitiveness of firms, business consulting, micro and small-sized enterprises

1. Introduction

In the literature on management in the micro and small enterprises sector, the issue of the influence of undertaken innovations on these enterprises' competitiveness

is considered one of the significant challenges for business running in an increasingly uncertain environment, especially for micro-scale entities [Sipa, Gorzeń-Mitka, Skibiński 2015; Adamik 2011, p. 26; Ciszewska-Mlinaric, Mlinaric, Obłój 2011, pp. 23–35]. The scope and intensity of this relation is very diverse due to numerous industry specific conditions which relate to the scale and age of enterprises, attitudes and skills of enterprise management and innovative ability and knowledge absorption [Navarro, Eldridge, Wandosell 2016; Blackburn, Hart, Wainwright 2013; Stawasz 2013; Wiklund, Shepherd 2003]. The literature on factors influencing innovativeness and competitiveness of small enterprises is extensive. Nonetheless, there is little in-depth empirical material on the role of particular factors in relation to small entities operating in the Polish economy. These are characterized by less experience in comparison to small companies from the "old" EU countries, mainly due to a relatively short period of development of the Polish SME's sector (25–30 years), unsatisfactory state of development of business advisory services, lower effectiveness of public support, etc.

Business advice is considered to be a factor in creating knowledge among managers and improving the level of management in the form of a professional and independent service. The use of business knowledge obtained from advisors for the needs of innovativeness and competitiveness poses numerous challenges for micro and small enterprises, all the greater, given that they usually do not have a proper management structure and professional managers. An important role can be played here by the ability of the managers to acquire business knowledge, including the ability to recognize the value of new knowledge, to acquire it and to transform it into a commercial result [Zahra, George 2002]. For this reason, it may be interesting to look at the discussed issue of the relationship between innovation and competitiveness, with particular emphasis on the role of business consulting and the ability of the managers to absorb knowledge.

The chapter discusses the impact of innovativeness on the competitiveness of micro and small-sized enterprises in the context of a moderating role of business advice and the ability of the managers to acquire business knowledge in this process. A hypothesis about the positive and significant influence of innovativeness on the competitiveness of enterprises, strengthened by business advice and the ability of the managers to absorb business knowledge, has been adopted. The chapter presents the results of an empirical study conducted with the use of CATI method on a sample of 400 Polish micro and small-sized enterprises using business advice. The statistical and econometric methods were used (Pearson correlation coefficient and ordered probit model). The analysis of research results does not

confirm the direct dependency between innovativeness and competitiveness of enterprises. However, the use of business advice and increasing the ability of the managers to absorb business knowledge strengthens this relationship and can be recognized as effective factors in improving competitiveness, especially of enterprises with already high competitiveness.

2. Differentiation of micro and small-sized enterprises according to innovativeness and competitiveness

One of the stimulators of the competitiveness of enterprises is their innovativeness, and the conditions and factors of this process are of interest to both researchers and management practitioners as well as government policy supporting the development of small enterprises [Kay 1996, p. 97; Baldwin, Gelletly 2003, p. 51; Conway, Steward 2009, p. 16]. However, the link between innovation and competitiveness is not obvious, one-way, because both processes do not have to be the same, i.e. there may be companies with different competitiveness and degree of innovation [de Jong 2011; Dobni 2010]. After all, there are many innovations that are not successfully used by entrepreneurs to improve the competitive position of companies, just like there are many entrepreneurial activities carried out without the creation and/or continuous exploitation of innovation. This certain independence of the two dimensions may mean that innovation does not guarantee improved competitiveness and that poorly innovative companies may be highly competitive, contributing to growth and high profitability, among other things.

A certain independence of innovativeness and competitiveness of enterprises results from the fact that they are influenced by various factors [Edwards, Delbridg, Munday 2005; Siqueira 2008]. Competitiveness can be determined by factors such as the personal objectives of business owners, the resources and capabilities they possess (competences, financial resources, etc.), market conditions and dynamics, and market acceptance of a company's offer. The innovativeness of enterprises can be determined by the same factors, although they are to some extent more controlled by entrepreneurs who can define objectives that are pro-innovative, create independently inventions, ideas and ideas that are the basis of innovation. With given market and resource constraints, entrepreneurs may be unable to achieve the intended degree of innovation, but an entrepreneur who is constantly inventing new inventions and trying to be innovative is a different kind of an entrepreneur than the

one who starts a business with one innovation and makes little effort to increase the number of innovations owned by the enterprise [Stawasz 2013].

According to Schumpeter, an entrepreneur is also an innovator who – thanks to innovations – gains a competitive advantage (creative destruction) and that way creates income and new jobs. Schumpeter assigned this role to large entities due to their resources and capabilities. The role of small entities in the Schumpeterian "creative destruction" process was presented by Kirchhoff [1994, pp. 65–67]. In his view, entrepreneurship and innovation do not have to be identical processes, as Schumpeter claimed, which means diversifying enterprises in terms of "creative destruction". Using the Kirchoff concept, it can be concluded that the micro and small enterprise sector is not homogeneous, on the contrary, it is a set of very diverse units also in terms of competitiveness and innovativeness. With regard to the degree of innovativeness and the level of competitiveness, one can distinguish very different types of enterprises [Stawasz 2013; Newbert, Gopalakrishnan, Kirchoff 2008].

Creating innovative strategies that are effective in shaping competitiveness requires building innovation capacity, as well as business knowledge absorption capacity, including knowledge from external advisors [Nogalski, Karpacz 2012, p. 112; Branzei, Vertinsky 2006]. This refers to research and development effort, inventive activity, development of skills of managerial staff, as well as other employees in the scope of creating and implementing innovative solutions, formulation of innovative plans, as well as organizational structures, culture conducive to creation and absorption of knowledge and innovation, and building financial potential for innovation implementation [Sipa, Gorzeń-Mitka, Skibiński 2015]. Building the ability of the managers to acquire business knowledge, in turn, includes a constant monitoring of trends in technology and trends related to market and social changes, creating an external network of cooperation and cooperation with numerous external partners in the field of innovation, as well as using public support in the field of innovation. Access to external knowledge and other resources and services, as well as their absorption, is becoming an important factor in the effective innovation of enterprises, especially those of smaller scale [Faherty, Stephens 2016].

Access to external knowledge is easier thanks to the use of business advisory services which are understood as one of the elements of external support for micro and small enterprises. These services are aimed to help managers and enterprises in achieving their goals by: solving problems in the sphere of management, identifying and using new opportunities, learning and implementing changes [Yusoff 2010]. They include transfer of information about conducting business in the area of both current and strategic management [Blackburn, Hart, Wainwright

2013], and thus serve as a potential source of competitive advantage [Gooderham et al. 2004].

Advisory services are provided by professional consultants from the public or commercial sector and take on various forms, ranging from providing general knowledge, through specialized training, to coaching and mentoring [Mole et al. 2013]. The sources of business advisory also encompass accountants, suppliers, bank employees, customers or other trading partners. Due to the fact that the general approach to management in new or micro enterprises is usually informal, entrepreneurs also often use informal sources of advice, cheap and easily accessible, including friends and family or other advisers from their own environment [Soriano, Castrogiovanni 2012]. The use of formal or informal advisory services can influence the performance of enterprises [Chatterji et al. 2019].

The advantages of business consulting include direct and indirect impact. The former concerns the provision of strategic advisory to improve innovation, growth and development of the enterprise. Indirect effects, on the other hand, include business support in the area of solutions and procedures to increase knowledge, experience and practices of managers useful for strategic management, as well as supporting the relationship of managerial knowledge – formulation of development strategies [Łobacz, Głodek 2015; Ramsden, Bennett 2005].

The use of business advice is generally stimulated by the gap between the internal knowledge resources of enterprises and the resources necessary to achieve business goals [Carey 2015]. This seems to be particularly important for innovative enterprises, especially when their competitive advantage depends on the possibility of effective access to knowledge resources [Kang, Kang 2009]. Among the factors that may determine the use of advice services one can include factors characterizing the manager (education and experience), factors related to the enterprise (scale of operations, age) and factors related to development orientation (having a development strategy) [Zoe, Ertug, George 2018].

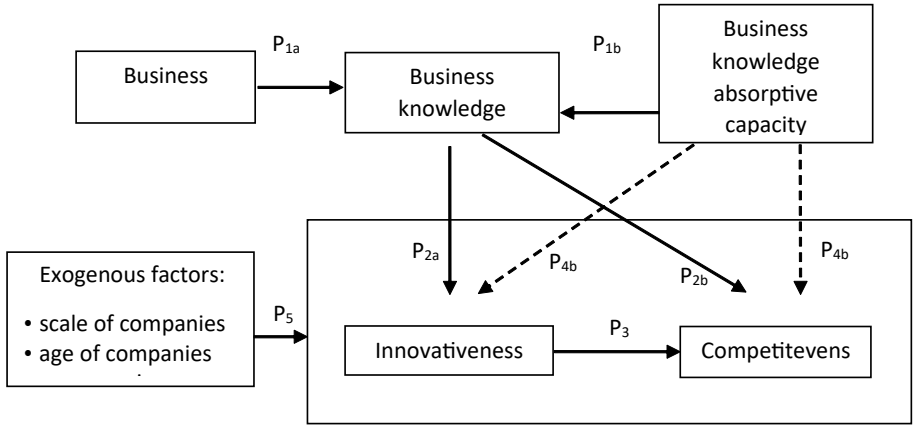
To assess the role of business advice for the functioning of micro and small-sized enterprises, and in particular for the innovativeness and competitiveness of companies, the concept of business knowledge absorption capacity may be useful. In management literature, the ability to absorb knowledge is defined as the ability of enterprises (mainly managers, but also employees) to recognize the value of new knowledge, to assimilate it and to transform it into a commercial result [Zahra, George 2002; Kozarkiewicz 2016]. It is a dynamic ability which – acting as a moderator – can affect the results of enterprises in a dynamic environment by supporting, among others, raising business knowledge of the managers,

improvement of management level, and of innovation process [Matejun 2015; Engelen et al. 2014].

Acquisition and use of external business knowledge by micro and small enterprises to improve their functioning poses challenges to them in terms of building business knowledge absorptive capacity, all the greater, given that they usually do not have an adequate management structure and professional managers (this applies in particular to micro-enterprises). An important role is played by the ability to recognize the value of the offered advisory information and the ability to assimilate it in order to analyze, interpret and understand it [Bojica et al. 2018]. These skills are particularly important and difficult in technologically advanced and innovative industries [Patterson, Ambrosini 2015]. The ability to transform information means the ability to change and develop procedures that allow to integrate existing knowledge with advisory knowledge, increase the knowledge resource, modify it, and achieve the synergy effect. In turn, the ability to exploit the resulting resource of knowledge means the possibility of improving the existing or creating new management competences (e.g. for building development strategies, developing innovations).

Relationships between the level of business knowledge of the managers and their ability to absorb business knowledge obtained from business advisors seem to be an important element in shaping the relationship innovativeness – competitiveness of micro and small enterprises. Strong dependencies mean that the ability of the managers to absorb business knowledge seems to be a condition for the effectiveness of use of advisory services to raise the level of knowledge of the managers. In turn, greater knowledge of the managers has a positive impact on the improvement of the business management level of enterprises, which may result in the improvement of business results (innovativeness, competitiveness, growth, profitability).

Figure 1. Proposed impact model



Source: author's own study.

The model of dependencies illustrating the impact of innovativeness on shaping competitiveness of micro and small companies in the context of using business advice and the ability of the managers to absorb business knowledge is presented in figure 1. The following impacts are distinguished: the impact of business advice on the level of business knowledge of the managers (P_{1a}) and the impact of the ability of the managers to absorb business knowledge on the level of business knowledge of the managers (P_{1b}), the impact of business knowledge of the managers on the innovativeness of companies ($P_{2a)}$ and on the competitiveness of companies (P_{2b}), the impact of innovativeness on companies' competitiveness (P_3). It was also distinguished for indirect (through impact on improving the level of knowledge of the managers) influence of ability of the managers to absorb business knowledge to improving innovativeness (P_{4a}) and competitiveness of companies (P_{4b}). Selected factors related to the enterprise and personal characteristics of the managers are treated as so-called the exogenous factors (P_5).

3. Test method and specifics of the sample

The chapter uses the results of research conducted by means of computer-aided direct telephone interviews (CATI), using a questionnaire form with owners or co-owners of entrepreneurs or their main managers. The research methodology assumes that the sample will consist of 400 Polish enterprises from the micro

and small enterprises sector (with the number of employees up to 49 persons) from various industries, randomly selected by means of a random number generator from a group of 9703 enterprises from the REGON GUS database operating throughout the country, meeting the criterion of innovativeness and at the same time using external business consulting services during the last three years preceding the interview. The original data obtained during the survey was subjected to statistical analysis.

In the obtained sample, the majority of enterprises were very small, employing up to 9 persons, representing 55.1% of the total sample, while enterprises defined as small enterprises employing 10 to 49 persons constituted 44.9% of the sample. The market structure of 400 enterprises is dominated by the local and domestic market (37.5% and 45.5% of the sample, respectively), while entities with the dominant international market constituted 16.8% of the total sample. Mature enterprises with a 4–10 year presence on the market prevailed (49.8% of the sample), while the average employment was 7.7 people. The industry structure of the studied sample was very diverse: services (74.8% of enterprises) predominated, followed by trade (15.5% of enterprises) and production (9.8% of enterprises).

The sample was dominated by companies managed by one person (60% of entities), and then by two persons (about 28% of companies). 12.3% of enterprises have management boards consisting of three or more persons. Half of the managers have technical education or a background in natural sciences, followed by economic education (31%). Managers of companies are characterized by extensive professional experience, which is confirmed by the average age of work of managers, which is high and amounts to 12,6 years.

In the years 2014–2016, all the surveyed enterprises used business advice services related to their business activity, mainly in the areas of financing and accounting (39.3% of entities), law and taxes (18.5% of companies), production, logistics and IT (12.5% of companies) and strategic management and development (10.5% of companies). Nearly 59% of enterprises using business advice services stated that they obtained benefits as expected, and 35% of enterprises obtained benefits partially in line with expectations. Only 6% of the entities stated that the achieved consulting results were not in line with their expectations.

4. Results of the research procedure

Business knowledge of the managers

The assessment of the level of business knowledge of the managers concerned their opinion on the current state of knowledge in the scope of managing the company in various areas, including techniques and methods of managing. The Likert scale of 1–5 points was used, where 1 point meant a very low level of knowledge, and 5 points meant a very high level of knowledge. The average level of business knowledge in the studied population was quite high and amounted to 3.81 points. This demonstrates the high self-assessment of managers regarding the level of their business knowledge. Very low level of business knowledge was reported by 1.5% of managers, and very high by 26%.

The most frequent and at the same time the most important source of raising the level of business knowledge of the managers of the surveyed companies was learning from their own experiences (in the opinion of 67% of respondents). Other sources are less important. Learning from business partners as the most important source of raising business knowledge of the managers is indicated by 15.5% of companies, participation in courses and trainings by 10% of companies, and the use of business consulting by 7.5% of companies. Taking into account the multiple answers, the basic source of raising the level of business knowledge of the managers for over ¾ of companies was learning on the basis of their own experience, for about 40% of companies it was learning from business partners and courses and trainings, while for about ¼ of companies it was the use of business consulting.

The assessment of the impact of business consulting on raising the level of business knowledge of company managers was based on the respondents' opinions on a scale from 1 to 5 points, where 1 point meant a very weak impact and 5 points meant a very strong impact. This impact was high, in the case of 89.2% of companies the managers increased their level of business knowledge as a result of business consulting, and in the case of 46.7% of the companies a significant increase in knowledge was reported (4–5 points). The average score was 3.3 points. This confirms the correlation between business consulting and the level of business knowledge of the managers (P_{1a}).

Ability of the managers to absorb advisory knowledge

The assessment of managers' ability to absorb business knowledge obtained from business consulting concerned their opinions about their skills in recognition, assessment, assimilation and practical use of business knowledge on the Likert scale from 1 to 5 points, where 1 point meant a very low rating, and 5 points very high rating of management skills.

The average score of managers' ability to absorb advisory knowledge was quite high and amounted to 3.6 points. High scores are associated with many characteristics of enterprises. These assessments are higher in the case of more innovative, more competitive, more pro-developmental companies, more often using formal planning procedures, as well as in the case of higher assessment of the managers' level of knowledge, more frequent use of advisory services, including vocational counselling and learning from professional consultants. The ability to acquire knowledge from a business advisor depends on the level of business knowledge of the managers. In the group of managers with a high level of knowledge, 61.3% of them highly evaluate their skills in the field of advisory knowledge absorption, while in the group of managers with a low level of knowledge, this applies to 29.2% of managers.

Innovativeness of enterprises

The research on the companies' innovativeness concerned the measurement of the level of novelty of the most important changes introduced in the years 2013–2016. It concerned the novelties that the company introduced to its offer, i.e. new or improved products/services, or improved production methods/services or changes in the organization of the company's activity. In the sample, all companies were innovative, however, the majority of companies had a low level of innovativeness, because the changes introduced were new only at a company's level (47.8%) or at the local scale (21.0%). Companies introducing changes with a very high level of innovativeness (on an international scale) constituted only 7.8% of the sample.

The higher the innovativeness of enterprises, the slightly higher was the average employment (except for companies with the highest innovativeness on an international scale). In the case of the group of companies with low innovativeness, the average employment was 7.4 persons, and for the group of companies with high innovativeness – 8.3 persons.

Competitiveness of enterprises

The criterion for assessing the competitiveness of enterprises was the estimation of the advantage of enterprises over their main competitors in terms of resources, such as modernity/innovation of the offer, costs/prices, quality, service, promotion, logistics, customer service, etc. on the Likert scale from 1 to 5 points, where 1 meant a very low competitiveness and 5 a very high competitiveness. The average level of competitiveness of companies was moderate and amounted to 3.3 points, while the median was 3,0 points. A very weak competitive position was held by 4.3% of companies, and a very strong one by 14.2%.

Companies with heightened competitiveness (scores of 4–5 points) are larger and older than companies with decreased competitiveness (scores of 1–3 points). The largest companies with 20–49 employees have the highest competitiveness score (average score of 3.8 points), and the smallest companies with 1–4 employees have the lowest competitiveness score (average score of 3.2 points). The average score for the competitiveness of young companies (up to 3 years of operation) was 2.9 points, while for mature companies (over 4 years of operation) 3.4 points.

External conditions of competitiveness of companies manifested themselves in market and sector differences. Relatively the most favorable conditions for the competitiveness of companies occurred in the manufacturing sector (average score 3.5 points) and in the regional market (average score 3.4 points).

Dependencies

To identify the correlation between innovation and competitiveness in the context of business advisory and the ability of the managers to absorb advisory knowledge, the Pearson correlation coefficient was used (Table 1). The analysis of research results does not confirm that there is a statistically significant correlation between innovation and competitiveness of enterprises – the correlation coefficient is 0.049. Taking into account the use of business consulting services and the ability to absorb the obtained business knowledge, this picture of the relationship changes: innovation and competitiveness of enterprises using business consulting are statistically correlated – the correlation coefficient is high (0.600) at the 0,01 level of significance. This may indicate that the improvement in innovation of enterprises using business consulting results in an increase in their competitiveness, which is in line with the proposal P_3.

The analysis showed a statistically significant, though moderate, relationship between managers' ability to absorb business knowledge obtained from business consulting and improvement in the level of business knowledge of the managers

(correlation coefficient is 0.351 at the 0,01 level of significance), which confirms the role of managers' ability to absorb knowledge in raising the level of their business knowledge (proposal P_{1b}).

The analysis also confirmed the impact of raising the level of business knowledge of the managers as a result of business consulting on the improvement of innovativeness and competitiveness of enterprises. These dependencies are statistically significant and high. The correlation coefficient in the first case is 0.440 and 0.508 in the second case. Therefore, the greater the increase in the level of business knowledge of managers obtained from advisor, the greater the improvement in innovativeness of enterprises, which is confirmed by the proposal (P_{2a}), as well as the greater the improvement in the level of competitiveness of enterprises, which is confirmed by the proposal (P_{2b}).

The research also indicates an indirect impact (through the impact on raising the level of business knowledge of the managers) on the ability of the managers to absorb advisory knowledge in order to improve innovation and competitiveness of enterprises. These dependencies are statistically significant, although moderate. In the first case, the correlation coefficient is 0.221 and in the second case – 0,315. This may mean that the greater the ability of the managers to absorb advisory knowledge, the greater the improvement in innovativeness of enterprises, which is confirmed by the proposal (P_{4a}), and the higher the level of competitiveness of enterprises, which is confirmed by the proposal (P_{4b}).

The results of the research indicate a statistically significant, although moderate, impact of the age of enterprises using business advisory on the improvement of innovativeness of enterprises (the correlation coefficient is 0.131) and on the improvement of competitiveness of enterprises using business advisory (the correlation coefficient is 0.114). Apart from a statistically significant, although moderate, impact of management experience on the improvement of innovativeness of enterprises using business advisory (correlation coefficient is 0.118) and on the improvement of competitiveness of enterprises using business advisory (correlation coefficient is 0.175). Similarly, the age of companies and the experience of the managers have a positive, although moderate impact on the ability of the managers to absorb advisory knowledge, and thus – as it seems – on the relationship between innovativeness and competitiveness of companies. On the other hand, no statistically significant influence of the scale of enterprises on innovativeness and competitiveness of the surveyed companies using business consulting was found.

In order to verify whether business advice contributes to improving the relationship between innovativeness and competitiveness of the surveyed companies, the parameters of the following probit models were also estimated:

$KONK_i^* = aINNNOW_i + \chi_i\beta + \varepsilon_{1i}$, (1.a)

$KONK_i = m$, when $\mu_m < KONK_i^* < \mu_{m+1}$, m = 1,2,3,4,5 (1.b)

$PKONK_i^* = aPINNNOW_i + \chi_i\beta + \varepsilon_{2i}$, (2.a)

$PKONK_i = m$, when $\mu_m < PKONK_i^* < \mu_{m+1}$, m = 1,2,3,4,5 (2.b)

where:

- $KONK_i$ is the level of competitiveness based on the assumption of a lack of advisory services measured on the Likert scale from 1 to 5, whereas $INNNOW_i$ indicates the level of innovativeness.
- $PKONK_i$ denotes an increase in competitiveness as a result of the use of business advice,
- $PINNNOW_i$ denotes an increase in innovativeness as result of use of business advice.
- vector χ_i is made up of other variables affecting competitiveness and growth.
- it is understood that $\mu_i = -\infty$ and $\mu_5 = +\infty$.

Table 2 presents the estimates of the parameters of two ordered probit models (with and without advice). The relationship between innovativeness and competitiveness in a model without business consulting turned out to be negative and statistically insignificant. Other control variables turned out to have a positive and significant impact on the level of competitiveness of companies. The results for the competitiveness growth equation within the business advisory framework differ significantly. The increase in innovativeness proved to be a very strong stimulus for the growth of competitiveness of enterprises in the conditions of business consulting.

Table 2. Estimation of parameters of two ordered probit models (with and without business consulting)

Variable (threshold parameter)	Estimation for an equation explaining the level of competitiveness	Estimation for the explanatory equation for the increment of competitiveness in advisory conditions
INNOW	-0.032	-
PINNOW	-	0.605***
ZAW	0.268***	0.316***
SKALA	0.019***	0.010*
WIEK	0.303***	0.035

Variable (threshold parameter)	Estimation for an equation explaining the level of competitiveness	Estimation for the explanatory equation for the increment of competitiveness in advisory conditions
μ_2	0.134	1.859
μ_3	1.077	2.829
μ_4	2.223	4.022
μ_5	3.114	4.791

INNOW – innovativeness of companies; PINNOW – an increase in innovativeness as result of use of business advice; WIEK – the age of the companies; SKALA – the size of companies; ZAW – the ability of the managers to absorb advisory knowledge.

Source: author's own study.

A comparison of the parameter estimates for both models indicates the stimulating role of business advice in relation to the relationship between innovativeness and competitiveness. Under advice conditions, a strong positive impact of innovativeness growth on competitiveness growth is observed. The obtained results indicate a moderating role of business advice for the relations between innovativeness and competitiveness of the surveyed micro and small companies.

4. Conclusions

The analysis of the results of the empirical research conducted among 400 Polish micro and small innovative enterprises indicates a positive impact of business consulting on the increase in the level of business knowledge of the managers. A positive correlation was also found between the ability of the managers to absorb advisory knowledge and the improvement of business knowledge of the managers, which confirms the role of managers' ability to absorb advisory knowledge in raising the level of their business knowledge.

The hypothesis of a statistically significant correlation between innovativeness and competitiveness of enterprises has not been confirmed. However, this picture of the lack of dependence is changed when the fact of using business advisory services and the ability of the managers to absorb the acquired advisory knowledge is taken into consideration. The obtained results identify a moderating role of business advisory for the relation between innovation and competitiveness, significantly strengthening the relation between innovativeness and competitiveness of enterprises.

The analysis also confirmed the positive impact of raising the level of business knowledge as a result of business consulting on the improvement of innovativeness and competitiveness of enterprises. This may mean that with the increase in the level of business knowledge obtained from the advisor, the innovativeness and competitiveness of enterprises increase. The research also indicates an indirect positive influence (through the influence on raising the level of the managers' knowledge) of the management's ability to absorb business knowledge on the improvement of innovativeness and competitiveness of enterprises. This may mean that the greater the ability of the managers to absorb knowledge, the greater the improvement of innovativeness and competitiveness of enterprises. In conclusion, it can be stated that both business consulting and the ability of the managers to absorb knowledge can be considered effective factors for improving innovation and competitiveness of micro and small enterprises.

Among the characteristics that can influence the innovativeness and competitiveness of micro- and small enterprises using business advice, there are factors related to the companies and managers themselves. The age of enterprises and the experience of manager's have a positive impact on the growth of innovativeness and competitiveness of enterprises. The older the company and the greater the experience of the managers, the greater the increase in innovativeness and competitiveness of companies. Similarly, the age of companies and the experience of the managers have a positive, although moderate, impact on their ability to absorb business knowledge. However, the influence of the scale of enterprises on the innovativeness and competitiveness of the surveyed companies was not noticed.

Table 1. Dependencies

		1	2	3	4	5	6	7	8	9	10
1	WZ	1.000									
2	INNOW	0.090	1.000								
3	KONK	0.320*	0.049	1.000							
4	PWZ	0.149**	0.136**	0.078	1.000						
5	PINNOW	0.248**	0.087	0.177**	0.440**	1.000					
6	PKONK	0.325**	0.047	0.235**	0.508**	0.600**	1.000				
7	WIEK	0.149**	0.023	0.221**	0.077	0.131**	0.114*	1.000			
8	DOSW	0.322**	0.005	0.177**	0.125*	0.118*	0.175*	0.444**	1.000		
9	SKALA	0.227**	0.028	0.190**	-0.185**	-0.016	0.048	0.081	0.237**	1.000	
10	ZAW	0.286**	0.087	0.220**	0.351**	0.221**	0.315**	0.119*	0.133*	0.032	1.000

, * and ******* denote significance at 0.1, 0.05 and 0.01 level of significance, respectively; WZ – the level of knowledge of the managers; INNOW – innovativeness of companies; KONK – competitiveness of companies; PWZ – an increase in the business knowledge of the managers; PINNOW – an increase in innovativeness as result of use of business advice; PKONK – an increase in competitiveness as a result of the use of business advice; WIEK – the age of the companies; DOSW – the experience of the managers; SKALA – the size of companies; ZAW – the ability of the managers to absorb business knowledge.
Source: author's own study.

