COMMERCIALIZATION OF TECHNOLOGY – EFFICIENT SALES OF PATENTS, LICENSES AND RESULTS OF RESEARCH

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Introduction

Managing a research project properly in phases preceding its debut on the market allows us to minimize the risk of making a wrong decision about investing in the development of research and implementing new technologies. In the process of commercialization the possibilities of implementation should be investigated at every stage, from an idea for research to disseminating its results. The analysis of the Polish market and examples presented in the article „Commercialization of results of scientific research – efficient sales of new technologies and research results" shows that investments of the business sphere in research and development are comparably low in Poland compared to the utilization of R&D products on the international market. High pace of generationg inventions and innovations doesn't necessarily mean they are transferred to the economy. The following article shows what knowledge and skills support the process of commercialization – transforming ideas, research results achieved in laboratories into a market value. Scientific research doesn't only need to be necessary, but also have to take into consideration the strategic element of competitiveness of the results of research in every organization. Commercialization of knowledge and technology may be shaping the added value for an idea, results of research, technology and a new product, building a business model of contemporary or future organization basing its development on new technologies or new products. Competences in commercialization of technology allow us to absorb new technologies in order to improve the functioning of a company or a research and scientific institution.

The article consists of four parts. The first part covers the theoretical context of commercialization of research results. In the second part a practical context of commercialization of research results on the basis of assessment of the level of maturity of technology is presented. Next the models of cooperation between the R&D sector and companies on transfer and commercialization of technology are discussed. In the fourth part the empirical analysis used for the assessment of the possibility to implement patents, lincenses and research results is described.

Commercialization of research results – theoretical context

The resources of scientific units[1] are the foundation of commercialization of research results. The commercialization of research results can be carried out by means of creating companies[2] (*spin-offs, start-ups*), the sale of licenses[3], *joint venture, direct sale of an invention, know-how and know-why*[4]. Markman et al.[5] provide three theories which help understand commercialization: ambidextrous organizations, cognition, social learning, knowledge spillover. According to these theories the factors determining the process of commercialization are: creators of technology or research themselves, specialization and unique competences of an organization, venture capital investments and a network of cooperation for internationalization of technology. From a practical point of view the first step towards commercialization should be to learn about the sources of development of new technologies. Two basic sources of commercialization are knowledge about the possibilities of new technology (eg. technological feasibility, belonging to the preferred branches of the economy) and knowledge about the needs of target markets and their purchasing potential (eg. knowledge about the requirements of buyers of technology in relation to technical and purchasing characteristics of technology, knowledge about the requiremnents of investors in relation to the business model of implementing technology, the size of the market and purchasing models). The identification of a dominant source of the process of commercialization should also allow us to answer the question, whether the process of commercialization is subordinate to the development of technology or a new product. Global Commercialization Group (GCG)[6] established at the University of Texas at Austin in order to search for commercial projects at the university (as an institution of the environment of business - IOB) bases comercialization on four sources: international competitiveness, access to capital, potential of the market and sustainable development (Picture 1). International competitiveness supports identification of the most competitive technologies, defines optimum strategies of competitiveness and raises motivation for international cooperation. Access to capital creates conditions for the development of technology, boosts the attractiveness of research, enables various kinds of aid from business, boosts access to venture capital (private capital) and to own and public funds. Access to the market above all postions technologies and goves them shape both in terms of technical and marketing characteristics. Access to the market and market potential determines the emergence of many stages of the process of commercialization and diminishes investment risk. Technology of, for example, measuring tempera-

1 Scientific units conduct research and development works in a continuous way. Research and development activity is creative activity covering scientific or development works undertaken in a systematic way in order to raise the resources of knowledge and using the available knowledge for creating new applications. Scientific research can be basic, applied or industrial. Development works involve using knowledge, technology and economic activity for planning, for example, production. Detailed explanation of these terms is available in the act from April 30 O finansowaniu nauki, Dziennik Ustaw z 2010 r. nr 96, Poz. 615.

2 Ch. Lendner, University technology transfer through university business incubators and how they help start-ups, [in:] Handbook of Research on Techno-Entrepreneurship, red. F. Thérin, Edward Elgar, 2007, p. 163-169.

3 M. J. Jackson, G. M. Robinson, M. D. Whitfield, Technology transfer of nanotechnology product from U.S. universities, [in:] Commercializing Micro-Nanotechnology Products, CRC Press, 2008, p. 71-80.

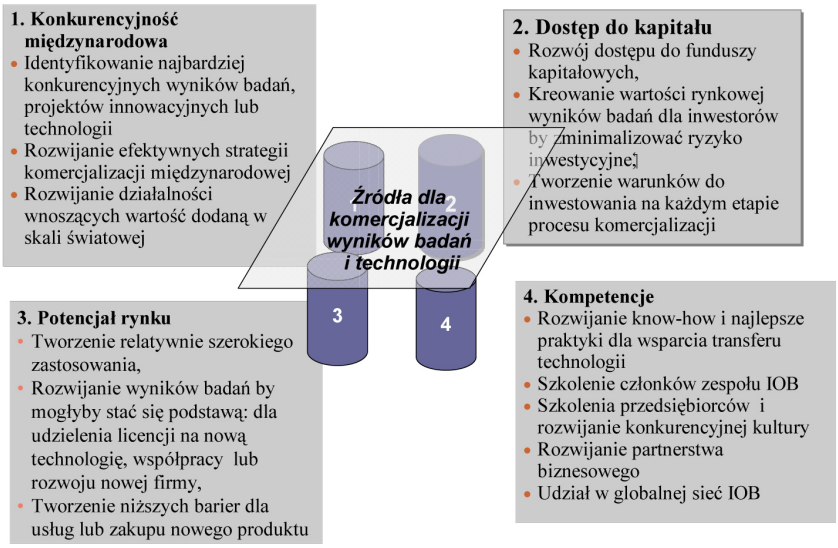
4 D. M. Trzmielak, W. B. Zehner, Metodyka i organizacja doradztwa w zakresie transferu i komercjalizacji technologii, PARP, Łódź-Austin 2011, p. 150-165.

