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CONCEPTS OF INNOVATION IN TECHNOLOGY TRANSFER ON THE EXAMPLE OF SELECTED COUNTRIES

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ABSTRACT

The aim of the study was to analyse the existing concept of technology transfer and the experience of selected countries. The starting point was outlining the essence of the strategic paradigm of the innovation and technology transfer theory. The concept of the subject-territorial origin of innovation was also interpreted, emphasizing the fact that small companies, linked to one another in a network of business relationships, form structures that bind them to the environment in which they operate, This translates into effectiveness of the processes of technology transfer. The paper also analyses the dynamic and interactive models of technology transfer in selected countries with a long tradition of noticeable effects in terms of transfers of innovative technology solutions.

Key words: strategic management, technology transfer model

INTRODUCTION

Technology transfer as a system for creating effects of innovation is a process, which occurs in different ways, depends on the nature and intensity of interaction between many factors that determine it. Literature distinguishes several approaches to the analysis of the process. In theories of innovation, the strategic paradigm results from adoption of three basic assumptions regarding the functioning of enterprises. It assumes that:

- the activity of companies is based on markets and resources;
- entrepreneurs look to the future;
- entrepreneurs make decisions with regard to the operational efficiency on the market.

These conditions determine the decision on the need of formulating a strategy as a declaration of a specific behaviour, that takes into account both all its resources and external conditions. In addition, a strategic approach to innovation and technology transfer encourages companies to focus on customer needs and customer demand. Including innovation in the development strategy is an essential factor to effective competition (Table 1). An important element that entrepreneurs need to heed is the ability to turn knowledge into innovation [Wojnicka 2011].

The greatest challenge of contemporary enterprises is the perception of the role of business cooperation. It is this only, and not the traditional overtaking of the competition, that can determine market success. Open innovation stands in opposition to closed innovation, which is an innovative process unfolding entirely within the company.

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Table 1. Strategic theories of innovation

Models of innovation	Characteristic
The linear, supply-side model	According to the supply-side model, new solutions can occur regardless of the market and influence the development of certain needs [Weresa 2007]. The supply-side model is a linear one, i.e. the innovative activity follows a specific sequence of events. This sequence is simple and does not take into account the dynamics and complexity of the innovation process. The development of this model run from the 1950s to mid-1960s
The demand model (the so-called market pull)	The demand model emphasizes the role of the market in shaping innovation – it is the demand that determines the formation of new solutions. This approach saw the development of marketing and quality management to ensure that products and services meet the requirements of customers. In the mid-1970, the success of the company began to be determined by customers, therefore, the products needed to meet their needs [Mierzejewska 2008]
The supply and demand models	One of them is the chain model (mid-1970s to early 1980s), which was extended by feedbacks between the different stages of the innovation process. The formation of innovation is affected not only by the sphere of science, but also the market situation.
Models of integrated systems and networking	These models take into account the indications of the innovation system concept and how important links are to the innovativeness of the companies. Networking and creating systems are easier nowadays due to the existing electronic devices, including computer simulation modelling, the joint development of companies or departments using CAD/CAM (Computer-Aided Design/Modelling) systems. In addition, the internet has increased the efficiency of business connections with the outside world. These models deal with the importance of location for the efficiency of cross-linking – e.g. Porter diamond [Porter 1995]
The distributed model	In this model, innovation mainly creates new things and improving the existing ones, in order to create more value. Achieving this result depends on an efficient system of knowledge transfer

Source: Own study based on the presentation by Wojnicka [2011].

According to the concept of closed innovation (Fig. 1), an organization counts only on its own resources, protecting its knowledge and best employees. Closed innovation is characterised by:

- employing and retaining the company's most talented staff;
- creating new solutions only within the company, which gives the novelty advantage in the introduction on the market;
- the desire to introduce a new solution as the first company on the market;
- considerable financial expenditure on the internal R&D department;
- controlling the company's intellectual property, so that the competition wouldn't take advantage of it.

