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The role of external environment in creating technology entrepreneurship in small and medium-sized enterprises

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1. Introduction

High technologies are currently a main source of development not only for the biggest world economies and large enterprises functioning dynamically within them, they also constitute a challenge for small and medium-sized enterprises. Increasing the level of technology innovation, product and service modernity as well as competitiveness in international and global market, is a significant problem in the current development phase of Polish SMEs. **Technology entrepreneurship** is one of the forms of activity, which can foster the realization of the above aims.

It is based on cooperation between commercial enterprises and institutions of business environment functioning mostly in the field of science and technology, oriented towards transformation of research and scientific potential into commercial technology innovations leading to development of products and services. The following dimensions influence the process of creating technology entrepreneurship in small and medium-sized enterprises:

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- internal environment of a company, including first of all qualifications and competencies of employees and the management, controlled resources, ability to create and develop knowledge as well as ability to develop relational resources,
- external environment, including first of all the potential of educational, technical and technological, economic and international (global) environment. Institutional dimension of environment in which SMEs function, which includes a range of institutions from business environment, also gains in importance,
- interactions between these two areas, including forms, directions and effects of cooperation oriented towards creating and developing technology entrepreneurship.

Taking this into account, presentation and evaluation of the role of external environment in creating technology entrepreneurship in small and medium-sized enterprises have been adopted as the **aim of the article**. Particular attention was paid to the **role of networks** between enterprises and institutions being a part of business environment, fulfilling significant functions in the process of development of technology entrepreneurship. The study presents results of research conducted in the Department of Management at Technical University of Lodz in the years 2007-2008.

2. Technology entrepreneurship in SME sector

Technology entrepreneurship can be defined as a process ensuring bigger practical usefulness to results of scientific research by means of efficient cooperation between scientific centres, capital market and business support institutions as well as enterprises dealing with producing and selling high technology products and services.

It can be treated as a tool transforming research and potential of scientific institutions into specific goods and services, which directly or indirectly improves consumers' benefits and influences better dynamics of economic growth. However, knowledge transfer to private enterprises becomes a condition of efficiency of this mechanism, which increases their productivity and, as a consequence, generates the creation of new economic entities, increase in investments and employment, first of all in the field of high technologies (Matusiak, Matusiak 2007, p. 160). Attention should be paid to the fact that a lot of companies oriented towards product and technology innovation arose on the basis of knowledge and technologies transferred from universities and research and development units by scientific staff educated within these units. It particularly concerns branches such as microelectronics, telecommunications,

making new materials, designing systems of management and production organization, biotechnologies or IT software (Grudzewski, Hejduk 2000, p. 259).

The definition of technology entrepreneurship relating mostly to internal dimensions of enterprises' functioning is presented by W.M. Grudzewski and I.K. Hejduk (Grudzewski, Hejduk 2008, pp. 80-85). It means a process of making new products, applying contemporary technologies, flexible reactions to changes taking place in the market as well as introducing innovations in all fields of functioning of a company and also its sub-contractors. In this dimension, technology entrepreneurship is related to basic pillars of economy based on knowledge, which include: innovation, educational as well as information and communication system, processes of knowledge management at organizational level as well as regional aspects and also institutional and business environment.

The technology entrepreneurship formula allows describing a problem of increasing innovativeness and competitiveness of enterprises by means of more efficient use of research results on new technologies. It can be particularly useful for small and medium-sized enterprises, which have already reached certain level of development (the so called micro-enterprises are not taken into consideration here) and need contemporary technologies in order to lead independent R&D activity. As opposed to large business organizations with their own laboratories and R&D centres, small and medium-sized enterprises hoping to develop, are to a great degree "doomed" to transfer and adaptation of new technological solutions from universities and scientific and technical background, taken broadly.

These enterprises have often functioned for several or more years, but technologies and technical equipment of many of them, taken over or purchased from former state enterprises, are obsolete. Owners' care of this equipment allowed prolonging its use, but currently it does not ensure products and services with appropriate quality standards and market expectations. On the other hand, these entities are often characterized by a tendency to take up innovative actions and significant activity in introducing new products in the market. As far as smaller economic entities are concerned, the following features are conducive to increase in entrepreneurship and creativity: proximity to market and clients, fast information flow and decision-making process, favourable atmosphere of work and mutual mobilization (Lachiewicz 2003, pp. 16-19). Therefore, further development of these enterprises is impossible without knowing how to use technology entrepreneurship.