5 G. D. Markman, P. T. Gianiodis, Ph. H. Phan, D. B. Balkin, op. cit., p. 1058-1075.

6 Internal materials of Global Commercialization Group, IC2, University of Texas at Austin, 2009.

ture with the accuracy of one hundredth of a degree can be used in many areas. Measuring temperature with accuracy of one hundredth of a degree allows detecting cancer, but it is also very helpful for rescue services and measurements at night, in very difficult conditions. Depending on the availability of the market, the prototype, testing the prototype, patent clearance, evaluation of the market, probing the market and launching the product will vary. Sustainable development can be interpreted from the point of view of building a network of cooperation and building the culture of innovativeness helps support creators, businessmen and investors at the same time. Due to the lack of culture of commercialization, for example, public assets spent on research results in research units are not allocated to cooperation with the industry, which results in that specialist laboratory equipment becomes obsolete and its necessary to finance it again with public funds.

Picture 1. Sources of commercialization of research results and technologies according to GCG



Source: Prepared on the basis of materials P. Zukowski, Eco-system, Global Commercialization Group, materials for presentation at Center for Technology Transfer UL, October 2009

In the process of commercialization of research results it is important to foresee future actions. Cadenhead[7] calls the analysis of consequences of actions a „snapshot of the future". At a certain moment in the process of commercialization it is necessary to abandon competitive thinking and prepare for cooperation with business. In another case commercialization is ineffective both economically and technically. Economically, because there is no return on capital, which could again be used for research, technically – because

7 G. M. Cadenhead, No longer MOOT. The premier new venture competition from idea to global impact, Remoir, 2002, p. 186-191.

the lack of industrial application makes it hard to change the technical parameters of technology so that it could be used in practice[8]. Markman et al.[9] point again to the acceleration of the development of technology or new product in the process of commercialization. In a global economy in which new technologies spread very fast, the efficiency of the process of commercialization depends on the pace of adoption of new technologies. In new sectors the pace of generating new research for the purpose of obtaining new parameters or characteristics of a product is very high. Acceleration of the development of technology and new products through adaptation of technology or product in new sectors of the market or in the same sectors of the market, but for new segments of buyers of products and users of technology spreads the cost of developing technology. This allows raising the probability of success of new technology and new product. At the same time Large et al.[10] strongly emphasize the influence of the human factor, especially the research team, on the shape of the process of commercialization. The theory of cascading engagement points out that the success of transfer of science and technology requires a team, personality for every stage of the process of commercialization. Building the success of commercialization of technology depends on the commercialization team.

Members of the team deal with:

- research – they build the quality of science and technology and research processes,
- transferring science and technology – they carry out market analysis and necessary structure of financial and personal resources necessary for further commercialization (eg. they employ patent agents and together with them they prepare a strategy of protection of intellectual property, look for support of the industry and for support within an organization, they are prepared to transform technological traits into market traits and to introduce market needs to the project so that it can gain commercial value),
- they implement technology – they introduce new product or process to the market (by means of a new company, granting licenses, selling research results or contributing resources to cooperation between business and a scientific unit).

The sources of commercialization influence the existence and shape of particular stages of the process of commercialization. Analyzing the above-mentioned theories, it is possible to formulate the following sources of commercialization of science and technology:

- supply and demand for academic research results;
- commercial demand (for technology or a new product);
- tangible assets;
- human resources;
- know-how and know-why;
- supply of financial assets.

8 Plasma screen invented at the University of Illinois wouldn't have been created without research on ionisation of gases. The search for a practical application made it possible to find an alternative to traditional tv screens.
9 G. D. Markman, P. T. Gianiodis, Ph. H. Phan, D. B. Balkin, op. cit., p. 1060.
10 D. Lange, K. Belinko, K. Kalligatsi, Building successful technology commercialization teams: pilot empirical support for the theory of cascading commitment, "Journal of Technology Transfer" 2000, Vol. 25, p. 169-180.

Universities bring up outstanding scientists who want scientific achievements, who are ambitious and take up new scientific or R&D challenges. They create new solutions which later are introduced to the market. Scientific achievements and competition among scientists generate demand for new research projects. Another source of commercialization is commercial demand stimulated by the need to introduce new technologies to the market, the need of entrepreneurship and the need for success of a new product. It constitutes a condition for growth on the target market and determines the competitive position of a company, it raises the quality of life, limits the risk and uncertainty associated with the activities of an organizatios[11]. Simon and Fassnacht point out that commercial demand may cause price preferences[12] (that is, behaviour and policy of companies, which achieve their goals by means of appropriate management instruments) and force using or not using a particular technology. The price of new technology and the costs of utilization and exploitation have to be considered in scientific research just as their influence on the development of science. Material and personal resources play a major role in commercialization in all stages of the process (above all in the first one, when the risk of failure is very high). Material resources influence, among others, the acceleration of technology, because they determine what new laboratory research and tests will be carried out. This determines the characteristics of the prototype and what new needs of the target markets will be identified. Material and personal resources determine the phases of generating ideas, building prototype or testing. Know-how and know-why are essential in phases of introduction to the market. Depending on the planned utilization of intellectual property, various models of transfer of knowledge and technology to the industry are possible (granting licenses, creating a new company based on particular know-how, joint-venture, cooperation). The supply of financial assets is important at every stage, but it becomes even more important just before entering the market. The lack of free financial assets in capital funds can stall even breakthrough solutions, however, excess of financial assets may be behind commercialization of trivial technologies, which are less important from the point of view of science, the development of a sector or a company. All of these factors create a kind of environment for commercialization. This environment enables us to commercialize ideas and research results and achieve better or worse effects. However, as Lichtenthaler[13] remarks, an organization preparing new technological solutions might not identify the opportunities for application of new technologies due to searching for new solutions to its problems. Other sectors for commercialization are often not recognized and as a consequence new technology never enters the market or arrives after a delay[14].

