COMMERCIALISATION OF RESEARCH RESULTS – COOPERATION BETWEEN SCIENCE AND BUSINESS

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Abstract

When analysing the term commercialisation one should answer the crucial question: what mechanisms govern commercialisation of knowledge and technology as well as which resources and sources determine it. The article presents a theoretical deliberation concerning the development of issues related to the commercialisation of research results in the last century. A review of literature precedes the section on sources for the commercialisation of knowledge and technologies when considering research results and technology providers. The author claims that analysis of technological resources also determines the possibilities for the cooperation between science and business. It is important for the selection of the commercialisation strategy to describe technological resources and their complementarity. Strong technological resources and their market availability ensures independent technological development. However, a lack of technological resources or the chance to acquire them encourages an innovative organisation to pass know-how or technologies to another, capable organisation which is willing to commercialise this knowledge on the market. Frequently however when commercialising research results, organisations establish cooperation on the market in order to build resources to implement research results. This article, 'Commercialisation of research results – cooperation between science and business', is concluded with an example depicting the cooperation between scientists and business people in a new spin-off company set up in order to build technological resources and the market implementation of a device for measuring the structure of soft material surfaces.

Key words: commercialisation of research results, spin-offs

Commercialisation of research results at universities – theoretical deliberations

Rothwell [1992] points out that in the 1950s and 60s one could clearly determine technology, its innovativeness (the level of knowledge) as an important factor shaping commercialisation. In the 1970s marketing played the main role. As a result of the marketing approach, commercialisation was identified with the launch of a new product on the

market. The following decade saw attempts to integrate all the operations concerning research and technological development with marketing. Later years witnessed the influence of networking on the commercialisation of technologies. Knowledge gathering and links with commercialisation stakeholders had a strong influence on the management of research results and technology from the moment of concept to market launch. At the beginning of the 21st century, commercialising processes, market links, accumulation of knowledge and cooperation between companies generating innovations was key to achieving the highest implementation results. Open innovations also started to play a major role in commercialising processes. Open innovations is connected to utilising work and research projects previously developed elsewhere but abandoned as being unviable, too niche or difficult to continue with [Pomykalski, 2001].

Commercialisation of research results and technology in Polish literature is viewed more often as launching a new product or technology on the market [Sojkin, 2010; Matusiak, 2010; Stawasz, 2008]. Operations included in the commercialisation process before and after patenting are highlighted by Klincewicz [2010]. Additionally, he stresses the importance of identifying the actors in each stage of commercialisation. Commercialisation of research results and technology should consider the key and indispensable operations shaping the value-added of an idea, research results and products before and at the launch stage of a technology or product on the market. The actors in the commercialisation process and the factors shaping it determine the construction of an organisation's business model when launching new technologies and products on the market.

The process of commercialisation is linked with the transfer of knowledge and/or technologies which can lead to the creation of spin-off or start-up companies [Lendner, 2007], granting licences [Jackson, Robinson, Whitfield, 2008] or sale of *know-how* or *know-why*. Markman et al. [2005] provide four categories which assist in understanding commercialisation: innovative organisations, experiences, the learning process and the spread of knowledge. According to these four categories, the determinants of the commercialisation process include creators of technologies and research, specialisation and unique competencies of an organisation, *venture capital* investment as well as cooperation networking for the internationalisation of technologies. From a practical point of view, the first step towards commercialisation should be recognising the sources for the development of new technologies, and not the stages in the commercialisation process. Then the process