The open innovation model is thus based on the belief that companies can, and should, explore ideas and ways to conquer the market not only within their own structures, but also in the environment (Fig. 2). A part of the innovation process (whether at the level of development of the product, or its implementation) can be transferred outside the organization. It is also possible for the business to develop an idea drawn from the outside. A more open approach allows to reject at the initial stage the ideas that have no chance of successful commercialization.

The open innovation concept assumes that [Mierzejewska 2008]:

- the company can't hire all the best specialists, therefore it should seek partners from different backgrounds and disciplines;

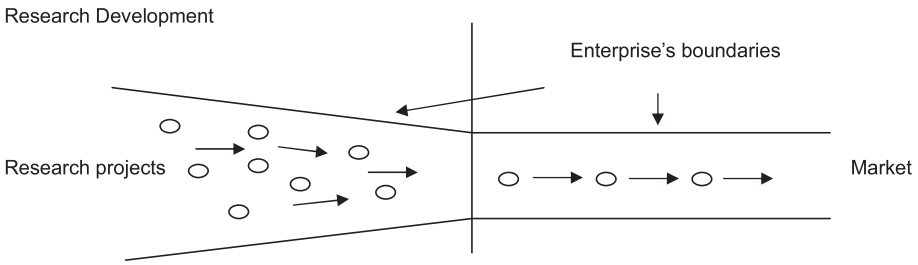

Fig. 1. The closed model approach in the innovation process

Source: Own elaboration based on the presentation by Mierzejewska [2008].

- external research and development is important;
- the company needs not initiate research itself to be able to benefit from them – it may draw from external ideas;
- building an effective business model is more important than being first;
- success can be achieved through a combination of internal and external ideas;
- one can benefit from the use of intellectual property from outside the company, as well as the use of external expertise, if it will improve business performance.

When analysing the open innovation model, one should recall the Hobcraft model (Fig. 3), indicating the use and combining the internal and external knowledge in enterprises. To implement it, it is necessary to change the thinking about innovation. In this view, innovation is seen as a process which can engage a broad group of employees.

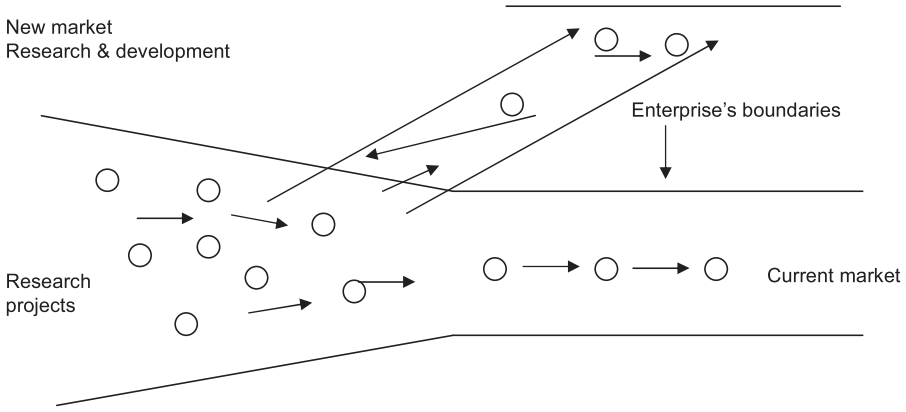

Fig. 2. The open model approach in the innovation process

Source: Own study based on Chesbrough [2003].

Therefore, enterprises must keep in mind that it is worth creating conditions favourable for the staff to engage in innovation, and that consumers should be informed about the company's activities and included in the innovation process. Here, trust and appropriate behaviour are very important, as are relationships, which help make the company open to external expertise. The advantage of using the model by P. Hobcraft [Hobcraft 2011] is not only the creation of innovation, but also the possibility of a rapid response of an organization to a changing environment [Wojnicka 2011].