11 M. Barańska-Fischer, Innowacje produktowe jako źródło wyróżniających firmę zdolności, [in:] Zarządzanie produktem – teoria, praktyka, perspektywy, Wydawnictwo Akademii Ekonomicznej w Poznaniu, Poznań 2008, p. 104-110.
12 H. Simon, M. Fassnacht, Preismanagement, Gabler, 2009, p. 177.
13 U. Lichtenhaler, Externally commercializing technology assets: An examination of different process stages, "Journal of Business Venturing", 2008, nr 23, p. 445-464.
14 D. Trzmielak, Komercjalizacja nauki i technologii. Determinanty, metody, strategie i analiza empiryczna, praca habilitacyjna, maszynopis 2010.

The assessment of maturity of technology

The greatest difficulty in the process of commercialization of the results of R&D projects is adapting the characteristics of a product/technology to the requirements of potential clients and convincing these clients that the offered project satisfies their requirements. This is not just a technical issue, but it also requires considering many other aspects, eg.: social, psychological, legal etc. Apart from rare caes, when a new product or technology really satisfies the needs of clients which until now couldn't be satisfied and thus is unique (ie. lack of comparable offer on the market) we usually have to deal with broad competition of similar or alternative solutions. In such situation not only technical parameters but also a broad range of other traits, which are supposed to guarantee obtaining added value from purchasing new product/technology (higher than in case of alternative offers eg. easier operation, reliability, after-sale service, customer service, possibility to renovate a product, preservation of value over time, possibility of reselling or obtaining rights to sub-licensing) may be more important for the customer. In case of unique products or technologies there is also the risk of using untested solutions.

It is an obvious thing that buyers (except for a small group of the so-called innovators) prefer solutions they already know or which have been tested by others. Nobody likes to be the „guinea pig", unless he can receive proper compensation for such a role. This rule is valid also in case of economic solutions, especially as making a wrong choice may lead to at least losing the invested financial assets, time, prestige etc. The risk and the associated potential „punishments" are greater in case of products/technologies at an early stage of development.

To assess the level of maturity of technology (SDT) we can use the method based on Technology Readiness Level[15] (TRL) adopted by NASA and the Pentagon. It assumes the divison of of the process of commercialization of a product/technology from basic research to full introduction to the market into 10 stages. Table 1 presents their names and definitions.

SDT levels mark the ending of particular stages of the development of technology/product. From a more general perspective levels 1-3 SDT can be described as associated with the development of technology which is the foundation of a product (Concept), stages 4-6 can be described as creating a prototype of the product and testing it (Testing), stages 7-9 involve the demonstration of the prototype of the product under conditions resembling actual conditions of utilization (Demonstration).

The higher the SDT level, the lower the risk associated with implementation/purchase of a product.

Other factors which have a significant impact on success in commercialization of technology, on the basis of experience of the authors of the article, are the following:

- cultural differences between the scientific and business environment – they arise from various perspective, systems of value, procedures and habits in this environment. For example: in scientific work achieving a positive result and publishing it is most important, the cost and time of achieving the-

15 Using the Technology Readiness Levels Scale to Support Technology Management in the DoD's. ATD/STO Environments, A Findings and Recommendations, Report Conducted for Army CECOM; C. P. Graettinger, S. Garcia, J. Siviy, R. J. Schenk, U.S. Army CECOM RDEC STCD; P. J. Van Syckle, U.S. Army CECOM RDEC STCD, September 2002, SPECIAL REPORT, CMU/SEI-2002-SR-027.

se results plays a minor role; in business the basic parameter is the relation of benefits to costs of achieving results, and the duration of works may be even more important (eg. in a competitive race it seems that it is more important to position oneself in a market niche, rather than achieve specific characteristics of a product);

Table 1. Stages of assessment of the level of maturity of technology

STD	Level of maturity of technology	Criteria of the development of technology
1	Observation and publication of the basic rules of particular technology	The lowest level of development of technology: research concerning the scientific basis of particular technology, defining its main characteristics and possibilities of using them in practice; concept research on paper.
2	Formulating the concept of particular technology and/or its application in a particular product	Start of work on concept of actual application of particular technology on a speculative basis, without in-depth investigation of its feasibility; work limited to analysis on paper.
3	Analytical and experimental investigation of critical functions and characteristics of particular technology	Virtual analyses and laboratory studies leading to testing analytical predictions concerning particular components of particular technology; examples of partial research confirming most important functions or parameters of the technology.
4	Testing basic elements and/or components of the product in laboratory environment	Defining the parameters of a product created on the basis of the technology; proposing and later work on a laboratory model from existing elements and testing its basic components in laboratory conditions; comparably low credibility of functional parameters of the product.
5	Testing basic elements and/or components of the product in an environment similar to the real one	Building basic components of the prototype of a product, integration of particular elements into functional whole and testing in conditions close to reality (eg. recreated in a laboratory); high credibility of functional parameters of a product and determining the usefulness of a product.
6	Testing the prototype of a product or its critical components in an environment reflecting reality	Building prototype with final elements and testing it in conditions reflecting reality in a laboratory or in operational conditions.
7	Demonstrating the prototype of a product (system) in real operational conditions	Final prototype or prototype close to the final product; all elements integrated, hardware and software together (system), testing full functionality of a product in real conditions; operational parameters and defined operational and service requirements.
8	Building, testing and demonstrating the product in its usable version	Building usable prototype/s targeted at the final user, satisfying the requirements of production; testing all utilitary parameters including satisfying operational and service requirements with participation of final users.
9	Obtaining certificates of compliance of the product with appropriate norms of quality and utilization	Producing a sample batch of a product; carrying out the procedures of certification in order to check compliance with appropriate norms of quality and utilization; achieving readiness to launch mass production.
10	Launching the product on the market – ending the process of commercialization of technology	Completing the process of commercialization – launching sales of a product, users test the product under conditions of everyday utilization.

