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ANALYSIS AND COMPARISON OF TOOLS SUPPORTING
COMMERCIALIZATION OF RESEARCH RESULTS

Effective commercialization and technology transfer of scientific knowledge require global collaboration across sectors. In the present time use of tools of science and technology substantially supports dialogue between scientist including partners from industry and academia. In particular, information technologies provide many solutions and opportunities to communicate, interact and share information. The aim of our study was to analyze and compare available tools supporting commercialization of research results. In particular, we focus on functionalities of these tools to see what qualities they provide for their users and how that could support the process of commercialization. We found out that available tools are diverse and might be used to establish new contacts, solve some scientific problems and find new collaborators. Current trends show that we should expect new solutions, new functionalities and tools supporting business-science cooperation in the future.

Keywords: transfer of scientific knowledge, information technology, business, science.

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АНАЛІЗ І ПОРІВНЯННЯ ІНСТРУМЕНТІВ КОМЕРЦІАЛІЗАЦІЇ
РЕЗУЛЬТАТІВ НАУКОВИХ ДОСЛІДЖЕНЬ

У статті обґрунтовано, що ефективна комерціалізація і трансфер наукових знань у виробництво вимагає глобальної співпраці між різними галузями економіки, науки і бізнесу. Зокрема, інформаційні технології пропонують безліч рішень і можливостей для спілкування, взаємодії і обміну інформацією. Проаналізовано і порівняно наявні інструменти комерціалізації результатів наукових досліджень, функціональні можливості і якості цих інструментів у процесі комерціалізації. Наявні засоби є різноманітними і можуть бути використані для створення нових контактів, вирішення наукових проблем і залучення нових співробітників. Поточні тенденції показують, що в майбутньому слід чекати нових подібних рішень, нових функціональних можливостей і інструментів підтримки співпраці між бізнесом і наукою.

Ключові слова: трансфер наукових знань, інформаційні технології, бізнес, наука.

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АНАЛИЗ И СРАВНЕНИЕ ИНСТРУМЕНТОВ
КОММЕРЦИАЛИЗАЦИИ РЕЗУЛЬТАТОВ
НАУЧНЫХ ИССЛЕДОВАНИЙ

В статье обосновано, что эффективная коммерциализация и трансфер научных знаний в производство требует глобального сотрудничества между различными отраслями экономики, науки и бизнеса. В частности, информационные технологии предлагают множество решений и возможностей для общения, взаимодействия и обмена информацией. Проанализированы и сравнены имеющиеся инструменты коммерциализации результатов научных исследований, функциональные возможности и качества этих инструментов в процессе коммерциализации. Имеющиеся средства разнообразны и могут быть использованы для установления новых контактов, решения научных проблем и привлечения новых сотрудников. Текущие тенденции показывают, что в будущем следует ожидать новых подобных решений, новых

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функциональных возможностей и инструментов поддержки сотрудничества между бизнесом и наукой.

Ключевые слова: трансфер научных знаний, информационные технологии, бизнес, наука.

1. Introduction.

Increasing the role of cross-sector collaboration in commercialization of research results. As a result of technological revolution and economical pressures in recent years companies are forced to make more efforts to gain advantage over competitors and keep business profitable. One of the critical elements for staying on top is innovation. According to the definition of BusinessDictionary.com, innovation is a process of translating an idea or invention into a good or service that creates value or for which customers will pay. The main enabling force for new ideas and invention is research. Many companies carry out research within their key technological areas themselves by creating research and development (R&D) departments. The industries which are knowledge and technology intensive include chemical, biotechnology, pharmaceutical, cosmetic, IT, aerospace and other engineering.

Looking at the example of the pharmaceutical industry which R&D expenditures as a proportion of gross output are among the highest of any manufacturing industry, it is observed that the innovation has become increasingly dependent on research spread within small innovative biotechnology spin-offs and within public research institutions. Traditionally, public R&D focuses more heavily on basic or "pre-technology" research that is difficult to patent and commercialize, while most private R&D emphasizes applied research and product development. Nowadays, new medical technologies are more likely than before to originate in institutions engaged in basic science such as universities and scientific institutes which perform high quality research using state of the art technologies [4, 6].

New ideas benefit society and economy only when transferred to everyday life and commercialized. Commercialization is mostly the domain of entrepreneurs rather than academia. Consequently, firms are increasingly contracting with universities and other institutions in the public sector as a major source of scientific discovery [12].