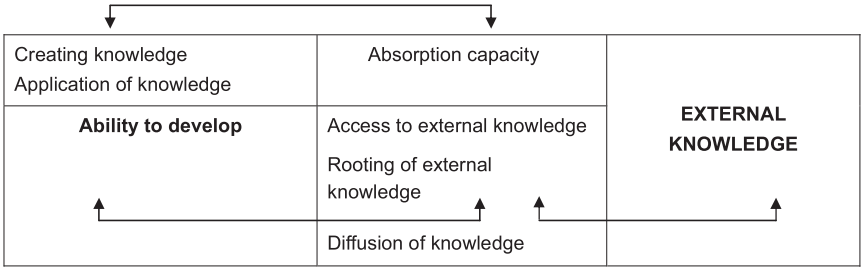

Fig. 3. Open innovation model by P. Hobcraft

Source: Own elaboration based on Wojnicka [2011].

Thus, the benefits generated by enterprises as part of an open innovation model include, in particular: the use of an underrated source of knowledge and ideas, maintaining good, effective relationships with customers, suppliers and business partners and taking swift action in the case when inefficient processes have been diagnosed.

TERRITORIAL ORIGIN OF INNOVATION

In the current economic and market conditions, innovativeness of individual companies consists of the ability to build complex relationships and network structures on the local or regional level, as well as to participate in them. This is particularly important for the sector of micro-, small- and medium-sized enterprises, which generally do not have the capital and substantial base that would allow to achieve a significant competitive advantage in international markets. The result of this phenomenon is the increasing openness of enterprises to external markets and dissemination of the provided products and services, which leads to the increase the number of places where enterprises can operate.

It determines the rivalry between different spaces (regions) as potential business locations, which have a specific set of values needed for running a business [Daszkiewicz 2004]. Regions compete to attract entities and funds that can impact the acceleration of their development in terms of innovativeness, as well as socioeconomic growth. Intertwined into a business network, small businesses form a structure of overlapping dependencies – the links that bind them to the environment in which they operate [Daszkiewicz 2004]. The resulting network effect should be interpreted as a circumstance in which the economic efficiency of enterprises depends not only on the interrelated phenomena of location or the development of demand in the network, but also on the network itself [Allaire and Firsirotu 2000].

The network allows focusing on core skills, used and activated in a coordinated way, ensuring a business entity with both survival and strengthening of the position among its competitors, thanks to multilateral relations of cooperation [Perechuda 2007]. In network structures, competitiveness and innovativeness of a company depends, on the one hand, on its own potential, and on the other, the quality of the environment in which it operates [Przygrodzki 2007].

Cooperation and networking offers many advantages and benefits to the entities cooperating on a local and regional level. Among those most often mentioned are: reducing uncertainty and increasing confidence in an unstable economic environment, risk sharing by several companies/partners, increasing flexibility, expanding the field of operation, the ability to acquire new development capacity, the possibility of easier access to scarce resources and skills [Buchholz and Werner 1998]. Networking allows to achieve the benefit of both the scale and the range [Rokoszewski 2002]. The relationships existing between enterprises can relate to various areas of their business (e.g. R&D), providing an opportunity to improve productivity and generate synergies. In the regions of knowledge, many stakeholders are related into flexibly managed structures, however the network is not limited

to the representatives of economic life, but it allows inclusion also of the social participants, e.g. universities or research institutes. Mutual cooperation and interaction of these actors of the regional scene create a base for starting a collective learning processes [Domański 2000]. Innovation and technology transfer are the main determinants of economic development in a given territory.

DYNAMIC AND INTERACTIVE MODELS OF TECHNOLOGY TRANSFER

Generally, the basis for all innovative activity of the company is the existing scientific and technical knowledge. If in a given case, this knowledge is insufficient, research and development work is undertaken in order to expand it. Therefore, the innovation process begins by determining what new products, processes and technologies can be successfully implemented in business practice within the specified time, or what improvements can be made in existing products, processes or technologies. An important role at this stage is played by market and marketing research, providing information from the market, on which the solutions will be commercialized.