Source: Prepared on the basis for: Using the Technology Readiness Levels Scale to Support Technology Management in the DoD's. ATD/STO Environments, A Findings and Recommendations, Report Conducted for Army CECOM; C. P. Graettinger, S. Garcia, J. Siviy, R. J. Schenk, U.S. Army CECOM RDEC STCD; P. J. Van Syckle, U.S. Army CECOM RDEC STCD, September 2002, SPECIAL REPORT, CMU/SEI-2002-SR-027.

- correct assessment and taking advantage of a „window of opportunity" for a given technology/ product – market opportunity first has to be noticed, identified and later used; due to competition on the market a window of opportunity is open only for a short time until other players on the market notice it and start development works; most often these „other players" have greater potential at their disposal, thus it is necessary to reckon with the eventuality that their efforts will be successful, that is, that they will be able to deliver a competitive product, in such situation only being the first to enter the market with a particular product gives us a chance to take a more advantageous position on the market;
- proper identification of stages of development of technology / product and carrying out adequate analysis at every stage – the greater the knowledge of SDT of a given product / technology, the better the understanding of stages necessary for their full commercialization and the chance to select the right set of tools, personnel and other resources, as well as carying out right operations on the road to implementation success on the market;
- building an adequate potential at every stage of commercialization and using the opportunities of external support – at every stage of commercialization of technology / product various sets of tools, assets and resources are required; an organization conducting the process of commercialization, apart from extreme cases of huge corporations, usually don't have all of this at their disposal. That's why it is important to build partnership with entities, which may be interested in the success of commercialization and have adequate material assets at their disposal (financial assets, executive potential, materials etc.) as well as non-material assets (knowledge, contacts etc.)

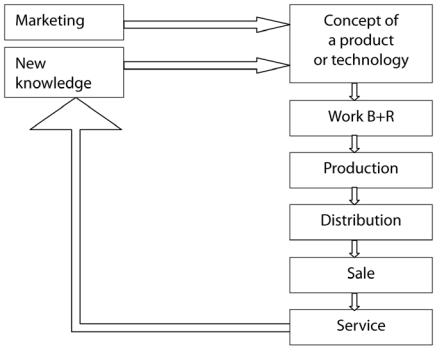
The basic conclusion from the implementation of a few technology commercialization projects (list of projects in attachment 1) is the possibility to raise the chance of success in commercialization of technology by applying the „pull" approach, thus conducting research and implementing technology with a particular recipient as early as possible. This approach requires:

- initiating R&D works by the economy or discussing interest of particular recipients from the economy at a very early stage of R&D works, instead of carrying out these works within scientific centres;
- basing scientific works on professional marketing (researching the market of technology) on a global scale, instead of on indiviaual contacts of scientists; checking existing solutions and especially reference solutions - Best Available Technologies (BAT);
- close cooperation between science and economy at every stage of the research project up till the creation of joint research and implementation teams;
- investigating the efficiency and quality of research and implementation processes, applying appropriate tools for assessment of these processes;
- applying advanced organizational and informational tools for selection, research and implementation works and supporting the implementation of innovative projects such as:
  - assessment of the level of progress of commercialization of technology (TRL),
  - tools for the assessment of the potential for commercialization of technology (eg. Eureka!),

- investigating references to patents, publications,
- TTiKW (transfer of technology and commercialization of knowledge) models,
- triple helix model,
- open innovation model,
- network model – interactive,
- SADT, IDEF-type models, system dynamics.

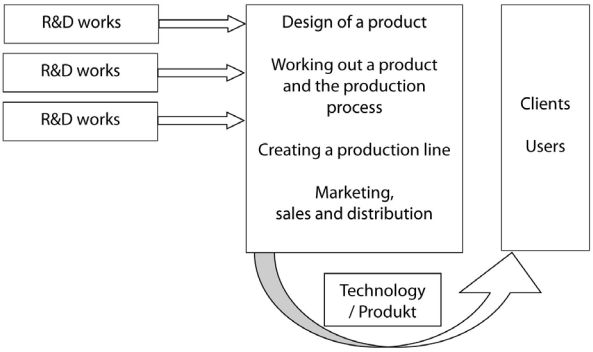
The following pictures (2 and 3) show the „traditional" approach, in which particular stages of commercialization of technology are carried out in a linear way and the initiative for R&D works comes only from scientific institutes, as well as the „pull" model, in which a series of processes are carried out simultaneously and representatives of the economy are engaged in the creation of a technology product from the very start of works.

Rysunek 2. Liniowy – następczy model innowacji produktowej



Źródło: Opracowanie własne.

Rysunek 3. Sieciowy – interaktywny model innowacji produktowej



Źródło: Opracowanie własne.

Models of cooperation between the R&D sphere and companies on transfer and commercialization of technology.

It is possible to distinguish between four basic models of cooperation between R&D organizations and companies on the transfer and commercialization of technology:

- Sale of technology;
- Granting licenses;
- Establishing a company;
- Agreement on cooperation.