Global trends show that commercialization is the more and more popular way of collaboration between university scientists and companies. This kind of cooperation gets popularity especially among the fastest-growing sectors, as life science and technology. European commercialization market grows rapidly. Dedicated financial instruments and supporting organizations are created. Many other initiatives supporting commercialization of research results are also developed. Many of them are formed due to support of the European Union and the governments of the EU member states.

However, one can still find many barriers between worlds of science and business. Such barriers might be financial, organizational, philosophical, cultural or mental.

There are some issues which have been recognized to be crucial for productive academia-industry collaboration and these include characteristics such as promoting an active dialogue between academia, industry, and public sector [10,11] or using free and open sourcing of data and information as the customary basis for collaboration [2].

In the present time use of tools of science and technology substantially supports the dialogue between scientists including partners from industry and academia. In particular, information technologies provide many solutions and opportunities to communicate, interact and share information easily and effectively despite geographical barriers. Recently R&D infrastructure has been enriched with many interactive online platforms which are meant to support scientific research, technology transfer and collaboration between different parties involved in a process of commercialization. The aim of this study was to analyze and compare available tools supporting commercialization of research results. In particular, we focus on functionalities of these tools to see what qualities they provide for their users and how that could support the process of commercialization.

2. The analysis method. Many initiatives supporting the commercialization process have the form of a web portal. However, such tools have different functionalities and aims. That is why the analysis method is needed to compare and evaluate them.

In general, such functionalities' comparison is not a trivial task, because there are several aspects which need to be considered. In the literature one can find few methods dedicated to assessment of applications development and functionalities. Lee et al. [9] described the analysis where key attributes of a web development method were measured. Koch [7] compared the phases covered by some web development methods. Gu et al. [5] explored the web development requirements. A.L. Domingues et al. [3] proposed a method considering functionalities conception, planning and client evaluation stages. There are also methods distinguishing modeling and development of both traditional and web user interfaces [8].

Our case study was performed using the top down technique. It is composed of 3 main steps (Fig. 1):

1. Considered web portals are divided into several groups.
2. For each group 2 aspects are considered:
 - a. Information - data available on web portals.
 - b. Functional - basic and additional web portals functionalities.
3. Web portals functionalities are analyzed and compared in groups and among them.

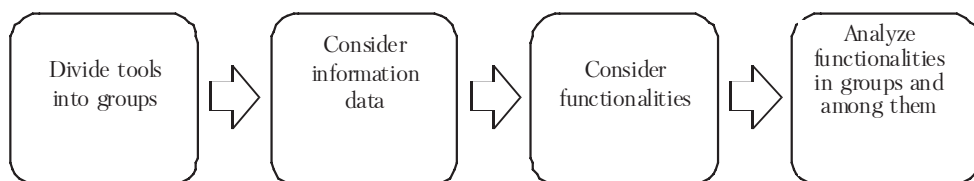


Figure 1. Steps of the analysing method

The proposed method gives the information and functional points of view. It also enables to consider additional aspects such as subscriptions and paid features. Moreover, considering basic and additional functionalities gives an opportunity to identify and compare functionalities common to all groups, common to particular groups and unique.

There are many web portals supporting the cooperation between science and industry. Their availability and features are different, so they were divided into 4 groups:

1. Social networks - portals dedicated to activities of communities.
2. Knowledge sharing portals - tools dedicated to joint development and acquisition of knowledge.
3. Information platforms - portals containing the data on different activities and initiatives.
4. Collaboration platforms - tools offering sophisticated work group tools.

This classification was performed due to the information and functional point of view. All analyzed tools can be easily assigned to the one of mentioned groups.

Another important aspect of the comparison method is standardization of terminology. The terminology considered in the case study is presented in Table 1.

All tools considered in the case study will be described using functionalities defined in Table 1. Those functionalities will be divided into 2 classes (main and additional). The division will be performed according the usefulness and the purpose of applications groups.

3. Results analysis. Diversity of applications' functionalities results in distinguishing 4 groups (social networks, knowledge sharing portals, information platforms, collaboration platforms).

Social networks. There are many social networking portals dedicated to academic and business representatives. Such portals usually offer only one type of user profile - all users have the same rights and are treated equally. Some of these portals are dedicated to specific thematic areas (eg. www.ginnn.com, <http://gin.cloud9network.com/> - operate in the field of management, knowledge transfer and innovation), while others are dedicated to the users interested in many different branches. These portals offer classic functionalities which enable to create and edit user profiles and to complement them with work and experience-related data. Moreover, one can also use panel discussions and links and content sharing.

Social networks support research results commercialization due to detailed user profiles and discussion panels. They usually do not support advanced collaboration tools or matching partners. They are focused on simple experiences and good practices exchange.