of commercialisation will be based on two main sources of knowledge: the possibilities of new technologies and the knowledge of target market requirements. Identifying the dominant source for the process of commercialisation will enable one to answer the question of whether the process of commercialisation is subordinate to the development of technologies or new products as well. Global Commercialization Group[20] set up at the University of Texas in Austin in order to search for commercial projects at the university, bases commercialisation on four competitiveness factors, international competitiveness, access to capital, access to markets and market potential. International competitiveness encourages the identification of the most competitive technologies, determines optimal competitiveness strategies and better motivates international cooperation. Access to capital facilitates the development of technologies, boosts the attractiveness of research, allows a variety of forms of support: from business angels, venture capital to own or public funding. Access to the market determines mainly the technology's standing and its technical and marketing nature. Access to the market and market potential stimulates the many stages of the commercialisation process and removes investment risk. The example shown below of the technology of measuring temperature to a 100th of a degree can be applied in various fields. The measurement of temperature to a 100th of a degree allows for the detection of some types of cancer and, in rescue services and the armed forces, is applied to measure the temperature at night in the difficult and dangerous conditions of finding hidden or buried people. Depending on market accessibility, there are different routes for the creation of a prototype, the analysis of patent clearance, market assessment, market testing, market launch (medical or military devices) and, as a consequence, the stages of the commercialisation process follow. Balanced technological development can be interpreted in the context of networking building and the building of an innovative organisation's culture which supports all creators, entrepreneurs and investors. The lack of the right climate for commercialisation means that public funds for example are spent on research results in research centres which will not be allocated for cooperation with industry, thereby resulting in the absorption of the funds (together with other laboratories) and the necessity for further funding for future research development from the public purse. Analysing the results of the research by Rudolfa et al. [2003], one can assert that innovativeness

[20] Materiały wewnętrzne Global Commercialization Group, IC2, University of Texas at Austin, 2009.

and the objective of implementing research results, technologies and products should be the basis for well-functioning innovative organisations. However, the generation and development of research results and technology is facilitated by a favourable climate for commercialisation, which allows researchers to look into the future application of research results.

Cadenhead [2002] calls the analysis of a consistent monitoring (in order to implement a technology or a product) *a snapshot of the future.* At a certain stage of the commercialisation process, one should abandon creativity and begin cooperation with business, otherwise commercialisation is ineffective both economically and technically: economically as there is no return of capital for reinvestment in research, technically due to a lack of industrial application. This hampers changes to technical technology parameters so that it may be applied in practise[21]. Markman et al. [2005] pay particular attention to the acceleration of the development of technology or a new product through the commercialisation process. In the global economy, in which new technologies spread rapidly, effectiveness and most of all the effectiveness of the commercialisation process depends on the speed of new technology absorption in new sectors, the speed of generated parameters and product characteristics. The acceleration of the development of technologies and new products through technology or product adaptation to new sectors, or the same market sectors but within new segments of product purchasers and technology users, spreads the costs of technology development. It allows an increase in the likelihood of success for a new technology or product[22]. Large et al. [2000] emphasise the impact of the human factor, mostly research teams, on the shape of the commercialisation process. In their theory on cascade commitment they draw attention to the fact that the success of technology and science transfer requires a unique approach for each stage of the commercialisation process. The commercialisation team have a significant impact on the building of the success of technology commercialisation. The team members working in the area of research, gather knowledge which can be a value added for the market.

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21 The Plasma monitor, invented at the University of Illinois would not have come about without research into gas ionisation. The search for apractical application led to this alternative to the traditional kinescope television .

22 Nanosilver for example is a common material utilised in new products. If we consider its anti-bacterial and anti-fungal qualities we can apply it in a variety of new products such as: dishwasher tablets for more effective cleaning (household chemicals), in anti-allergy ointment for horses (cosmetics for animals), ant-bacterial self levelling floors (electronic industry clean rooms) and fibre for anti-allergy materials (textile industry).

They shape the quality of technology and the research processes. People working for the transfer of knowledge and technology evaluate market analysis more efficiently as well as financial and human resource structures crucial for further commercialisation (e.g. engage patent spokespeople, prepare the strategy for the intellectual property protection, search for support from industry and within their own organisation, prepare to change technological features into market features, as well as consider the project market needs necessary to boost their economic value). Specialists responsible for the implementation of technologies or licence sales, know how to construct a proper business model for the commercialisation of technologies.