The sale of technology usually takes place under conditions of competition on the market, that is, the existence of a few or even about a dozen solutions that can be offered to a potential buyer. The main goals in the process of sale of technology are: identifying buyers, defining the technology or research results satisfying the needs and requirements of the market, preparing an offer of consulting services associated with the so-called after-sale service necessary in the process of implementing technology, preparing a contract and the terms of sale (price and subject of sale) and preparing a presentation of technology and services. The cooperation of R&D organizations and companies is comparably the weakest when the model of sale of technology is used, compared to granting licenses or an agreement on cooperation, as well as establishing a new business unit. The model of cooperation should be suitable for the culture of organization, competences of employees or knowledge of the processes taking place in the economy.

Granting licenses is most often used for the purpose of implementing a technology on the market by means of exchange or purchase of intellectual property. This model serves the purpose of commercializing technology without the risk of bearing the costs of investment, for example, in a new company. The cooperation between the licenser and the licensee is essential for the implementation of the subject of the license, because it is the licenser who has greater knowledge of the technology. There are various models of granting licenses: purchasing a license and the model of cross-licensing (combining intellectual property of organizations[16]). The licensing model enables the commercialization of technology or research results, it is characterized by lower financial risk than establishing a new business entity or implementing the technology. The licenser doesn't bear the costs of investment in the implementation. However, investment risk in case of purchasing a license concerns the technology and not the investment in the activities of a company. License gives the licenser control over the utilization of rights to technology. The inclination towards applying the strategy of granting licenses increases along with growth of competition on the market and the growth of significance of protection of intellectual property on a particular market[17]. It decreases in case when the level of protection of rights to intellectual property is low[18].

16 D. Trzmielak, S. Byczko, Zarządzanie własnością intelektualną w przedsiębiorstwie i na uczelni, Instytut Badań nad Gospodarką Rynkową, Urząd Marszałkowski Województwa Pomorskiego, Gdańsk 2010, p. 85-86.
17 R. H. Pitkethly, Intellectual property strategy in Japanese and UK companies: patent licensing decisions and learning opportunities, "Research Policy" 2001, p. 425–442.
18 Y. J. Kim, Choosing between international technology licensing partners: An empirical analysis of U.S. biotechnology firms, "Journal of Engineering and Technology Management", 2009, Vol. 26, p. 57–72.

The licenser usually makes the decision about transferring intellectual property based on the analysis of resources and the risk of entering the market.

Contributing intellectual property in exchange for shares is the third model of cooperation in transfer and commercialization of technology. In order to commercialize the results of research and development works we can establish partnerships or share-holding companies. Share-holding companies due to their more complicated structure and higher costs of starting activity, compared to partnerships, are advisable for the transfer of technologies which have already been prepared for implementation[19]. SPartnerships are an attractive form of running business activities by establishing the so-called spin-offs, when employees, students, doctoral students or other private persons become the owners of the company. The takeover of shares by investment vehicles[20] established by universities requires setting up share-holding companies. New company's works on implementation of technology should also cover defining the market (buyer). The company, already at the time of establishment should have clear prospects for sale of research results or new technology and predictions concerning the effects of its activities. It is advisable to prepare plans of implementation and development on the market before starting activities in order to minimize the costs of these activities.

The main purpose of the model of cooperation agreement is cooperation with a partner who is interested in conducting research together in order to sell research results or implement technology. A joint venture makes sense when the resources of two or more entities are mutually complementary. Every organization participating in research and scientific cooperation between a R&D unit and a company should be highly specialized in its branch. This creates conditions for cooperation and allows conducting the research process more efficiently. This requires identifying the system of flow of information in organizations and specifying the contributed resources, especially non-material resources. The basic reason for starting cooperation is the synergy of resources of institutions needed for working out and implementing new technology. Combining resources reduces the time of preparation and carrying out research thanks to the absence of the phase of looking for eg. a subcontractor. It reduces the volume of necessary spending, as organizations in course of conducting and implementing research take advnatage of their partners' resources. The fact that cooperation may reduce the risk of failure of research and implementing new technology is also very important, because the monitoring of effects is carried out by a few organizations[21].

19 D. Trzmielak, S. Byczko, Zagadnienia własności intelektualnej, Polska Agencja Rozwoju Przedsiębiorczości, Warszawa, 2011, p. 31-39.

20 Investment vehicles can only be established in form of share-holding companies, that is, limited liability company and joint stock company.

21 D. Trzmielak, B. Zehner, Metodyka i organizacja doradztwa w zakresie transferu i komercjalizacji technologii, PARP, Łódź-Austin 2011, p. 170-190.

Assessment of the potential for implementation of patents, licenses and research results – an empirical analysis

Research assumptions

Baker et all[22] try to prove on the basis of analysis of the British market that investments of the business sphere in research and development are comparably low compared to the utilization of R&D products in international competition. Investing in research and development can mean purchasing licenses, patents, research results and co-financing costs borne by those who develop technolgy projects[23]. Financing R&D activities or financing implementations undoubtedly contributes to cooperation between organizations. The compensational role of investments in managing future revenues is very important. Entities cooperate in order to directly obtain financing or invest in promising innovations[24], but technological cooperation and the cooperation of technological organizations can be strengthened by gaining knowledge, raising technological capacity and as a consequence, competitiveness[25]. Markowski[26] classifies stimuli and obstacles in contacts between science and business practice. On this basis it is possible to conclude on the one hand that for example in Poland there is insufficient financing for the R&D sphere, but at the same time such obstacles as: poor equipment of laboratories, unwillingness to patenting, low level of social capital, lack or low level of quality of services provided by organizations from the surroundings of business hampering investments, lack of professional knowledge concerning the assessment of phases of the process of commercialization.