Chapter 5

Development of Human Resources in Micro and Small Enterprises as a Result of the Use of Business Advisory Services

Abstract: Effective management of micro and small enterprises, including their human resources, is important from the point of view of their development in a turbulent environment. Business advisory services are one of the methods of development of managers as well as employees. The aim of the paper is to discuss the importance and specificity of human resources in micro and small businesses and to determine the impact of business advisory services on shaping the business knowledge of managers and employees of these companies. The role of the capacity to absorb business advice-related knowledge in this process is also indicated. The study was based on the results of the research carried out by the authors of the text. The research was representative of the sector of micro and small innovative companies in Poland benefiting from business advisory services.
Key words: micro and small firms, human resources, business knowledge, business advice

1. Introduction

The literature on management in the sector of micro and small enterprises mentions the low level of managerial competences covering business knowledge of managers and their management skills of innovative companies as one of the significant challenges for running companies successfully in an ever more unstable environment [Adamik, Bednarska-Wnuk 2014]. These companies have limited resources

by definition, including in many cases limited knowledge about management and business experience in human resources management. The necessary knowledge and skills can be developed independently by managers, as well as acquired from the environment from business partners or advisors in the form of a professional service and affect the course and results of actions taken and consequently the survival and/or success of companies [Łobacz, Głodek 2015; Blackburn, Hart, Wainwright 2013]. The ability of owner/manager or other employees to absorb business knowledge may play an important role in this process, especially in the case of companies operating in a dynamic environment [Engelen et al. 2014; Viljamaa 2011].

The aim of this chapter is to discuss the importance and specificity of human resources in micro and small innovative enterprises and to determine the impact of economic consultancy on the formation of business knowledge of managers and employees of companies. The assumption of positive and significant influence of business advisory on raising the level of business knowledge of managers and other employees of enterprises, strengthened by the ability to absorb business knowledge and, as a result, on raising the level of management of enterprises, has been adopted. The chapter presents the results of an empirical study conducted with the use of CATI method on a sample of 400 Polish micro and small-sized enterprises using business advice. In the selection of entities, a random operator was used on the basis of a database from the REGON GUS database operating throughout the country. Meeting the criterion of innovation, i.e. they introduced novelties to their offer in the years 2014–2016 i.e. new or improved products/services, or improved methods of production/ service provision or changes in the organization of operations, and at the same time using the services of external business consulting. However, the investigation rejected replies from parties which did not meet the sampling criteria and provided incomplete or incorrectly completed questionnaires. The statistical and econometric methods were used (Spearman rank correlation coefficient). The analysis of the survey results confirms that there is a correlation between economic consultancy, the ability of managers to absorb the knowledge acquired through the use of consultancy, and the level of business knowledge of managers and the level of management. In the opinion of managers of micro and small innovative companies, the use of business advisory and improvement of managers' ability to absorb knowledge obtained from advisors raises the level of their business knowledge and employees, and can be considered as an effective factor in raising the level of management, especially in companies with already high level of management, as well as in increasing the innovativeness of companies.

2. The role of human resources in micro and small businesses

In the scientific discussion on the growing importance of human capital in the management of micro and small enterprises, the owners of these entities are forced to search for new solutions in the field of human resources management (HRM) adjusted to their specific needs and conditions of functioning in a turbulent environment. Employees' competences, knowledge, skills and experience are the priority for improving and maintaining the efficiency and effectiveness of a small enterprise [Czapla 2011]. In accordance with the resource approach, enterprises, including small ones, build their competitive advantage on the basis of resources such as human, organizational, financial, property and relational capital [Hamel 2002; Kok et al. 2003; Pauli 2016]. Human capital is an important source of building competitive advantage due to its uniqueness [Pocztowski 2007; Muogbo 2013]. This applies especially to small companies, which have limited ability to compete through expansion into new markets, price strategy, product/service diversification, which results from their specificity i.e. local range of operations, small market share or the importance of close and direct relations with customers and suppliers [Matejun 2015, p. 31].

Human resources management in micro and small companies is significantly different from that in large companies. An important problem is the lack of a systematic approach to human resources management. The reasons for this situation are: (i) low awareness of the role of HRM in the company among owners of these enterprises, (ii) low inclination to incur costs related to the implementation of human resources management methods and tools, (iii) reluctance to engage resources in enterprises related to HRM, (iv) lack of profit in a short period of time resulting from the effects of human resources activities [Cewińska, Wojtaszczyk 2016].

Micro and small enterprises have their own specificity resulting from their size and simple organizational structure. This structure is characterised by a relatively low degree of formalisation and usually has one decision centre with a special role of the owner in the leading position [Lisowska 2016], which limits the personal function to basic tasks related to the HRM [Pocztowski, Pauli 2013]. The most poor scope of personnel processes is visible in entities with traditional production profiles, where these processes are simplified and intuitive. However, in the case of micro and small enterprises operating in modern sectors using innovative technologies, employing highly qualified employees, personnel processes are more complex [Kok et al. 2003]. Therefore, it is reasonable for employees to have knowledge and a wide range of skills allowing them to properly perform the tasks entrusted

to them [Karwiński 2006; Smolarek 2016]. Owners often do not notice this problem and do not see the necessity or do not have the resources to conduct more advanced personnel management processes, especially in the area of personnel development.

On the basis of previous considerations. it is justified to recognise human capital as a strategic resource of micro and small enterprises, which results from the following characteristics of these entities [Pauli 2016, p. 153]:

- have less than a large access to material and financial assets;
- the source of success for companies is a new product or service, which was created thanks to the creativity of employees and the ability to identify customer needs;
- the lack of developed and organisational units means that a key role in these enterprises is played by people with interdisciplinary competences, effective in many fields, who play an important role in these enterprises;
- do not implement advanced procedures, which causes the efficiency and effectiveness of operations to be directly dependent on the employees' competences.

For the development of human resources in micro and small innovative companies, professionalisation in the area of human resources management is essential. Professionalism is associated with high skills and competences, i.e. as a professional person it can be recognized as one who has appropriate knowledge, skills, can act independently and is aware of his own value, has the ability to perform variable roles in the company, is comprehensive in terms of skills and experience, flexible in action, focused on the development of competence [Kok et al. 2003; Pocztowski, Pauli 2013, pp. 11–12]. In the case of micro and small innovative enterprises, a high level of knowledge, competence and skills of the owner may have a positive impact on the implementation and implementation of appropriate personal processes, while the lack of such knowledge, awareness and skills may result in the marginalization of the role of HRM and concentration of the owner's activities on the basic activity [Pocztowski, Pauli 2013, p. 13]. The implementation of these measures consists, amongst others, in research of development needs of employees and methods of employee development and determination of the measurement of development programmes [Trochimiuk 2013; Stefański, Godlewska-Werner 2016] as well as making knowledge available, e.g. through training, coaching, economic consulting and monitoring progress in the implementation of the planned career path and its modification in accordance with the company's objectives and the needs and aspirations of employees [Suchodolski 2010].

Employee development is defined as activities aimed at supplementing knowledge necessary to perform current work and providing opportunities for additional development of knowledge, skills and competences in terms of promotion or organisational change [Listwan 1995, p. 72]. The implementation of these activities consists of three stages: (i) preparation, which includes planning the employee's development path; (ii) implementation, identification of activities related to the implementation of the employee's development plan, e.g. through training, self-realization and relocation of employees; (iii) controlling, assuming monitoring of progress in the implementation of the planned career path and its modification in accordance with the company's objectives and the needs and aspirations of employees [Suchodolski 2010, pp. 211–222].

Employee development in micro and small companies is often done informally and mainly through training. These trainings are usually of an internal nature and are aimed at introducing newcomers to work, adapting to their roles and adapting to the organisational culture. These trainings are a spontaneous response to the current situation in the company, resulting from the needs and serve to solve emerging problems related to human resources management [Trochimiuk 2013, p. 128]. Seldom in small companies, training courses are a response to the needs and expectations of employees in terms of development [Pocztowski, Pauli 2013, p. 13]. The vast majority of these entities do not define long-term employee development plans, which is a result of low awareness of the benefits that will be visible in the long term. In small enterprises, training needs are not studied, and training is selected on the basis of entrepreneur's intuition and/or on the basis of opportunities that appear on the market in the form of trainings, often free of charge, and are dedicated to this type of enterprises. The starting point for making a decision on training is not the needs of employees or enterprises, but an attractive offer of training and consulting companies [Cewińska, Wojtaszczyk 2016, p. 377].

Trainings in micro and small companies are conducted using various techniques, which are selected on the basis of the financial capacity of the entity. Due to the limited financial resources in these companies, the most frequently used for improving the skills and competences of employees are training in the workplace on the job, external training in the form of participation in conferences, fairs and distance learning in the form of e-learning. These are forms of training characterized by low costs and the possibility of quick application of acquired knowledge or skills [Trochimiuk 2013, p. 131; Cewińska, Wojtaszczyk 2016, p. 379]. Much less often such methods as coaching and mentoring are used, they require a lot of commitment and high qualifications of managers. Additionally, in the case of coaching,

when it is carried out by an external company, it is a very expensive undertaking and not always possible to apply in small companies. In this context, another form of employee development may be economic consultancy, which will undoubtedly allow for professionalisation of human resources management, including employee development in innovative micro and small enterprises.

3. The impact of business advisory services on improving business knowledge of human resources in micro and small enterprises

Due to limited financial resources in micro and small innovative companies, workplace training, external training in the form of participation in conferences, fairs and distance learning in the form of e-learning are most often used to improve knowledge and skills of employees. Much less frequently in micro and small companies such methods as coaching are used, which can be treated as an instrument to strengthen the learning processes of entrepreneurs and employees by acquiring new skills, correcting ineffective behaviours, but on the basis of already existing knowledge [Shelest 2016, pp. 25–40]. Therefore, this tool can rather be described as a factor increasing the level of knowledge, including business knowledge, but to a limited extent it is related to the inflow of knowledge from outside [Stawasz et al. 2018].

In a way, a separate channel of knowledge and innovation transfer, including business knowledge, to micro and small enterprises are employees acquired from outside, with knowledge that constitutes a potential for its implementation within the company. Therefore, during the selection process it is justified to assess the competence of potential candidates for employees in the area of knowledge, ability to cooperate and work as a team (including especially sharing knowledge with others), creativity and the ability to accept other people's ideas and the ability to transfer knowledge [Majewska-Bator, Bator 2011]. External business knowledge is also acquired through appropriate management of contacts with market participants. In the context of acquiring business knowledge, the most important groups of market participants include business partners, suppliers, customers, shareholders, strategic investors and competitors [Stawasz et al. 2018].

On the other hand, the relations of these entities with the broadly understood business environment, including institutions operating in the area of training and education, business partners and economic advisors, are considered an important external source of increasing knowledge in micro and small innovative enterprises.

Economic consultancy gives the possibility to acquire knowledge that takes into account the specificity of a given entity and its challenges. Of course, in this case the quality of the counsellor, his substantive and interpersonal competences becomes particularly important. He participates in the process of selecting knowledge that can be useful for micro and small enterprises and plays a leading role in the process of adapting it to a specific market situation [Łobacz, Głodek 2015]. From this perspective, economic consultancy seems to be one of the resources available for micro and small enterprises [Chrisman, McMullan, Hall 2005] and can have a significant impact on the management and development of these entities. Managers of these companies rarely have the knowledge necessary to run an effective and successful business [Hutchinson, Quintas 2008]. Necessary and scarce knowledge can be obtained from the environment, from advisors. It is designed to help managers achieve their goals through: Solving management problems, identifying and exploiting new opportunities, learning and implementing change [Yusoff 2010].

Among the determinants of using consulting services by micro and small innovative enterprises, the factors characterizing the owner/manager (education and age of the manager, position in the enterprise), factors related to the enterprise itself (scale of activity, age, Industry, location, profile of activity, legal form of enterprises) and factors related to the development orientation of the enterprise (possession of a development strategy, knowledge gap) have a significant impact. These factors, their interactions, differentiate the micro and small enterprises sector in terms of the scope and intensity of using consulting services [Stawasz et al. 2108; Mole, Baldock, North 2017; Dobrea, Maiorescu 2015].

The concept of knowledge absorption capacity may be useful for assessing the effectiveness of business advisory in raising the level of business knowledge of managers and other employees, and indirectly for improving the level of management of enterprises. In management literature, the ability to absorb knowledge is defined as the ability of an enterprise to recognize the value of knowledge, its assimilation and transformation into a commercial result [Zahra, George 2002]. It is a dynamic ability, it influences gaining a competitive advantage in a dynamic environment by supporting, among others, the process of innovation, strategic flexibility [Matejun 2015; Volberda, Foss, Lyles 2010]. The development of the ability to absorb knowledge obtained from advisors poses challenges to micro and small enterprises, all the greater, given that they usually do not have an appropriate management structure and professional managers.

In the analysis of relations characterizing the influence of business advisory services on business knowledge and management in micro and small innovative

enterprises, the following three impacts can be distinguished: (i) impact of business advisory on business knowledge of managers and other employees, (ii) impact of managers' ability to absorb knowledge obtained from advisors on the level of business knowledge of managers and other employees, and (iii) impact of business knowledge on the level of management. Selected factors related to the enterprise and personal characteristics of the manager may be treated as so-called exogenous factors.

4. Impact of business advisory services on increasing business knowledge of human resources in micro and small innovative enterprises in the light of research

Methodology

The study on the impact of business advisory services on human resources development in micro and small innovative enterprises was conducted in 2016[1]. The survey was conducted using the CATI method using an anonymous questionnaire with owners or co-owners of enterprises or their main managers.

The methodology of the survey assumed that the sample would comprise 400 Polish entities from the micro and small enterprises sector (with up to 49 employees) from various industries, randomly selected by means of a random number generator from the group of 9703 enterprises from the REGON GUS database operating throughout the country, meeting the criterion of innovation and simultaneously using external business advisory services within the last three years preceding the interview. A total of 400 correctly filled in questionnaires were obtained. However, the survey rejected answers from entities that did not meet the criteria for sample selection and provided incomplete or erroneously filled in questionnaires. The original data obtained as a result of the survey were subjected to statistical analysis and comparative statistical analysis.

The market structure of 400 enterprises surveyed is dominated by the local and domestic market (37.5% and 45.5% of enterprises respectively), while 17% of enterprises operated on the foreign market. The industry structure of the sample was very diversified: services prevailed (74.7% of enterprises), followed by trade

[1] NCN project entitled *Shaping the competitiveness of a small company – the role of business consulting* (No UMO-2012/07/B/HS4/03019).

(15.5% of enterprises) and production (9.8% of enterprises). Mature enterprises with 4–10 years of market presence prevailed (49.8% of the sample), while the average employment rate was 7.7 persons. 60.1% of companies were entities managed by one person, and then by two persons (27.6% of companies), 12.3% of companies have management boards consisting of three or more persons, as far as family relations in the management of enterprises are concerned. in the studied population family companies prevail (70.8% of all entities in total). Over a half of managers had technical and natural education (53.3%), followed by economic education (31.8%) and legal and humanities education (14.9%). The managers of the companies had extensive professional experience (measured by the length of service in managing the company), which is confirmed by the average age of the managers' work, which is high and amounts to 12.6 years.

All companies met the innovation criterion, i.e. they introduced novelties to their offer in 2014–2016, i.e. In this period, they also used business advisory services related to their business activity in the following areas: financing sources and accounting (39% of entities), legal and tax services (18.5% of companies), production, logistics and IT (12.5% of companies), strategic management and development (10.5% of companies), marketing, sales and purchases (8.5% of companies), organisation and management (8.3% of companies) and personnel management (2.5% of companies). Among the motives for using business consulting, the gap in business knowledge of managers, company management problems and development priorities of enterprises were distinguished. Sporadic (several times in the analysed period) use of consulting services dominated (about 62% of companies) and in the case of every seventh enterprise consulting services were used only once, while every fourth company often or very often used consulting services. Nearly 59% of enterprises using economic advisory services stated that they had obtained benefits in line with expectations and 35% of enterprises had obtained benefits partially in line with expectations. Only 6% of the entities stated that the results obtained were not in line with their requirements.

Research results – Business knowledge of the managers

The assessment of the level of business knowledge of managers concerned their opinion on the current state of knowledge in the field of company management in its various areas, including techniques and methods of management in the Likert scale (1–5 points, where 1 point means a very low level of knowledge, and 5 points means a very high level of knowledge). The average level of business knowledge in the studied population was quite high and amounted to 3.81 points. It proves high

self-esteem of managers of the presented level of business knowledge. Very low level of business knowledge was recorded by 1.5% of managers, and very high by 26%. The level of business knowledge of managers significantly differs according to the size of companies: in micro businesses it is 3.7 points and in small companies 4.2 points, which means that the level of business knowledge of managers increases with the increase in the scale of companies.

The most popular and at the same time the most important source of increasing business knowledge of managers in the surveyed companies was learning on the basis of own experience (in the opinion of 67% of companies). Other sources are of lesser importance. Learning from business partners as the most important source of raising business knowledge of managers is signaled by 15.5% of companies, participation in courses and trainings by 10% of companies, and using economic advisory services by 7.5% of companies. Taking into account multiple answers, the basic source of increasing business knowledge of managers for over ¾ of companies was learning on the basis of own experience; for about 40% of companies it was learning from business partners and from courses and trainings, while for about ¼ of companies it was learning from business advising.

The assessment of the impact of business consulting on raising the level of business knowledge of managers and other employees of companies was based on the opinion of respondents in the Likert scale from 1 to 5 points, where 1 point means very little impact and 5 points means very little impact. This impact was higher for management (mean score of 3.3 points) and lower for other employees (mean score of 2.2 points). In 90% of companies, management increased business knowledge as a result of business consulting, and in half of companies – as a result of other employees.

This confirms that there is a correlation between business advice and the level of knowledge of managers and to a lesser extent of other employees. A certain explanation of this state of affairs may be the fact that consulting services were used primarily by managers of companies and then by other employees.

The influence of business advisory services on improving the level of business knowledge of managers shows differences according to the scale of companies: in micro-firms the average score was 3.4 points, while in small companies it was 3.0 points, which means that smaller companies benefited relatively more from business advisory. On the other hand, in the case of employees of the surveyed companies, there were different dependencies: in micro-firms, the average assessment of the impact of economic consultancy on raising the level of business knowledge was 2.1 points, while in small companies it was 2.5 points, which

means that as the scale of the companies increases, the employees made relatively more use of business consultancy.

The ability of managers to absorb business knowledge acquired from advisors

The assessment of managers' ability to absorb business knowledge of managers of companies obtained as a result of business consulting concerned their opinion on their ability to recognize, evaluate, assimilate and apply this business knowledge in practice [Todorova, Durisin 2007] in the Likert scale from 1 to 5 points, where 1 point meant a very low mark and 5 point a very high mark of managers' skills. The average score was quite high and amounted to 3.6 points. High scores are related to many characteristics of enterprises. These assessments are higher in the case of more innovative, more competitive, more development-oriented companies, using formal planning procedures more frequently, as well as companies with higher level of knowledge of their managers [Stawasz et al. 2018].

Problems with company management

As a criterion for assessing the occurrence of management problems in the surveyed companies on the basis of the managers' opinions, the assessment of a total evaluation indicator assuming values in the Likert scale from 1 to 5 points in three selected areas (development management, coordination of activities, current management), where 1 point meant a very low evaluation of the occurrence of management problems, and 5 points meant a very low evaluation of the occurrence of management problems – very high assessment of the occurrence of management problems. The average assessment of the occurrence of management problems was moderate, at 2.1 points. A very low evaluation of management difficulties was reported by 31.8% of managers and a very high evaluation of management difficulties was reported by only 1.0% of managers. Relatively the greatest difficulties were in development management and the lowest in day-to-day management of companies.

The assessment of the impact of business consulting on improving the level of company management was based on the opinion of respondents in the Likert scale from 1 to 5 points, where 1 point means very little impact and 5 points means a very big impact. The average impact of business consulting in the surveyed population was assessed as moderate and amounted to 2.7 points. For general management, the impact was 2.7 points, 2.6 points for strategic management and 2.8 points for coordination and 2.7 points for day-to-day management. The above data indicate a noticeable, although not very diversified, impact of business

consulting on the improvement of management level in innovative small companies. High scores for improvement of management level as a result of obtained consulting services are related to the characteristics of the company and consulting (consulting process, family relations among managers, frequency of using sources of business knowledge).

Dependencies

To identify dependencies the Spearman rank correlation coefficient was applied (Table 1). The analysis of research results indicates statistically significant relationships between the occurrence of problems in the management of the surveyed companies and the level of business knowledge of the managers and their ability to absorb the acquired knowledge and their experience, as well as the scale and age of the companies. The lower the level of business knowledge of managers (the correlation coefficient is -0.161 at the 0.01 level of significance), the lower the managers' ability to absorb knowledge (the correlation coefficient is -0.214 at the 0.01 level of significance) and the lower the managers' experience (the correlation coefficient is -0.114 at the 0.01 level of significance). Problems with company management are greater in smaller and younger companies (correlation coefficient is respectively: The correlation coefficient is -0.125 and -0.102 at the 0.01 level of significance).

In the opinion of company managers, the obtained economic consultancy had a positive impact – as it has already been shown above – on the level of business knowledge of managers and other employees and on the level of company management, as well as on the relationships between these variables. Increasing the level of business knowledge of managers and other employees was strongly related – the rank correlation coefficient was 0.427 at the 0.01 level of significance. It seems that the increase in the level of business knowledge of managers in micro and small companies as a result of the obtained economic advisory is a condition for increasing the level of knowledge of other employees.

Raising the level of business knowledge of the management staff and other employees is related to the ability of managers to absorb the acquired advisory knowledge. The rank correlation coefficient for both cases assumes moderate values and amounts to 0.334 and 0.282, which may mean that the higher the ability of managers to absorb knowledge obtained from advisors the higher the improvement in the level of business knowledge of managers and other employees in small companies obtained as a result of economic consultancy. It may also indicate the dependence of increasing the knowledge of other employees on the ability of

the management staff to absorb the advisory knowledge and to transfer it effectively in the company.

Improvement of management level as a result of obtained business advisory was strongly dependent on increasing the level of business knowledge of managers and other employees. In the first case, the rank correlation coefficient amounted to 0.491 and in the second case to 0.465 at the 0,01 level of significance). Therefore, it can be concluded that, according to the opinion of respondents, increasing the level of business knowledge of managers and other employees as a result of obtaining advisory services in micro and small companies has a positive impact on the improvement of the management level of companies.

Table 1. Correlations

		1	2	3	4	5	6	7	8	9
1	WZ	1.000								
2	PZ	-0.161**	1.000							
3	PPZ	0.192**	0.025	1.000						
4	PWZ	0.131**	-0.022	0.491**	1.000					
5	PWPP	0.323**	0.083	0.465**	0.427**	1.000				
6	ZAW	0.290**	-0.214**	0.255**	0.334**	0.282**	1.000			
7	SKALA	0.304**	0.125*	-0.011	-0.119*	0.265**	0.038	1.000		
8	WIEK	0.140**	-0.102*	0.077	0.080	0.089	0.138*	0.078	1.000	
9	DOSW	0.340**	-0.114*	0.147**	0.065	0.175**	0.124*	0.193**	0.480**	1.000

*significance level < 0.05; **significance level < 0.01; WZ – the level of knowledge of the managers; PZ – the management problems; PPZ – the management level improvement; PWZ – improvement of business knowledge level of managers; PWPP – improvement of business knowledge level of other employees; ZAW – the ability of the managers to absorb advisory knowledge; SKALA – the size of companies; WIEK – the age of companie; DOSW – the experience of the managers.

Source: authors' own study.

The study also points to an indirect impact (by increasing the level of knowledge of managers) on the ability of managers to absorb business knowledge acquired from advisers to improve the level of management. The relationship is statistically significant, although moderate – the correlation coefficient was 0.255 at the 0.01 level of significance. This may mean that the greater the ability of the management staff to absorb advisory knowledge, the higher the improvement in the level of company management.

The research also included selected factors related to the manager (professional experience) and the company itself (age and scale). A statistically significant

influence of managerial experience on raising the level of business knowledge of other employees, including business consulting, was found. In the first case, this impact is moderate. The correlation coefficient is 0.175. No statistically significant correlation was found between managers' experience and increasing their knowledge level as a result of obtaining advisory services. On the other hand, it positively influences the improvement of management level.

The research results in a statistically significant impact of the scale of enterprises on raising the level of business knowledge of managers and other employees as a result of the obtained business consulting. In the first case, the impact is small and concerns mainly smaller companies (the correlation coefficient is -0.119 at the 0.05 level of significance). In the latter case, the impact is moderate and increases with the increase in the size of the enterprises (the correlation coefficient is 0.265). On the other hand, the scale of the company did not have a statistically significant connection with the improvement in the level of management of the companies, which may mean that the improvement in management level as a result of the obtained business consulting, as shown by the managers' opinions, took place regardless of the size of the companies.

The age of companies did not have a statistically significant connection with increasing the level of business knowledge of managers and other employees, as well as with improving the management level of the surveyed companies, which may mean that the improvement of the level of business knowledge and management level as a result of the obtained business advisory, as demonstrated in the opinions of managers, took place regardless of the age of the companies.

The ability of managers to absorb knowledge acquired from advisors depends on their experience in managing companies and the age of the companies. The dependencies are moderate – the correlation coefficient of rank is adequate: 0.124 and 0.138 at the 0.05 level of significance. However, no influence of the scale of companies on the development of managers' ability to absorb knowledge obtained from advisors was found.

5. Conclusions

Micro and small innovative entities have limited resources, including in many cases limited management knowledge and business experience in human resources management. This causes numerous problems in the effective management of companies. The necessary skills can be developed independently by managers as well as

acquired from the environment, from contractors or advisors in the form of professional service, influencing the course and results of actions taken, and consequently the survival and/or success of companies. An important role in this process may be played by the ability of managers to absorb business knowledge from advisors.

The analysis of research results clearly shows the relationship between the occurrence of problems in the management of the studied micro and small companies and the level of business knowledge and managers' abilities to absorb the knowledge gained, as well as their experience, as well as the scale and age of the companies.

Business advice may be one of the sources of raising the level of business knowledge, both of managers and other employees in micro and small innovative companies. In the opinion of managers, in 90% of companies they have increased the level of their business knowledge as a result of economic consultancy, and in half of companies the remaining employees have also increased their level of knowledge. This confirms the existence of dependencies between business advice and increasing the level of business knowledge of managers, while to a lesser extent it concerns the remaining employees. Raising the level of business knowledge of managers and other employees was strongly related. It seems that increasing the level of business knowledge of management staff in micro and small companies is a prerequisite for increasing the level of knowledge of the remaining employees. It may also indicate the dependence of increasing knowledge of the remaining employees on the ability of the managing staff to absorb advisory knowledge and to effectively transfer it in the company.

Increasing the level of business knowledge of managers and other employees as a result of obtaining advisory services positively influences the improvement of management level in micro and small innovative companies. On the other hand, an increase in the level of business knowledge of managers without a simultaneous increase in their ability to absorb knowledge obtained from advisors, however, does not significantly affect the improvement of the management level of companies. Raising the level of business knowledge of both managers and employees and at the same time high ability of managers have a positive influence on improving the level of management of innovative companies.

The study found a moderating influence of selected factors related to the professional experience of a manager and the size of enterprises on the increase of the level of business knowledge of managers and other employees and on the improvement of the management level as a result of obtaining advisory services. The scale of companies and the experience of managers have a positive, although

moderate, impact on the improvement of the management level of companies and on the increase of the level of business knowledge of managers and other employees. The scale of companies has a positive, although moderate, impact on improving the level of business knowledge of managers and other employees. On the other hand, the experience of managers has a positive and moderate impact on the improvement of the management level of companies and on improving the level of business knowledge of other employees.

The age of companies and the experience of managers have a positive but moderate influence on the ability of managers to absorb the knowledge gained from advisors. However, the influence of the age of companies on the level of business knowledge and on the level of management of micro and small enterprises was not noticed.