Technology entrepreneurship phenomenon can relate in particular to high technology small and medium-sized enterprises. They can be defined as innovation enterprises, functioning in the fields of industry or services

considered as highly technological, taking into account at the same time quantity and quality features characteristic to smaller business entities (Matejun 2008, p. 18). The segment of these enterprises has strongly developed in the last decades of the twentieth century and in current decade, first of all in the USA, Japan and countries of West Europe. They function in the fields of biotechnology, electronics, nanotechnologies, information technologies, etc.

The concept of technology entrepreneurship in its theoretical assumptions combines an approach from the point of view of entrepreneurial theory of a firm with essential influence of theories based on innovations and cooperation. **Entrepreneurial theory of a firm** attracts attention to the fact that institutional limits between an enterprise and market are created by minimization of uncertainty costs and enterprise and entrepreneurship are perceived as constant creation of new ideas concerning the way in which their assets should be allocated, shared and revitalized, in conditions of this uncertainty. Both forces – entrepreneurship as flexibility of action and enterprise, as a certain constancy, allow the company to face uncertainty, i.e. the phenomenon of lack of knowledge about current facts and future possibilities (Noga 2009, pp. 143-147).

The role of **innovations** in technology entrepreneurship is crucial. Their significance was emphasized already at the beginning of the twentieth century by J. Schumpeter. They creatively disrupt economic balance by introducing and popularizing new production methods, contributing thus to increase in profit and consumption. As a result, institutional and organizational limits between an enterprise and its environment are formed by maximizing advantages from introducing innovations. In this case, market role of innovative enterprise is stressed, which, on the one hand, implements innovations due to its activity, and, on the other hand, creates new markets, often in the form of “blue oceans”. This theory also draws attention to the fact that the increase in size of enterprise kills entrepreneurship (Noga 2009, pp.147-151). It should be also pointed out that even in Schumpeter’s theory, business support organizations e.g. banks or other financial market institutions ensuring coverage of expenditure, considerable in relation to previous expenses, are essential for the processes of creating innovations (Gruszecki 2002, p. 199).

Technology entrepreneurship can be also described on the basis of the assumptions of **enterprise innovation theory** by J. Schmookler and other authors analyzing enterprise from the point of view of its research and development activity. In this theoretical trend, R&D sphere plays a crucial role in forming, functioning and developing an enterprise while the process of creating inventions is perceived as one of the most important autonomous (specific) aims of establishing a firm (Noga 2009, pp. 153-154).