The research project, the results of which are presented in a subchapter, was conducted between 2007 and 2010. One of the leading subjects was empirical research and analysis of awareness of and application of assessment of the implementation potential of an organization. A measuring instrument (online questionnaire) was prepared in two language versions and three sets of questions – for scientists, companies and representatives of institutions from the surroundings of business. The database of scientific institutions, companies and institutions from the surroundings of business in Poland and abroad was prepared on the basis of databases available in Poland and abroad. In the period from 2007 to 2009 a sample of almost 12,000 respondents was created. Limited rate of response (calculated on the basis of all filled out questionnaires) amounted to about 5% and full rate of response (return rate of all fully filled out measuring instruments) was limited to 3%. In total almost 670 questionnaires filled out in full or partially were obtained. The survey covered 63 countries, the collected data represents 43 countries.

22 K. Baker, L. Gheorghiu, H. Cameron, United Kingom public and collaboration in R&D, [in:] European Collaboration in Research and Development: Business Strategy and Public Policy, red. Y. Caloghirou, N. S. Vonortas, S. Ioannides, Edward Eldar, 2002, p. 186-209.

23 W. J. Mitchell, Challenges and opportunities for Remote Collaborative Design, [in:] Collaborative Design and Learning Competences Building for Innovation, red. J. Bento, J. P. Duarte, M. V. Heitor, W J. Mitchell, Praeger, 2004, p. 4-12.

24 L. W., Busenitz, Innovation and performance implications of venture capital involvement in the ventures they fund, [in:] Handbook of Research on Venture Capital, red. H. Landström, Edward Eldar, 2007, p. 194-218.

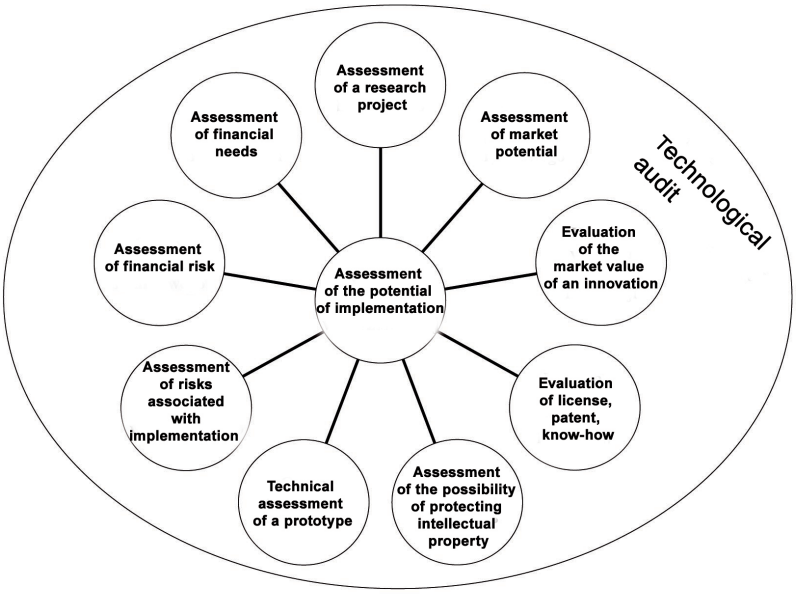
25 Z. Balbinot, L. P. Bignetti, Technological capabilities of high technology firm in cross border alliances, [in:] Management of Technology New Directions in Technology Management, red. M. H. Sherif, T. M. Khail, Elsevier, 2007, p. 249-261.

26 T. Markowski, Bariery współpracy na styku nauka-praktyka a rozwój regionalny, [in:] Partnerstwo dla Innowacji, red. B. Piasecki, K. Kubiak, Wydawnictwo SWSPiZ, Łódź 2009, p. 97-104.

Analysis of results – components of the assessment applied in the process of commercialization

Proper management of a research project, development and implementation of research results at the stage of their pre-market life allows us to minimize the risk of making a wrong investment decision. In the process of commercialization at every stage it is possible to assess the potential of implememention. The research proposed testing the importance of particular assessmeents taking place at particular stages of the process of commercialization and their importance for particular entities. Picture 4 presents types of assessment subject to empirical analysis.

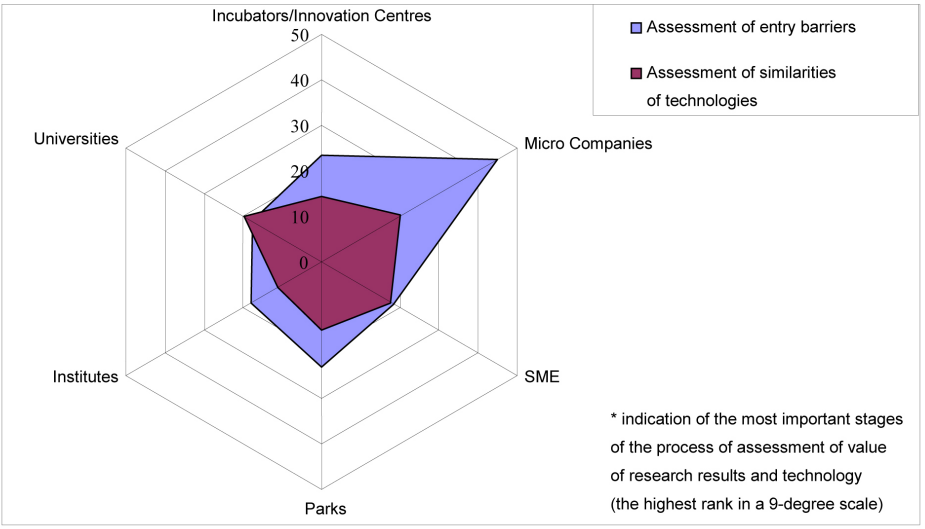
Picture 4. Types of assessments made in the process of commercialization



Source: Own materials

In the research concerning the significance of assesments of the implementation potential a statistical relation between organizations dealing with development and implementations and two stages of the process of commercialization were shown: the assessment of entry barriers and the assessment of similarity of technologies. On the basis of the surveyed sample it is possible to conclude that the assessment of entry barriers is the most important stage of the process of commercialization. This stage was chosen as the most important by five out of six types of organizations. The research shows that only at universities the phase of assessment of similarity of technolgies is considered as more important. Almost a half of companies employing up to 10 people pointed to entry barriers as the most important phase of commercialization. One out of five entrepreneurs from the segment of micro companies and universities pointed to comparison of similarities of technologies as a key element (picture 5).