With a market, technical and technological knowledge, one moves to the next stage of design analysis, i.e. devising plans for development, searching for ideas and solutions to the problem [Baruk 2006]. In the next stage of the process, the developed ideas are evaluated through the prism of defined criteria, in order to select the optimal variant for the given organizational and technical conditions. The selected concept is subject to detailed design: one can build and test a prototype, introduce adjustments, and in the final phase of the process, decide to start production. In the variant ending with the development of product innovation, it is delivered to the market through appropriate channels of distribution. The mutual relationship between knowledge, technology and innovation is shown by the model of interactive innovation process in Figure 4.

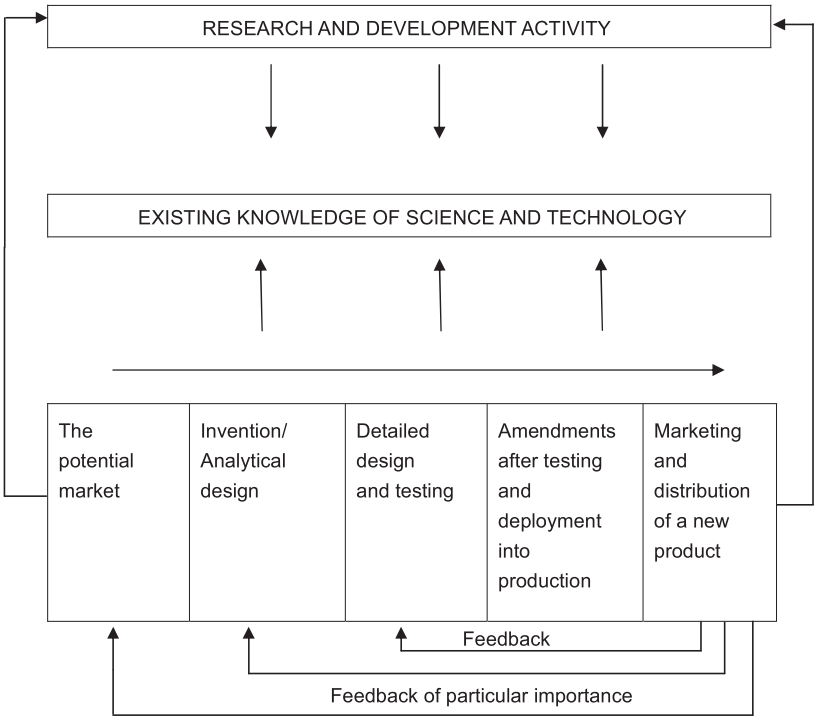

Fig. 4. Interactive model of the innovation process (the innovation chain)

Source: Own elaboration based on Baruk [2006].

Activities related to the introduction of product innovation create the so-called central chain of innovation, often requiring feedback [Baruk 2006]. If the implementation of individual stages of the innovation process requires the use of the existing scientific and technical knowledge, entrepreneurs use the available resources, e.g. through access to public technology databases. However, in certain situations, the existing state of the art may not be sufficient, therefore, research and development is taken up to expand it. In the working stage of the invention, while developing the patent and analytical design, problems may arise, which would require direct contact of the business with the research and development sphere. The company associates with R&D entities by contributing to its financial operations and providing it with equipment and technological procedures. In return, the company receives research results and knowledge used in all stages of the innovation chain.

The feedback model by Kline [1985] generally shows the innovative activity in terms of interaction between market needs and opportunities, the scientific and technical base, and the company's capabilities. This model emphasizes the complexity of the innovation process and the uncertainty of the results at each stage, which often makes it necessary to return to the previous stages. It allows, however, to overcome the difficulties. This means that there is a lot of feedback between the individual stages of the innovation process.

The success of a specific innovation project is determined by the company's ability to maintain effective relationships between the successive stages of the innovation process. Particular importance in the model is attributed to the interaction between the marketing stage and the stage of the invention's development, as well as technical aspects of the innovation process. According to this model, R&D activity is a supporting factor, a way of solving problems that arise at different stages of the innovation process. It can be applied at each of these stages, however, it is not a precondition or the sole source of innovative ideas [CSO 2002].