Knowledge sharing portals provide such features as blogs, forums, sharing data between users and user groups, adding and sharing thematic articles containing branch information, best practices and know-how. Such portals offer also tools of personal (such as adding content, commenting, rating) and group (forums, news-groups) work. In addition, these portals usually implement advanced search mechanisms considering keywords, tags, categories, creation dates.

Typical examples of knowledge sharing portals are: platform of medical data exchange dedicated to new drugs creation (www.collaboratedrug.com/), portal collecting multidisciplinary research data (<http://www.communigram.net>, www.researchgate.net), supporting medical decisions portal dedicated to doctors (www.Konsylium24.pl), knowledge exchange portal containing technology transfer and licensing of intellectual property data dedicated to scientists, entrepreneurs and support organizations working in the field of life science ([ACTUAL PROBLEMS OF ECONOMICS, #7 \(145\), 2013](http://www.biofit-</p></div><div data-bbox=)

event.com). Some portals (for example, www.researchgate.net) also enable to create and share a database of publications.

Table 1. The terminology used in the case study

No	Functionality name	Description
1	Profiles for all users	One general type of user profile.
2	Profiles for scientists	Profile dedicated to scientists, containing data adjusted to university employees.
3	Profiles for companies	Profiles dedicated to companies or companies employees, containing data adjusted to business people.
4	Forum	Typical web forum containing users' posts organized in threads and subthreads.
5	Discussion panels	Web panels dedicated to interest groups discussions containing posts, comments, blogs and additional materials.
6	Advanced searching	Web portal advanced searching considering details information – for example, about the repository content, users data etc.
7	Tag cloud	Simple portal content searching based on categories, tags and keywords. More popular expressions are highlighted.
8	Potential partners searching	Searching is usually based on available users profiles data.
9	Potential partners matching	Matching might be performed based on different kind of criteria (for example: roles, skills, interests, areas of teaching).
10	FAQ	Responses for frequently asked questions.
11	Ask a question	Opportunity to ask questions to portal administrator or to experts if available using a web form.
12	Online chatting	Opportunity to ask questions to portal administrator or to experts if available using chat.
13	News and events	Information about actual events regarding the portal scope presented in different forms (calendar, list etc.)
14	Newsletter	E-mail subscription.
15	Data and information sharing	Sharing data, articles, comments and other materials on a particular issue.
16	Knowledge creation and sharing	Publishing high quality materials, joint content creation, verification and actualization, group discussion.
17	Documents sharing	Publishing and sharing different kind of materials and documents, regarding different kind of privileges.
18	Publishing of cooperation offers	Offers of business partnerships (including ideas and results to dispose and tasks to solve) are published by users.
19	Publishing of job offers	Business offers of jobs, practices etc.
20	Scientific publications searching and uploading	Scientific users might published and shared list of papers and abstracts.
21	Business and institutions database	Database containing details of organizations (usually opened to cooperation and commercialization)
22	Searching of innovations	Searching is usually based on the data acquired from integrated tools (for example: Google Scholar, Google Patent Search).
23	Partnering network	Joint problems and tasks solving in the process of partners cooperation; tasks integration.
24	Define problem/ add solution	Defining problems to solve; presenting new inventions and solutions (usually organized in categories).
25	Messages exchange	Private messages sending.
26	Success stories	Successful case studies.
27	Crowdsourcing	Defined problems are solved by users or group of users by internet tools using brainstorm challenge. A user (usually a company) who defined a problems chooses the best solution and rewards the solver or solvers' group.
28	Partner invitations through social media	New partners and users might be invited to share the portal info through social media.

Table 2. Functionalities of social networks

No	Functionality name	Main functionality	Additional functionality
1	Profiles for all users	X	
4	Forum	X	
5	Discussion panels	X	
6	Advanced searching		X
7	Tag cloud		X
10	FAQ		X
13	News and events		X
14	Newsletter		X
15	Data and information sharing	X	
17	Documents sharing	X	
18	Publishing of cooperation offers		X
19	Publishing of job offers		X
21	Business and institutions database	X	
25	Messages exchange	X	
28	Partner invitations through social media	X	

This group includes also transfer of knowledge and technology supporting platform. Such platforms share databases of contacts within the business ecosystem and give access to innovation managers offering technical support (e.g., <http://www.open-codetransfer.pl>, <http://www.scitt.paip.pl>). Knowledge repository platforms have limited ability to support directly the knowledge commercialization. They rather serve as a platform which bring together a large amount of useful information and knowledge including user profile data. However, they do not have features that enable professional commercialization support, such as partners matching functionalities.