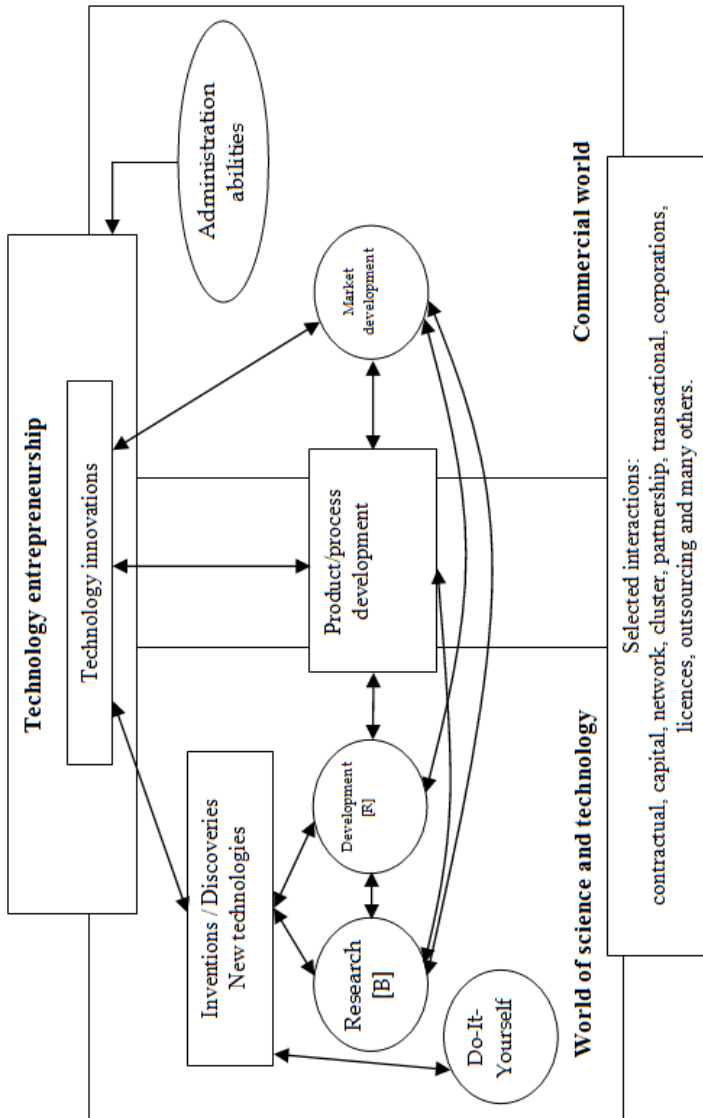


Figure 1. Interactions taking place between the world of science and technology and commercial world in the process of creating technology entrepreneurship
 Source: own study on the basis of (Poznańska 2010, p. 6).

The explanation of significance of technology entrepreneurship in the process of functioning of small and medium-sized enterprises can be also searched for on the grounds of **enterprise theory determined by intellectual capital** (Noga 2009, p. 205-207). According to this approach, more and more specific assets such as knowledge, talent or market relations become the object of market transactions and contracts. Due to the meaning of this capital, an enterprise plays a coordinating role in coordinating economy, in relation to the market and its contribution in the coordination consists most of all in creating and attracting intellectual capital.

Therefore, in all approaches at defining technology entrepreneurship, interactions between the world of science and technology and commercial world become a key to its creation. They include various relations and dimensions of cooperation between spheres of science, capital market institutions, public institutions and enterprises. Centres dealing with pilot implementation, market analyses, education in the field of new technologies and mediation in the process of their transfer to economic sphere, fulfil a special role.

All the segments and types of institutions create certain complex of activities making up technology entrepreneurship process but various organizational solutions functioning where science and economy meet, play a special role. The most frequent forms include: spin-off enterprises, the so called professor's or academic companies, industry and technology parks, organizations defined as business angels and other forms organizing the initial phases of technology entrepreneurship. A lot of innovation enterprises have also appeared in Poland recently, in scientific and student environment (technology transfer centres, private companies run by recognised creators of new technological solutions, etc.). Basic interactions taking place between the world of science and technology and commercial world in the process of creating technology entrepreneurship are presented in Figure 1.

It is entrepreneurs themselves and small and medium-sized enterprises' managers who played a significant part here. Their creativity in searching for contemporary solutions, ability to obtain information and negotiate conditions of technology transfer as well as preparing for reception and diffusion of these technologies inside an enterprise, are also very important elements of the process of technology entrepreneurship. In this field, young and very well educated entrepreneurs, able to cooperate with scientific and research and development centres within the so called nascent entrepreneurship are given an essential importance.

3. The role of networks in creating technology entrepreneurship

The development of technology entrepreneurship in small and medium-sized enterprises sector is therefore related to the cooperation of various institutions and business entities. It requires a relevant business environment. A lot of researchers and practitioners from SME sector consider that this environment is formed by **network organizational forms**. It is where, similarly to the creation of cluster networks and development of innovativeness, main factors of competitiveness of contemporary small and medium-sized enterprises are seen (Daszkiewicz 2008, p. 119). Putting emphasis on the significance of internal relations, network solutions can be defined as relatively permanent sets of relationships between organizations, characterized mostly by horizontal relationships, giving the possibility of decentralized planning and control of network elements (Nohria, Eccles 1992, p. 399). Network members are at the same time characterized by co-specialization, contributing a unique ability to create values such as knowledge resources or access to market, which enables realization of both individual and collective aims (Koza, Lewin 1999, p. 638].

Obtaining the effect of synergy by means of cooperation of many business partners is, therefore, the essence of networks, and the effect is achieved by adjusting individual operational activity to the strategy of the whole network (Lachiewicz 2008, p. 8). On the basis of business references, certain specific features of network organization can be presented (Łobos 2000, p. 97):

- decisions concerning resources are taken not only integrally by transaction sides (which is characteristic to market relations) but also collectively by cooperating sides,
- flow of resources between cooperating partners is repeatable not temporary,
- mutual expectations of cooperating sides concern longer time horizon,
- information accessible for cooperating sides are much more comprehensive than in the case of market coordination,
- negotiations and alliances, not competition, are forms of coordination of activities between cooperating sides.