Moreover, every organisation which undertakes the commercialisation of knowledge or technology (e.g. a company, science and research institute or centre for technology transfer) has their own specific market features. These features impact on the company's standing in its field. This difference is so vast that a uniform identifying of tendencies and capabilities for the effective development of research results and technologies in different stages of the market commercialisation process is very difficult. Research results and an idea for a technology are worthless up to the moment of their application and value added for stakeholders is indicated who participate in the commercialisation process and during the market development of the life cycle of a technology and a product. Commercialisation process determinants, an organisation's unique market features and sources of commercialisation all impact the existence and shape of the individual stages of the commercialisation process and, as a result, condition the effective implementation of research results and technologies on the market [Trzmielak, 2013].

The sources of research result commercialisation

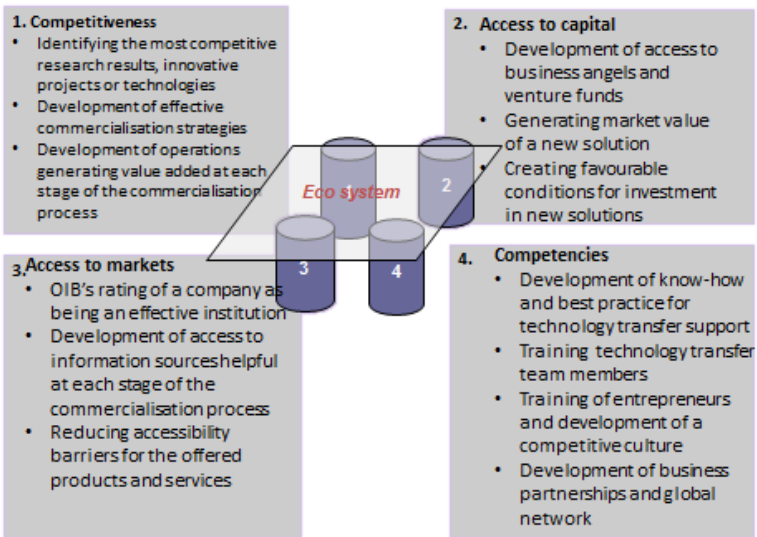
When analysing the above theories, one can enumerate the following sources of knowledge and technology commercialisation from the point of view of the provider of research results and technology.

- Supply and demand for the academic research results;
- Commercial demand (for a technology or new product);
- Material resources;
- Human resources;
- *Know-how* and *know-why;*
- Supply of financial resources.

Universities educate and support the development of renown scientists who wish to gain scientific achievements and patents, are ambitious

and undertake new scientific or research and development challenges. They create new solutions for the market. Scientific achievements and competition among scientists foster demand for new research. Other sources of implementation are commercial demand stimulated by the need for the introduction of a new technology to the market, entrepreneurship or the need for a new product's success. These condition growth in the target market, determine the company's competitive advantage, boost the quality of life and reduce the risk and uncertainty of a company's operations [Barańska-Fischer, 2008]. Commercial application of an invention stems from a company's efforts in the field of technological innovations [Peaucelle, 1999]. Simon and Fassnacht [2009] point out that commercial demand may lead to price control (a company's operations and policy which implement their aims through adequate management tools) and affect whether the technology is applied or not. Tangible and intangible resources have a huge impact in the initial stages of the commercialisation process. Tangible resources influence, among others, the acceleration of technologies that conditions which new features a prototype will receive or which new target market demands will be identified. They determine idea generation, prototype building and testing stages. The supply of financial resources is significant at every stage and becomes key at the stage of nearing the market. A lack of accessible financial resources in equity may stop even the most ground-breaking solutions, whereas a glut may lead to the commercialisation of technologies of lesser importance from the point
of view of sector or company development.

All these factors create a sort of ecosystem for commercialisation. This ecosystem means (Graph 1) that we may, but are not forced to, commercialise ideas and research results to a greater or lesser effect. Lichtenthaler [2008] however, highlights that an organisation preparing new technological solutions might not take into account all applications for new technologies as it searches for new solutions exclusively for its own needs and other sectors where the technologies could be potential implemented are frequently overlooked. As a consequence, the new technology may never reach the market or arrive after a delay.