MODELS OF TECHNOLOGY TRANSFER IN SELECTED COUNTRIES

The largest suppliers of modern technologies around the world are big companies, which have their own R&D facilities. However, it is small- and medium-sized companies that are the authors of the most interesting and innovative implementations of technologies. And it is they that have the most flexibility in matching the innovation to the specific needs of emerging markets. Organized in clusters and networks, small- and medium-sized enterprises use the latest technology without investing millions, but with the support of local and regional instruments, such as technology transfer centres, science and technology parks and technology incubators [Madej 2006].

The basic condition for an effective technology transfer is creating favourable conditions for the scientists and businessmen to communicate [Mikolajczyk et al. 2009], primarily places where entrepreneurs can operate. Table 2 presents an overview of institutional systems supporting the process of technology transfer in selected countries.

Renowned world institutions or groups bringing together professionals in the field of technology transfer and ensuring the flow of knowledge and experience in this area are:

- Association of European Science & Technology Transfer Professionals (ASTP). Its mission is to improve and promote the transfer of knowledge and technology between the European research base and the industry.
- Association of University Technology Managers (AUTM). The main objective of the AUTM is to support and develop academic technology transfer worldwide.
- Licensing Executive Society International is a cluster of 32 associations of practitioners involved in the process of technology transfer and specialists in licenses and intellectual property rights.
- Technology Innovation International is an association of professionals promoting the support of innovation, and providing services in the field of technology transfer.
- Polish Business and Innovation Centers Association in Poland. Its mission is to support the process of business incubation through meeting the needs of those who advise and assist entrepreneurs in starting a business, business development and survival on the market.

Table 2. Overview of institutional systems supporting the process of technology transfer in selected countries

Country	GERD (Gross Domestic Expenditure on R&D)	Priority of innovation policy	Features of the system
1	2	3	4
Ireland	1.79% of GDP	The priority is technology transfer in the form of foreign direct investment (FDI) and the import of foreign technology assets in the form of patents, licenses, know-how etc. and creating favourable conditions for foreign investors: • Industrial Development Agency and Enterprise Ireland are responsible for attracting foreign investments. • The role of the Ministry of Industry, Trade and Employment, under which runs the Office of Science and Technology (OST), responsible for the operation, development and coordination of science, technology and innovation • Enterprise Ireland offers access to venture capital and grants for start-ups	• Stable science and technology policy ensures the achievement of various targets that are important for the economy • Consistent and cooperating institutional environment with clearly separated tasks within specific areas • Huge bargaining power to attract foreign entrepreneurs • The ability to support new entrepreneurs in their innovation and R&D business
Germany	2.82% of GDP	The largest number of patents in Europe per 1 million inhabitants (576 patents in 2010, worldwide leader, South Korea: 2,697 patents, Poland: 84 patents): • Territorial division of tasks related to supporting technology transfer (the federal and regional level) • As in Finland, an interministerial coordinating institution operates – the Joint Scientific Conference (Federal Ministers of Education and Research, and of Finance + ministers of separate Bundeslands)	The division of the institutions responsible for initiating and supporting R&D in schools/research institutes and enterprises: • Schools/research institutes: the Research Community • Companies: The Working Group of the Industrial Research Association 'Otto von Guericke' AiF (particularly strong support for SMEs) • The system's advantage: vast expertise accumulated in various federal and regional institutes, which bears the fruit of development and implementation of innovative technologies • The system's weakness: the degree of complexity and fragmentation resulting, among others, from a federal system of government
Finland	3.87% of GDP	• One of the best systems of technology transfer in the world • R&D in areas of particular importance to the Finnish economy, setting priorities • The first country to introduce co-ordination of the science policy at the interministerial level – the Finnish Council for Science and Technology	• Coherent institutional environment with a clear mission and specific areas of operation • Networks of cooperation between research institutes and universities and companies (enterprises allocate funds for research carried out there) • Conducting research, which is useful for the economy and having an effective system of commercialization of new technologies (innovative concepts are typically used by enterprises)

Table 2 cont.