In the case of technology entrepreneurship, **network approach to entrepreneurship** gains in importance, according to which an entrepreneur becomes a unit with personal experience, rooted in network (Birley 1985, pp. 101-117). Entrepreneurship is seen here as a function of structures of possibilities and market chances as well as motivated enterprises having access to resources (Aldrich, Zimmer 1986, pp. 3-23). Small and medium-sized enterprises networks can be at the same time analyzed from two perspectives mutually

complementary and often overlapping: networks of personal contacts of entrepreneur and cooperation networks of SMEs (Starnawska 2008, pp. 141-142).

Network organizations are vested with extraordinary economic force. Although costly as far as their building is concerned, they are cheap and fast in use, accessible from each place and at every time. They allow sharing knowledge effectively, unite people with people, people with data and information, but also incite informal communication style. Specific character of mental work causes that networks have essential advantage over vertically integrated organizational structures of enterprises. Designing and building complex products requires many people with specialized knowledge, working in small, virtual and dynamic departments (Krawiec 2005, p. 129).

In business references and research works, many divisions of network organizations can be found. Applying criterion of sustainability and force of relationships between entities making up a network, essential from the point of view of the hereby considerations, the following types of network organizations can be distinguished, after P. Boulanger (Boulanger 1995 after: Brillman 2002, pp. 426-427):

- integrated networks, consisting of scattered units which legally or financially belong to one group; network head office which influences greatly the functioning of network partners,
- federated networks, i.e. groups of legal or single entities that realize the bond of their needs and are willing to create ways of their fulfilment themselves,
- contract networks, based on concession or franchising agreements concluded between statutory independent partners,
- direct relationships networks, most often found in the sphere of political and religious activity but also used in economic processes.

Network structures allow obtaining a range of advantages for partnership organizations being a part of them and for the whole network structure. The most important include (Cygler 2002, pp. 151-155; Child, Faulkner 1998, pp. 114-115; Lachiewicz 2008, p. 31)

- economy of scale effects and possibilities to obtain bigger range of market interactions,
- reducing uncertainty of action and limiting risk due to loyal cooperation of network partners in turbulent environment,
- increasing flexibility of functioning due to fast reallocation of resources and bearing much lower costs of their obtaining and using;

- possibility of increase in competitiveness of entities making up a network by means of increasing speed and flexibility of action and complementarity in creating value chain,
- maximizing possibilities of development of network partners by specialization and integration of actions as well as by coordination of realization of common projects,
- giving a chance of easy and relatively cheaper access to scarce resources and abilities as well as their fast transfer between units making up a network,
- increasing organizational mobilization in case of arising certain market chances,
- obtaining and exchanging information faster due to combination of contemporary communication methods and lower costs of obtaining information and its circulation,
- increase in innovativeness of partners in the sphere of technology, organization and marketing,
- increasing efficiency of actions in conditions of globalization and technological progress.

The above mentioned advantages point to a special role of networks in creating technology entrepreneurship in small and medium-sized enterprises. The concepts of networks can be particularly useful both in processes of integrated design of products and processes, i.e. searching for network forms of integration of research and development and production and service ventures (Santarek 2005, p. 79), and also in commercialization phases of technology innovations. Therefore, both favourable conditions of general environment and the occurrence of relationships with elements of direct (competitive) environment, are the necessary conditions for the use of potential of external environment in the process of creating technology entrepreneurship in small and medium-sized enterprises. Among business support institutions, which enter into useful networks with small and medium-sized enterprises in the process of creating technology entrepreneurship, the following can be distinguished (Łunarski 2009, pp. 193-195):

- universities, which aside from scientific functions also fulfil didactic tasks,
- scientific and research as well as research and development units including science institutes, research and development centres, R&D departments in large enterprises,
- production and service enterprises, both acquiring and implementing new technologies and also generating specific knowledge necessary for their activities,
- various mediating or consulting institutions, centres of scientific and technical or patent information and other,

- entrepreneurs' associations and associations of enterprises, universities, scientific and research units taking up joint actions in order to achieve difficult and complex aims,
- governmental institutions, e.g. ministries and also relevant local governments' institutions at the level of province, district or town/borough.

Variety of business support institutions is conducive to the development of networks in the process of creating technology entrepreneurship in small and medium-sized enterprises. On the one hand, networks are a natural consequence of searching for complementary resources in the process of creating innovations, on the other hand, they are an essential condition for development of entrepreneurship understood as flexibility of action, supported at the same time by stability of organizational solutions at organizational level.