Table 3. Functionalities of knowledge sharing portals

No	Functionality name	Main functionality	Additional functionality
2	Profiles for scientists	X	
3	Profiles for companies	X	
4	Forum		X
5	Discussion panels	X	
6	Advanced search	X	
7	Tag cloud		X
8	Potential partners search	X	
10	FAQ		X
11	Ask a question	X	
12	Online chat		X
13	News and events		X
14	Newsletter		X
15	Data and information sharing	X	
16	Knowledge creation and sharing	X	
17	Documents sharing	X	
18	Publishing of cooperation offers	X	
19	Publishing of job offers		X
20	Scientific publications search and upload	X	
21	Business and institutions database	X	
22	Searching for innovations		X
25	Messages exchange	X	
28	Partner invitations through social media	X	

This group of platforms provides information on individual projects and initiatives related to cooperation of science and industry. This group of platforms supports establishing contacts between scientists and entrepreneurs but usually, it is limited to specific initiatives. Example portals (<http://kujawsko-pomorskie.ssn.paip.pl/>, <http://orp.euris-programme.eu/>) apply to specific type of cooperation - like internships in companies offered to scientists. Other types of information platforms collect and provide information on various events, projects and conferences regarding a specific topic. For example, www.tech-transfer.eu contains a list of supported projects, news and other information on educational programs and conferences. Another example, portal <http://www.techtransfer.umich.edu> is an information portal dedicated to research programs related to inventions and patents. Other platforms stores information on conferences, projects, partners offering search engine (for example, <http://www.imi-partnering.eu>) and information in the field of protection of intellectual property and commercialization of science results (<http://www.innovaccess.eu>).

A more extensive project is a biomedical and biotechnology portal <http://life-science.pl> which contains information on projects, seminars, trade fairs, conferences and other events. It has also a database of companies and institutions issuing cooperation offers in the field of life science. The portal provides also computing power for research and enables results publishing and disseminating.

All information platforms, however, have limited functionalities and serve as informative portals. They do not have the functionalities associated with knowledge bases, they do not offer advanced search and matching tools, or tools strictly dedicated to partner cooperation.

Table 4. Functionalities of information platforms

No	Functionality name	Main functionality	Additional functionality
1	Profiles for all users	X	
2	Profiles for scientists	X	
3	Profiles for companies	X	
6	Advanced searching		X
7	Tag cloud		X
8	Potential partners search	X	
10	FAQ	X	
11	Ask a question		X
13	News and events	X	
14	Newsletter	X	
15	Data and information sharing	X	
18	Publishing cooperation offers	X	
19	Publishing job offers	X	
21	Business and institutions database		X
25	Messages exchange		X
26	Success stories	X	
28	Partner invitations through social media		X

Collaboration platforms. This kind of platforms offer different forms of cooperation in the scope of knowledge commercialization, including sales of innovations and crowdsourcing. They usually offer such features like diversified profiles (separately for business and science partners), sophisticated communication tools and documents exchange.

Among collaboration platforms one can find portals offering crowdsourcing. It is a modern solution that enables to issue problem to solve. Such problems are usually defined by a company. Users (usually scientists) present their solutions, verify and discuss solutions of other users. If the problem is resolved, the company introduces the chosen solutions and rewards solution providers.

Among portals supporting cooperative problem solving one can find: <http://www.datastation.com>, <http://www.chaordix.com>, <http://www.onebillion-minds.com>. There are also tools that provide a database of problems to solve. Those problems are studied by scientists working alone or in groups (for example, <http://www.hypios.com/>).

Another type of collaboration platforms are portals developed by consulting agencies offering development of solutions dedicated to specific problems reported by companies. For this purpose, association networks of scientists and entrepreneurs are formed. Their activities are supplemented by additional expert consultations. Access to the platform is usually charged. Such portals are dedicated to creation of commercial experts networks and innovation sales, such as <http://www.innovaro.com>, <http://www.skild.com/>, <http://www.innoget.com>, <http://presans.com> or <http://www.bigideagroup.net/>. Such platforms usually sell comprehensive business support services such as designing, launching new solutions, monitoring the sales process. Expert networks are usually composed of selected, previously employed scientists. Such networks are usually closed for researchers from outside and platforms are dedicated primarily to business users.