1	2	3	4
United States of America (USA)	2.8% of GDP	Research funding sources: federal, state, private. The chief national organ for science and research is the federal Office of Science and Technology Policy. In 2010, 783 patents were filed per 1 million residents (third place in the world)	• Substantial tax incentives for institutions and private companies funding research • Guaranteed protection of patent rights • 90% of research is carried out by R&D departments of universities and private companies, based on government commissions and the system of grants • Approximately half the cost of research is covered by the government, which finances large national programs, and through contracts implemented by research institutes of universities, of the industry, and by independent research institutes • Expenditure on basic research amounts to approx. 14% of total expenditure, and on applied research and development – approx. 86%
Israel	4.3% of GDP	In the past 20 years, a spectacular growth in the sectors of high technology has been noted, placing the country among the world leaders in innovation: • Key institution – Office of the Chief Scientist at the Ministry of Economy, an institution responsible for the implementation of grant programs • Technology transfer is based on technology transfer companies (FTT), from the moment of identification of the research and inventions developed by the academia, to concluding a contract transferring the rights to their commercial application	• Priority – the ICT sector (income from the sales of ICT technologies accounts for 31% of the value of the country's export) • Dynamic development of the venture capital market in terms of VC investments in relation to GDP of the country; with the index 0.73%, Israel ranks second in the world, after the United Kingdom • One of the leaders in terms of high-tech industry start-up businesses • R&D is 80% funded by the private sector. What was the reason for the success of innovation in Israel? • The key factor is decades-old and consistently implemented actions of the Israeli government • The strategy – high-tech sector as an opportunity for the country to achieve a competitive advantage on the international arena

Source: Own study based on training materials: http://www.poig.gov.pl/konfszkol/konferencje/Documents/Prezentacja_ProfKurzydlowski.pdf (accessed 13.03.2013).

CONCLUSION

There are no easy solutions to problems associated with the creation of conditions for the development of innovation. It is most especially due to the differences between innovations: their scale, type, range or sector. However, all of them have two things in common. First, innovation is a process, and not a one-time event, and must be treated and managed accordingly. The second important characteristic of all the innovative processes, and resulting from the former, is that the interference with the factors affecting the objective of this process is possible, in order to influence the outcome.

The structure of an integrated system of procedures is closely associated with effective management of innovation. It can increase the competitive ability of enterprises, for example by swifter introduction of new products, or a better use of the new technology. Please note also that innovation needs to be managed in an integrated way; one can't just manage or improve skills in one's chosen field.

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KONCEPCJE INNOWACJI W ZAKRESIE TRANSFERU TECHNOLOGII NA PRZYKŁADZIE WYBRANYCH KRAJÓW

STRESZCZENIE

Transfer technologii, jako system kreowania efektów z innowacji, to proces, który przebiega w różny sposób w zależności od charakteru i intensywności oddziaływania wielu czynników go determinujących. W literaturze wyróżnia się wiele podejść do analizy tego procesu. Celem pracy jest analiza istniejących koncepcji transferu technologii oraz doświadczeń wybranych krajów. Punktem wyjścia było nakreślenie istoty paradygmatu strategicznego teorii innowacji i transferu technologii. Dokonano także interpretacji koncepcji podmiotowo-terytorialnego pochodzenia innowacji, akcentując fakt, że małe firmy, powiązane w sieć relacji biznesowych, tworzą struktury wiążące je z otoczeniem, w którym funkcjonują, co przekłada się na efektywność procesów

transferu technologii. W pracy dokonano także analizy dynamicznych i interaktywnych modeli transferu technologii w wybranych krajach o długoletniej tradycji o zauważalnych efektach w zakresie transferów innowacyjnych rozwiązań technologicznych.

Słowa kluczowe: zarządzanie strategiczne, model transferu technologii