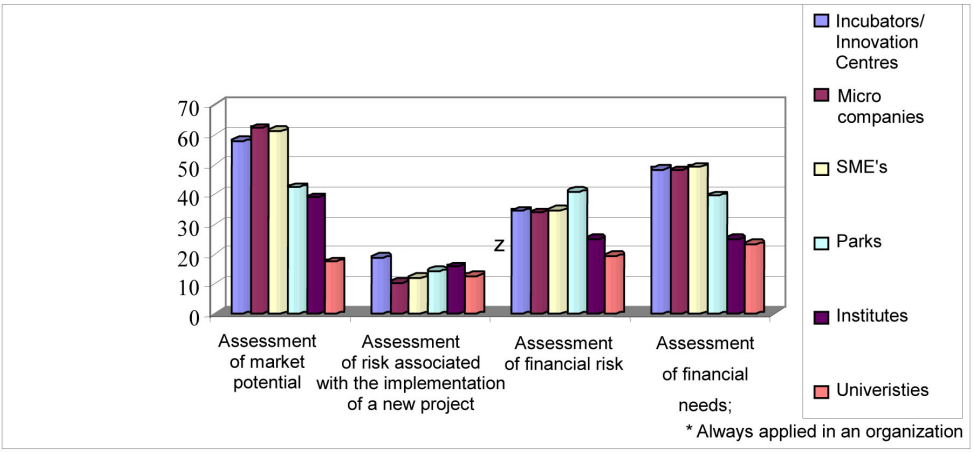
Picture 5. The structure of indication of key stages of assessment of a reasearch project, according to the surveyed organizations



Source: Own materials on the basis of research conducted in the years 2007-2010.

Apart from indicating which stages are most important for the surveyed organizations, it is important to highlight the practical application of various methods supporting management of research results and technology. In case of application of the chosen ten assessments (Picture 4), a statistical relation appeared between four of them and incubators, innovation centres, micro companies, SME's, parks, institutes and universities. All surveyed groups pointed to the assessment of market potential as a comparably significant issue. The significance of the market, the possibility to purchase research results and technologies are recognized above all by companies. Almost two thirds of the surveyed declared that in their innovative activites they always resort to the assessment of market potential. In case of universities only every fifth respondent regards the stage of managament of research results, technology and new product as essential. Academic institutions recognized the analysis of financial needs as crucial. Almost every fifth respondent identifying himself with science in academic centres, pointed to the application of the assessment of financial needs in his institution. Additionally, an analysis of research results shows that technology incubators, innovation centres and companies, in a similar proportion, confirmed practical utilization of: assessments of market potential, assessment of financial risk and assessment of financial needs in any situation associated with commercialization (Picture 6).

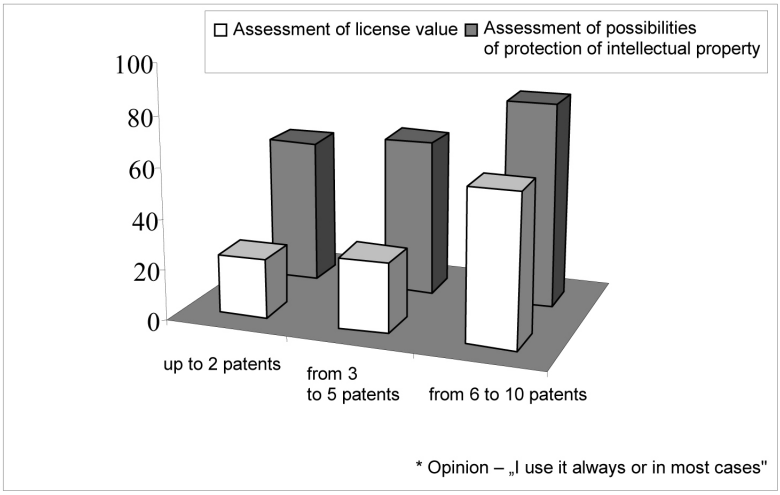
Picture 6. The structure of indications of assessment of implementation potential by five groups from the surroundings of business



Source: Own materials prepared on the basis of research carried out in 2007-2010 .