Chapter 6

Entrepreneur's Participation in the Business Advice Process – Insights from the Case Studies of Innovative Small Firms in Polish Regions

Abstract: Business advisors are considered one of the most important sources of knowledge, significant for the development of innovative small businesses. Although the process perspective is important to understand conditions of business advice effectiveness, descriptions of business advice process available in the literature present the perspective of the advisors, who are responsible for final outputs and results, while the role and perspective of an entrepreneur is not clearly understood. Therefore, the objective of this paper is to identify structure of the advisory process for small innovative firms, taking into account the perspective of the entrepreneur. The analysis is based on qualitative research using in-depth interviews conducted among entrepreneurs from three distinctive Polish regions, who used business advice in the process of developing their small innovative businesses. It is argued that the close and effective collaboration between the advisor and an entrepreneur can be regarded as a factor that may have an impact on the quality of knowledge which is developed as a result of the advisory process as well as on the level of its adaptation to the specific situation and needs of a given company, and small business owners has the power to considerably manage the process in a way to serve their needs in the best possible way.

Key words: small innovative firms, business advice, business advice process, case study

1. Introduction

Small firms, which are a vital part of modern economy, are characterized by a number of specific features which make them different from larger enterprises. Those features include, for example, market approach, availability of financial resources, organizational conditions and technological powers. All these causes that a small firm isn't a simply reduced version of a large company, just like large company cannot be perceived as over-scaled small firm [Storey 1990]. Therefore in line with low level of management processes formalization, the process of knowledge acquisition, and its use for business development, can be perceived as unique when small firms are regarded [Łobacz 2015]. The knowledge development related process is even more specific for small innovative firms, as they constantly need new knowledge to develop improved market offers, especially in the early stages of development [Łobacz 2018].

Business advisors are considered one of the most important sources of knowledge, significant for the development of innovative small businesses. The results of business advice acquired by firms in specific circumstances and perception of its usefulness are broadly examined in the literature [Hurmerinta-Peltomäki, Nummela 2004; Yusuf 2010; Hinton, Hamilton 2013]. The studies include also a number of barriers related to the use of advisory services by small business owners [North et. al. 2011], among which the cost of services and psychological issues are mostly emphasized.

However the process of business advice, regardless of its relation to small or large, innovative or non-innovative firms, is in the literature described in the holistic approach, without a detailed perception of what exactly happens at subsequent stages of the process. Additionally, in the process descriptions available in the literature the perspective of business advisor is taken, while the role and perspective of an entrepreneur is nor clearly understood. This approach causes difficulties in reliable reasoning about successes and failures of advisory services and especially in conscious management of advisory contracts by small business owners.

Therefore, the objective of this paper is to identify structure of the advisory process for small innovative firms, taking into account the perspective of the entrepreneur. The analysis is based on qualitative research using in-depth interviews conducted among entrepreneurs from three distinctive Polish regions, who used business advice in the process of developing their small innovative businesses. As the study is explorative in nature, the conclusions formulated

provide an insight into further research and analysis, when the entrepreneur's participation in the business advice process is considered.

2. Business advice for small innovative firms

Entrepreneurs managing their small firms, of natural causes, rarely have the complete knowledge, necessary for the effective and efficient management of the current activities of the company and its development [Hutchinson, Quintas 2008]. As the demand for knowledge is higher when strategic change is considered [Łobacz 2015], access to external knowledge resources may become one of the factors influencing the behavior of companies and the ability of their development. For example, the use of external knowledge can contribute significantly to lower the barriers to development and reducing the perceived risk associated with decision -making by innovation-focused entrepreneurs [Głodek, Łobacz 2013]. Necessary and scarce knowledge can be acquired from the external environment in various forms, one of which is business advice. The acquired knowledge can be then used by an entrepreneur to improve management methods, identify and exploit market opportunities, or implement product changes [Ajmal, Nordstrom, Helo 2009; Yusuf 2010; Łobacz 2012].

The literature emphasize that business advice for small firms is different from the advice provided for larger companies [Mole 2013]. The visible differentiation relates, among others, to types of business advisors which are used. It is demonstrated that small business owners very frequently use advisors from outside the group of consulting companies and professional advisers [North et al., 2011; Soriano, Castrogiovanni 2012]. Instead they acquire knowledge from people belonging to the so-called family and friends' circles, or from the individuals with who they are bounded in business relations, e.g. firm's accountants, suppliers, banks representatives, customers or business partners [Blackburn, Jarvis 2010]. Advice received from these kind of sources is particularly used by the early stage firms and companies immersed in the transformation process [North et al. 2011]. Informal sources of advice are also more typical for family firms, which generally represent relationship- and trust-based approach in business [Strike 2012; Łobacz 2018].

Despite the wide range of business advice for small firms, and extensive public support directed at the development of the advisory services available to small businesses, research results report rather disappointing results of advisory services, resulting mostly from a number of problems in cooperation between

the entrepreneurs and the advisors. Many of these are associated with the psychological factors [Adamson 2000]. This includes problems related to the lack of confidence in relations with advisors and the need to build trust before and during the counseling process. Difficulties in building of a trust-based relationship are often a function of fear from unethical behaviors of potential advisors (possibility to disclosure precious information about the company), and/or limited beliefs in advisor's competences and abilities in solving real business problems, which lead very often to abandon decision about using of business advice, or result in significant erosion of potential results of the counselling process [Scott, Irwin 2009; North et al. 2011]. All these aspects affect mostly the advice process, in which a strategic change in small firm's business orientation is considered [Łobacz et al. 2016], in which a strong collaboration between the entrepreneur and the advisor is required [Łobacz 2020; Głodek 2020].

Entrepreneur and advisor participation in the advisory process

The literature review relating to business advice for small firms allows to distinguish two different roles of advisors: (1) the role of an expert providing external expertise tailored to the requirements of a given company, and (2) the role of a change process participant in the knowledge transfer process and the creation of new knowledge on the basis of strong interaction with the entrepreneur. In various ways, this point of view is presented in works of Christensen and Klyver [2006], Koszałka and Sluismans [2011], North et al. [2011], Labas, Courvisanos and Henson [2015], or Łobacz et al. [2016]. In the first role, the role of expert, the advisor is seen as a purely external knowledge resource. Use of this knowledge resource is reasonable from the firm's point of view, if there is a need of its incidental use only in the specific circumstances, which company is facing one very specific moment. In the second role, the role of a change process participant, the advisor is understood as a person who participates in the creation of knowledge needed by the company in the process of cooperation with the entrepreneur. In this case the advisor's role is to expand knowledge cumulated in the company and thus it differs fundamentally the way in which it supports the enterprise. Thus, in the second approach, the cooperation between the entrepreneur and the advisor determines the possibility of the existence of a successful change process in which solutions are developed.

Considering the existence of both approaches, it can be concluded that strong entrepreneur-advisor collaboration in the advice process is not a generally necessary condition of its success, but that it is rather an enabling and efficiency generating trigger when a deep strategic change of a company is implemented. The

close and effective collaboration can be then regarded as a factor that may have an impact on the quality of knowledge which is developed as a result of the advisory process as well as on the level of its adaptation to the specific situation and needs of a given company.

However when the process of business advice is analysed, these two distinctive entrepreneur-advisor collaboration approaches are not clearly addressed. In the literature studies the counselling process is seen as a sequence of consecutive events, which follow one another, regardless of problem which is in place to be solved and the collaboration scheme which is necessary to make it happen. The need to differentiate approaches to business advice process depending on type of a problem the company is facing has been communicated by many authors, to include North et al. [2011], Koszałka and Sluismans [2011], or Łobacz et al. [2016]. In their considerations, they suggest that the currently available models of small firm business advice process fail in including some very important stages of the process, at which entrepreneur-advisor collaboration is present and trust-based relations are developed. Moreover, since collaboration is an enabling factor of the process, the participation of two sides in this process should be simultaneously regarded.

3. Business advise process from the advisor's perspective

Business advice is a process understood as a sequence of activities involving at least two parties: (1) the party who provides advice (adviser) and (2) the party who receives the advice (the owner or manager of the company). Each of them participate in the process for other reasons and expect different outcomes. Thus, this process is seen by any of the parties from a different perspective, but both taking steps that require particular skills and level of involvement.

The literature is strongly dominated by the perspective of an advisor, whose role is to control the advisory process. In this perspective the advisor leads the process and other people involved in it. Thus this is the role of the advisor to diagnose a problem which will be addressed in the process, as well as to provide the right knowledge in the right way. It should be emphasized that this view often refers to personal counseling regarding various spheres of life, in particular, career counseling. The basis here is the relationship between two people participating in the process, which to a large extent has a psychological background.

Therefore, psychological counseling models are used in this respect, for example a four-stage model formulated by Brzezinski and Kowalik [1991], which

assumes four stages of the process, including: (1) the advisor's initial preparation to counseling for a specific person, (2) the advisor's initial contact establishment with the person being advised, (3) the actual stage of consultancy, and (4) the final stage regarding the advisor's summary of the entire process. In relation to the advisor's approach to consultancy delivered for people developing their businesses, Brammer [1984] has described a slightly more extensive process, divided into 8 stages[1]:

1. "Introduction" – aimed at preparing the counselor and establishing mutual relations.

2. "Clarification" – in which both sides determine the problem and the reasons for assistance.

3. "Structuring" – aims to formulate on what conditions the process of assistance will last, and to indicate the first steps necessary to establish cooperation; the condition for further relationship is the agreement of the person seeking cooperation and taking over responsibility for his participation in this process, in particular honest talking about himself.

4. "Relationship" – aimed at building and deepening mutual interactions by using verbal and non-verbal communication.

5. "Exploration" – consisting mainly of the active work of an advisor consisting of analyzing problems, formulating goals, planning activities, collecting facts, expressing deeper feelings, teaching new skills.

6. "Consolidation" – referring to the fact that the counselor considers alternative solutions, puts new skills into practice, tries to define his own feelings.

7. "Planning" – an action plan is prepared, unpleasant feelings are reduced and new skills or behaviors are included to change the existing situation.

8. "Completion" – it includes a summary of the entire counseling process by the counselor and counselor, evaluation of results and termination of the relationship/contract.

Obviously, business consulting has features that distinguish it from personal consulting. First of all, there exist no or little disproportion of the bargaining power between participants of business consulting, which is typical for the relationship between a career canceller and a high school student [Pisula 2010]. In the business advice process, the recipient is usually the entrepreneur who manages the company. It is the person paying for the consultancy contract, which is a potential factor for

[1] Ho-Kim and Marti [1999] described the process from the perspective of the consultant pointing to five separate steps.

a better bargaining position than the adviser - the party implementing the contract. In addition, it should be emphasized that one of the entrepreneurial features is the pursuit of independence [Mazzarol 2011], which results in low tolerance of the situation in which the parties involved are not in an equal relationship.

In the business consulting relationship, therefore, we are dealing with a consulting party that actively influences the consulting process. This means that not only the advisor decides about the style of consulting, or also about its scope and form. On the contrary, the course and effectiveness of the advisory process is the result of the interaction of both parties and the entrepreneur's decision regarding the desire to invest in consultancy resulting from a given interaction. It also leads to the conclusion that the counseling process may – but does not have to – be dominated by the party receiving the counseling as the party dictating and controlling the terms of the relationship. Significant exceptions to this rule are consulting processes for companies that are financed under EU funds. There are rigid formal requirements associated with this source of funding that advisors must meet, and failure to do so means that they do not receive remuneration for consultancy. Caban-Piaskowska [2014] described the structure of advisory activities implemented under one of the EU programs in Poland. She indicated six stages of consultancy, which are determined in connection with the creation of documentation confirming the performance of the advisory service.These include:

1. Prepare and provide the database advisors.
2. Notification by the document "declaration of accession to advice".
3. Meeting the client and the lead advisor – determining the advisory need and composition of the advisory team, and generating a "preliminary consultancy service card" (WKUD – abbreviation in Polish).
4. Establishment of an advisory group and forwarding the WKUD document to this group.
5. Advisory group meet the client, undertake joint discussion, preparation and signing of the "consultancy service card".
6. Preparation by the advisers of presentations and consultancy documents, and the entrepreneur signing the acceptance report of consultancy services and completing the questionnaire for the consultancy process.

The presented approach indicates that also in this perspective the advisory process is perceived from the perspective of the advisor's needs and requirements and documenting his work. The entrepreneur's perspective has been taken into account to a very limited extent.

4. Advisory process taking into account the entrepreneur's perspective

Characteristics of the study. Methodology

The study was conducted in 2014–2016 on a group of twenty small innovative companies using business consulting. Twenty interviews were carried out in Polish companies in three regions of Poland: Lodzkie region, Pomeranian and Lower Silesia. Interviews were conducted personally by the authors of the publication. The study adopted the multiple case study model [Yin 1982]. This strategy is considered a valuable approach in the research of small companies, mainly due to its ability to analyze individual or complex research problems in an environment rich in variables affecting the context of functioning. Thus, as part of the empirical data collection process, a qualitative measurement was used for the described part of the study, which was carried out using the individual in-depth interview technique.

In-depth interviews were carried out at the company's headquarters with the owners or main managers of the companies. In the case of several management managers, the interview was conducted with a person from among them who was indicated as having knowledge related to the consulting processes. The contents of individual interviews were (with the knowledge and consent of interlocutors) recorded on digital media, which enabled their repeated reproduction at the stage of data analysis. Regarding the process of qualitative data analysis, the principles of the classical variation of grounded theory were applied. The collected empirical material was subjected to theoretical coding and factual coding in order to saturate the theoretical categories and determine the cause-effect relationships.

Entrepreneur's perspective

Within the group of enterprises covered by the research project, two types of advisory process structures seen from the entrepreneur's side were identified. They differ in the complexity and scope of control by the entrepreneur.

The first of these refers to consultancy situations in which the entrepreneur maintains control over the process and sets out its stages. This group was dominated by cases of consulting, with a relatively small impact on the overall business and competitiveness of the company. In these cases:

- The advisor is required to have professional knowledge in a given field, but the knowledge provided is not unique, and therefore it can be provided by other entities,

- The required knowledge relates to areas that the entrepreneur considers as those that do not generate key added value for the company.

The consultancy process of this type consisted of five stages:

1. Diagnosis of a company problem – the entrepreneur identifies and defines a problem that can become the basis for consulting.

2. Searching for a suitable adviser – using various strategies (various sources, including personal and business relationships) and a different time range, often the process of seeking a consultant is not very intensive and implemented as if by the way.

3. Presentation of the advisor's problem and approval of the scope of consultancy – such formal, written consultancy or consultancy agreements may be used at this stage on a trust basis – without a written agreement.

4. Implementation of an advisory service – carried out exclusively by an advisor or as part of various forms of cooperation, with the entrepreneur or, more broadly, the company's staff.

5. Settlement of consultancy services (technical and financial).

The second type of consulting process referred to cases of consulting significant from the point of view of the overall business of the company[2]. Seven stages can be distinguished as part of this type of process.

1. Diagnosis of an enterprise problem – the entrepreneur identifies and defines a problem that can become the basis for consulting.

2. Searching for a suitable advisor – using various strategies (various sources, including personal and business relationships) and a different time range, often the process of seeking a counselor is not intensive and implemented as if by the way.

3. Presentation of the adviser's problem and initial analysis of the problem – in the analyzed cases, when the entrepreneur's original intentions were presented to the adviser and analyzed, the adviser decided to criticize them in various forms and point to the weaknesses of the original concept.

4. Repeated diagnosis of the company's problem – followed by a period (several meetings, covering even more than a month of work) of discussions and work related to suggesting and analyzing various options that could be an area of potential changes in the company and thus consulting.

5. Defining and agreeing the scope of consultancy – as a result of the process, there was a fundamental change in the diagnosis regarding the scope of the

[2] A detailed description of this type of advice and its effects are presented in Stawasz et al. [2018].

company's needs and the scope of consultancy needed. Here, the effect of redefining the problem in the analyzed cases was a diagnosis indicating the need for a complete remodeling of the company's business model (including partly the characteristics of its product), or a fundamental change in the company management model.

6. The implementation of the consultancy service – was carried out in close cooperation with the entrepreneur.

7. Settlement of consultancy services (technical and financial).

Comparing both types of processes with each other, the main difference is visible in the first part of the process, which relates to the diagnosis of the problem. It is associated with a fundamental change in his perception by the entrepreneur as a result of interaction with the adviser. During this interaction, entrepreneurs verified their previous assumptions about the problem to be solved by the adviser, and as a consequence their role in the process also changed. Instead of being a party completely deciding on the process, they became the party who agreed the next steps with the advisers. It was possible, among others by establishing trust relationships between the parties.

In the context of identified cases, the second structure of consultancy can even be called "accidental consultancy" or "evolutionarily developing" consultancy. The initial intentions of the entrepreneur with regard to the scope and area of consulting differ significantly with the final results. Instead of improving a separate element of the company's operations, ultimately the consulting changed the company's operating rules.

5. Conclusions

The analysis of the structure of the business consulting process for small innovative companies indicates the factors that distinguish it from psychological or personal counseling. The approach changed the focus of analysis from the method of providing consultancy services, to the problem solving process and to factors related to process control. It increases the importance of requirements specified by the entrepreneur, followed by the search and selection of the "right" advisor. It creates the space for modifications of entrepreneur's requirements due to interaction with advisors, or even resignation from the use of advisory services due to disappointment with the quality of support received.

Two distinguished types of the advisory process differ in the scope of the consultant's participation at the stage of diagnosing the company's problem. Entrepreneurs are rather reluctant to allow business advisors to participate in this phase, which indicates the importance to keep control over what is happening in their company. On the other hand, if the adviser participates in the diagnosis stage of the problem, there is often a repeated diagnosis, which in consequence leads to a redefinition of the initial assumptions regarding the scope of advice.

Entrepreneur's perspective allows to introduce two types advisory process and to analyse management of this process, including process control issues. The presented analysis confirms the importance of the entrepreneur's attitude and actions for the effectiveness of the advisory process. In particular its plays a key role in the process of choosing the adviser, defining and redefining the area of consulting as well as the scope of entrepreneur participation in the advisory activities.

The use of entrepreneur's perspective creates new methodological and research opportunities. Several areas relevant for future research on business advice for small innovative companies can be identified. These include: (i) an analysis of the impact of the diagnosis development method on the advisory results, with special attention on the importance of incorrect diagnosis of the problem made independently by entrepreneur; (ii) the importance of trust in the conclusion, formulation and enforcement of consultancy contracts, taking into account the division into types of consultancy related to interaction between the consultant and the entrepreneur; (iii) the existence of different forms of consultancy related to the participation of an advisor at various stages of the consultancy process; (iv) the existence of various entrepreneur strategies in the selection of advisors and management of the advisory process.

Chapter 7

Adoption of Innovation. Dynamic Drivers and World and Regional Good Practices on E-health Services

Abstract: This chapter recognizes that the e-health comprises innovations in majority medical specialization branches as: pediatric, cardiology, neurology, psychiatry, cancer and blood disease and urology, radiology, pathology, dermatology, surgery, family medicine and oncology. The paper focuses on main purpose of telemedicine, the influence of innovation on economic and clinical benefits. Afterwards, the adoption of telemedicine solutions on the market in the healthcare organizations and by physicians and patients in diffusion process is explained. Finally the comparison of the implementation of the telemedicine programs within different medicine fields and countries can be found by the reader.
Key words: adoption of innovation, innovation in health care, adoption of e-health

1. Introduction

Today, we cannot imagine a modern healthcare organization that doesn't use ICT (Information and Communication Technologies) on everyday basis. ICT in a healthcare organization should include all functional areas of hospital's medical activity, as well as all areas of management. Today high technologies and new products are available, whose implementation allows to create new services defined as e-health or telemedicine. They are quite a specific form of providing healthcare, which requires constant cooperation and complementation of two fields: medicine and teleinformatics. Medicine offers know-how on methodology of providing healthcare services and health assessment, while teleinformatics provides

technical tools for delivering the services that under normal conditions require more expensive and direct interaction of the patient with the doctor.

2. The significant role of innovation in the e-health services development

The implementation of e-health requires both the organization's and customer's change. Changing the way an organization works is supported with new technology, managerial and administrative processes, the distribution of medical services and relations with patients. The relations with patients are central to organizational improvement and to the enhancement of organization effectiveness [Cuyler, Holland 2012, pp. 342–343]. Telemedicine implementation changes the organization's strategy, the organization's technologies used, organization's culture and structures, the role of doctors and administrative staff and patients relations. American Telemedicine Association identifies telehealth and telemedicine as synonyms. Another synonym is e-health. However, the meaning of above words would be different in terms of basic and more precise characteristic. Telemedicine has been described very narrowly, only as the delivery of health care at a distance by electronic telecommunication, typically used to share information between a physicians and medical professionals (it refers to Telemedicine 1.0). New telecommunication technologies developed the medical services based on the delivery of health care at a distance – it refers to Telemedicine 2.0. According to literature and World Health Organization [2009, pp. 8–10; Vuèkovic et al. 2003, pp. 54–59], we can state that there are five main purposes of telemedicine:

1. to provide clinical support to the patients;
2. to connect users of medicine services who are not in the same physical location to overcome geographical barriers;
3. to involve the use of various types of ICT by physicians and patients;
4. to improve healthcare services;
5. to reduce the geographic isolation of patients.

E-health innovations hold great potential for societies, medical organizations (administrative staff, doctors, managers of health care organizations), families and individuals. The telemedicine has been used in the growing number of specialization branches as: radiology, pathology, dermatology, surgery, cardiology, psychiatry, family medicine, cardiology, pediatric, oncology [Vuèkovic et al.

2003, pp. 54–59]. The specialization branches, where telemedicine has still the narrowest implementation and use, are dentistry and orthopedics [2017 U.S. Telemedicine 2017, p. 16]. The most popular services offered via telemedicine by American health care organizations [2017 U.S. Telemedicine 2017, p. 14] are following: second opinions or specialty opinions, mental health services, urgent care or after-hours care, outpatient hospital services, remote patient monitoring, emergency department services, store and forward uses (excluding radiology and pathology), inpatient hospital services, destination medicine services, telestroke, telepharmacist. Above all, telehealth gives opportunity to increase the level of health protection, improves clinical management, gets the better access to the new medical technologies, and leads to increase quality and efficiency health care and makes cost-effectiveness for users and providers of medical services. New medical services using the electronic telecommunication technologies refer also to: telediagnosis, telepresence, teleconsulting, telemonitoring, and telesurgery [Lyuboslavsky 2015, pp. 275–276]. Telemedicine can also cover the terminology related to cybertherapy [Gouvernet, Haddouk 2017, pp. 10–15].

3. Analysis of perspectives for Polish e-health services

The current Polish healthcare system lacks the mechanism of coordination of the care provided to the patient. For example, after a treatment at a hospital ward, the patients have to organize further specialist care or rehabilitation themselves. This decreases effectiveness of the earlier treatment, as very often the patient is lost at what to do, gives up the painful process of seeking rehabilitation, and is demotivated by long waiting times. Also the Primary Health Care (PHC) does not fulfill its role. PHC doctor, as the provider of medical services, often does not receive information about the treatment of patients from his active list from different places of the system, hence he cannot coordinate care necessary for the patient. Lack of this information has negative effect on the treatment of the patient, who is left to himself and to whom medical expert did not show the right path. Another pain in the system is also atomization of medical services in the field of outpatient specialist care (ASV). Many hospitals closed their specialist clinics, which were often commercialized and privatized as a result. Hospitals do not cooperate with those units on everyday basis, which further intensifies the loss of the patient in the system and impedes coordination of the treatment. One of the fundamental effects of this lack of coordination is frequent use of ASV that generates long waiting ques,

and more significantly makes the patient lost in the system, which ruins effects of the treatment from one level of providing healthcare services, due to the lack of continuation on another level [http://i.rynekseniora.pl/i/00/27/73/002773.pdf]. This diagnosis of the lack of the necessary elements of a medical service, and the need for more effective medical care, shows a gap in the offers of medical organizations, doctors (individual services providers) and intermediaries (e.g. firms from ICT sector) for services in the healthcare industry.

Innovations in telemedicine in a healthcare organization should include all functional areas of the hospital's medical activity, as well as all areas of management. When it comes to medical activities it is mainly supporting software, which primarily allows keeping patient's electronic medical documentation in accordance with requirements for this documentation, entering and sharing this part of patient's documentation that is intended for the patient's Internet account. It must also provide possibility of authorization of those entries by medical staff, as well as authorization of various statements and declarations that are signed by the patient in the hospital. It must also foresee appropriate formulas of confirming and authorizing the entries. In this scope, hospital's ICT system, which is the core element of telemedical systems, should have applications supporting: patients' medical documentation including archiving, patients' traffic, pharmacy, analytical laboratory, bacteriological laboratory, diagnostic imaging (radiology, ultrasonography, endoscopy), specialist clinic, rehabilitation clinic, systems of intensive medical care and emergency medical services. Additionally applications (telemedical solutions) supporting decision making processes in clinical and outpatient treatments should be introduced – wider look at telemedicine [Korhonen et al., 2018].

Ultimately all information about state of our health, previous diseases and treatments will be transferred to Internet, which will eliminate the need to carry any documentation of our medical history. Finally the patient will not have to remember all the medicines he had been taking in last few years, or the information when he had flu or a broken leg. All that data will be stored in an e-system that will be available for every doctor who is treating us. It is worth noticing that such a change will speed up the process of diagnosis, and the choice of the best treatment. And it will all happen thanks to comprehensive and immediately available information on previous diseases, treatments, medications etc.

E-prescription will definitely simplify the procedure of buying medicaments by patients. Pharmacists will always be able to read doctor's instructions, and patients will not be able to lose the e-prescription. Apart from those obvious functions,

users will receive a number of smaller options such as reminders of appointments, or prescriptions' expiry dates, submitting PHC declarations in e-form, and many more [https://www.u24.pl/internetowe-konto-pacjenta-ezdrowie-gov-pl/].

Typology of telemedicine forms

Telemedicine uses information and communication technologies for transfer of medical data from one place to another in order to improve patient's health. It is not a competitor to traditional medicine, but a tool facilitating work of medical personnel, and acting to the benefit of the patient. Telemedical solutions are more and more frequently applied, thus we can also talk about: telecardiology, teleradiology, teleurology, telesurgery or teleaudiology. Classification of telemedical solutions is presented in table 1.

Table 1. Classification of telemedical solutions

Telemedicine solutions	Characteristics
Telediagnosis	Description of the test takes place in a different location than it was made. Diagnosis is made on the basis of data sent by electronic transmission between distant medical facilities (computer files). The most common example of telediagnosis is teleradiology (description of images by teleradiology center) or cardiology (tele-ECG).
Telemonitoring	Patient with a chronic disease is equipped with a device that measures his vital functions at fixed intervals, and the results are sent to a telemonitoring center. Special algorithms analyze received data, and upon recognizing abnormalities they will alarm the doctor on duty, who initiates an intervention.
Teleconsulting	A video-interview between a PHC doctor, a patient, and a medical specialist. Thanks to audio-video technology and on-line transmission, the consulting doctor is able to gain medical history from the patient, or even make a check-up. The benefit of this solution is a fact, that the patient can be consulted by doctors of different specialties during a case conference, which allows to take an interdisciplinary look at patient's problems.
Telerehabilitation	Sharing teaching materials on rehabilitation, and video-conferences where the therapist controls quality and correctness of the rehabilitation exercises performed, thanks to which the patient can recover in optimal conditions, at home. Telerehabilitation provides faster access to rehabilitation, additionally eliminating costs caused by the distance of rehabilitation center from the patient's location.
Teleteaching	Trainings, lectures, presentations, accessible from every place on the planet, thanks to information and communications technology. Websites and portals providing on-line transmissions of break-through operations are becoming increasingly popular. Teleteaching can increase qualifications of medical personnel, which in turn increases the level of medical care provided.

Telemedicine solutions	Characteristics
Telesurgery	„Remote" operations, where a surgeon remotely controls an operating robot, which performs each phase of the operation according to surgeon's instructions and movements. This solution was initiated by the military, thanks to which a soldier on the front line could have been operated by a doctor from a clinic on a different continent [http://paga.org.pl/upload/source/RAPORTY/2016_11_25_Telemedycyna_04_WWW.pdf].
Telepresence	Live telecommunication is used to assist physicians or other health care organization staff as medical consultants and specialists to deliver health care services to remote hospitals and patients. The service is offered in type of direct patient care, health education, and clinical consultation in critical care using a two-way audiovisual link produced a better clinical care and educational effect than the telephone call. It is real-time video distant-monitoring support in the intensive care unit. The telepresence is based on the different physical location and livestreaming.