4. The example of network structure supporting development of technology entrepreneurship

The issue of the role that external environment plays in creating technology entrepreneurship also occurred in the course of the research conducted in the years 2007 - 2008 at Department of Management at Technical University of Lodz. The research concerned issues related to internal communication in network organizations and comprised an overall number of 50 organizations functioning in 10 network structures. In the researched group of enterprises and other organizations, the following four types of network structures were distinguished:

- networks based on brand, i.e. functioning mostly on the basis of franchising method,
- networks in the form of chambers and business associations,
- networks based on business-science cooperation,
- networks created on the basis of cluster idea (creating clusters).¹

Clear elements of entrepreneurship were observed mostly in networks based on business-science cooperation and those created in the form of clusters. In all network types, small and medium-sized enterprises participate. These enterprises are the most interested in creating and developing these structures.

¹ The research was conducted by the team consisting of: S. Lachiewicz (chief), A. Pietras, P. Pietras and J. Wasiela-Jaroszewicz within the framework of research project of Ministry of Science and Higher Education. It was conducted using questionnaire survey method (50 filled in questionnaires) and direct interview with representatives of researched networks (10 interviews) in the area of Central Poland.

Centre of Advanced Technologies is a typical example, it functions as a consortium and leads research, development and implementation activity in the field of contemporary technologies, medicine, food industry and environmental protection. The Centre comprises 15 units including 9 enterprises and 6 science and research organizations. These units can be divided into two groups, i.e. the so called partnership units of first and second circle. A simplified structural scheme of the Centre is presented in Figure 2.

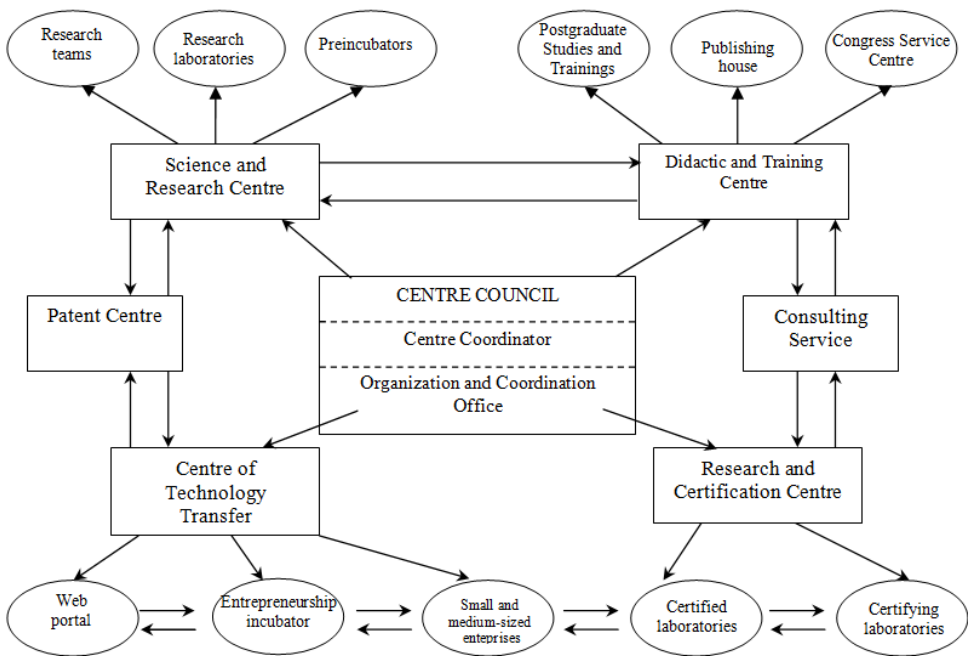


Figure 2. The scheme of „Centre of Advanced Technologies” network organization
 Source: own study on the basis of interviews and documentation from selected high-technology consortia.

First circle partnership units fulfil leading functions in analyzed network structure and directly participate in relations with coordination centre (network centre). On the other hand, **second circle partnership units** (e.g. laboratories, publishing house, and incubators) remain in close network contacts with the first group of units, although, in reality, these dependencies and communication

relationships as well as research and implementation relationships take place between all network partners.