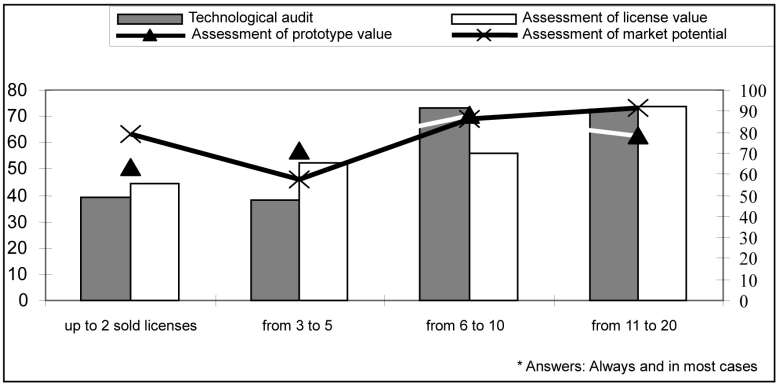
Loking for common tendencies, important relations between the investigated variables additionally brought information about the practical application of the assessment of the value of license, possibilities of protecting intellectual property, the assessment of the value of prototype, the assessment of market potential and technical audit by two groups of the surveyed: sellers of licenses and patents. In the analysis the following responses were included: „always" and „in most cases we apply" (Pictures 7 and 8). Undoubtedly, the growth of experience in sales of licenses and patents boosts knowledge and practical utilization of various kinds of analyses in pre-market management of science and technology. Statistical relation in the surveyed sample appeared between the segment of respondents selling licenses and the assessment of value of licenses and possibilities of protecting intellectual property and between the sellers of patents and the assessment of the value of licenses, prototype, market potential and using technological audit. Two thirds of the respondents who sell most licenses apply always or in most cases the assessment of the value of licenses. Four out of five respondents declared that they resort to the assessment of possibilities of protecting intellectual property. In the segment of patent sellers, the proportion of the surveyed applying almost always four indicated assessments was comparably higher. Nine out of ten respondents commercialize patents using the assessment of market potential. In case of other assessments the proportion of respondents is comparably lower, but in all segments of respondents who have sold more than 11 patents about three quarters admits that they always and in every case resort to technological audit, the assessment of the value of protoype and license (Picture 7).

Picture 7. Percentage of responses concerning the utilization of various assessments in the process of commercialization for statistically important characteristics in the surveyed group of license sellers



Source: Own materials prepared on the basis of research carried out from 2007 to 2010.

Picture 8. Applying assessments in the process of commercialization in the group of surveyed license sellers



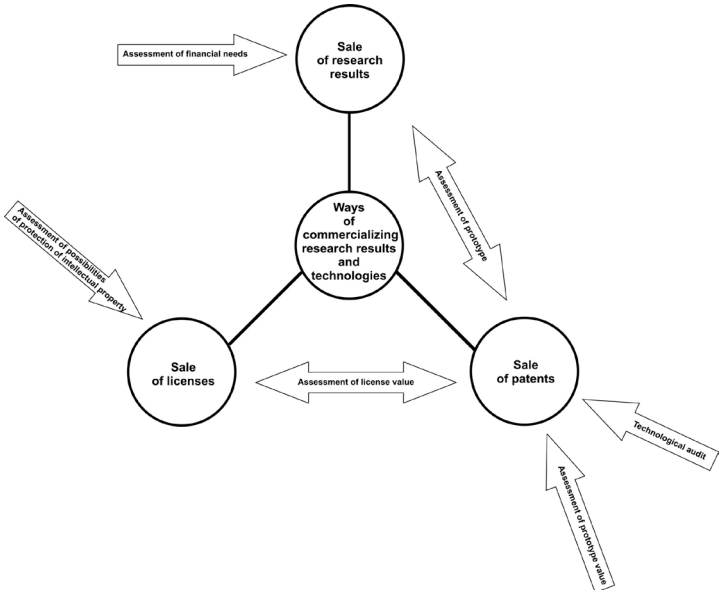
Source: Own materials prepared on the basis of research conducted from 2007 to 2010.

The analysis of assessments applied by particular entities in the process of commercialization, in the surveyed sample, suggests the conclusion that there are both common traits and differences in selling research results, licenses and patents. Relying on the statistical relation between the surveyed traits and entities selling intellectual property, six main traits, which dominate during the development and implementation of know-how and patents, were distinguished. Sellers of patents base their activities associated with patent management on the assessment of prototype, assessment of license value

and value of invention as well as on technological audit. The assessment of value of licenses and assessment of possibilities of implementation is important for license sellers. At the same time sale of research results is based on the assessment of prototype and analysis of financial needs. The evaluation of licenses and the assessment of possibilities of implementation is important for license sellers. At the same time the sale of research results is based on the assessment of prototype and the analysis of financial needs. Patent refers to industrial property and is often a part of a technology or a new product. For this reason the assessment of prototype and the importance of technological audit cannot raise any doubts. On the other hand in transactions which involve sales of patents or contributing patents to a company as a non-material and legal value, various forms of license agreements, which include the estimated value of a particular industrial property, can be used.

The assessment of possibilities of protecting intellectual property has been distinguished as an important method in license sale transactions. The sale of licenses can include the sale of an invention (including a patent – industrial property) as well as copyrights (sale of eg. software). It is possible to conclude unequivocally that the possibilities of protecting against copying and plagiarism are substantially lower in case of license sales, compared to selling copyrights. Protection of copyrights can involve legal, commercial and marketing actions. However, a patent application or a granted patent are already a means of protection of technical innovation. That's why the appearance of the assessment of the possibility of protecting intellectual property in course of selling licenses can be interpreted as a logical consequence of existing difficulties in copyright protection (Picture 9).

Picture 9. Model of assessment of implementation potential in the process of commercialization among entities commercializing research results and inventions



Source: Own materials prepared on the basis of research carried out in 2007-2010.

Conclusion

Dynamic development of economy based on knowledge poses new challenges for science and Polish companies. One of these challenges is striving to boost the utilization of potential of labour, knowledge and capital in order to build up new forms of competitive advantage. Authors of the article emphasize that new solution, in order to be commercialized, should have, apart from innovative technical characteristics, a market potential strong enough to attract capital for further research and development. The commercialization of technologies and research results is a road map for scientists working on new solutions and for business and public administration supporting the development of technology. In an era of rapid dissemination of innovations, expert knowledge on the assessment of economic value of a research project is a key factor facilitating the development of new technologies. Growth of spending on research and development is very important for creating conditions for competitiveness of research projects, but proper assessment of possibilities of implementation as well as the model of cooperation of R&D sector with business on transfer and commercialization of technology also play a very important role. Cooperation of many environments, exchange of information, using resources together bring greater effects from comparable expenses.

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