Source: based on literature review [Matthews et al. 2017, pp. 1212–1218; Brunetti et al. 2017, pp. 137–146].

However, Larson et al. argue that introducing digital communication does not itself indicate economic and clinical benefits. It is one of the reasons physicians favor traditional healthcare to telemedicine. The cost of time spent on telemedicine coordination work is generally imperceptible. The patients declare objections to delegating technical and logistic tasks to external providers [Larsen et al. 2016].

Adoption of e-health and diffusion theory

Diffusion of health care innovation assures an effective use of knowledge and technological resources. This in turn provide with new technology for health care product and services s for suppliers and the new product or services for recipients. "Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system" [Rogers 1983, p. 5]. It is special type of communication, where physicians, health care organizations and the patients (recipients) create and/or share information with each other in order to adopt or reject innovations. The concept of telemedicine innovation diffusion comprise knowledge diffusion (about new healthcare services), and the innovation output diffusion (new technology used in health care services or in service delivery process). The concept of the innovation diffusion process is the knowledge spillovers [Klincewicz 2011, pp. 22–24], the adoption of telemedicine solutions on the market (in the healthcare organizations and by physicians and patients) and the development of product or services business process that differs from what was originally implemented or introduced on the market [Oslo Manual 2018, p. 129].

The key areas of innovation implementation in telemedicine are the delivery of healthcare services, interaction between patient and healthcare professional and the proactive care and preventive interventions through use of new technologies. The perceived attributes of the innovation define the decision makers' rate of innovation adoption. The authors indicate five key attributes of good innovation characteristic: relative advantage, compatibility trialability, observability and complexity [Morrison et al. 2012, pp. 137–144]. The key attributes which determine eHealth innovation adoption are explained on the examples of dentistry and cardiology telemedicine (Table 2 and 3). The implementation of innovation should be preceded by the recognition of assessment the potential benefits of the new technology or products to the innovation suppliers and recipients. The innovation adoption decision in an organization requires solutions to existing problems, the increased productivity or improved operational efficiency [Mndzebele 2013, pp. 473–476]. Compatibility is connected to the past experience and needs of potential adopters. The attribute corresponds also with value system of decision makers and fits in perfectly with the innovation suppliers and recipient's needs [Menachemi, Burke, Ayers 2004, pp 617–632]. Next significant attribute in discussion about innovation adoption has crucial influence on the first stage of diffusion process – trialability. This innovation characteristic is responsible for the first innovation usage or purchase. If the first adopters (first clients, patients, physicians, suppliers) decide on the first "trial", encourage others (next adopters or followers) to the experiment with innovation.

Observability is the degree of innovation added value visibility. Each member of the diffusion process of innovation has different benefits assessment. The inventor, organization or individual responsible for innovation implementation and development on the market has to analyze and take into consideration the way of usual product or services attributes perceiving (as quality, usability, price, newness, brand).

Table 2. The key attributes of innovation in cardiology e-health

Description of e-health service	Characteristics	Description of characteristic
Possibility to create a „Heard Team – heart surgeon, cardiologist, and an intervention cardiologist". During coronarography the team members, who are in their specialist hospitals, can consult with the heart surgeon arteriosclerosis changes and via video they can together decide whether to implant the stents or decide on bypasses.	Relative advantage	Effectiveness of heart surgery intervention.
	Compatibility	Bigger intervention team with wider range of competences in comparison to a team without telemedical support.
	Trialability	Before the surgery, images and film can show multitude of cases, and how complicated the decision of a heart surgeon is, which makes a decision to adapt a new solution easier.
	Observability	Statistics of „Hard Team's" operations' effectiveness that confirms increased effectiveness or analyses of potential effects of the team.
	Complexity	Effectiveness of the assessment, lower number of complications, enhanced reputation of the medical unit, lower costs of specialist treatment thanks to the lower number of interventions.

Source: own research.

Table 3. The key attributes of innovation in dentistry e-health

Description of e-health services	Characteristics	Description of characteristic
The telemedical service proposed for implementation in stomatology is: telestomatology service (in the field of prevention), which is a control examination of the oral cavity with an inside-mouth camera and assessment of the oral cavity health state, including remote consultancy with a specialist doctor via Internet. Examination conducted in primary schools by stomatology nurse or a team of stomatology students (e.g. as a part of their apprenticeships).	Relative advantage	Control, diagnostic, and prevention examination.
	Compatibility	Examination conducted in schools by medical support staff, thanks to the usage of telestomatology solution.
	Trialability	Examination with an inside-mouth camera allows a specialist doctor to make an assessment and establish diagnosis.
	Observability	Preventive tests, initial diagnosis, elimination of the fear of dentists.
	Complexity	Effectiveness of assessment, awareness of the need for treatment, quick information exchange (parents – specialist doctor), elimination of the need for stomatology offices in schools, reduction of treatment costs thanks to an early diagnosis, large portion of population covered with the examination.

Source: the interviews with physicians.

Table 4. The key attributes of innovation in maternity and obstetrics e-health

Description of e-health service	Characteristics	Description of characteristic
The proposed solution is a remote, at-home monitoring of heart action of a baby and of contractions. A mobile device is placed at home, in patients' (mother and the baby) room, and at a chosen time, non-invasively a fetal heart rate monitoring is done. Data and photos are sent to a health care center or to a doctor or a midwife that provide care for the patients.	Relative advantage	Speed of labor intervention, increasing level of safety of an endangered pregnancy.
	Compatibility	Negative experiences of hospitalized patients with endangered pregnancies, and positive experiences of patients spending the same time at home.
	Trialability	Simplicity of the telemedical service, easy to recognize reduction of endangered pregnancy risk.
	Observability	Comparison of the risk of a patient with an endangered pregnancy being at home with and without the telemedical service.
	Complexity	Fetal heart rate monitoring, constant monitoring, no need for visit and stay in a hospital, safety of the patients staying at home, lower cost of the care, higher comfort of a patient despite an endangered pregnancy, higher safety of the baby in an endangered pregnancy.

Source: own research.

4. Implementation of the e-health programs within the different fields

The healthcare sector is facing unprecedented challenges, which are magnified by aging population and the desire to provide care for all. Telemedicine may offer the innovation services by which healthcare professionals provide better, easier and more effective treatments of diseases related to aging, including dementia and other neurodegenerative disorders, specifically by video-based telehealth (aid in longitudinal, continuous monitoring) [Chirra et al. 2018, pp. 1–10]. Telemedicine program can also facilitate modification of oncology treatments in real time, by reviewing the outcomes of patients [Pedrosa 2017, pp. 863–869]. The digital technology developments and wide access to ICT technologies increase the possibilities of telehealth programs implementations. ICT new products gave rise to developments in new healthcare services, also or first of all, in high-risk patients' populations such as: aging, transplant patients [Jandovitz et al. 2018], living in the rural areas.

The introduction of new technology under the health care project induces the sociotechnical challenge that has to be overcome [Jayasinghe et al. 2016]. The telehealth is often placed where medical care is dispensed, lack of awareness of the medical services and local doctor has high trust [Elder, Clarke 2007, pp. 1–12]. Telemedicine programs in the world regions are described in the Table 5.

Table 5. E-health programs in the world regions

Program	Description	Regions
Wisconsin Live Health Online	A telemedicine company, Wisconsin members can have a live, video-based visit with a physician who can provide a diagnosis and treatment plan, as well as prescribe medications. According to a news release, a Live Health visit will cost the same or less than an in-person visit for eligible plan members.	North America
Children's Plans Telemedicine Partnership	The Center for Telehealth at Cincinnati Children's already offers to practice pediatrics in other countries (e.g. Republic of Dominican) consultations in pediatric cardiology, neurology, psychiatry, cancer and blood disease and urology.	North America
Project ECHO, The Office of the National Coordinator for Health Information Technology and the American Medical Association	Project ECHO features weekly videoconferencing sessions that allow primary care physicians in rural Arizona and Utah to consult with specialists and present patient cases. To build on this information exchange, the ONC The Office of the National Coordinator for Health Information Technology and the AMA (American Medical Association) are developing clinical quality measures for hepatitis C testing and will bring them into patient care through the development of clinical decision support tools. Participating providers will also connect to public health databases and other clinical data systems to monitor the success of the program and expand interventions to larger swaths of the population.	North America
Six district hospitals and 25 clinic sites around the Eastern Cape, Republic of South Africa	The goal of Telemedicine is to increase the accessibility of specialized health care in rural areas. Patients in rural areas do not have to travel long distances to urban hospitals in order to access specialist care, whilst waiting times and transportation costs are reduced.	South Africa
The Institute of Pathology Pathology of the Medical Faculty in Zagreb	It enables a direct communication (visual) between the peripheral hospitals and referral facilities in the interior of the country as well as a connection of centers with referral centers abroad in the fields of diagnostics, consultations or education	South Europe
Gading Pluit Hospital, Sahid Hospital and JEC Hospital, as well as at the RSCM,	Apply telemedicine are implemented in the form of seminars and surgery (surgery online).	South and East Asia

Program	Description	Regions
Husada Utama Surabaya Hospital and Regional General Hospital	Did in the form of teleradiology.	South and East Asia
Indian telemedicine project	The rural kiosk to transfer medical information from rural areas to urban centers.	South and East Asia
Virtual clinics for ear, nose, throat, dermatology and radiology in Pakistan	Virtual clinics facilitated the treatment of patients in the north of the country.	South and East Asia
Project P1 Center for Information Systems of Health Care.	The aim of the project is creation of a platform, which will provide such e-services as e.g. Online Patient Account (OPA), e-prescription or e-referral.	Central East Europe
Telemedical projects in the World Hearing Center in Kajetany	Teleconsultations were conducted in 2000, when an image of an ear recorded by a video-otoscope was transmitted via Internet for analysis and consultation. This event started activities of the Institute promoting telemedicine in Poland. During following years many projects were carried out, including: • 2002 r. – live transmission of the world's first operation of a hearing implant's insertion to a person with so called partial deafness; • 2004 r. – transmission of an image from an operating microscope to a mobile phone. Application of a new branch of telemedicine – mHealth; • 007 r. – development and pilot implementation of a telelifting method to a clinical practice. The method was a remote programming of hearing implants; • 2009 r. – a Polish Nationwide Network of Auditory Telerehabilitation was created. It consists of 20 telerehabilitation centers all over the country. Project was funded from the Norwegian Financial Mechanism.	Central East Europe

Sources: https://www.beckershospitalreview.com/healthcare-information-technology/13-recently-announced-telemedicine-programs.html; Cilliers, Flowerday 2013; Vuèkovic et al. 2003, pp. 54–60; Elder, Clarke 2007, pp. 166–70; Jayasinghe, Crowder, Wills 2016, pp. 1–12; http://paga.org.pl/upload/source/RAPORTY/2016_11_25_Telemedycyna_04_WWW.pdf.

5. Summary

Strategic postulations of the healthcare system's reform declare deep changes in its two main areas: corrective medicine (healthcare services), and public health. The first phase is the reform of the system, which aims to increase effectiveness of the publics funds involved, to simplify the system for its users (patients, medical professionals, administration), as well as aims to change the philosophy from

commercial to public with use of modern teleinformation technologies [http://i.rynekseniora.pl/i/00/27/73/002773.pdf].

Telemedicine is a specific form of providing healthcare services. It requires constant cooperation and mutual complementation of two fields: medicine and teleinformatics. Neither of those fields is sufficient by itself when it comes to telemedicine.

Medicine provides know-how in methodology of providing healthcare services and professional assessment of health state. Teleinformatics provide technical tools for delivery of the services that under standard conditions require more expensive, direct interaction of the patient and the doctor.

That is why the basic element of telemedicine's development is building a relation between service providers and IT companies, supported by mutual trust, which will guarantee safe delivery of the services. This trust must bring about the trust of the patient, who should believe that the quality of remote medical care that employs modern technologies is not worse from traditional care, but better and can bring benefits to him, simply because it provides constant access to medical care, which in turn provides continuous care for the patient [http://www.izbamedpol.pl/data/Pliki/96/Plik/Raport---telemedycyna-(fin)10.03.2015.pdf].

Chapter 8

Role of Territorial Capital in Building Smart Regional Specialisation. Case Study of Łódź Industrial Heritage

Abstract: This paper aims to present the post-industrial legacy of Łódź as territorial capital that has laid foundations for the building of smart regional specialisation. It provides a synthetic description of the notion of territorial capital to demonstrate post-industrial potential of the city and its innovative capacity. The paper is the end result of an interdisciplinary approach combining economic, social, and spatial aspects. The research method applied in it is a *case study* analysis involving: (1) critical analysis of the subject-matter literature, (2) statistical methods, and (3) desk research of reports, analyses and expert opinions. In the author's opinion, this specific capital that got accumulated and emerged over two centuries in the form of knowledge, skills, architecture, social and economic relations has generated a unique territorial potential and still exerts significant impact upon the development of innovative capacity of Łodź agglomeration.
Key words: smart regional specialisations, territorial capital, territorialisation of development, post-industrial heritage, Łódź growth

1. Introduction

Two recent decades witnessed a shift from the interpretation of space understood in the categories of a static location of resources and economic operators towards a dynamic approach, in which territory is defined through the lens of relations and activities of local actors, as well as social and institutional capital. In this approach, territory is a place where resources are generated and information, knowledge and skills get accumulated as a result of joint effort. Territory is the source of innovation

and a co-author of economic success of individual actors. A. Rallet stresses that territorial development makes references to space, which is not taken for granted but actively constructed by its history, culture and various social networks. How a territory works is not determined by decision-makers who adopt development policies but comes from the mobilisation of internal forces and engagement of individual operators [Rallet 2008, p. 298].

A far-reaching re-interpretation of factors and mechanisms of social and economic development, discussed within the framework of territorial paradigm, introduces the notion of territorial capital and territorialisation of development processes. This approach puts strong emphasis on the importance of the embeddedness of growth in the territorial tissue. It also highlights intangible growth externalities, co-development of new values and resources, as well as the unique nature of a particular location. Also economic traditions, norms and capital, entrepreneurship of local residents, specific knowledge and skills can be seen as components of territorial capital.

In this context, the paper intends to show the post-industrial heritage of Łódź as territorial capital that can provide foundations for the building of smart specialisation. It provides a synthetic description of the notion of territorial capital to demonstrate post-industrial potential of the city and its innovative capacity. The paper is an effect of an interdisciplinary approach combining economic, social, and spatial aspects. The research method applied in it is a *case study* analysis involving: (1) critical analysis of the subject-matter literature, (2) statistical methods, and (3) desk research of reports, analyses and expert opinions.

2. Territorial capital: Re-interpretation of development factors and conditions

The term 'territorial capital' has been introduced into economic sciences through the framework of the territorial development paradigm and it still awaits an unambiguous interpretation [Toth 2015, pp. 1327–1344]. It was used for the first time in the OECD publication "Territorial Outlook" in 2001 in the context of the ways of building competitive advantages of places [OECD 2001, pp. 15–16]. Studies and analyses of Italian and French economists, especially the works by R. Camagni and R. Capello [Camagni 2008; Camagni 2009, pp. 118–132; Camagni, Capello 2013, pp. 1383–1402] are crucial for how the term is interpreted.

Generally speaking, territorial capital is seen as a type of capital that is linked with a particular territory (territorialisation), even though effects of its deployment into the production of goods, services, technological solutions, local and regional brands, etc. can be transferred to supra-regional or international level [Sokołowicz 2015, p. 66]. Classically interpreted territorial capital includes all elements of a given space that have been created as a result of accumulation, interaction and synergy to produce specificity of a given place. These are specific external benefits, generated and available through multidimensional interactions of users of a particular territory. Territorial capital emerges from place-based resources, such as: cultural heritage, social and relational capital, a system of territorial norms and regulations. Territorial capital also includes the ability to cooperate, creativity, business climate or know-how, and innovation skills. Many theoretical interpretations expand the notion of territorial capital with tangible aspect of access to natural resources or infrastructure although their relevance is seen as secondary [Capello, Caragliu, Nijkamp 2009, p. 1].

Diverse approaches and interpretations are unanimous in seeing territorial capital as a:

- specific resource, built endogenously and strongly place-based. It creates specific and unique conditions for business;
- strategic and valuable resource, rare and unique good, which contributes to comparative advantage of a territory and offers particularly favourable conditions to economic operators;
- determinant of the development policy and its territorial orientation, fitting into specific development circumstances of a given place (territorialisation of development policy).

Territorial capital makes a place unique and rare at cultural, spatial, social, and economic levels. It is often stressed that the success of spatial economic systems depends not just on the quantity and quality of material resources they have. The richness and complementarity of intangible resources as well as their development are gaining in importance. These elements are inherently linked with their location in a given place and embeddedness within local networks of relations, labour market, local culture, and institutions. Mobilising territorial capital by adjusting investment projects to the specificity and resources of a given place results in higher return on investment [OECD 2001, p. 16]. Territorial capital generates higher profits in appropriately selected investment projects and fosters synergy effects between businesses and sectors of economy [European Union 2011, pp. 12–13].

Territorial development paradigm provided framework for the term 'territorialisation'. Territorialisation of development processes is based on the fact that economic decisions are always influenced by local institutional conditions, which exert significant impact upon behaviour patterns and responses to changes. Social and cultural environment shapes – but also is shaped by – economic interactions and all types of economic activity are deeply rooted in social relations networks [Sokołowicz 2015, pp. 166–167]. Territorialisation is interpreted as the anchoring of economic development processes in the territorial tissue, the embeddedness of economic activities in social relations and in the institutional environment together with mobilising the mechanisms of co-creating new values and strategically valuable resources [Hess 2004, pp. 165–186]. In classical approach, economy gets embedded through traditions, norms, customs, culture or cooperation principles that have developed within the local community and which are different across the spatial spectrum and strongly place-dependent.

Economists agree that development capacities lie, to a large extent, in the power of place-based (territorialised) and unique resources which are much more valuable than relatively universally available capital or infrastructure. Agglomeration economies, creativity, entrepreneurial spirit, as well as the presence of institutions, relational and social capital are elements which – directly or indirectly – generate the ability of a place to transform and produce competitive advantages [Nowakowska 2018, p. 14].

3. Territorialisation of Resources as a Building Block for Smart Regional Specialisations

Territorialisation of development processes has become a fundamental category in the idea of smart regional specialisations. Originators of this approach to the shaping of innovation capacity in regions stress the need to integrate sectoral/industry approach with a clearly territorial approach [Foray, Van Ark 2007, p. 2; Foray, David, Hall 2007].

Within sectoral perspective, attention is drawn to the identification of the area of specialisation deriving from technological advantages of the region. The domain should be selected as a result of a bottom-up, pro-entrepreneurial process that engages business partners. Specialisation must be closely linked with market needs while priority directions of research should meet the needs of

recipients of these research studies. Specialisation domain should be strongly linked with science and R&D sector. It also needs a well-developed and well-functioning science and research institutions having a good market reputation, economically successful, linked with a dense network of ties with the business sector. On top of that, a well-developed system of institutional support (the so called institutional environment) is more than necessary as it acts as intermediary between R&D sector and business (e.g., science and technology parks, technology transfer centres, innovation incubators or venture capital funds).

In the regional perspective attention focuses on endogeneity and specificity as well as on concentration and complementarity of regional potentials necessary to develop smart specialisation (the so called territorial advantage). It is also stressed that regional environment (territory) is not neutral in building innovation capacity of operators and the mere technological advantage may be not enough to develop a highly competitive specialisation. Territory is a source of innovation processes and territorial development mechanisms are vital success factor in building up innovation capacity.

The embeddedness of specialisation domain in the social, institutional and economic tissue is the pre-condition to develop smart regional specialisations. By placing specialisation domain within endogenous resources of the region, anchoring it in the past, in social and economic heritage, we create a specific competitive advantage resulting from the accumulation of knowledge, experiences, and traditions. Moreover, the anchoring of specialisations in the entrepreneurial milieu with sustainable and dense network relations and well-developed cooperation channels facilitates the transfer of information and knowledge and provides foundations for generating innovative solutions.

Smart specialisations can successfully develop when within a particular territory we can find potential that is diverse but affined. Smart specialisations necessitate complementary regional resources and an environment that offers them a powerful development support through, e.g., the system of education, infrastructural and institutional resources or related industries. This is a way for a region to build a strong economic system, linked with relational ties and interdependences, capable of achieving strong competitive position at international level [Nowakowska 2015, pp. 310–318].

Territorialisation of smart regional specialisations highlights links between the dynamics of changes in innovation capacity of regions and features of a territory. It stresses specific interdependence and symbiosis between the activities of economic operators and a territory. Resources, features, and growth rate of

a territory on the one hand attract investments and create innovation capacity of businesses but, on the other hand, enterprises co-create the development logic of a territory and decide about its competitiveness. Economic operators use resources available in a territory but, at the same time, they co-create them, by which they link their development strategies with the location of their activities.

4. Industrial Heritage of Łódź: Territorial Capital for Building Smart Regional Specialisations

In Poland, Łódź is the best example of a 19th century industrial city built on industrial monoculture focused around the textile and apparel industry. This monoculture economy, which managed to survive for almost two centuries in the city, collapsed as a result of systemic transformations and the shift to market economy in the early 1990s. Textile and apparel industry experienced a rapid and deep decline which brought economic distress and degradation to the city and impoverished its population. Huge, state-owned factories and enterprises failed to successfully face market economy requirements and the competition of high quality products originating from Western Europe, on the one hand, and cheap, low quality products that started to arrive from Asia, on the other hand [Walker 1993, pp. 1065–1080]. In the early 1990s, unemployment rate in Łódź exceeded 25%.

Social and economic transformation that the city has been experiencing for the last 25 years is marked with deep evolution in the approach to post-industrial heritage, from negation to affirmation. In the first stage of transformation, political and economic decision makers mostly rejected the obsolete and inefficient post-industrial heritage and were looking for new development paths for the city. Over time, people started to realise and appreciate the value of this specific territorial capital so unique for Łódź. The approach to city development shifted towards valorisation of post-industrial heritage and using it as a foundation of unique, regional specialisation. This change in the perception of post-industrial qualities concerned economic and architectural potential (mainly post-industrial buildings) but also more intangible values, such as traditions, names or traditional skills.

Architecture, especially textile factories representing the biggest cluster of post-industrial structures in Europe, is the key component that decides about the uniqueness of Łódź. Numerous and rather characteristic buildings and spatial structures constructed mostly when the city flourished and developed into

a big European textile centre have until to-date remained the most monumental buildings in the city while post-industrial factory and housing districts are types of settlements that cannot be found anywhere else in the world. Post-industrial premises adapted in recent decades to new economic and social functions have no doubt become the trademark of Łódź. They have also shaped the image of the city and transformed its negative perception as an industrial, working class city into a positive, thriving and modern narrative. In this context, adaptation of post-industrial buildings to functions connected with entrepreneurship, broadly understood culture, science, and creativity is particularly important [Nowakowska, Walczak 2016, p. 53].

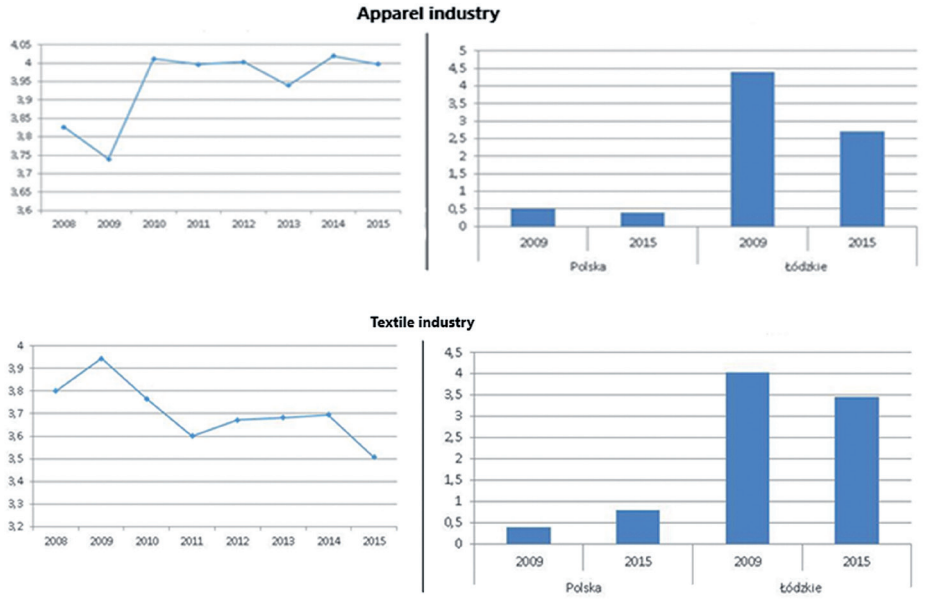
Industrial heritage of Łódź is visible not only in its urban planning layout or architectural potential, but it remains to be present in the economic structure. However, the industrial structure and profile of the city has changed. Large economic operators, true giants that would employ several thousand people in the best years, transformed into small and medium-sized (many of them family-run) businesses drawing upon the potential of knowledge, experiences, and skills that had developed in the previous decades. Former employees and workers of state-owned enterprises spontaneously came up with bottom-up initiatives of establishing their own micro-enterprises taking advantage of available and skilful human resources, as well as machinery and equipment sold by bankrupt factories. The 1990s witnessed an explosion of entrepreneurship and rapid growth of the population of small and medium-sized enterprises in the textile and apparel industry.

The emergence of micro and small enterprises in the Łódź agglomeration in the early 1990s triggered the development of a vast and impressive body of wholesale and retail infrastructure for clothing and textile products. It was a spontaneous and endogenous bottom up initiative of local entrepreneurs who organised themselves to provide an outlet for their production, something unprecedented at European scale. Today, the place is built up with premises offering the biggest trading space in Central Europe where customers may buy clothes, fabrics, haberdashery, etc. manufactured by over 2,500 businesses. It has become the centre from which Polish clothes are exported to international markets, a kind of a fashion city.

Łódź continues to be dominated by the textile and apparel industry. The location quotient (LQ) in 2016 calculated based on the number of businesses in textile industry amounted to 3.22, while in the clothing industry – 3.92 [ROT 2018, p. 111]. Strong concentration of the production of textiles and clothing is

also confirmed by location quotients LQ calculated based on the employment (figure 1), which unambiguously identify these industries as regional specialisations. In 2016 clothes and textile products accounted for more than 15% of the total production sold. These two industries employed over 26% of employees in the manufacturing sector [Statistical Office in Łódź 2016]. The above quoted values have been increasing for several years. Łódź agglomeration is the national champion in the production of many textile products (e.g., ca. 90% of tights and 62% of cotton fabrics manufactured in Poland originate from the Łódź region) [Deloitte 2012, pp. 67–71].

Figure 1. Changes in levels of specialisation in the years 2008–2015 (location quotient LQ calculated based on employment)



Source: ROT [Regional Territorial Observatory], Stworzenie narzędzi do monitorowania innowacyjności regionu łódzkiego z wykorzystaniem procesu przedsiębiorczego odkrywania [Tools for monitoring innovation in the Łódź Region], p. 142.

Textile and apparel industry in Łódź is based on spatial proximity and direct relations, which have created dense and lasting networks of cooperation. As a result, a number of formal and informal clusters and cluster initiatives proposing innovative solutions have developed in the city. There is, inter alia, Klaster

Innowacji Tekstylnych [Cluster of Textile Innovations] and Klaster Zaawansowanych Technologii Przemysłu Włókienniczo-Odzieżowego [Cluster of Advanced Textile an Garment Industry Technologies] (housing the Polska Platforma Technologiczna Przemysłu Tekstylnego [Polish Technological Platform for Textile Industry]).