Table 5. Functionalities of collaboration platforms

No	Functionality name	Main functionality	Additional functionality
2	Profiles for scientists	X	
3	Profiles for companies	X	
4	Forum		X
5	Discussion panels	X	
6	Advanced search	X	
8	Potential partners search	X	
9	Potential partners matching	X	
10	FAQ		X
12	Online chat		X
14	Newsletter		X
17	Documents sharing		X
18	Publishing cooperation offers	X	
19	Publishing job offers		X
21	Business and institutions database	X	
23	Partnering network	X	
24	Define problem/ add solution	X	
27	Crowdsourcing	X	
28	Partner invitations through social media		X

Fig. 2 presents Venn diagram comparing functionalities of all 4 groups (social networks, knowledge sharing portals, information platforms, collaboration platforms). Only main functionalities were taken into consideration. Successive numbers represent functionalities presented in Tables 1-5.

Among unique functionalities one can find forums (dedicated to social networks), asking a question, knowledge creation and sharing and scientific publications searching and uploading (dedicated to knowledge sharing platforms), FAQ, news and events, newsletter, publishing job offers, success stories (dedicated to information platforms), potential partners matching, define problem/ add solution, crowdsourcing (dedicated to collaboration platforms).

3 of presented functionalities (tag cloud, online chatt and searching for innovations) belong only to additional functionalities group. The rest of functionalities (profiles for all users, profiles for scientists, profiles for companies, discussion panels, advanced search, potential partners search, data and information sharing, documents sharing, publishing of cooperation offers, business and institutions database, messages exchange, partner invitations through social media) have been assigned to 2 or 3 groups. There are no functionalities belonging to all groups.

4. Discussion and summary. The presented case study considered many services and functionalities. All these tools were designed to support strengthening cooperation between scientists and entrepreneurs. Diversity and popularity of such applications proves that communication between the world of science and the world of business needs to be built and supported. Such tools might be used to establish new contacts, solve some scientific problems, find new collaborators. They also enable breaking the existing barriers, such as difficulties in establishing international contacts, finding new ideas and solutions, getting access to new sources of development financing [1].

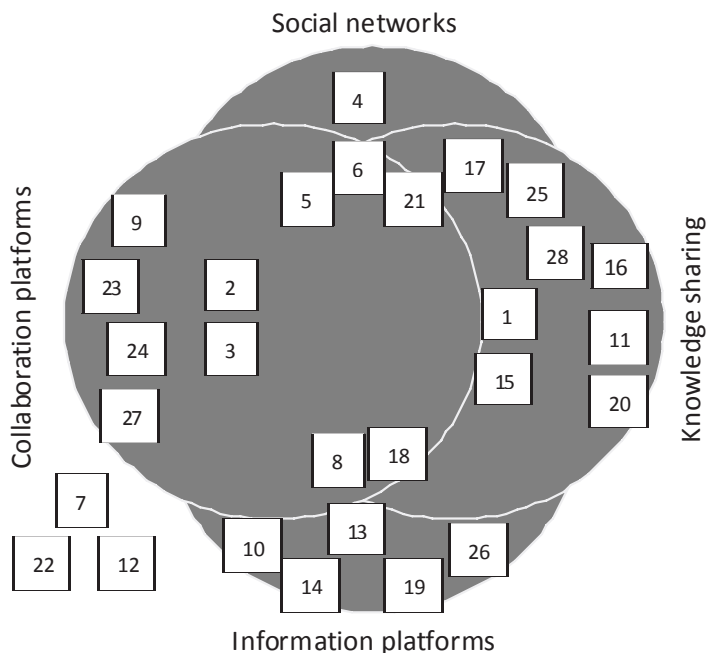


Figure 2. Comparison of functionalities

Such tools are needed not only to establish new business contacts, but also to maintain and strengthen them. Sustainability and reliability of cooperation are of great importance for both partners. Many of the presented tools and functionalities

provide access to safe and reliable source of information and knowledge. Their popularity prove that many business and science partners treat them as a additional source of innovation development. Research results commercialization is a great opportunity for scientists to present their solutions and for research and development (R&D) companies departments to get new products and offers.

Dynamically increasing number of Internet platforms supporting commercialization of research results and commercial success of some of them, indicates that information and communications technologies are willingly applied to support technology transfer, partnering, licensing and exploitation of research results. Virtual intermediaries exploiting technological convergence of telecommunications, computers and media proved themselves to be effective tools to support new model of scientific communication recognized as an open innovation.

The idea of research results commercialization is getting more and more popular. However, tools supporting commercialization need to be safe and reliable. There is still a need to develop new solutions, new functionalities and tools supporting business-science cooperation. It is a trend which is worth to be supported and assisted.

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