Graph 1. Ecosystem for research results commercialisation

Source: Own work: based on P. Zukowski, *Eco-system*, Global Commercialization Group, presentation material CTT UŁ, October, 2009.

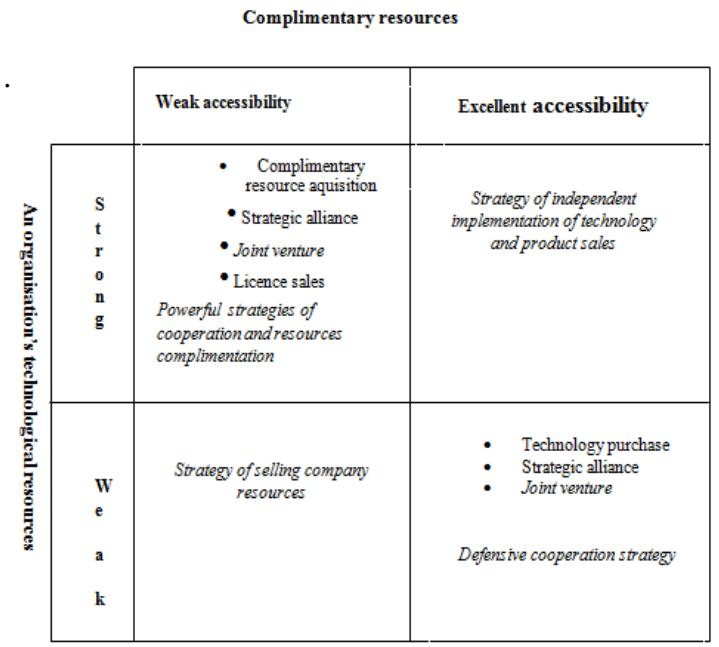
Cooperation between science and business – analysis of technological resources and their complimentarity

When analysing various commercialisation strategies, one can assume that the main principle for technology commercialisation is foremost capital: accumulating research funds, raising capital for an organisation's growth, return of investment expenditure and profit. Commercialisation strategies must indicate the path for knowledge capitalization [Thukral, et. al., 2008]. The choice of niche or larger scale market does not only depend on the readiness of a technology entering a small or larger market but also on the resources of a company (e.g. capital and human). Megantz [1996] links the dependency between the path of commercialisation and a company's technological resources as well as resources available from the market. One can differentiate four scenarios which determine the success of a commercialisation strategy (Graph 2):

- Strong technological resources and excellent complimentary resource accessibility – the preferred *strategy for independent technology implementation and product sale*;

- Strong technological resources but low access to complementary resources – *powerful cooperation and resource supplementing strategy*;
- Weak technological resources but high access to complimentary resources – *defensive cooperation strategy*;
- Weak technological resources and low access to complimentary resources – *selling resource strategy*;

The first analysed scenario points to the benefits of independent implementation of a technology on the market, production and product sales. In the area of academic companies, the market launch of new technologies may be implemented through spin offs. Spin offs receive the rights to intellectual property in exchange for a share of the company. Setting up a new spin off company also entails the granting or purchase of licenses. Companies may also attempt to buy technologies (with adequate financial resources), release them independently on the market and profit from product sales.



Graph 2. Commercialisation strategies depending on the competitiveness of own and complementary resources

Source: Own work based on: R. C. Megantz, *How to license technology*, Wiley, New York 1996, p. 4, D. M. Trzmielak, Komercjalizacja wiedzy i technologii. Stymulanty i strategie. Wydawnictwo Uniwersytetu Łódzkiego, Łódź 2013, p. 97.