Over the last decade, apparel and textile industry is increasing its technological and innovative potential in the economic structure of the city and region. It is well illustrated by the dynamics of outlays of enterprises in the Łódź voivodeship on innovation (Table 1). In the years 2009–2015 in two key industries, i.e., in the clothing industry the outlays increased eleven times while in the textile industry six times.

Table 1. Innovation outlays in enterprises of the Lodz region [in thousands of PLN]

PKD* section	2009	2015	Dynamics of changes
Manufacture of wearing apparel	1991	22831	1,146.7 %
Manufacture of textile products	2163	22862	594.6%

Source: GUS 2017.

*PKD – Polish Classification of Economic Activities

In Łódź agglomeration there is a dynamically developing sector of modern technologies (Pro Humano Tex). The city has got an especially big potential in non-woven fabric and knitting technologies, as well as in ballistic textiles and raw materials technologies. Łódź also hosts a big number of R&D centres pursuing intensive innovation activities in the apparel and textile industry, which step by step transform this traditional industry into a modern industrial structure. Their list includes, inter alia: Textile Research Institute, Institute of Biopolymers and Chemical Fibres, Institute of Security Technologies MORATEX, Research and Development Centre of Textile Machinery, Institute for Sustainable Technologies in Textile Machinery, and the Institute of Dyes and Organic Products in Zgierz. They offer substantial support to the industry.

Elements of Łódź industrial heritage can also be traced in the educational profile of universities. Strong concentration of skilful academics, unique knowledge, technical skills, and specialist competence transferred from generation to generation are additionally fostered by extensive educational services. Vocational schools and university courses available in the Łódź agglomeration respond to the demand of textile and apparel industry (e.g., courses in industrial design, design, materials science and engineering).

The heritage of industrial Łódź is also visible in the development of business environment in the city, which is strongly oriented to meet the needs of textile and apparel industry. The industry is assisted by related industries, such as: design, fashion, and industrial design. For many years already Łódź has been successfully aspiring to become the Polish capital of fashion. The city hosts the Polish fashion week called Łódź Young Fashion (until 2016 known as Fashion Philosophy). On top of that, since 2007 the international Łódź Design Festival has been organised here. It is the most prestigious event in the design industry in Poland and in Central and Eastern Europe that attracts big numbers of visitors (over 200,000) [PARP, *Diagnoza stanu designu* 2015; BBS Question Mark 2017].

Łódź has got its social and institutional specificity. The city's creative potential comes from the multicultural social and economic structure that emerged here in the years of its dynamic growth. Łódź, the city of four cultures, at the turn of the 19th and 20th centuries was known for its tolerance as a melting pot of cultural and national diversities that peacefully co-existed making part of this urban organism. Due to the origins of the city, traditional bourgeois class with its typically conservative attitudes almost cannot be found here, which makes it a unique place, open and friendly to creative industries [Nowakowska, Walczak 2016, p. 54].

4. Conclusion

Beyond any doubt, Łódź is a city that developed for and around industry (textile and apparel industry). One can clearly see the evolutionary and endogenous development processes closely linked and dependent on historically shaped development path resulting, to a large extent, from the industrial past of the city. Contemporary growth of Łódź derives from territorial capital that has got accumulated and embedded here and is visible in the experience and competences of its residents, in the economic structure, social relations and culture, in institutions, architecture, and urban planning.

Łódź – the city that was built on textile industry – continues to be driven by its power. It is the capital of Polish textiles, which flourishes and acquires international allure. Post-industrial heritage adds on the specificity and uniqueness to the social, economic, and spatial tissue of Łódź. This territorial capital transforms traditional textile and apparel industry into a modern hi-tech sector of economy. Textile and apparel manufacturing is gaining in importance in the economic structure of the city and it clearly acts as an anchor of smart regional specialisation.

Chapter 9

Maps of Relationship between Science, Economy and Technology as an Instrument to Identify Smart Specialization Niches in Łódzkie Voivodship

Abstract: The aim of this paper is to present possible use of the aforementioned classifications in order to develop a map of major relationships between disciplines of science and branches of economy, which cover high- and medium-high-technologies, and therefore to identify the most promising niches of smart specializations in Łódzkie Voivodship, which to the greatest extent reflect scientific and economic potential of the voivodship. Results of the National Foresight Programme – implementation of the project's results[1], were used to write this paper.
Key words: smart specialization, relations between science, economy and technology

1. Introduction

Science, technology and economy are subjected to a number of different classifications, which are based on specific international standards. To classify science and technological disciplines, a standard approved by OECD is used [The Polish Central Statistical Office – GUS 2018a]. Similar standard used for social and economic purposes of the R&D is *NABS Nomenclature for the Analysis and Comparison*

[1] The project commissioned by the Ministry of Science and Higher Education MNiSW, contract No DS. 621/NPF/2011.

of Scientific Programmes and Budgets [Eurostat 1994 and 2008]. The above mentioned standards constituted basis for the development of the Polish classifications [Polish Journal of Laws 2018.1818], which are used, among others, by the National Science Centre (*Narodowe Centrum Nauki*)[2] or the Central Committee for Degrees and Titles (*Centralna Komisja do Spraw Stopni i Tytułów*)[3]. *International Patent Classification* [Polish Patent Office 2006, as amended] is the standard used for the technological activities, whereas *International Standard Industrial Classification for All Economic Activities ISIC* [UN 2008] is the standard used to classify the economic activities. *Classification of Business Activities in Poland PKD 2007* [Polish Journal of Laws 2007.251.1885 as amended] is based on the *Statistical classification of economic activities in the European Community NACE* Rev.2 [Official Journal of the European Union L 393/1], which also conforms to the *ISIC*. *The Polish Classification of Goods and Services PKWiU 2015* [Polish Journal of Laws 2015, item 1676] is complementary to *PKD 2007*. *High-Technology Sector and Product Classification* [Hatzichronoglou 1997] is the standard used to identify high-, medium-, and low-technologies, whereas to classify the high-technologies products, the *Standard International Trade Classification SITC* Rev. 4 [UN 2006] is used.

2. Classical approach in identifying smart specializations

In the traditional approach the country's/region's specialization is determined by the interaction between characteristics of the industries and characteristics of the countries/regions, where said industries are being developed (Table 1). This interaction defines countries'/regions' specialisation in technologically intensive industries/services, or industries/services with high economies of scale, or with capital intensity, or with skill and higher skills intensity [Aiginger, Davies 2004; Aiginger, Rossi-Hansberg 2006; Dierx, Ilzkovitz, Sekkat 2003; Hallet 2000; Krugman, Venables 1995].

[2] The classification in question can be found on www.ncn.gov.pl/finansowanie-nauki/panele-ncn.
[3] The classification in question can be found on http://www.ck.gov.pl/articles/id/10.html.

Table 1. Specialisation as a result of interaction between the characteristics of the industries and characteristics of the countries/regions, where such industries are being developed

Industry characteristics	Country/region characteristics
• Economies of scale • Technology level • R&D intensity • Capital intensity • Share of labour: Skill intensity and Higher skills intensity • Agricultural input intensity • Intra- and inter-industry linkages • Final demand bias • Sales to industry • Industrial growth	• Market potential • Capital labour ratio • Average manufacturing/service wage • Relative wages in particular country/region vs other countries/regions • Researcher and Scientists • Skill intensity and Higher skills intensity • State aid

Source: compiled on the basis of Midelfart-Knarvik et al. [2000].

According to this approach specialization has mainly historical background, and particular countries/regions have relatively little chances to introduce new (other than the already developed) areas of specialization [Balmann et al. 1996; Capello, Nijkamp 2009; Frenken, Boschma 2007; Hudson 2007; Lee, Mason 2008; Puffert 2004; Rafiqui 2009].

The current (conforming to the *Europe 2020* strategy) concept of smart specialization is different from this approach and instead it refers to technological change [Aghiona, David, Foraye 2009; Foray, David, Hall 2009; Foray, David, Hall 2011] which takes place in the territorial capital[4]. Its core elements are formed by the general purpose technologies[5] (Box 1) and the resulting position of the country/region in the global innovation network [Dedrick, Kraemer, Linden 2011; Foray, David, Hall 2009, Giuliani, Pietrobelli, Rabellotti 2005; Hansen, Birkinshaw 2007; Pietrobelli, Rabellotti 2011]. The expected results consist in the increased efficiency of the European Research Area [Varblane, Ukrainksi, Masso 2010], and more effective implementation of the cohesion policy [European Commission 2011a]. In case of the latter it is believed that there are more fundamental (than the history itself) evolutionary mechanisms, particularly (technological) process of learning and adaptation, as a result of which country's/region's specialisation depends more on the strategy[6] (than on the history), as well as on choosing different paths

[4] Territorial capital is regarded as a distinct bundle of factors which guarantee competitive advantage of particular countries/regions [Athey, Nathan, Webber 2007; McCann, Ortega-Argilés 2011; OECD 2001].
[5] *General purpose technologies*.
[6] The concept of so called intended competitive advantage [cf. Cooke, Leydesdorff 2006; Furman, Porter, Stern 2002].

of technological development [Garud, Karnøe 2001; Martin, Sunley 2007; Maskell, Malmberg 2007].

Box 1. General purpose technologies

General purpose technologies are used in the increasing number of sectors, and their implementation causes increased production efficiency, as well as generates inventions and innovations in the increasing number of applications. In the report drawn up by the High Level Group such technologies are referred to as the key enabling technologies[7], while many other reports call them critical or generic. As a result of their implementation extreme scientific or technological progress is achieved and very dynamic economic growth is observed, which however tend to decrease as the technologies in question become 'more mature'.

Source: based on the European Commission 2011b.

As a result of defining the smart specialization in this way, the previous principles for providing financial support to R&D and innovation activities has been abandoned (neutrality and not favouring any areas of research/economic activities) to the benefit of concentrating resources on a small number of key research/innovation priorities.

In the classical approach the bottom-up interactive entrepreneurial discovery process [World Bank Group 2015] is the basic instrument used to identify smart specializations. However, it generally leads to determining a relatively large number of areas of smart specializations, which take into consideration various interests of many participants from different environments (economy, science, public administration, society) and consequently cause dispersion of expenditures for R&D and innovation activities. Therefore the process in question can be, and should be, supported by other instruments, which help concentrate smart specializations on the most promising niches, which effectively increase innovative and competitive strength of particular regions. Maps of relationship between science, economy and technology are an example of such instruments.

1. Structure of the maps of relationship between science, economy and technology

To develop maps of relationship between science, economy and technology, functional classification of R&D activities (Box 2) is combined with mind mapping methodology [Buzan, Griffiths 2016].

[7] *Key enabling technologies*.

Box 2. Examples of functional division

'Examples of functional division are as follows: type of R&D activity (basic research, applied research and development), products type (or the sector they are delivered to), R&D discipline (e.g. natural sciences, engineering and technical sciences, social sciences, humanities and art), as well as social and economic aim (e.g. economic growth, public health, environment, education).'

Source: The Polish Central Statistical Office – GUS 2018, p. 87.

Product types, distinguished on the basis of the product nature criteria, are used to develop the maps of relationship. In this case directions of scientific research/technologies are classified according to the product type developed with the use of particular research/technology, and are described as specified in the Polish Classification of Goods and Services *PKWiU 2015*. However, it is better to identify product types on the basis of product's application criteria, and using this criteria allows to classify the directions of scientific research and technologies on the basis of final products manufactured by particular sector, and to describe them as specified in the Classification of Business Activities in Poland *PKD 2007*. It must be borne in mind that both classifications (*PKWiU 2015* and *PKD 2007*) use conceptual, scope and code relations (Box 3).

Box 3. Conformity of divisions adopted in *PKD 2007* and in *PKWiU 2008*

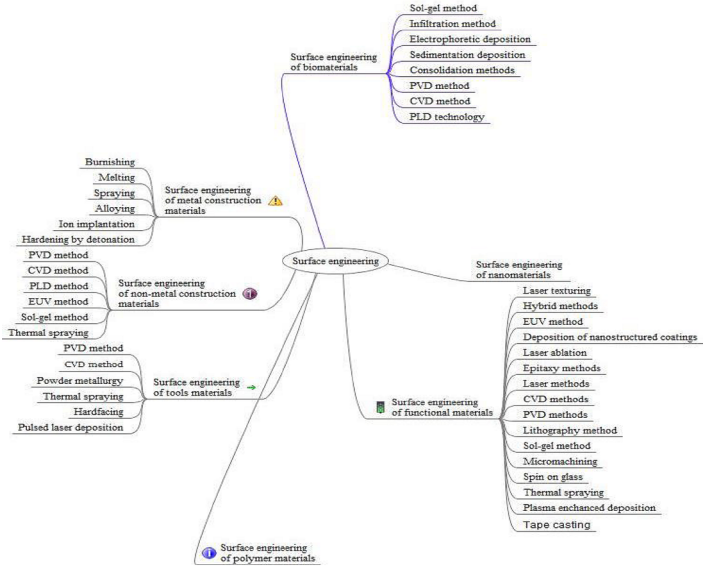
PKWiU 2015 is the classification, which identifies product groups divided into seven levels provided for in *PKD 2007* and *Combined Nomenclature* (*CN 2019*)[8]. The first four levels of *PKWiU 2015* are based on the product division adopted in *PKD 2007* (*NACE Rev.2*). Product division specified on these levels are similar to the division of economic activities adopted in *NACE Rev.2* and *PKD 2007*, which is evidenced by 4-digit symbols (YY.YX) of *PKWiU 2015* conforming to the symbols adopted in *NACE Rev.2* and *PKD 2007*. The only exceptions are the products of fishing and aquaculture (division 03), sitting furniture and furniture accessories specified in class 31.00, building and construction of buildings specified in division 41, retail trade specified in division 47, and scientific research and development in interdisciplinary sciences specified in division 72. The names used in particular levels of PKWiU 2015 refer to the corresponding names of activities adopted in PKD 2007. On the fifth and sixth level ('categories' and 'subcategories') of *PKWiU 2015* product division adopted in the Statistical classification of products by activity (*CPA*) has been specified by applying similar 5- and 6-digit symbols and names On the seventh level adopted division has allowed for internal needs of the country.

Source: Journal of Laws 2015, item 1676.

[8] Combined nomenclature is specified in the Commission Implementing Regulation (EU) 2018/1602 of [11] October 2018 amending Annex I to Council Regulation (EEC) No 2658/87 on the tariff and statistical nomenclature and on the Common Customs Tariff (Official Journal of the European Union L 273).

To visualise relations between product types and directions of scientific research/technologies defined in this way, mind maps has been developed, which organise the whole material in hierarchical order and categories[9] of the major organising terms. An example of an organising term is *surface engineering*, which cover the following categories: *surface engineering of metal construction materials, surface engineering of non-metal construction materials, surface engineering of biomaterials, surface engineering of nanomaterials, surface engineering of functional materials, surface engineering of polymer materials, surface engineering of tools materials.* Each of the above mentioned categories is divided into further subcategories. For instance the *surface engineering of biomaterials* category includes *infiltration methods, electrophoretic deposition, sedimentation deposition, consolidation methods, PVD methods,* etc. (Figure 1). Such organisation may be further scrolled 'down'. It can also be scrolled 'up' by switching *surface engineering* category to *advanced materials technology.*

Figure 1. An example of the material organising by means of hierarchies and categorisation



Source: own study.

[9] OPI project *Polish classifications of science* (www.opi.org.pl/Analizy-statystyczne-i-ewaluacja/newsId/72/p/2.html) is an interesting example of using mind maps to visualise the relation between independent sets of similar data on science.

2. Identification of the promising niches in smart specialization areas in Łódzkie Voivodship

According to the Regional Innovation Strategy of Łódzkie Voivodship – LORIS 2030 [RSI WŁ 2030, Deloitte and ŁARR 2013], areas of smart specialization are formed by a matrix of six industries with the highest development potential and of four key technological areas. Industries with the highest development potential are as follows: modern textile and fashion industry, including design (cf. Annex, Table 1); advanced building materials (cf. Annex, Table 2); medicine, pharmacy, cosmetics (cf. Annex, table 3); power industry, including renewable energy sources (cf. Annex, Table 4); innovative agriculture and food processing (cf. Annex, Table 5) as well as IT and telecommunications (cf. Annex, Table 6). Some of these industries (pharmacy and telecommunications, software and IT consultancy services, as well as information service activities) are considered as high technologies and high-tech services, as specified by GUS [2019].

Key technological areas which define smart specializations include biotechnologies (cf. Annex, Table 7), nanotechnologies and functional materials (cf. Annex, Table 8), mechatronics (cf. Annex, Table 9) as well as communication and IT technologies (cf. Annex, Table 10).

Combination of the above mentioned directions of scientific research and technologies with the above mentioned areas of business activities, where the former are, or may be applied, allows to identify a number of interesting niches, which emerge from particular areas of smart specializations of Łódzkie Voivodship.

The niches in biotechnology are as follows:

- *biological sewage treatment and controlled self-purification*, as well as *reuse of waste and neutralising of hazardous substances,* which are particularly useful in waste processing and disposal – according to PKD 2007 they are classified as group 38.2 forming a part of *power industry*;
- *biotechnologies in power industry*, used (among others) to manufacture biofuels (PKD 2007, class 20.59); in the production of electricity (PKD 2007, class 35.11); manufacture of gaseous fuels (PKD 2007, class 35.21) and steam, hot water and air conditioning manufacturing and supply (PKD 2007, class 35.30), forming a part of *power industry*;
- *pharmaceutical technologies*, used particularly in the manufacture of basic pharmaceutical substances (PKD 2007 21.1) and manufacture of medicines and other pharmaceutical products (PKD 2007 21.2), forming a part of *medicine, pharmacy and cosmetics*;

• *cosmetology biotechnologies*, used particularly in the manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations (PKD 2007 20.4), forming a part of *medicine, pharmacy and cosmetics*;
• *biotechnologies for industrial products* commonly used in the manufacture of chemicals and chemical products (PKD 2007, division 20); manufacture of rubber and plastic products (PKD 2007, division 22); manufacture of other non-metallic mineral products (PKD 2007, division 23) and manufacture of fabricated metal products, except machinery and equipment (PKD 2007, division 25). These activities form a part of *power industry and advanced building materials*;
• *agricultural biotechnologies and food processing biotechnologies* used mainly in the *innovative agriculture and food processing, as well as power industry*;
• *textile biotechnologies*, used mainly in (among others) the preparation and spinning of textile fibres (PKD 2007, class 13.10) manufacture of fabrics (PKD 2007, class 13.20); finishing of textiles (PKD 2007, class 13.30); manufacture of other textiles (PKD 2007, class 13.90); manufacture of leather clothes (PKD 2007, class 14.11) and workwear (PKD 2007, class 14.12); tanning and dressing of leather, manufacture of bags (PKD 2007, group 15.1); manufacture of footwear (PKD 2007, group 15.2) and manufacture of man-made fibres (PKD 2007, group 20.6). These activities form a part of *modern textile and fashion industry;*
• *biotechnologies of chemical processes*, used particularly in the processing and preserving of fruit and vegetables (PKD 2007, class 10.39); operation of dairies and cheese making (PKD 2007, class 10.51); manufacture of bakery and farinaceous products (PKD 2007, group 10.7); manufacture of other technical and industrial textiles (PKD 2007, class 13.96); manufacture of other textiles (PKD 2007, class 13.99); manufacture of dyes and pigments (PKD 2007, class 20.12); manufacture of glues (PKD 2007, class 20.52), as well as manufacture of electronic components and boards (PKD 2007, group 26.1). These activities form a part of both *innovative agriculture and food processing,* and *modern textile and fashion industry, advanced building materials,* as well as *IT and telecommunications.*

The niches in nanotechnology are as follows:
• *nanosensors* and *nanoactuators*, used mainly in the forestry and logging (PKD 2007, division 2) and manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations (PKD 2007, group 20.4), forming a part of *medicine, pharmacy, cosmetics, and power industry*;

• *materials and processes for nanoelectonics and photonics, as well as integrated circuits*, used particularly in the crop and animal production, and hunting (PKD 2007, division 1); manufacture of food products (PKD 2007, division 10); manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations (PKD 2007, group 20.4); manufacture of plastics products (PKD 2007, group 22.2); manufacture of glass and glass products (PKD 2007, group 23.1); manufacture of computer, electronic and optical products (PKD 2007, division 26); electricity, gas, steam, hot water and air conditioning manufacturing and supply (PKD 2007, division 35); telecommunications (PKD 2007, division 61); social care (PKD 2007, divisions 87 and 88). These activities form a part of *innovative agriculture and food processing; medicine, pharmacy, cosmetics, advanced building materials, IT and telecommunications, as well as power industry*;
• *flexible and organic micro and nanoelectronics*, used particularly in the manufacture of wearing apparel (PKD 2007, division 14); manufacture of footwear (PKD 2007, group 15.2); manufacture of plastics products (PKD 2007, group 22.2); manufacture of glass and glass products (PKD 2007, group 23.1); manufacture of computer, electronic and optical products (PKD 2007, division 26); telecommunications (PKD 2007, division 61) as well as human health activities and social care (PKD 2007, divisions 86, 87 and 88). These activities form a part of *modern textile and fashion industry, advanced building materials, medicine, pharmacy, cosmetics, IT and telecommunications.*

The niches in mechatronics are as follows:
• *automatics and industrial processes control, automatics and transportation processes control, sensor systems and actuator systems,* as well as *transmission and monitoring*, which are commonly used in all areas of the regional smart specialization;
• *automatics and mining processes control*, used mainly in the animal raising (PKD 2007, group 01.4); manufacture of other non-metallic mineral products (PKD 2007, division 23); production of electricity and gaseous fuels (PKD 2007, classes 35.11 and 35.21) and other human health activities (PKD 2007, class 86.9), forming a part of *advanced building materials*; *medicine, pharmacy and cosmetics, and innovative agriculture and food processing*;
• *medical and rehabilitative robotics*, used particularly in other telecommunications activities (PKD 2007, group 61.9) and human health activities and social care (PKD 2007, classes 35.11 and 35.21), forming a part of *medicine, pharmacy and cosmetics, as well as IT and telecommunications.*

Niches in the information and communication technologies are as follows: *expert systems, management systems, information systems, ICT networks and measuring systems,* which are commonly used in all areas of the regional smart specialization.

3. Conclusions

Development Strategy of Łódzkie Voivodship 2020 [SR WŁ 2020] identifies 16 regional smart specializations, which are formed at the intersection of [Province Government of Łódzkie Voivodship 2013]:

- technological areas: biotechnology, nanotechnology and advanced materials, mechatronics and Information and Communication Technologies;
- industries: cosmetics, pharmacy, medicine, furniture, machines and electrical machines, textiles, agri-foodstuffs, building materials, power industry, eco-industries and creative industries;
- specialised services in health care, ecological services, logistics, BPO, IT.

Regional Innovation Strategy of Łódzkie Voivodship RSI WŁ 2030 identifies regional areas of smart specialization, which take the form of a matrix of six areas of economic activities, which have been mentioned above (cf. Annex, Tables 1–6) and four technological areas (cf. Annex, Tables 7–10) – analogous to the ones specified in the Development Strategy of Łódzkie Voivodship 2020.

Therefore it seems, that there is a large number of areas of smart specializations (cf. Table 4), as a result of which state aid becomes considerably fragmented with the risk of 'blurring' development goals for the voivodship.

Table 4. Areas of smart specializations defined in the Development Strategy of Łódzkie Voivodship Łódzkie 2020 and in the Regional Innovation Strategy LORIS 2030

Development Strategy of Łódzkie Voivodship Łódzkie 2020	Regional Innovation Strategy LORIS 2030
Areas of economic activities	
• industries: – cosmetics, pharmacy, medicine, furniture, machines and electrical machines, textiles, agri-foodstuffs, building materials, power industry – eco-industries – creative industries • services: specialised services in health care, eco-services, logistics, BPO, IT.	• modern textile and fashion industry (including design) • advanced building materials • medicine, pharmacy, cosmetics • power industry, including renewable energy sources • innovative agriculture and food processing • IT and telecommunications
Technological areas	
• biotechnologies • nanotechnologies and advances materials, mechatronics • Information and Communication Technologies	
low carbon and energy efficient technologies	

Source: based on the information from the Province Government of Łódzkie Voivodship [2013], Deloitte and ŁARR [2013].

Maps of relationship between science, economy and technology described in this paper may be used as a starting point for activities aimed at successive limiting of the number of regional areas of smart specialization to the most promising niches, which can strengthen innovative and competitive position of the voivodship.

As a result of such activities, development policy of the voivodship will become a more effective instrument aimed at achieving the main target – which forms the basis of smart specialization concept - i.e. EU Cohesion Policy [European Commission 2010], according to which in the next (2021–2027) programming period skills aimed at smart specialization, industrial transformation, increase of research and innovation potential, as well as use of advanced technologies [European Commission 2018b] will still be considered as major priorities.

Annex

Table 1. Detailed list of industries forming modern textile and fashion industry, including design

Division	Group	Class	Subclass	Name
13				Manufacture of textile products
	13.1	13.10		Preparation and spinning of textile fibres
			13.10.A	Manufacture of cotton yarn
			13.10.B	Manufacture of wool yarn
			13.10.C	Manufacture of man-made fibres yarn
			13.10.D	Manufacture of yarn from other textile fibres, including manufacture of sewing thread
	13.2	13.20		Manufacture of fabrics
			13.20.A	Manufacture of cotton woven fabrics
			13.20.B	Manufacture of wool woven fabrics
			13.20.C	Manufacture of man-made woven fabrics
			13.20.D	Manufacture of other woven fabrics
	13.3	13.30	13.30.Z	Finishing of textiles
	13.9			Manufacture of other textile products
		13.91	13.91.Z	Manufacture of knitted and crocheted fabrics
		13.92	13.92.Z	Manufacture of made-up textile articles
		13.93	13.93.Z	Manufacture of carpets and rugs
		13.94	13.94.Z	Manufacture of cordage, rope, twine and netting
		13.95	13.95.Z	Manufacture of non-wovens and articles made from non-wovens, except apparel
		13.96	13.96.Z	Manufacture of other technical and industrial textiles
		13.99	13.99.Z	Manufacture of other textiles not elsewhere classified
14				Manufacture of clothes
	14.1			Manufacture of clothes except for articles of fur
		14.11	14.11.Z	Manufacture of leather clothes
		14.12	14.12.Z	Manufacture of workwear
		14.13	14.13.Z	Manufacture of other outerwear
		14.14	14.14.Z	Manufacture of underwear

Division	Group	Class	Subclass	Name
		14.19	14.19.Z	Manufacture of other wearing apparel and accessories
	14.2	14.20	14.20.Z	Manufacture of articles of fur
	14.3			Manufacture of knitted apparel
		14.31	14.31.Z	Manufacture of knitted and crocheted hosiery
		14.39	14.39.Z	Manufacture of other knitted and crocheted apparel
15				Manufacture of leather and tanned leather goods
	15.1			Tanning and dressing of leather; dressing and dyeing of fur; Manufacture of luggage, handbags and similar leather goods; manufacture of saddlery
		15.11	15.11.Z	Tanning and dressing of leather; dressing and dyeing of fur
		15.12	15.12.Z	Manufacture of luggage, handbags and similar leather goods; manufacture of saddlery
	15.2	15.20	15.20.Z	Manufacture of footwear
20				Manufacture of chemicals and chemical products
	20.6	20.60	20.60.Z	Manufacture of man-made fibres
32				Other manufacture of products
	32.1			Manufacture of jewellery and related articles
		32.12	32.12.Z	Manufacture of jewellery and related articles
		32.13	32.13.Z	Manufacture of imitation jewellery and related articles
46				Wholesale except for sale of vehicles
		46.16	46.16.Z	Agents involved in the sale of textiles, clothing, fur, footwear and leather goods
	46.4			Wholesale of household appliances
		46.41	46.41.Z	Wholesale of textiles
		46.42	46.42.Z	Wholesale of clothing and footwear
		46.48	46.48.Z	Wholesale of watches, clocks and jewellery
47				Retail sale except for retail sale of vehicles
	47.1			Retail sale in non-specialised stores
	47.5			Retail sale of household appliances in specialised stores
		47.51	47.51.Z	Retail sale of textiles in specialised stores
	47.7			Retail sale of other products in specialised stores
		47.71	47.71.Z	Retail sale of clothing in specialised stores
		47.72	47.72.Z	Retail sale of footwear and leather goods in specialised stores
		47.77	47.77.Z	Retail sale of watches, clocks and jewellery in specialised stores

Division	Group	Class	Subclass	Name
	47.8			Retail sale via stalls and markets
		47.82	47.82.Z	Retail sale via stalls and markets of textiles, clothing and footwear
	47.9			Retail sale not in stores, stalls or markets
		47.91	47.91.Z	Retail sale via mail order houses or via Internet
73				Advertising, market research and public opinion polling
	73.1			Advertising
		73.11	73.11 Z	Advertising agencies activities
	73.2	73.20	73.20.Z	Market research and public opinion polling
74				Other professional, scientific and technical activities
	74.1	74.10	74.10.Z	Specialised design activities
	74.2	74.20	74.20.Z	Photographic activities

Source: based on the Classification of Business Activities in Poland (PKD) 2007.