Focusing on first circle organizations, the relationships are discussed below in synthetic form. **Science and Research Centre** realizes common research programs and smaller research and implementation ventures. It also coordinates the work of research teams as well as laboratories and preincubators. **Didactic and Training Centre** deals with working out programs and realizing trainings, seminars and postgraduate studies for employees and entrepreneurs, mainly from SME sector. The subject matter of trainings is conducive to implementation of new technologies in individual enterprises. In addition to that, Centre cooperates with Publishing house and Service Centre dealing with organization of congresses.

Technology Transfer Centre establishes contacts with partners in business, manages innovation projects, gives advises enterprises implementing contemporary technologies and deals with their promotion. At the same time, it conducts market research in the scope of these technologies, sells licences and deals with commercialization of new technologies, taken broadly, associates partners in network and establishes interregional and international cooperation in the scope of entrepreneurship and innovation.

Centre cooperates closely with Web Portal which administers information resources concerning effects of science and research and training activity as well as Entrepreneurship Incubator and directly with enterprises belonging to SME sector. Centre also takes up various actions in business environment, e.g. it functions in National Services System and applies for accreditation to National Innovation Network.

Research and Certification Centre conducts research on substances, goods and materials used in these types of technology and those arising as a result of their using. **Patent Centre** cooperates first of all with Science and Research Centre and Technology Transfer Centre in the area of issues related to patent law. On the other hand, **Consulting Service** cooperates with all subjects cooperating with the Centre and plays the specific role of counsellor, information transfer and intercessor between research teams and enterprises.

Coordinating organ of the network, placed in the centre of Exhibit 2, requires separate consideration. **Centre Council** is an organ that controls the functioning of the whole organization, it formulates and approves plans of activities and coordinates their realization. It also supervises coordinator's activity. **Centre Coordinator** is responsible for efficient realization of work plan of the whole network. They organise current cooperation of implementers of individual

ventures, manages funds of the centre, is responsible for appropriate administration and accounting service and represents Centre in external contacts. Centre coordinator can establish executive teams for the realization of certain tasks and can use the help of **Organization and Coordination Office**, which ensures current administration service.

The functioning of network structure organised in this way was very highly evaluated by small and medium-sized enterprises in the course of the research. The most important advantages pointed at by the respondents include: increase in market possibilities of functioning, representing interests of network partners in external relationships, e.g. towards suppliers and banks as well as possibility to exchange ideas, projects and know-how. The significance of these advantages was particularly recognised by young companies and those without developed technological potential.

5. Summary

The presented reference studies and selected research results indicate that development of technology entrepreneurship among small and medium-sized enterprises requires specific external environment. Network structures with various configurations and degrees of permanence are one of the most important forms of creating such environment.

The increase in number of such network organizations in various spheres of functioning of small and medium-sized enterprises provides, therefore, chances for more dynamic transfer of innovation within technology entrepreneurship.

Summary

The role of external environment in creating technology entrepreneurship in small and medium-sized enterprises

Technology entrepreneurship as a process of ensuring greater practical usefulness to results of scientific research by means of efficient cooperation between science and technology sphere and commercial sphere, can be conducive to increase in technological innovativeness, contemporariness and competitiveness of small and medium-sized enterprises. Internal environment of these entities, external environment and interactions between these two spheres influence the process of its creation in enterprises belonging to SME sector. The article presents the

role of external environment in creating technology entrepreneurship in SMEs. Particular attention is paid to the role of networks between enterprises and business support institutions that fulfil significant functions in the process of development of technology entrepreneurship.

Streszczenie

Rola środowiska zewnętrznego w kreowaniu przedsiębiorczości technologicznej w małych i średnich firmach

Przedsiębiorczość technologiczna jako proces zapewnienia większej użyteczności praktycznej wynikom badań naukowych poprzez skuteczną współpracę pomiędzy sferą nauki i techniki oraz sferą komercyjną może sprzyjać zwiększeniu innowacyjności technologicznej, nowoczesności i konkurencyjności małych i średnich przedsiębiorstw. Na proces jej kreowania w firmach sektora MSP ma wpływ zarówno środowisko wewnętrzne tych podmiotów, otoczenie zewnętrzne, jak również interakcje zachodzące między tymi dwoma strefami. W artykule przedstawiono rolę środowiska zewnętrznego w kreowaniu przedsiębiorczości technologicznej w małych i średnich firmach. Szczególną uwagę zwrócono na rolę powiązań sieciowych pomiędzy przedsiębiorstwami a instytucjami składającymi się na otoczenie biznesu, pełniącymi istotne funkcje w procesie rozwoju przedsiębiorczości technologicznej.

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