Strong technological resources and weak accessibility to complimentary resources lead to the need for cooperation with other companies in order to supplement, unite and strengthen resources. A high level of own technological resources gives a strong tender position when negotiating with other companies. Figueiredo et al. [2007] emphasised the importance of the will to cooperate and the division of risk due to the development and implementation of technology. Combining a company's resources brings a synergy effect which particularly strengthens the operations of the cooperating parties and may accelerate the implementation of a technology providing it is possible to transfer knowledge and access valuable resources of partners. Commercialisation of technology and its market launch may occur through joint ventures and licence sales.

Accessibility to complementary resources, when having weak technological resources, which manifest themselves through, for example, the lack of protection for intellectual property and the lack of competitiveness of the technology once on the market, calls for technology purchase, search for cooperation and setting up mutual ventures. Transfer of technologies mainly flows 'towards' companies.

A weakness of technological resources and significant barriers in resource acquisition when establishing cooperation with other companies will force an organisation to reconsider the validity of technology development and technology resource maintenance.

Following Hughes and Morgan [2007] and their proposal of strategy development planning and effective resource application, based on *Resource – Advantage Theory* (R-A: *theory*, *Resource-Advantage Theory*) we can define technological resources as ones which enable the extraction of key resources while building a commercialisation strategy, as well as resources that facilitate imitation and resources building the value of technology. According to this theory, technological resources that build a commercialising strategy include six areas:

1. Access to capital – for the development of new technologies;
2. Rapport with target market - communication with technological stakeholders, knowledge of alternative technologies and competition market;
3. Elements of structural resources, such as laboratories, equipment, intellectual property protection systems and implemented processes;

4. Human resources facilitating commercialisation, such as employee experience of commercialisation, skills in the development of technology, mobility, acceptance of routine and change;
5. Intellectual resources: knowledge, patents, utility models, trademarks, product marks and licenses;
6. Social resources: networking, culture of innovation and prestige.

The construction and selection of a commercialising strategy should be based on the heterogeneous nature of resources. High versatility facilitates the introduction of powerful strategies, low versatility however leads to defensive operations or abandoning the development of a technology [Trzmielak, 2013].

Commercialisation of research results based on the creation of spin offs

The commercial nature of research results and the process of setting up spin offs. The subject of one commercialisation, which was created at a Polish university, is based on many years of research on conducting substances, semi-conductors and insulators[23]. Research into as low as nanometre and atomic magnification precision is a challenge for many scientists, both in Poland and across the World. Research concerning the achievement of atomic magnification led to the creation of software and electronic components facilitating the complete processing of recorded images. Commercialisation of research results, and measurement software systems were mainly focused on the implementation of devices for soft substance research, such as proteins, DNA, polymers, etc. without affecting their integrity. The target sectors of these research results are, for example, nanotechnology, electronics, material and biomedical engineering, along with medicine. All of these sectors have enjoyed dynamic growth over recent years which brings promising commercial potential for the research results, created software and devices. Market potential is created by the many parties requiring specialist measurements and image processing. The main buyers include: industrial laboratories, companies which are technologically advanced in scientific research in the biotechnological and medical sectors, universities, science institutes, testing stations for material resistance, biomaterial producers, laboratories of medical diagnostics which monitor biological processes at the monoparticle level and