Table 2. Detailed list of industries pertinent to the manufacture of advanced building materials

Division	Group	Class	Subclass	Name
20				Manufacture of chemicals and chemical products
		20.12	20.12.Z	Manufacture of dyes and pigments
	20.3	20.30	20.30.Z	Manufacture of paints, varnishes and similar coatings, printing ink and mastics
		20.52	20.52.Z	Manufacture of glues
22				Manufacture of rubber and plastic products
	22.1			Manufacture of rubber products
		22.19	22.19.Z	Manufacture of other rubber products
	22.2			Manufacture of plastic products
		22.21	22.21.Z	Manufacture of plastic plates, sheets, tubes and profiles
		22.23	22.23.Z	Manufacture of builders' ware of plastic
23				Manufacture of other non-metallic mineral products
	23.1			Manufacture of glass and glass products
		23.11	23.11.Z	Manufacture of flat glass
		23.12	23.12.Z	Shaping and processing of flat glass
		23.14	23.14.Z	Manufacture of glass fibres
		23.19	23.19.Z	Manufacture and processing of other glass, including technical glassware
	23.2	23.20	23.20.Z	Manufacture of refractory products

Division	Group	Class	Subclass	Name
	23.3			Manufacture of ceramic construction products
		23.31	23.31.Z	Manufacture of ceramic tiles and flags
		23.32	23.32.Z	Manufacture of bricks, tiles and construction products, in baked clay
	23.4			Manufacture of other ceramic and porcelain products
		23.43	23.43.Z	Manufacture of ceramic insulators and hollow insulators
		23.44	23.44.Z	Manufacture of other technical ceramic products
		23.49	23.49.Z	Manufacture of other ceramic products
	23.5			Manufacture of cement, lime and plaster
		23.51	23.51.Z	Manufacture of cement
		23.52	23.52.Z	Manufacture of lime and plaster
	23.6			Manufacture of concrete, cement and plaster products
		23.61	23.61.Z	Manufacture of concrete products for construction purposes
		23.62	23.62.Z	Manufacture of plaster products for construction purposes
		23.63	23.63.Z	Manufacture of ready-mixed concrete
		23.64	23.64.Z	Manufacture of mortars
		23.65	23.65.Z	Manufacture of fibre cement
		23.69	23.69.Z	Manufacture of other articles of concrete, plaster and cement
25				Manufacture of metal products, except for machines and equipment
		25.12	25.12.Z	Manufacture of metal elements of building woodwork

Source: based on the Classification of Business Activities in Poland (PKD) 2007.

Table 3. Detailed list of industries pertinent to medicine, pharmacy and cosmetics

Division	Group	Class	Subclass	Name
20				Manufacture of chemicals and chemical products
	20.4			Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations
21				Manufacture of basic pharmaceutical substances and medicines, as well as other pharmaceutical products
	21.1	21.10	21.10.Z	Manufacture of basic pharmaceutical substances
	21.2	21.20	21.20.Z	Manufacture of medicines and other pharmaceutical products

Division	Group	Class	Subclass	Name
86				Healthcare
	86.1	86.10	86.10.Z	Hospital activities
	86.2			Medical practice activities
		86.21	86.21.Z	General medical practice activities
		86.22	86.22.Z	Specialist medical practice activities
		86.23	86.23.Z	Dental practice activities
	86.9	86.90		Other human health activities
			86.90.A	Physiotherapeutical activities
			86.90.B	Emergency ambulance activities
			86.90.C	Nurses and midwives activities
			86.90.D	Paramedical activities
			86.90.E	Other human health activities not elsewhere classified
87				Residential care activities
	87.1	87.10	87.10.Z	Residential nursing care activities
	87.2	87.20	87.20.Z	Residential care activities for mental retardation, mental health and substance abuse
	87.3	87.30	87.30.Z	Residential care activities for the elderly and disabled
	87.9	87.90	87.90.Z	Other residential care activities
88				Social work activities without accommodation
	88.1	88.10	88.10.Z	Social work activities without accommodation for the elderly and disabled

Source: based on the Classification of Business Activities in Poland (PKD) 2007.

Table 4. Detailed list of industries forming power industry, including renewable energy sources

Division	Group	Class	Subclass	Name
2				Forestry and logging
	02.2	02.20	02.20.Z	Logging
20				Manufacture of chemicals and chemical products
	20.5			Manufacture of other chemical products
		20.59	20.59.Z	Manufacture of other chemical products not elsewhere classified (biofuel)
35				Electricity, gas, steam, hot water and air conditioning manufacturing and supply
	35.1			Production, transmission, distribution and trade of electricity
		35.11	35.11.Z	Production of electricity
		35.12	35.12.Z	Transmission of electricity

Division	Group	Class	Subclass	Name
		35.13	35.13.Z	Distribution of electricity
		35.14	35.14.Z	Trade of electricity
	35.2			Manufacture, distribution and trade of gaseous fuels through mains
		35.21	35.21.Z	Manufacture of gaseous fuels
		35.22	35.22.Z	Distribution of gaseous fuels through mains
		35.23	35.23.Z	Trade of gaseous fuels through mains
	35.3	35.30	35.30.Z	Steam, hot water and air conditioning manufacturing and supply
				.
38				Collection, processing and neutralizing of waste; recovery of materials
	38.2			Processing and neutralizing of waste
		38.21	38.21.Z	Treatment and disposal of non-hazardous waste

Source: based on the Classification of Business Activities in Poland (PKD) 2007.

Table 5. Detailed list of industries forming innovative agriculture and food processing

Division	Group	Class	Subclass	Name
1				Growing of crops, raising of animals, hunting, including support activities
	01.1			Growing of non-perennial crops
		01.11	01.11.Z	Growing of cereals, leguminous crops and oil plants, for seeds, except rice
		01.12	01.12.Z	Growing of rice
		01.13	01.13.Z	Growing of vegetables, including melons, and of roots and tubers
		01.14	01.14.Z	Growing of sugar cane
		01.15	01.15.Z	Growing of tobacco
		01.16	01.16.Z	Growing of fibre crops
		01.19	01.19.Z	Growing of other non-perennial crops
	01.2			Growing of perennial crops
		01.21	01.21.Z	Growing of grapes
		01.22	01.22.Z	Growing of tree and bush tropical and subtropical fruits
				.
		01.23	01.23.Z	Growing of tree and bush citrus fruits
		01.24	01.24.Z	Growing of tree and bush pome fruits and stone fruits
		01.25	01.25.Z	Growing of other tree and bush fruits and nuts

Division	Group	Class	Subclass	Name
		01.26	01.26.Z	Growing of tree oleaginous fruits
		01.27	01.27.Z	Growing of beverage crop
		01.28	01.28.Z	Growing of spices, aromatic, drug and pharmaceutical crops
		01.29	01.29.Z	Growing of other perennial crops
	01.3	01.30	01.30.Z	Plant propagation
	01.4			Raising of animals
		01.41	01.41.Z	Raising of dairy cattle
		01.42	01.42.Z	Raising of other cattle and buffaloes
		01.43	01.43.Z	Raising of horses and other equines
		01.44	01.44.Z	Raising of camels and camelids
		01.45	01.45.Z	Raising of sheep and goats
		01.46	01.46.Z	Raising of swine/pigs
		01.47	01.47.Z	Raising of poultry
		01.49	01.49.Z	Raising of other animals
	01.5	01.50	01.50.Z	Agricultural cultivation together with raising of animals (mixed activity)
	01.6			Support activities for crop production and post-harvest crop activities
		01.61	01.61.Z	Support activities for crop production
		01.62	01.62.Z	Support activities for farm animal production
		01.63	01.63.Z	Post-harvest crop activities
		01.64	01.64.Z	Seed processing for propagation
10				Production of food
	10.1			Processing and preserving of meat and production of meat products
		10.11	10.11.Z	Processing and preserving of meat, excluding poultry meat
				.
		10.12	10.12.Z	Processing and preserving of poultry meat
		10.13	10.13.Z	Production of meat products, including poultry meat products
	10.2	10.20	10.20.Z	Processing and preserving of fish, crustaceans and molluscs
	10.3			Processing and preserving of fruit and vegetable
		10.31	10.31.Z	Processing and preserving of potatoes
		10.32	10.32.Z	Manufacture of fruit and vegetable juice
		10.39	10.39.Z	Other processing and preserving of fruit and vegetables
	10.4			Manufacture of oils and plant and animal fats
				.
		10.41	10.41.Z	Manufacture of oils and other fluid fats

Division	Group	Class	Subclass	Name
		10.42	10.42.Z	Manufacture of margarine and similar edible fats
	10.5			Manufacture of dairy products
		10.51	10.51.Z	Operation of dairies and cheese making
		10.52	10.52.Z	Manufacture of ice cream
	10.6			Manufacture of grain mill products, starches and starch products
		10.61	10.61.Z	Manufacture of grain mill products
		10.62	10.62.Z	Manufacture of starches and starch products
	10.7			Manufacture of baker's and farinaceous products
		10.71	10.71.Z	Manufacture of bread; manufacture of fresh pastry goods and cakes
		10.72	10.72.Z	Manufacture of rusks and biscuits; manufacture of preserved pastry goods and cakes
		10.73	10.73.Z	Manufacture of macaroni, noodles, couscous and similar farinaceous products
	10.8			Production of other food
		10.81	10.81.Z	Manufacture of sugar
		10.82	10.82.Z	Manufacture of cocoa, chocolate and sugar confectionery
		10.83	10.83.Z	Processing of tea and coffee
		10.84	10.84.Z	Manufacture of condiments and seasonings
		10.85	10.85.Z	Manufacture of prepared meals and dishes
		10.86	10.86.Z	Manufacture of homogenised food preparations and dietetic food
		10.89	10.89.Z	Manufacture of other food products not elsewhere classified
	10.9			Manufacture of prepared feeds and pet foods for animals
		10.91	10.91.Z	Manufacture of prepared feeds for farm animals
		10.92	10.92.Z	Manufacture of prepared pet foods

Source: based on the Classification of Business Activities in Poland (PKD) 2007.

Table 6. Detailed list of industries pertinent to IT and telecommunications

Division	Group	Class	Subclass	Name
26				Manufacture of computers, electronic and optical articles
	26.1			Manufacture of electronic components and electronic printed circuits
		26.11	26.11.Z	Manufacture of electronic components
		26.12	26.12.Z	Manufacture of electronic printed circuits

Division	Group	Class	Subclass	Name
	26.2	26.20	26.20.Z	Manufacture of computers and peripheral equipment
	26.3	26.30	26.30.Z	Manufacture of (tele)communication equipment
	26.4	26.40	26.40.Z	Manufacture of consumer electronics
	26.5			Manufacture of instruments and appliances for measuring, testing and navigation; manufacture of watches and clocks
		26.51	26.51.Z	Manufacture of instruments and appliances for measuring, testing and navigation
				.
		26.52	26.52.Z	Manufacture of watches and clocks
	26.6	26.60	26.60.Z	Manufacture of irradiation, electromedical and electrotherapeutic equipment
	26.7	26.70	26.70.Z	Manufacture of optical instruments and photographic equipment
	26.8	26.80	26.80.Z	Manufacture of unrecorded magnetic and optical media
58				Publishing activities
	58.2			Software publishing
		58.21	58.21.Z	Publishing of computer games
		58.29	58.29.Z	Other software publishing
61				Telecommunications
	61.1	61.10	61.10.Z	Wired telecommunications activities
	61.2	61.20	61.20.Z	Wireless telecommunications activities, excluding satellite telecommunications activities
	61.3	61.30	61.30.Z	Satellite telecommunications activities
	61.9	61.90	61.90.Z	Other telecommunications activities
62	62.0			Computer programming activities and computer consultancy activities, as well as related activities
		62.01	62.01.Z	Computer programming activities
		62.02	62.02.Z	Computer consultancy activities
		62.03	62.03.Z	Computer facilities management activities
		62.09	62.09.Z	Other information technology and computer service activities
63				Information service activities
	63.1			Data processing, hosting and related activities; Web portals
		63.11	63.11.Z	Data processing, hosting and related activities

Division	Group	Class	Subclass	Name
	63.9	63.12	63.12.Z	Web portals
				Other information service activities
		63.91	63.91.Z	News agencies activities
		63.99	63.99.Z	Other information service activities not elsewhere classified
74				Other professional, scientific and technical activities
	74.1	74.10	74.10.Z	Specialised design activities

Source: based on the Classification of Business Activities in Poland (PKD) 2007.

Table 7. Biotechnologies

Shortened name	Full name of the direction of research/technologies
• Functional food	• Manufacture of functional food using materials obtained from special raising of animals or growing of plans in special conditions, or from specially selected varieties, also the ones subjected to biotechnological modification, including genetic engineering methods.
• Treatment of industrial waste water	• Biotechnological methods for the treatment of industrial waste water
• Bio, nano, bionics	• High-efficiency industrial biotechnologies, which are sustainable and integrated with nanotechnologies and bionics solutions, to be used in different sectors of economy, in particular in pharmacy, food processing, health care and environmental protection.
• Methane and hydrogen production	• Production of methane and hydrogen using biotechnological methods
• Hormonal medicines	• Development of hormonal medicines, in particular peptides and proteins, using biotechnology
• Industrial biotechnologies of products	• Industrial technologies and biotechnologies of products
• Bactericides and fungicides	• Research aimed at developing effective bactericides and fungicides, which do not have adverse impact on the environment
• Medical and pharmaceutical biotechnologies	• Medical and pharmaceutical biotechnologies, including biomaterials
• Biotechnologies used in the environmental protection	• Biotechnologies used in the environmental protection
• Natural products	• Technologies used for the manufacture natural products by means of biotechnology and plants genetic engineering methods - products manufactured from plants enriched with therapeutic substances

Shortened name	Full name of the direction of research/technologies
• Bleaching and modification of cotton fibres	• For bleaching and modification of cotton fibres biotechnology methods are to be used
• Fibrous materials	• Development of bio-cellulose (bacterial cellulose) based fibrous materials for special purposes - biotechnological method for the manufacture of cellulose fibres
• Finishing of textiles	• Biotechnologies in finishing of textiles
• Biotechnologies in leather and footwear industry	• Biotechnologies in leather and footwear industry used for the manufacture of premium goods and products with barrier properties
• Enzymes	• Obtaining and using enzymes capable of working in diversified technological conditions, originating from hyperthermophilic, psychrophilic, halophilic, alkaliphilic and eutectophilic microbes, to process different foodstuffs and by-products, and capable of limiting energy consumption
• Packagings made from renewable and biodegradable materials	• Packaging materials made from renewable and biodegradable materials
• Biofuels and biomass from intentional plantings	• Obtaining, production of biofuels and biomass from intentional plantings
• Biomass for heat production	• Use of biomass for heat production on a small and medium scale
• Biomass-based microgeneration	• Biomass-based microgeneration
• Biomechatronic hybrid systems	• Biomechatronic hybrid systems which combine life organisms or biological structures with mechatronic systems for special purposes
• Systems and processes for organic waste co-incineration	• Smart systems and processes for organic waste co-incineration with conventional fuels
• Biomass liquefaction technology	• Biomass liquefaction technology
• Recovery of resources and materials from municipal and industrial waste water	• Technologies for recovery of resources and materials from municipal and industrial waste water
• Stabilisation and improvement of biofuels' properties	• Methods for stabilisation and improvement of biofuels' performance properties
• Utilisation of waste liquid	• Methods for utilisation of waste liquid from surface and reduction metal working processes
• Biological sewage treatment and controlled self-purification	• Innovative environmental protection technologies, which use constant monitoring and biological sewage treatment and controlled self-purification
• Low- and zero-waste production technologies	• Low- and zero-waste production technologies

Shortened name	Full name of the direction of research/technologies
• Reuse of wastes and neutralising of hazardous substances	• Industrial methods for reuse of wastes and neutralising of hazardous substances
• Molecular engineering of industrial catalysts	• Molecular engineering of industrial catalysts
• Next generation biofuels	• Next generation biofuels from renewable sources, including wastes
• Carbon and biomass co-incineration	• Technology for direct carbon and biomass co-incineration
• Micro-organisms and enzyme preparations	• Use of micro-organisms and enzyme preparations of micro-biological, plant or animal origin to manufacture food products and food additives
• Vaccines and other biologically active compounds	• Manufacture of vaccines (antigen proteins), sera, proteins' and other biologically active compounds' hormones by overexpression in bacterial, yeast, plant and animal vectors
• Biosynthesis and biotransformation	• Biosynthesis and biotransformation of natural compounds and their analogues useful in pharmacy and cosmetic industry
• Biocatalysts	• Obtaining new biocatalysts of chemical reactions
• Biofuels	• Manufacture of industrial and power raw materials (biofuels)
• Biofuels from biomass	• Production of liquid biofuels (ethanol, liquid hydrocarbons) from biomass
• Micro-biological fuel cells	• Micro-biological fuel cells
• Alternative energy sources	• Use of alternative energy sources e.g. biomass or waste incineration, construction of biogas plants, etc.
• Biogas for the production of electricity	• Technologies using biogas for the production of electricity
• Biopolymers	• Biopolymers - technologies for the manufacture of biodegradable plastics based on renewable sources, considered as an alternative solution to the petroleum-based plastics. e.g. lactic acid polymers and co-polymers, polyhydroxy acids
• Industrial enzymes	• Technologies used in the industrial enzymes production
• Biocatalysis and yeast-based bio-processes	• Biocatalysis and bio-processes using yeasts, bacteria and enzymes derived from these organisms
• Immobilisation of biologically active substances	• Technologies used for immobilisation of biologically active substances
• Bioproducts	• Processing of plant materials to bioproducts
• Biomaterials for controlled dosage of medicines and nutrients	• Technologies for the manufacture of biomaterials for controlled dosage of medicines and nutrients

Shortened name	Full name of the direction of research/technologies
• Bandage biomaterials	• Technologies for the manufacture of bandage biomaterials
• Scaffold for tissue engineering	• Technologies for the production of scaffold for tissue engineering and artificial hybrid organs
• Sensors for diagnostic purposes	• Technologies for the manufacture of sensors for diagnostic purposes in medicine, food industry and environmental protection
• Fermented food products	• Technologies for the manufacture of fermented food products
• Micro-organisms used for treatment of waste water and neutralisation of wastes	• Technologies using micro-organisms for treatment of waste water and neutralisation of wastes
• Wastes and sewage sludge for energy purposes	• Technologies for using wastes and sewage sludge for energy purposes
• Municipal biowastes	• Technologies for processing of municipal biowastes
• Utilitarian use and biodegradability of wastes	• Technologies for utilitarian use and biodegradability of wastes originating from agriculture, food industry and production of biofuels, including second-generation biofuels
• Hazardous wastes	• Technologies for processing of hazardous wastes
• Waste packagings	• Recycling technologies for waste packagings, mainly from plastics (including technologies using catalytic methods to degrade waste polymer materials to liquid fuels)
• Composite products	• Technologies for processing of wastes to composite products
• Biodegradable packagings	• Technologies for the production of biodegradable packagings
• Bioleaching of metals	• Technologies for bioleaching of metals from industrial wastes and bioleaching of heavy metals from sewage sludge
• Removal of biogens	• Technologies for removal of biogens from sewage, mainly nitrogen and phosphorus
• Biodegradability of aromatic hydrocarbons	• Technologies for biodegradability of aromatic hydrocarbons, including PAH, aliphatic hydrocarbons and polychlorinated biphenyls (PCB)
• Catalytic systems	• Technologies using new catalytic systems for oxidation of contaminants in waste water treatment plants
• Membrane systems	• Technologies for removing contaminants from water and sewage using methods based on the innovative membrane systems
• Bioremediation	• Technologies for bioremediation of contaminated land

Shortened name	Full name of the direction of research/technologies
• Genetic engineering	• Technologies using genetic engineering in agricultural production, instead of chemical substances which contaminate natural environment
• Fibrous materials	• Development of bio-cellulose (bacterial cellulose) based fibrous materials for special purposes is to occur - biotechnological method for manufacture of cellulose fibres
• Bionanomaterials as imaging contrast agents used in tomography	• Bionanomaterials as imaging contrast agents used in tomography
• Prosthetic biomaterials	• Biomaterials - e.g. smart prosthesis, blood vessel prosthesis releasing medicines, bone prosthesis
• Biomaterials for tissue engineering	• Biomaterials for tissue engineering
• Stent-valves	• Stent-valves using material from cell cultures
• Micro-biological sensors	• Advanced micro-biological sensors

Source: compiled on the basis of Nazarko et al. [2012].

Table 8. Nanotechnologies

Shortened name	Full name of the direction of research/technologies
• Next generation wood composite	• Nanomaterials and nanotechnologies used to manufacture next generation wood composites (of high quality and functionality)
• Conversion and final coatings	• Nanotechnologies used in application of conversion and final coatings
• Nanotechnologies used in food safety modelling	• Food safety modelling and research - food obtained using nanotechnological processes
• Nanotechnologies for protection of biosystems	• Monitoring and protection of biosystems using nanotechnologies
• Antibacterial nanotechnologies	• Antibacterial nanotechnologies
• Nanotechnologies for tissues and bones regeneration	• Nanomaterials and nanotechnologies for tissues and bones regeneration
• Nanotechnologies for coatings production	• Using nanotechnologies in the production of different coatings e.g. biocidal, biostatic, antistatic, hydrophobic, with electromagnetic radiation protection
• Nanotechnologies for photonics and eletronics	• Nanotechnologies for photonics, micro- and nano-electronics, sensors
• Nanotechnology-based medicines	• Technologies for the production of nanotechnology-based antitumor, neuro- and cardio-protective medicines
• Nanotechnologies for cutting tools and wood processing	• Nanotechnologies for cutting tools and wood processing

Shortened name	Full name of the direction of research/technologies
• Nanotechnologies for protection of wood	• Nanotechnologies for protection of wood (mechanical, physical, chemical, biological)
• Nanotechnologies of surface layers for biomedical purposes	• Nanotechnologies of surface layers for biomedical purposes
• Nanotechnologies related with special textiles	• Nanotechnologies related with special textiles e.g. bandage materials
• Nanotechnologies in the production of food packagings	• Nanotechnologies in the production of food packagings
• Nanotechnologies for military purposes	• Nanotechnologies for military purposes
• Materials technology and nanotechnologies for special purposes	• Materials technology and nanotechnologies for special purposes
• Nanotechnologies used to upgrade natural fibres	• Nanotechnologies will be used in natural fibres upgrading processes in order to equip the fibres with multifunctional properties
• Nanotechnologies for functional materials	• Thanks to nanotechnology it is possible to manufacture new attractive goods of special properties
• Fillers, nanofillers, reinforcing materials	• Manufacture of polymer materials - fillers, nanofillers, reinforcing materials
• Polymer composites	• Manufacture of polymer materials - polymer composites (nanocomposites, fibrous composites, polymer concretes)
• Nanoporous materials and nanostructures	• Nanoporous materials and other nanostructures
• Nanomaterials for wood composites	• Nanomaterials and nanotechnologies used to manufacture next generation wood composites (of high quality and functionality)
• Hybrid technologies for next generation wooden goods	• Integration of ionic liquid technologies, nanotechnologies and zero waste technologies for the production of eco-friendly materials and next generation wooden goods
• Nanostructures: medium for biological material culture	• Surface-modified polymers (nanostructures) - medium for biological material culture
• Nanolithography	• Nanolithography: surface engineering of nanomaterials
• Chemical deposition of nanometric layers	• Chemical deposition of nanometric surface layers from gaseous phase (CVD): surface engineering of nanomaterials
• Physical deposition of nanometric layers	• Physical processes of vapour deposition of nanometric surface layers (PVD): surface engineering of nanomaterials
• Atomic layer deposition	• Single atomic layer deposition (ALD): surface engineering of nanomaterials
• Electrodeposition of nanometric layers	• Electrodeposition of nanometric surface layers: surface engineering of nanomaterials

Shortened name	Full name of the direction of research/technologies
• Sol-gel for nanometric layers	• Sol-gel technology for obtaining nanometric surface layers: surface engineering of nanomaterials
• Surface treatment of nanomaterials	• Surface treatment of nanomaterials: surface engineering of nanomaterials
• Electrophoresis	• Electrophoresis: surface engineering of polymer materials
• Nanomaterials and multifunctional nanosystems	• Nanomaterials and multifunctional nanosystems
• Nanostructured materials for regenerative medicine	• Development of methods used for manufacturing of nanostructured materials for regenerative medicine
• Nanocoatings	• Nanocoatings
• Nanostructured biomaterials	• Nanostructured biomaterials
• Nanomaterials providing hydroinsulating properties of building materials	• Nanomaterials providing hydroinsulating properties of building materials
• Nanomaterials reinforcing building structures	• Nanomaterials reinforcing building structures
• Graphene	• Graphene
• Carbon nanotubes	• Carbon nanotubes
• Nanoparticles and metal nanowires	• Nanoparticles and metal nanowires
• Ultrathin magnetic layers	• Ultrathin magnetic layers
• Nanomaterials and nanotechnologies for tissues and bones regeneration	• Nanomaterials and nanotechnologies for tissues and bones regeneration
• Nanomaterials for printed electronics	• Nanomaterials for printed electronics
• Nanotechnologies for special textiles	• Nanotechnologies related with special textiles e.g. bandage materials
• Nanofibres reinforcing polymer materials	• Polymer materials reinforcement using nanofibres
• Materials and nanomaterials for photonics, micro- and nano-electronics, sensors	• Materials and nanomaterials for photonics, micro- and nano-electronics, sensors
• Nanomachining and micromachining	• Nanomachining/micromachining technology
• Nanomaterials for printed electronics	• Nanomaterials for printed electronics

Source: compiled on the basis of Nazarko et al. [2012].

Table 9. Mechatronics

Shortened name	Full name of the direction of research/technologies
• Automatic constant methanometry	• Automatic constant methanometry
• Control over working excavations lining	• Control over working excavations lining
• Automatic cyclic methanometry	• Automatic cyclic methanometry
• Automatics for renewable energy sources	• Automatics technologies supporting the use of renewable energy sources

Shortened name	Full name of the direction of research/technologies
• Automatics: vertical cable transport	• Automatics - vertical cable transport
• Automation and robotization of machining centres	• Flexible automation and robotization of machining centres
• Automation of incineration processes for woody biomass	• New equipment and measuring techniques using integrated technologies and automation of incineration processes for woody biomass, which provide monitoring of the power production
• Autonomous systems for environmental monitoring on a micro and macro scale	• Autonomous systems for environmental monitoring on a micro and macro scale
• Flexible automation and robotization of machining centres	• Flexible automation and robotization of machining centres
• Molecular electronics	• Measuring and testing apparatus for molecular electronics
• Biomechatronic hybrid systems	• Biomechatronic hybrid systems which combine life organisms or biological structures with mechatronic systems for special purposes
• Full control over processing processes	• Full control over particular processing technological processes
• Comprehensive systems for drilling dog headings	• Comprehensive mechanisation systems for drilling dog headings
• Real time control and registration of technological processes	• Introduction of data mining systems - real time control and registration of parameters in technological processes (e.g. measurement and adjustment of moulding sand moisture content, measurement of technological properties of the moulding sand using automated systems, introducing measurement systems to computerized integrating data acquisition systems e.g. temperature data from a number of high risk areas in the process, chemical analyses, etc.),
• Anchoring	• Anchoring - anchoring car (self-propelled anchoring car) with automatic turret and drillings suction
• Manipulators and robots used in foundry engineering	• Using of manipulators and robots in foundry technological processes
• Microrobotics and mechatronics in medicine	• Microrobotics and mechatronics in medicine, as well as therapeutic microdevices
• Microsensors and detection systems in medical diagnostics	• Research on microsensors and detection systems in medical diagnostics
• Mobile multifunctional inspection robots	• Mobile multifunctional inspection robots
• Nanorobotics in medicine and therapeutic nanodevices	• Nanorobotics in medicine and therapeutic nanodevices
• Robots used in gas distribution networks	• Repairs from inside of the pipes, using robots entering gas distribution network
• Fire extinguishing and rescue robots	• Smart fire extinguishing and rescue robots

Shortened name	Full name of the direction of research/technologies
• Mobile robots used for monitoring and protection of forests	• Monitoring and fire protection of forests, using satellite techniques and mobile robots
• Mobile robots for internal transport	• Technologies for application of autonomous mobile robots for internal transport
• Industrial robots with reconfiguration functionalities	• Industrial robots with reconfiguration functionalities and possible adaptation to particular tasks
• Robotization of assembly and manufacturing stands in machine-building industry	• Robotization of assembly and manufacturing stands in machine-building industry
• Powered support sections	• Control systems - powered support sections
• Specialised microsystems	• Technologies used in specialised microsystems
• Control over single elements of processing processes	• Control over single elements of processing processes
• Control over mining machines in working excavations	• Control over mining machines in working excavations
• Plough mechanization system	• Control systems - Plough mechanization system
• Automatic assembly systems	• Automatic assembly systems
• Automatics, IT and power supply systems used in coal mining	• Automatics, IT and power supply systems used in coal mining
• Systems for anchoring mechanisation and systems for monitoring of lining	• Systems for anchoring mechanisation and systems for monitoring of lining
• MEMS systems	• MEMS systems
• Remote surgery and remote control robots	• Remote surgery and remote control robots
• Transport automation and control systems	• Modern solutions used in transport automation and control systems: for vertical, railway, suspended and belt transport
• Universal solutions for stations, mould cavities and production lines of casting moulds	• Development of universal, unified structures, solutions for stations, mould cavities and production lines of casting moulds equipped with latest machines and devices (mechanised and automated)
• Equipment for NDT testing with automatic process implementation and interpretation of readings	• Smart equipment for NDT testing with automatic process implementation and interpretation/assessment of readings
• Robot equipment used in medicine and rehabilitation	• Technologies for robot equipment used in medicine and rehabilitation
• Automated technology for combined cutter-loader of high efficiency	• Automated technology for combined cutter-loader exploitation of high efficiency
• Automated technology for coal plough exploitation of high efficiency	• Automated technology for coal plough exploitation of high efficiency
• Automated and robot cavities and production lines	• Technologies for automated and robot cavities and production lines

Shortened name	Full name of the direction of research/technologies
• Miniaturised sensors and electromechanical mechanisms	• Technologies for the manufacture of miniaturised sensors and electromechanical mechanisms

Source: compiled on the basis of Nazarko et al. [2012].

Table 10. Information and Communication Technologies

Shortened name	Full name of the direction of research/technologies
• Data mining systems	• Introduction of data mining systems for real time control and registration of parameters in technological processes (e.g. measurement and adjustment of moulding sand moisture content, measurement of technological properties of the moulding sand using automated systems, introducing measurement systems to computerized integrating data acquisition systems e.g. temperature data from a number of high risk areas in the process, chemical analyses, etc.),
• Decision support systems	• Development trends in decision support systems
• Expert systems	• Expert systems
• Information systems	• Information systems
• Integrated safety systems	• Integrated safety systems
• Dispatcher systems for production processes	• Dispatcher systems for production processes
• Aerometry	• Aerometry
• Gasometry	• Gasometry
• Digital communication	• Digital communication
• Closed-circuit television	• Closed-circuit television
• Analog communication	• Analog communication
• Automatic constant methanometry	• Automatic constant methanometry
• Digital wire transmission systems	• Modern digital wire transmission systems using copper cables and optical fibres, as well as wireless transmission systems
• Neurocognitive systems	• Neurocognitive software and systems with their application, including built-in systems
• Content Management System	• Content Management System (CMS)
• ERP/MRP II/III++ systems	• ERP/MRP II/III++ systems
• Systems using quantum calculations	• Systems using quantum calculations
• Molecular calculation systems	• Molecular calculation systems
• Measuring systems	• Measuring systems integrated with technological processes
• Energy management systems in the buildings	• Development of energy management systems in the buildings (BMS)

Shortened name	Full name of the direction of research/technologies
• Smart control and operation management systems	• Smart control and operation management systems
• Scattered, wireless measuring systems	• Scattered, wireless measuring systems for monitoring of operation status of large or geographically scattered technical facilities
• Hybrid control systems using artificial intelligence	• Hybrid control system using artificial intelligence methods
• Stereo vision systems for monitoring of destruction processes	• Stereo vision systems for monitoring of destruction processes of materials and structures
• Control system for industrial equipment	• Control system for industrial equipment with tolerance of failures within data transmission path
• Telemonitoring system for machines and technological lines	• Telemonitoring system for machines and technological lines using Intranet/Internet
• Autonomous systems for environmental monitoring	• Autonomous systems for environmental monitoring on a micro and macro scale
• On-line measuring systems for incineration products	• On-line measuring systems for incineration products in volatile and solid state, and relevant equipment for their operation
• Smart monitoring systems for wear of electrical equipment	• Smart monitoring systems for wear of electrical and technological equipment in technical facilities
• Safety of information systems in cyberspace	• Safety of information systems in cyberspace
• Support systems for diagnostics and therapy, as well as exchange of medical information	• Support systems for diagnostics and therapy, as well as exchange of medical information via Internet and mobile platforms
• E-service systems	• E-service systems
• Technologies for smart transport management systems	• Technologies for smart transport management systems
• Technologies for smart knowledge management systems	• Technologies for smart knowledge management systems
• Technological communication systems - ugs-99/1	• Technological communication systems - ugs-99/1
• Dispatcher communication systems	• Dispatcher communication systems
• Telemonitoring and ICT systems for medical data transmission	• Telemonitoring and ICT systems for medical data transmission
• Medical counselling systems	• Medical counselling systems
• Spatial information systems	• Spatial information systems: data base systems and GIS systems used for visualisation and environmental management
• Decentralised energy systems	• Decentralised energy systems
• Smart systems	• Smart systems
• Large communication satellites in GEO orbit	• Large communication satellites in GEO orbit

Shortened name	Full name of the direction of research/technologies
• Communication satellites systems	• Communication satellites systems
• Mobile communication technologies	• Mobile communication technologies
• Optical fibre photonic structures	• Optical fibre photonic structures used in metrology and telecommunications
• Engineering for the manufacture of IT products	• Engineering for the manufacture of IT products
• ICT infrastructure	• Development of ICT infrastructure, including solutions providing their high functionality and digital data collection
• Integration of environmental and spatial data	• IT technologies used for integration of environmental and spatial data with current measurements of environmental parameters
• Corporate management information systems	• Corporate management information systems
• Spatial information systems	• Spatial information systems. Data base systems and GIS systems used for visualisation and environmental management (Environmental management)
• Optimising methods for searching large, image data bases	• Optimising methods for searching large, image data bases, as well as automatic and medical interpretation of medical images, including supporting functionalities of diagnostic instruments
• Mathematical modelling of facilities and processes	• Mathematical modelling of facilities and processes and using numerical techniques for static and dynamic analyses of building structures, mechanics of structural elements, probabilistic methods of design, application of artificial neural networks in civil engineering, etc.

Source: compiled on the basis of Nazarko et al. [2012].

Bibliography

Adamik A., Bednarska-Wnuk I. (2014), *Luka kompetencyjna a kompetencje kierownicze w MSP,* "Studia Ekonomiczne Regionu Łódzkiego", PTE Oddział w Łodzi, No. 13.

Adamik A. (2011), *Konkurencyjność i przewaga konkurencyjna MSP w teorii i praktyce* [in:] A. Adamik (ed.), *Kształtowanie konkurencyjności i przewagi konkurencyjnej małych i średnich przedsiębiorstw*, Wyd. C.H.Beck, Warsaw.

Adamson I. (2000), *Management consultant meets a potential client for the first time: the pre-entry phase of consultancy in SMEs and the issues of qualitative research methodology,* "Qualitative Market Research: An International Journal", 3(1), pp. 17–26.

Aghiona P., David P.A., Foraye D. (2009), *Science, technology and innovation for economic growth: Linking policy research and practice in 'STIG* Systems', "Research Policy" 38, pp. 681–693.

Aiginger K., Davies S.W. (2004), *Industrial specialisation and geographic concentration: Two sides of the same coin? Not for the European Union*, "Journal of Applied Economics", VII(2), pp. 231–248.

Aiginger K., Rossi-Hansberg E. (2006), *Specialization and concentration: a note on theory and evidence*, "Empirica", 33, pp. 55–266.

Ajmal M.M., Nordstrom F., Helo P. (2009), *Assessing the effectiveness of business consulting in project development operations*, "International Journal of Productivity and Performance Management", 58(6), pp. 523–541.

Annual Report on European SMEs 2017/2018 (2018), European Commission.

Athey G., Nathan M., Webber C. (2007), *What role do cities play in innovation, and to what extent do we need city-based innovation policies and approaches*?, "NESTA Working Paper", 01/June.

Baldwin J., Gelletly G. (2003), *Innovation Strategies and Performance in Small Firms*, Edward Elgar, Cheltenham.

Balmann A., Odening M., Weikard H-P., Brandes W. (1996), *Path-dependence without increasing returns to scale and network externalities,* "Journal of Economic Behavior and Organization", 29, pp. 159–172.

BBS Question Mark (2017), *Zaprojektowane w Polsce. Analiza potencjału ekonomicznego polskiego rynku wzornictwa,* Warszawa, http://www.lodzdesign.com/assets/Uploads/ZAPROJEKTOWANE-W-POLSCE.pdf.

Beauchamp M., Skala A. (2017), *Visegrad Startup Report 2016/2017*, Visegrad Fund.

Becsky-Nagy P. (2013), *Growth and venture capital investment potential for university spin-offs in Hungary*, "Applied Studies In Agribusiness and Commerce", 7, pp. 31–38. DOI: 10.19041/Apstract/2013/4-5/4.

Bennett, R., Robson, P. (2004). *The role of trust and contract in the supply of business advice*, Cambridge Journal of Economics, 28, pp. 471-488.

Benneworth P., Charles D. (2005), *University Spin-off policies and Academic Development in less successful regions: Learning from Two decades of Policy Practice*, "European Planning Studies", 13(4).

Blackburn R., Jarvis R. (2010), *The role of small and medium practices in providing business support to small- and medium-sized enterprises*, Information Paper, International Federation of Accountants, New York, USA.

Blackburn R.A., Hart M., Wainwright T. (2013), *Small business performance: business, strategy and owner-manager characteristics*, "Journal of Small Business and Enterprise Development", Vol. 20, No. 1, DOI: 10.1108/14626001311298394.

Bojica A.M., Estrada I., del Mar Fuentes-Fuentes M. (2018), *In Good Company: When Small and Medium-Sized Enterprises Acquire Multiplex Knowledge from Key Commercial Partners*, "Journal of Small Business Management", 56(2), pp. 294–311, DOI: 10.1111/jsbm.12258.

Brammer L.M. (1984), *Kontakty służące pomaganiu. Procesy i umiejętności,* Studium Pomocy Psychologicznej Polskiego Towarzystwa Psychologicznego, Warsaw.

Branzei O., Vertinsky I. (2006), *Strategic pathways to product innovation capabilities in SMEs*, "Journal of Business Venturing", No. 21.

Brown T. (2008), *Design thinking,* Harvard Business Review, June.

Brunetti N.D., De Gennaro L., Caldarola P., Molinari G., Di Biase M. (2017), *Telecardiology: What's new from Italy*, "European Research in Telemedicine", Vol. 6, pp. 137–146.

Brzeziński M. (2015), *Wdrażanie innowacji technologicznych*, Difin, Warsaw.

Brzezinski J., Kowalik S. (1991), *Rozmowa psychologiczna* [in:] H. Sęk (ed.), *Społeczna psychologia kliniczna*, PWN, Warsaw, pp. 320–326.

Buczyńska G., Frączek D., Kryjom P. (2016), *Raport z inwentaryzacji klastrów w Polsce 2015*, PARP, Warsaw.

Buzan T., Griffiths Ch. (2016), *Mapy myśli dla biznesu*, Helion Publishing House, Polish edition, Gliwice.

Caban-Piaskowska K. (2014), *Wybrane role konsultanta w procesie doradczym [Selected as consultant in the advisory process* [in:] M. Szymankiewicz, P. Kuźbik (eds.), *Zarządzanie organizacją z perspektywy metodologicznej. Wybrane zagadnienia* [*Management organization from the methodological point. Selected aspects*], Lodz University Press, Lodz, pp. 45–55.

Capello R., Nijkamp P. (2009), *Handbook of regional growth and development theories*, Elgar, Cheltenham.

Camagni R. (2008), *Towards a concept on territorial capital* [in:] R. Capello, R. Camagni, B. Chizzolini, U. Fratesi, *Modelling regional scenarios for the enlarged Europe*, Springer, Berlin, pp. 29–45.

Camagni R. (2009), *Territorial capital and regional development* [in:] R. Capello, P. Nijkamp (eds.), *Handbook of regional growth and development theories*, Edward Elgar Publishing, pp. 118–132.

Camagni R., Capello R. (2013), *Regional competitiveness and territorial capital: a conceptual approach and empirical evidence from the European Union*, "Regional Studies", Vol. 47, No. 9, pp. 1383–1402.

Capello R., Caragliu A., Nijkamp P. (2009), *Territorial capital and regional growth: increasing returns in cognitive knowledge use*, "Tinbergen Institute Discussion Paper", TI 2009-059/3, pp. 3–24.

Carey J.P. (2015), *External accountants' business advice and SME performance*, "Pacific Accounting Review", 27(2), 166–188, Doi: OI 10.1108/PAR-04-2013-0020.

Christensen P.R., Klyver K. (2006), *Management consultancy in small firms: how does interaction work?*, "Journal of Small Business and Enterprise Development", Vol. 13(3), pp. 299–313.

Cewińska J.. Wojtaszczyk K. (2016), *Zarzadzanie ludźmi w małych i średnich przedsiębiorstwach* [in:] R. Lisowska, J. Ropęga (eds.), *Przedsiębiorczość i zarządzanie w małej i średniej firmie. Teoria i praktyka*, Wydawnictwo Uniwersytetu Łódzkiego, Lodz.

Cilliers L., Flowerday S.V. (2013), *Health information systems to improve health care: A telemedicine case study*, "Journal of Information Management", Vol. 15(1), Art. #541, 5 pages, http://dx.doi.org/10.4102/ sajim.v15i1.541.

Ciszewska-Mlinaric M., Mlinaric F., Obłój K. (2011), *Zdolność relacyjna, kompetencji organizacyjne i wyniki finansowe małych i średnich firm słoweńskich*, "MBA", No. 4.

Chatterji A., Delecourt S., Hasan S., Koning R. (2019), *When does advice impact startup performance?*, "Strategic Management Journal", Vol. 40, pp. 331–356; doi.org/10.1002/ smj.2987.

Chesbrough H. (2003), *Open innovation,* Harvard Business School Press, Boston.

Chirra M., Marsili L., Wattley L, Sokol L., Keeling E., Maule S., Sobrero G., Artusi C.A., Romagnolo A., Zibetti M., Lopiano L., Espay A.J., Obeidat A.Z., Merola A. (2018), *Telemedicine in Neurological Disorders: Opportunities and Challenges*, "Telemedicine and e-Health", August, pp. 1–10, DOI: 10.1089/tmj.2018.0101 DOI: 10.1089/tmj.2018.0101.

Chrisman J., McMullan E., Hall J. (2005), *The influence of guided preparation on the long-term performance of new ventures,* "Journal of Business Venturing", Vol. 20, No. 6.

Conway S., Steward F. (2009), *Managing and shaping innovation*, Oxford, University Press.

Cooke P., Leydesdorff L. (2006), *Regional development in the knowledge-based economy: The construction of advantage*, "Journal of Technology Transfer", 31(1), pp. 5–15.

Cuyler R., Holland D. (2012), *Implementing Telemedicine. Completing Projects on Target on Time on Budget*, Xlibris, e-book.

Czapla T. (2011), *Modelowanie kompetencji pracowniczych w organizacji*, Wydawnictwo Uniwersytetu Łódzkiego, Lodz.

Dedrick J., Kraemer K.L., Linden G. (2011), *The distribution of value in the mobile phone supply chain,* "Telecommunications Policy", 35, pp. 505–521.

De Jong J.P.J. (2011), *Perceived competition and innovative intentions in Dutch small and medium enterprises*, "International Journal of Innovation Management", Vol. 15(4).

Deloitte, ŁARR (2013), *Regionalna Strategia Innowacji dla Województwa Łódzkiego – LORIS 2030 Regional Innovation Strategy for Łódzkie Voivodship – LORIS 2030*, Business Consulting S.A., Łódzka Agencja Rozwoju Regionalnego S.A.

Deloitte (2012), *Mapowanie technologii i priorytetyzacja technologii krytycznych. Analiza opracowana na potrzeby Regionalnej Strategii Innow*acji, Lodz.

Dierx A., Ilzkovitz F., Sekkat K. (2003), *European integration and the functioning of product markets: selected issues in: European Commission, European integration and the functioning of product markets*, "European Economy", Special Report 2, pp. 9–32.

Dobni C.B. (2010), *The relationship between an innovation orientation and competitive* strategy, "International Journal of Innovation Management", Vol. 14(2).

Dobrea M., Maiorescu I. (2015), *Entrepreneurial Outcomes and Organisational Performance Through Business Coaching,* "Amfiteatru Economic", Vol. 17, No. 38.

Edwards T., Delbridg R., Munday M. (2005), *Understanding innovation in small and medium-sized entreprises: a process manifest*, "Technovation", No. 25.

Elder L., Clarke M. (2007), *Past, present and future: experiences and lessons from telehealth projects,* "Open medicine", 1(3), pp. 166–170.

Engelen A., Kube H., Schmidt S., Flatten T.Ch. (2014), *Entrepreneurial orientation in turbulent environments: The moderating role of absorptive capacity*, "Research Policy", Vol. 43, No. 8.

Etzkowitz H., Leydesdorff L. (1995), *The triple helix: University-industry-government relations,* "EASST Review", No 1.

European Commission (2010), *Regional Policy Contributing to Smart Growth in Europe*, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM(2010)553 final.

European Commission (2011a), *Regional policy for smart growth in Europe 2020*, European Union, Brussels.

European Commission (2011b), *High-level Expert Group on Enabling Technologies. Final Report,* ec.europa.eu/enterprise/sectors/ict/files/kets/hlg_report_final_en.pdf.

European Commission (2018), *Proposal for a regulation of the European Parliament and of the Council on the European Regional Development Fund and on the Cohesion Fund*. COM/2018/372 final – 2018/0197.

European Union (2011), *Territorial state and perspectives of the European Union*, Gödöllő, pp. 12–13, www. http://ec.europa.eu/regional_policy/sources/policy/what/territorial-cohesion/territorial_state_and_perspective_2011.pdf (03.10.2018).

Eurostat (2019), *News Release*. First estimates of Research & Development expenditure. R&D expenditure in the EU increased slightly to 2.07% of GDP in 2017, January 10.

Eurostat (2011a), *High technology and knowledge-intensive sectors*, http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/Annexes/hrst_st_esms_an9.pdf.

Eurostat (2011b), *High tech products*, http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/Annexes/htec_esms_an4.pdf.

Eurostat (2008), *Comparison between NABS 2007 and NABS* 1992, http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/Annexes/gba_esms_an10.pdf.

Eurostat (1994), NABS. *Nomenclature for the analysis and comparison of scientific programmes and budgets Luxembourg,* Office for Official Publications of the European Communities.

Faherty U., Stephens S. (2016), *Innovation in micro enterprises: reality or fiction?*, "Journal of Small Business and Enterprise Development", Vol. 23, No. 2, DOI: 10.1108/ JSBED-11-2013-0176.

FORA (2005), *User-driven innovation: Results and recommendations,* Copenhagen.

Foray D., David P.A., Hall B. (2007), *Smart Specialisation: the Concept*, "Knowledge Economists Policy Brief", No. 9.

Foray D., Van Ark B. (2007), *Smart Specialization in a Truly Integrated Research Area is the Key to Attracting More R&D to Europe,* "Knowledge Economists Policy Brief", No. 1.

Foray D., David P.A., Hall B. (2009), *Smart specialisation – The Concept*, "Knowledge Economists Policy Brief", No. 9.

Foray D., David P.A., Hall B.H. (2011), *Smart specialization. From academic idea to political instrument, the surprising career of a concept and the difficulties involved in its implementation,* MTEI Working Paper 2011-001.

Frenken K., Boschma R.A. (2007), *A theoretical framework for evolutionary economic geography: industrial dynamics and urban growth as a branching process*, "Journal of Economic Geography", 7, pp. 635–649.

Garud R., Karnøe P. (2001), *Path dependence and creation,* Mahwah, Lawrence Erlbaum Associates.

Giuliani E., Pietrobelli C., Rabellotti R. (2005), *Upgrading in global value chains: Lessons from latin american clusters*, "World Development", 33(4), pp. 549–573.

Głodek P. (2017), *Trust and business consulting for small businesses*, "Entrepreneurship and Management", 18(12/1), pp. 307–318.

Głodek P. (2020), *Business Advisors and Small Businesses: Cooperation in the Framework of the Advisory Process* [in:] M. Bilgin, H. Danis, E. Demir, U. Tony-Okeke (eds), *Eurasian Business Perspectives. Eurasian Studies in Business and Economics*, Vol 15/2, Springer, Cham, pp. 65–80.

Głodek P., Łobacz K. (2013), *Model ryzyka w decyzjach strategicznych małych firm innowacyjnych* [in:] E. Urbanowska-Sojkin, P. Bartkowiak (ed.), *Ryzyko w zarządzaniu strategicznym*, Poznan University of Economics Press, Poznan, pp. 245–262.

Gooderham P., Tobiassen A.E., Doving E., Nordhaug O. (2004), *Accountants as Sources of Business Advice for Small Firms*, "International Small Business Journal", 22(1), pp. 5–22.

Griffin A., Price R.L., Vojak B.A. (2012), *Serial innovators*, Stanford University Press, Stanford.

GUS (2018a), *Frascati Manual 2015. Guidelines for Collecting and Reporting Data on Research and Experimental Development*, Polish edition, Warsaw, The Polish Central Statistical Office.

GUS (2018b), https://bdl.stat.gov.pl/BDL/ (05.06.2018).

GUS (2019), *Nauka i technika w 2017*, The Polish Central Statistical Office (GUS), Szczecin.

GUS (2020), *Selected entrepreneurship indicator in 2014–2018*, Warszawa, p. 29.

Gouvernet B., Haddouk L. (2017), *The small-world of cybertherapy The small-world of cybertherapy*, "Annual Review of Cybertherapy and Telemedicine", Vol. 15.

Hallet M. (2000), *Regional Specialisation and Concentration in the EU*, "Economic Paper", No. 141.

Hamel. G. (2002), *Leading the Revolution*, Harvard Business School Press.

Hansen M.T., Birkinshaw J. (2007), *The innovation value chain,* Harvard Business Review, HBR Spotlight, pp. 2–12.

Hatzichronoglou T. (1997), *Revision of the High-Technology Sector and Product Classification*, OECD Science, Technology and Industry Working Papers, 2, OECD Publishing, DOI: 10.1787/134337307632.

Hess M. (2004), *Spatial relationships? Towards a reconceptualization of embeddedness*, "Progress in Human Geography", Vol. 28, No. 2.

Hinton M., Hamilton R.T. (2013), *Characterizing high-growth firms in New Zealand*, "International Journal of Entrepreneurship and Innovation", 14, pp. 39–48.

Ho-Kim M.T., Marti J.F. (1999), *Educational method. Notebooks information and methodical guidance counselor*, 12, National Labor Office, Warsaw.

Hudson R. (2007), *Regions and regional uneven development forever? Some reflective comments upon theory and practice,* "Regional Studies", 41(9), pp. 1149–1160.

Hurmerinta-Peltomäki L., Nummela N. (2004), *From this temporary support systematic resource development: expert services from an SME perspective*, "Journal of Small Business and Enterprise Development", 11(2), pp. 233–243.

Hutchinson V., Quintas P. (2008), *Do SMEs do Knowledge Management? Or Simply Manage what they Know?*, "International Small Business Journal", Vol. 26, No. 2, pp. 131–154.

Innovation Activities of Enterprises in 2004–2006, GUS, Warsaw 2008, p. 153.

Isabelle D.I. (2004), *S&T commercialization strategies and practices* [in:] F. Thérin (ed.), *Handbook of Research on Techno-Entrepreneurship,* Edward Elgar, Cheltenham 2007, after Association of University Technology Managers and R.M. Hindie, J. Yencken, *Public research commercialization, entrepreneurship and new technology based firms: an integrated model,* "Technovation", October, Vol. 24, Issue 10.

Jandovitz N., Li H., Watts B., Monteiro J., Kohlberg D., Tsapepas D. (2018), *Telemedicine pharmacy services implementation in organ transplantation at a metropolitan academic medical center,* "Digital Health", Vol. 6, pp. 1–6.

Jasiński A.H. (2014), *Innowacyjność w gospodarce Polski: Modele, bariery, instrumenty wsparcia,* Publishing House of the Department of Management of the University of Warsaw, Warsaw.

Jasiński A.H. (2005), *Bariery Transferu Techniki na rynku dóbr zaopatrzeniowo-inwestycyjnych*, Wydawnictwo Naukowe Wydziału Zarządzania Uniwersytetu Warszawskiego, Warsaw, p. 61.

Jasiński A.H. (1992), *Przedsiębiorstwo innowacyjne na rynku*, KiW, Warszawa.

Jayasinghe D., Crowder R.M., Wills G. (2016), *Model for the Adoption of Telemedicine in Sri Lanka*, SAGE Open, July_September, pp. 1–12.

Kállay L., Vecsenyi J., Freész G., Vas G., Katona B. (2016), *European Start-up Monitor – Country Report Hungary. European Start-up Monitor*, https://europeanstartupmonitor.com/fileadmin/esm_2016/country_reports/Hungary_CountryReport.pdf. (4.05.2019).

Kang K.H., Kang J. (2009), *How do firms source external knowledge for innovation? Analysing effects of different knowledge sourcing methods*, "International Journal of Innovation Management", 13(1), pp. 1–17.

Karwiński M. (2006), *ZZL w małych i średnich przedsiębiorstwach* [in:] H. Król, A. Ludwiczyński (eds.), *Zarządzanie zasobami ludzkimi. Tworzenie kapitału ludzkiego organizacji*, PWN, Warsaw.

Kay J. (1996), *Podstawy sukcesu firmy*, PWE, Warszawa.

Kirchoff B.A. (1994), *Entrepreneurship and Dynamic Capitalism. The Economics of Business Firm Formation and Growth*, PRAGER, Wesport, London.