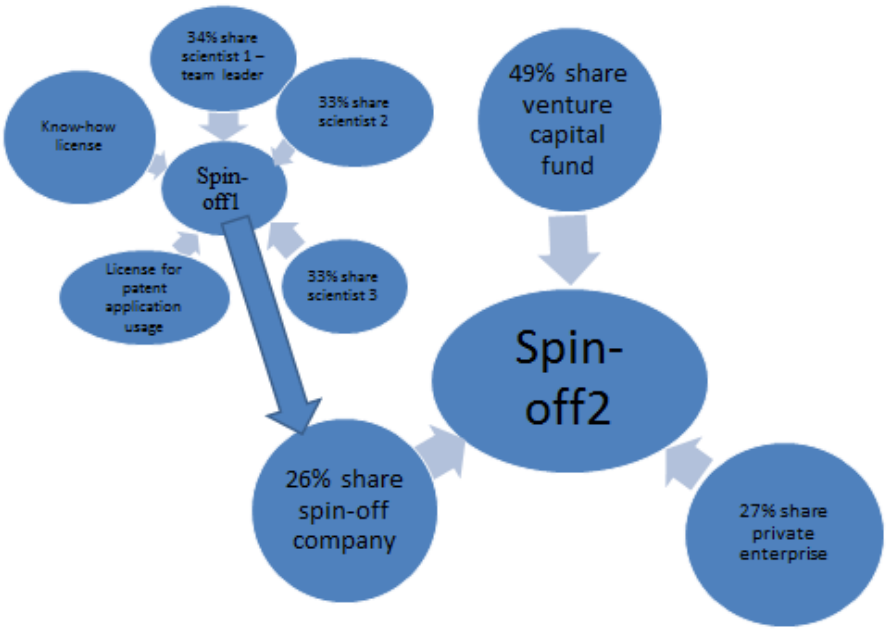
[23] Due to the fact that the companies have yet to be set up data on them, equity and acientist affiliation could not be provided. The reange of know-how and patent application have been altered in thecase study in order to protect confidential information.

pharmaceutical companies carrying out research on the impact of antibiotics, interactions of medication and bacteria, and DNA damage.

The research results produced at the university do not guarantee their immediate launch on the market, which stems from one crucial reason. The created prototype of the device was a laboratory prototype and it was necessary to prepare a market prototype which would be exhibited at fairs or presented directly to potential buyers. The timeline for the creation of a market prototype was estimated at one year. During this time it was necessary to improve the software, prepare electronic modules for serial production and militarisation of the laboratory equipment.

The scientists working on the prototype managed to attract the interest of an entrepreneur from the precision mechanics sector who possessed knowledge and devices indispensable for the production of a miniature version for researching soft substances without damaging their structure. The main problem in the implementation of this venture was its funding, from creation of the market prototype to its presentation to the final buyers and the opportunity to collect orders from institutions which carry out research into soft substances. Conversations between scientists and entrepreneurs were concluded with the idea of setting up a shareholding spin off company, which, along with the entrepreneur, will look for sources of capital until the moment of completion of the prototype and the market introduction of soft substance research devices. The intended spin off (limited liability) company is intended to be set up based on set up capital, know-how from the designing of the analogue and digital electronic system by three scientists as well as two university know-how licences on digital signal processing and the patent application for the Friction Force Microscope systems.

After a few weeks of searching and talks with the representatives of venture capital funds, there arose an interest from one wishing to join a mutual project which would set up a shareholder company for prototype preparation, distribution development, raising initial orders and sales of the devices for testing soft substances in the nanotechnology segment, material engineering, biomedicine and medicine. The structure of capital for the new spin off (spin-off 2) is presented in Graph 3. The new company is intended to consist of a venture capital share, precision mechanics company share and the whole share from spin-off 1. This new company had its targets set for two years, including: completion of market prototype within one year of the company's launch and production and sales in the second year of the device in an amount that would cover operational costs of the company for that year.



Graph 3. Constituents and shares of parties in planned or intended companies

Source: Own work.

Summary

Market commercialisation of research results produced by science and research centres requires foremost such resources as: results which catch the interest of the final receiver, research results which can be the basis for a technology or product, the demand for academic research results initiated by innovative companies, material resources, human resources, *know-how, patents or patent application* and the supply of financial resources. A company undertaking the task of commercialisation of research results should possess the above resources however they should be available via the market. Otherwise science and research organisations should change their field of research. The carrying out by a science and research organisation of research which does not enjoy market interest hampers further research funding and retaining personnel. Strong resources and excellent access to them allows the creation of spin-off companies and the introduction by these companies of a strategy of independent

implementation of a technology. Strong resources and low accessibility to complimentary resources or low technological resources and excellent access to resources, encourages cooperation and resource complementation strategy which is presented in the case study above.

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