Klein S.J., Rosenberg N. (1986), *An overview of innovations,* National Press Academy, Washington.

Klincewicz K. (2011), *Dyfuzja Innowacji. Jak odnieść sukces w komercjalizacji nowych produktów i usług.* Wydawnictwo Naukowe Wydziału Zarządzania Uniwersytetu Warszawskiego, Warszawa.

Kok J.P.M., Lorraine M., Uhlaner L.M., Thurik A.R. (2003), *Human Resource Management With Small Firms; Facts and Explanations,* Publications in the Report Series Research in Management ERIM Research Program: "Strategy and Entrepreneurship".

Kondo M. (2007), *Upsurge of University Spin-offs in Japan* [in:] M.H. Sherif, T.M. Khalil (eds.), *Management of Technology. New Direction in Technology Management*, Elsevier, Amsterdam.

Koszałka J., Sluismans R. (2011), *Doradztwo dla strategii rozwoju innowacyjnego* [in:] *MSP Advice for the development of innovative strategies in SMEs*, Polish Agency for Enterprise Development, Warsaw, Poland.

Korhonen O., Väyrynen K., Isomursu M. (2018), *Analyzing the role of a telemedicine system in health service personalization*, 27th International Conference on Information System Development, ISD2018, Lund, Sweden.

Kozarkiewicz A. (2016), *Koncepcja zdolności absorpcyjnej we współczesnych badaniach nad zarządzaniem projektami*, "Studia Ekonomiczne", Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach, Vol. 299, pp. 176–186.

Krugman P., Venables A.J. (1995), *The seamless world: A spatial model of international specialization*, Working Paper, 5220, National Bureau of Economic Research, Massachusetts.

Kubiak K. (2017), *Klastry – czynnik wsparcia przedsiębiorczości i rozwoju regionów*, A. Rogut, K. Wach, "Przedsiębiorczość i Zarządzanie", XVIII(12(2), Wydawnictwo Społecznej Akademii Nauk, Lodz–Warsaw.

Kuhn R.L. (1988), *Creative and Innovation for Science-Based Business* [in:] R.L. Kuhn (ed.), *Handbook for Creative and Innovative Managers*, McGraw-Hill Book Company, pp. 587–596.

Labas A., Courvisanos J., Henson S. (2015), *Business advisor knowledge and knowledge transference: a conceptual framework*, Small Enterprise Association of Australia and New Zealand, 28th Annual SEAANZ Conference Proceedings, July 2015, Melbourne.

Larsen S.B., Skovgaard S., Petersen M.G., Kjeldsen G.F. (2016), *Towards a shared service centre for telemedicine: Telemedicine in Denmark, and a possible way forward*, "Health Informatics Journal", Vol. 22, No. 4, pp. 815–827.

Lee I.H., Mason R. (2008), *Uncertainty, co-ordination and path dependence*, "Journal of Economic Theory", 138, pp. 262–287.

Lipczyński T. (2014), *Wiedza jako narzędzie budowy przewagi konkurencyjnej małych i średnich przedsiębiorstw,* "Informatyka Ekonomiczna", 1(31), pp. 47–58.

Lisowska R. (2016), *Specyfika funkcjonowania i rozwoju małych i średnich przedsiębiorstw* [in:] R. Lisowska, J. Ropęga (ed.), *Przedsiębiorczość i zarządzanie w małej i średniej firmie. Teoria i praktyka*, Wydawnictwo Uniwersytetu Łódzkiego, Lodz.

Lyuboslavsky V. (2015), *Telemedicine and Telehealth 2.0. A Practical Guide for Medical Providers and Patiens*, CreateSpace Independent Publishing Platform, e-book.

Łobacz K. (2012), *Koncepcja oceny procesu komercjalizacji przedsięwzięć gospodarczych w akademickich inkubatorach przedsiębiorczości*, doctoral dissertation, University of Szczecin, Szczecin.

Łobacz K. (2015), *Źródła wiedzy warunkującej innowacyjne działania przedsiębiorcze–konsekwencje dla sterowania kierunkami rozwoju systemów gospodarczych,* "Nierówności społeczne a wzrost gospodarczy", 41, pp. 412–431.

Łobacz K. (2018), *Kontrola kontraktu doradczego w małej firmie rodzinnej. Control of advisory contract in a small family business*, "Entrepreneurship and Management", 19(7/3), pp. 499–510.

Łobacz K. (2020), *Pivoting Strategic Business Approaches in the Strategic Business Advice Process: Lessons Learned from Case Studies of Small Innovative Firms* [in:] M. Bilgin, H. Danis, E. Demir, U. Tony-Okeke (eds.), *Eurasian Business Perspectives. Eurasian Studies in Business and Economics*, Vol 15/2, Springer, Cham, pp. 99–115.

Łobacz K., Głodek P. (2015), *Development of Competitive Advantage of Small Innovative Firm – How to Model Business Advice Influence within the Process?*, "Procedia Economics and Finance", Vol. 23.

Łobacz K., Głodek P., Stawasz E., Niedzielski P. (2016), *Utilisation of business advice in small innovative firms: The role of trust and tacit knowledge*, "Entrepreneurial Business and Economics Review", 4(2), pp. 117–138.

Majewska-Bator M., Bator P. (2011), Źródła wiedzy zewnętrznej wykorzystywane przez przedsiębiorstwa w działalności gospodarczej, "Współczesne Zarządzanie", No. 3, pp. 136–146.

Martin R., Sunley P. (2007), *Complexity thinking and evolutionary economic geography*, "Journal of Economic Geography", 7, pp. 573–601.

Maskell P., Malmberg A. (2007), *Myopia, knowledge development and cluster evolution*, "Journal of Economic Geography", 7, pp. 603–618.

Matejun M. (2015), *Absorpcja wsparcia w zarządzaniu rozwojem mikro. małych i średnich przedsiębiorstw – podejście strategiczne*, "Zeszyty Naukowe Politechniki Łódzkiej", No. 1194.

Matusiak K.B., Guliński J. (eds.) (2010), *Rekomendacje zmian w polskim systemie transferu technologii i komercjalizacji wiedzy*, PARP, Warsaw.

Matusiak K.B. (2006), *Rozwój systemów wsparcia przedsiębiorczości – przesłanki, polityka i instytucje,* Instytut Technologii i Eksploatacji, Radom-Łódź.

Matusiak K.B. (2009), *Uwarunkowania innowacyjności małych firm* [in:] A.H. Jasiński (ed.), *Innowacje małych i średnich przedsiębiorstw w świetle badań empirycznych*, Promocja XXI, Warszawa, pp. 54–85.

Matusiak K.B. (ed.) (2011), *Strategiczne obszary rozwoju parków technologicznych*, PARP, Gdańsk-Kraków-Opole-Poznań, Warszawa, pp. 15–22.

Matthews V.O., Popoola S. I., Adetiba E., Badejo J., Atayero A.A. (2017), *Cost-Effective Medical Robotic Telepresence Solution using Plastic Mannequin*, "International Journal of Electrical and Computer Engineering", Vol. 7, No. 3, pp. 1212–1218, DOI: 10.11591/ijece.v7i3, pp. 1212–1218.

Mazzarol T. (2011), *Entrepreneurship and Innovation. Readings and Cases*, Second ed., Tilde University Press, pp. 48–51.

McCann P., Ortega-Argilés R. (2011), *Smart specialisation, regional growth and applications to EU cohesion policy*, http://ipts.jrc.ec.europa.eu/docs/s3_mccann_ortega.pdf.

Menachemi N., Burke D., Ayers D. (2004), *Factors Affecting the Adoption of Telemedicine – A Multiple Adopter Perspective*, "Journal of Medical System", Vol. 28, No. 6, pp. 617–632.

Merx-Chermin M., Nijhof W.J. (2005), *Factors influencing knowledge creation and innovation in an organization,* "Journal of European Industrial Training", Vol. 29, No 2.

Midelfart-Knarvik K.H., Overman H.G., Redding S.J., Venables A.J. (2000), *The Location of European Industry*, "Economic Paper", No. 142.

Mndzebele N. (2013), *The Effects of Relative Advantage, Compatibility and Complexity in the Adoption of EC in the Hotel Industry*, "International Journal of Computer and Communication Engineering", Vol. 2, No. 4, pp. 473–476, DOI: 10.7763/IJCCE.2013.V2.229.

Mazurek B., Owczarek K. (2007), *Klaster tekstylno-odzieżowy w regionie łódzkim – moda czy konieczność* [in:] J. Otto, R. Stanisławski, O. Maciaszczyk (eds.), *Innowacyjność jako czynnik podnoszenia konkurencyjności przedsiębiorstw i regionów na jednolitym rynku europejskim*, Politechnika Łódzka – Monografie, Lodz.

Mole K., Baldock R., North D. (2013), *Who Takes Advice? Firm Size Threshold, Competence, Concerns and Informality in a Contingency Approach,* "ERC Research Paper", Vol. 9, pp. 1–38.

Mole K., North D., Baldock R. (2017), *Which SMEs seek external support? Business characteristics. management behaviour and external influences in a contingency approach*, "Environment and Planning C: Politics and Space", Vol. 35, No. 3.

Morrison L., Yardley L., Powell J., Susan M. (2012), *What Design Features Are Used in Effective e-Health Interventions? A Review Using Techniques from Critical Interpretive Synthesis,* "Telemedicine journal and e-health, Journal of the American Telemedicine Association", 18, pp. 137–144, doi: 10.1089/tmj.2011.0062.

Muogbo U.S. (2013), *The Impact of Strategic Human Resource Management on Small and Medium Sized Enterprises (A Study of some Selected Paint Manufacturing Firms in Anambra State Nigeria)*, "Global Journal of Management and Business Studies", Vol. 3, No. 3.

Navarro J.G.C., Eldridge S., Wandosell G. (2016), *International organizational performance: The influence of congenital learning and realized absorptive capacity*, "Journal of Small Business and Enterprise Development", Vol. 23(2), pp. 453–473, doi10.1108/JSBED-05-2014-0078.

Nazarko J., Ejdys J., Halicka K., Olszewska A.M., Gudanowska A.E., Wardzińska K., Krawczyk-Dembicka E., Magruk A. (2012), *Inwentaryzacja kierunków badań naukowych i technologii zidentyfikowanych w polskich projektach foresightowych*, http://npf.gig.eu/images/pliki/partnerzy/rezultaty/Zad.1/Podzadanie%201a%20i%201b_REZULTAT%201/PB/Raport_Inwentaryzacja_kierunkow_badan_naukowych_i_technologii_PB.pdf.

NIC (2008), *User-driven innovation: Context and cases in the Nordic region,* Lund.

Newbert S.L., Gopalakrishnan S., Kirchoff B.A. (2008), *Looking beyond resources: Exploring the importance of entrepreneurship to firm-level competitive advantage in technologically intensive industries*, "Technovation", No. 28, DOI: 10.1016/j.technovation.2007.07.002.

Nogalski B., Karpacz J. (2012), *Zdolność technologiczna jako źródło przewagi konkurencyjnej przedsiębiorstw produkcyjnych*, "Studia Ekonomiczne Regionu Łódzkiego", wydanie specjalne, PTE Łódź.

North D., Baldock R., Mole K., Wiseman J., Binnie C. (2011), *Research to Understand the Barriers to the Take up and Use of Business Support*, For the Department for Business Innovation and Skills, London.

Nowakowska A. (2018), *Od regionu do terytorium – reinterpretacja znaczenia przestrzeni w procesach rozwoju gospodarczego*, "Gospodarka Narodowa", 3(295), pp. 5–22.

Nowakowska A. (2015), *Inteligentne specjalizacje regionalne – nowa idea i wyzwanie dla polityki regionalnej*, "Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu", No. 380, pp. 310–318.

Nowakowska A., Walczak B. (2016), *Dziedzictwo przemysłowe jako kapitał terytorialny. Przykład Łodzi*, "Gospodarka w praktyce i teorii", No. 4(45), pp. 45–56.

OECD (1999), *Boosting Innovation Cluster Approach,* pp. 9–13.

OECD (2005), *Oslo Manual*, Paris.

OECD (2001), Territorial outlook. Territorial economy, Paris: OECD Publishing.

OECD (2007), Revised field of science and technology (FOS) classification in the Frascati Manual, DSTI/EAS/STP/NESTI(2006)19/FINAL.

OECD (2017), *OECD Multilingual Summaries. Entrepreneurship at a Glance 2017*, OECD Publishing, Paris, DOI: 10.1787/entrepreneur_aag-2017-en.

OECD (2001), *Territorial Outlook*, Paris.

Official Journal of the European Union L 393/1, *Regulation (EC) No 1893/2006 of the European Parliament and of the Council of 20 December 2006 establishing the statistical classification of economic activities* NACE Revision 2 and amending Council Regulation (EEC) No 3037/90 as well as certain EC Regulations on specific statistical domains.

Official Journal of the European Union L 273, *Commission Implementing Regulation* (EU) 2018/1602 of 11 October 2018 amending Annex I to Council Regulation (EEC) No 2658/87 on the tariff and statistical nomenclature and on the Common Customs Tariff.

Ortega-Argilés R., Piva M.C., Vivarelli M. (2011), *Productivity Gains from R&D Investment: Are High-Tech Sectors Still Ahead? Forschungsinstitut zur Zukunft der Arbeit*, Discussion Paper, No. 5975, Bonn.

Oslo Manual 2018, *Guidelines for Collecting, Reporting and Using Data on Innovation*, 4th Edition, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris/Eurostat, Luxembourg, https://doi.org/10.1787/9789264304604-en.

PARP, Portal Innowacji (2018), www.pi.gov.pl/Klastry/chapter_95064.asp (05.06.2018).

PARP (2017a), *Wdrażanie standardów zarządzania klastrem*, Poradnik koordynatora, Warsaw.

PARP (2017b), *Raport o stanie sektora małych i średnich przedsiębiorstw w Polsce*, Warsaw.

PARP (2015), *Diagnoza stanu designu*, Warsaw, www.badania.parp.gov.pl/design.

Patterson W., Ambrosini V. (2015), *Configuring absorptive capacity as a key process for research intensive firms*, "Technovation", Vol. 36–37, pp. 77–89.

Pauli U. (2016), *Zarządzanie talentami w małych i średnich przedsiębiorstwach*, "Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu", No. 429.

Pedrosa F., Shaikh F., Rivera G., Ribeiro R., Qaddoumi I. (2017), *The Impact of Prospective Telemedicine Implementation in the Management of Childhood Acute Lymphoblastic Leukemia in Recife*, Brazil, "Telemedicine and e-Health", Vol. 23, No. 10, pp. 863–869.

Pietrobelli C., Rabellotti R. (2011), *Global value chains meet innovation systems: Are there learning opportunities for developing countries*?, "World Development", 39(7), pp. 1261–1269.

Pisula D. (2010), *ABC doradcy zawodowego. Rozmowa doradcza.* Krajowy Ośrodek Wspierania Edukacji Zawodowej i Ustawicznej [National Center for Supporting Vocational and Continuing Education], Warsaw, Poland.

Pocztowski A. (2007), *Zarządzanie zasobami ludzkimi: strategie-procesy-metody*, PWE, Warszawa.

Pocztowski A., Pauli U. (2013), *Profesjonalizacja zarządzania zasobami ludzkimi w małych i średnich przedsiębiorstwach*, "Zarządzanie Zasobami Ludzkimi", No. 3–4, pp. 92–93.

Polish Journal of Laws 2007.251.1885, *Ordinance of the Council of Ministers of 24 December 2007on the Code List of Classification of Business Activities in Poland* (PKD).

Polish Journal of Laws 2015 item 1676 *Ordinance of the Council of Ministers* of 23 October 2015 on the Polish Classification of Goods and Services (PKWiU).

Polish Journal of Laws 2018.1818, *Ordinance of the Council of Ministers* of 20 September 2018 on the Classification of fields and disciplines of science and disciplines of the arts.

Porter M.E. (2001), *Porter o konkurencji*, PWE, Warsaw.

Prahalad C.K., Krishnan M.S. (2010), *Nowa era innowacji,* PWN, Warsaw.

Puffert D.J. (2004), *Path Dependence, Network Form, and Technological Change* [in:] W. Sundstrom, T. Guinnane, W. Whatley (eds.), *History Matters: Economic Growth, Technology, and Population,* Stanford University Press, Stanford, pp. 63–95.

Rafiqui P.S. (2009), *Evolving economic landscapes: why new institutional economics matters for economic geography*, "Journal of Economic Geography", 9, pp. 329–353.

Rallet A. (2007), *Commentaires du texte d'Olivier Crevoisier* [in:] A. Mollard et al., *Territories et enjeux du developpement regional*, Versailles, Editions Quae, p. 80.

Ramsden M., Bennett R.J. (2005), *The benefits of external support to SMEs: "hard" versus "soft" outcomes and satisfaction levels*, "Journal of Small Business and Enterprise Development", 12(2), 227–243.

Roberts E., Malone D. (1996), *Policies and structures for spinning off new companies from research and development organizations*, "R&D Management", Vol. 26 Issue 1, pp. 17–48.

Rogers E.M. (1983), *Diffusion of Innovations*, The Free Press, London.

Ropęga J. (2013), *Ścieżki niepowodzeń gospodarczych. Redukcja zagrożenia niepowodzeniem jako element strategii małej firmy*, Wydawnictwo Uniwersytetu Łódzkiego, Lodz.

ROT (2018), *Stworzenie narzędzi do monitorowania innowacyjności regionu łódzkiego z wykorzystaniem procesu przedsiębiorczego odkrywania*, Regional Territorial Observatory, Lodz.

Rothwell R., Zegveld W. (1994), *The handbook of industrial innovation,* E Elgar, Cheltenham.

SAPIE (2016), *Slovak Startups Report 2016*, Part of V4 Startup Survey.

Scott J.M., Irwin D. (2009), *Discouraged advisees? The influence of gender, ethnicity, and education in the use of advice and finance to UK SMEs*, "Environment and Planning C-Government and Policy", 27 (2), pp. 230–245.

Shelest O. (2016), *Inwestowanie w szkolenia – ryzyko pracownika?*, "Zarządzanie Zasobami Ludzkimi", No. 1(108), pp. 25–40.

Sipa M., Gorzeń-Mitka I., Skibiński A. (2015), *Determinants of Competitiveness of Small Enterprises: Polish Perspective*, "Procedia Economics and Finance", Vol. 27, pp. 445–453, DOI: 10.1016/S2212-5671(15)01019-9.

Siqueira A.C., Cosh A.D. (2008), *Effects of product innovation and organizational capabilities on competitive advantage: evidence from UK small and medium manufacturing enterprises*, "International Journal of Innovation Management", Vol. 12, No. 2.

Smolarek M. (2016), *Zarządzanie kadrami w małych przedsiębiorstwach*, "Marketing i Rynek", No. 3.

Sokołowicz M.E. (2015), *Rozwój terytorialny w świetle dorobku ekonomii instytucjonalnej. Przestrzeń – bliskość – instytucje*, Wydawnictwo Uniwersytetu Łódzkiego, Lodz.

Soriano D.R., Castrogiovanni G.J. (2012), *The impact of education, experience and inner circle advisors on SME performance: insights from a study of public development centers*, "Small Bussiness Economics", Vol. 8, pp. 333–349.

Sosnowska A., Łobejko S. (2007), *Efektywny model funkcjonowania klastrów w skali kraju i regionu*, Instytut Technologii Eksploatacji – Państwowy Instytut Badawczy w Radomiu dla PARP, Radom.

Stanisławski R. (2017), *Open innovation a rozwój mikro, małych i średnich przedsiębiorstw*, Publishing House of the Lodz University of Technology, Lodz.

Staszkiewicz M., Havlíková D. (2016), *Czech Startups Report 2016*, Aspen Institute in Progue.

Statistical Office in Łódź (Urząd Statystyczny w Łodzi) (2016), Sytuacja społeczno-gospodarcza Łodzi I-III kwartał 2016 r., www.lodz.stat.gov.pl.

Stawasz E. (2013), *Innowacje a konkurencyjność małych przedsiębiorstw*, "Organizacja i Zarządzanie", Zeszyty Naukowe, No. 53, Politechnika Łódzka, Lodz.

Stawasz E., Głodek P., Łobacz K., Niedzielski P. (2018), *Kształtowanie konkurencyjności małej firmy. Rola doradztwa biznesowego,* Wydawnictwo Uniwersytetu Łódzkiego, Lodz.

Stefański A., Godlewska-Werner D. (2016), Gotowość menedżerów do zmiany i podejmowania działań rozwojowych, "Zarządzanie Zasobami Ludzkimi", No. 3–4, pp. 110–111.

Stern S., Porter M.E., Furman J.L. (2000), *The determinants of national innovative capacity*, www.nber.org/papers/w7876.

Storey D.J. (1990), *Business Performance and Size* [in:] Z.J. Acs, D.B. Audretsch (eds.), *The Economics of Small Firms. A European Challenge*, Kluwer Academic Publishers, Dodrech / Boston / London.

Strike V.M. (2012), *Advising the Family Firm: Reviewing the Past to Build the Future,* "Family Business Review", 25(2), pp. 156–177.

Suchodolski A. (2010), *Ocenianie pracowników* [in:] T. Listwan (ed.), *Zarządzanie kadrami,* Wydawnictwo C.H. Beck, Warsaw.

Szultka S. (ed.) (2012), *Klastry w Polsce, raport z cyklu paneli dyskusyjnych*, PARP, Warsaw.

Świderek A., Wiśniewska J. (ed.) (2015), *Współpraca przedsiębiorstw a innowacje i transfer technologii – wybrane aspekty,* Naukowe Wydawnictwo IVG , Szczecin.

Tidd J., Bessant J. (2011), *Zarządzanie innowacjami*, Wolters Kluwer Publishing House, Warsaw.

Todorova G., Durisin B. (2007), *Absorptive capacity: valuing a reconceptualization*, "Academy of Management Review", Vol. 32(3).

Toth B.I. (2015), *Territorial Capital: Theory, Empirics and critical remarks*, "European Planning Studies", Vol. 23, No. 7, pp. 1327–1344.

Trochimiuk R. (2013), *Rozwój zawodowy pracowników w małych i średnich przedsiębiorstwach*, "Zarządzanie Zasobami Ludzkimi", No. 3–4, pp. 92–93.

Trzmielak D.M. (2009), *Entwicklung technologischer Firmen – theoretische und empirische Grundlagen* [in:] A. Warda, Z. Weigt (eds.), *Nachwuchswissenschaftler Präsentieren Ihre Forschung*, Wydawnictwo Uniwersytetu Łódzkiego, Lodz, pp. 153 –167.

Trzmielak D.M. (2015), *The Science and Technology Commercialization, Financing, Cooperation and Empirical Analysis* [in:] D. Gibson, J. Slovak (eds.), *Building Sustainable R&D Centerts in Emerging Technology Regions*, MUNI Press, Brno, pp. 189–206.

Trzmielak D.M., Zehner W.B. (2011), *Metodyka i organizacji doradztwa w zakresie transferu i komercjalizacji technologii*, PARP, Łódź-Austin.

Trzmielak D.M, Grzegorczyk M., Gregor B. (2016), *Transfer wiedzy i technologii z organizacji naukowo-badawczych do przedsiębiorstw,* Wydawnictwo Uniwersytetu Łódzkiego, Lodz.

Trzmielak D. (2011), T*echnology transfer and the development of new technology based firm. Polish perspectives and a case study on nanotechnology*. [in:] J.S. Butler, D.V. Gibson (eds.), *Global Perspectives on Technology Transfer and Commercialization. Building Innovative Ecosystem*, Edward Elgar, Northampton 2011: 239-269.

UN (2006), Standard International Trade Classification. Revision 4, Statistical Papers, Series M No. 34/Rev. 4, New York, United Nations.

UN (2008), International Standard Industrial Classification of All Economic Activities, Statistical Papers, Series M, No. 4, Rev. 4, New York, United Nations.

UP RP (2006 as amended), Międzynarodowa Klasyfikacja Patentowa, Polish Patent Office, Warsaw.

Varblane U., Ukrainksi K., Masso J. (2010), *Is smart specialisation a tool for enhancing the international competitiveness of research in CEE countries within ERA?*, http://www.eurosfaire.prd.fr/7pc/doc/1292235415_smart_specialization_varblane_urainski_masso.pdf.

Viljamaa A. (2011), *Exploring small manufacturing firms' process of accessing external expertise*, "International Small Business Journal", Vol. 29, No. 5.

Volberda H.W., Foss N.J., Lyles M.A. (2010), *Absorbing the Concept of Absorbing Capacity: How to Realize Its Potential in the Organization Field*, "Organization Science", Vol. 21, No. 4.

Vuèkovic I., Dilberovic F., Kapur E., Voljevica A., Bilalovic N., Selak I. (2003), *The Principles of Telemedicine in Practice*, "Bosnian Journal of Basic Medical Sciences", III(4), pp. 54–60.

Walker A.R. (1993), *Lodz: The Problems Associated with Restructuring the Urban Economy of Poland's Textile Metropolis in the 1990s*, "Urban Studies", No. 30(6), pp. 1065–1080.

Wiklund J., Shepherd D. (2003), *Knowledge-based resources, entrepreneurial orientation, and the performance of small and medium-sized businesses*, "Strategic Management Journal", Vol. 24, Issue 13, DOI: 10. IOO2/smj.36O.

World Bank Group (2015), *Toward an Innovative Poland: The Entrepreneurial Discovery Process and Business Needs Analysis*, http://documents.worldbank.org/curated/en/805821467993730545/pdf/106148-REPLACEMENT-POLISH-v2-REPORT-Web.pdf.

World Health Organization (2009), *Telemedicine: opportunities and developments in Member States: report on the second global survey on eHealth*, "Global Observatory for eHealth series", Vol. 2.

Yin R.K. (1982), *Studying phenomenon and context across sites*, "The American Behavioral Scientist", 26(1).

Yusoff N.H., Yaacob R., Ibrahim D. (2010), *Business Advisory: A Study on Selected Microsized SMEs in Kelantan, Malaysia*, "International Journal of Marketing Studies", 2(2), pp. 245–257.

Yusuf J.-E. (2010), *Meeting entrepreneurs' support needs: assistance programs are effective ?*, "Journal of Small Business and Enterprise Development", 17(2), pp. 294.

Zahra S.A., George G. (2002), *Absorptive capacity: a review, reconceptualization, and extension*, "Academy of Management Review", Vol. 27, No. 2, pp. 185–203.

Zarząd Województwa Łódzkiego (2013), Strategia Rozwoju Województwa Łódzkiego, Łódzkie 2020 [*Province Government of Łódzkie Voivodship (2013), Development Strategy of Łódzkie Voivodship*].

Zou T., Ertug G., George G. (2018), *The capacity to innovate: a meta-analysis of absorptive capacity*, "Innovation: Organization & Management", DOI: 10.1080/14479338.2018.1428105.

Żołnierski A. (2005), *Innowacyjność polskich przedsiębiorstw. Raport z Badań*. PARP, Warszawa.

2017 Telemedicine and Digital Health Survey Telemedicine Surges Ahead As Providers, Patients Embrace Technology, 2017, Foley & Lardner LLP.

2017 U.S. Telemedicine Industry Benchmark Survey 2017, Research Health, April.

http://www.strategia.lodzkie.pl/images/srwl_2020_uchwalona_26_02_2013.pdf.

https://www.beckershospitalreview.com/healthcare-information-technology/13-recently-announced-telemedicine-programs.html.

http://paga.org.pl/upload/source/RAPORTY/2016_11_25_Telemedycyna_04_WWW.pdf

http://i.rynekseniora.pl/i/00/27/73/002773.pdf.

https://www.u24.pl/internetowe-konto-pacjenta-ezdrowie-gov-pl/.

http://www.izbamedpol.pl/data/Pliki/96/Plik/Raport---telemedycyna-(fin)10.03.2015.pdf.

ISBN 978-83-64971-87-7

www.san.edu.pl