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Knowledge and Technology Transfer from Polish Public Research Organisations: A case study of the Institute for Sustainable Technologies – National Research Institute

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Abstract

As in the era of globalisation knowledge has become increasingly important to national innovation performance and competitiveness. Knowledge and technology transfer processes have therefore become the foundations of contemporary innovation-based economies, and an increasingly vital success factor for global entities, as they help individual organisations build and maintain their competitive advantage.

The development of the advanced and competitive knowledge-based economies has forced the governments to establish effective mechanisms and structures stimulating the transfer of knowledge between the R&D sector and the industry. As a result numerous legislative mandates regulating the issues of knowledge protection and commercialisation have been introduced. Such steps have also been undertaken by the Polish government and have led to an upward trend in the commercialisation of research results. However, the situation is still not satisfactory and, despite a number of good practices and success stories in this field, the scale of applications of results of research conducted at both Polish universities and PROs needs to be increased.

In the article the author presents a case study of a knowledge and technology transfer process from a Polish PRO. The analysis was conducted for a state-owned research institute with the status of a national research institute - the Institute for Sustainable Technologies – National Research Institute (ITeE-PIB) in Radom, Poland, which has great experience in the development and practical industrial application of innovative technological solutions.

1. Introduction

Substantial and significant changes have taken place in the organisation and management of knowledge and technology transfer processes in Poland, and Polish economy is now equipped with sufficient institutions and tools of an efficient innovation system. The first ideas for the creation of the support system for knowledge and technology dissemination emerged in Poland only after 1989, when the transformation process triggered the establishment of new mechanisms and structures stimulating the transfer of knowledge between the R&D and business

sectors. However, the socio-economic changes have not resulted in fundamental changes as far as the practical application of research results is concerned. Poland's innovation performance is well below that of the EU27 average [17, 3] and main weaknesses of the Polish innovation system are in the culture of innovation and the R&D-business linkages, which are traditionally very scarce. This particularly concerns the connection with big companies, which have their own R&D policy adjusted to their needs for an improved innovation performance mainly based on imported solutions [10]. The small and micro-enterprises, on the other hand, are to a great extent profit-driven, and pay less attention to innovative activity. In this group, only 15% businesses display interest in innovative activity [23].

The issues of the transfer of knowledge and the commercial application of research results are currently greatly stimulated by the government bodies [11], however, the limited experience of research organisations in this field [10], together with weak links between science and industry [8, 15], and ineffective technology transfer intermediaries [12, 22] are unfavourable and responsible for the unsatisfactory level of dissemination and commercialisation of research results. The effectiveness of knowledge and technology transfer processes, particularly from Polish universities, remains low due to many human-related (i.e. personality, motivation, knowledge, drive) and non-human (i.e. legal regulations, structure of organisation, internal policies, infrastructure, bureaucracy, lack of close interactions between the R&D and business sectors) factors [7, 13, 5]. In the case of Polish non-academic public research organisations (PROs), the effectiveness of knowledge and technology transfer processes is higher, yet not satisfactory either, as Polish PROs are still limited by legal regulations, funds and structural and organisational stagnation [20]. However, due to their orientation at applied research and the ties with industry closer than those between universities and the business sector, there are more success stories as far as practical application of research results from Polish PROs is concerned than from Polish universities.

The intent of this article is to present a case study of successful knowledge and technology transfer processes from a Polish PRO.

2. Knowledge and Technology Transfer from Public Research Organisations in Poland: Overview

The increase in innovativeness and competitiveness of any economy is determined by an effective execution of R&D tasks and a successful implementation of research results. PROs in Poland are therefore required to develop new technologies and publically disseminate the results of their research, which means that the transfer of knowledge and the industrial implementation of its assets are part of their statuary activity. Polish PROs, with substantial personnel and infrastructure potential, and particularly those with the status of National Research Institutes (only 14 such institutes in Poland), play a crucial role in the transfer of knowledge and technology between the R&D sector and industry [10]. Research institutes, defined in the Act on Research Institutes [1] as state entities independent in legal, organisational, economic and financial terms, conducting

scientific and applied research directed at their practical industrial implementation and application, are an important element of the Polish innovation system. Through the execution of research that is in line with the research directions specified in national and European strategic documents (i.e. Country's Development Strategy 2007-2015 or Europe 2020), PROs contribute to the development of Poland's innovation performance and boost its economic competitiveness. Compared to their European or American counterparts, Polish PROs are much smaller and more centralised in terms of their structure. They are usually composed of a few R&D units that have the status of organisational departments, which do not function as independent and autonomously governed research centres or laboratories affiliated to the PRO. Their structure resembles the structure of individual institutes within, i.e. the Fraunhofer Society in Germany, rather than that of the entire Society itself. They are characterised by limited budget and narrow means of obtaining financial support. Contrary to Polish universities, PROs in Poland are not State funded institutions *per se*, and the regular financial support they receive from the State budget is that intended for their statutory activity only, which constitutes a very little fraction of the entire R&D activity they conduct. The majority of funding Polish PROs receive, come from EU financed or government commissioned research programmes, including strategic programmes.

Despite the differences in size, structure and organisation of work, what Polish PROs and their international counterparts have in common is the fact that these are research institutions devoted to the execution of strategic research programmes, whose outcomes should be practically implemented to stimulate and contribute to the sustainable development of the entire national economy. Strategic research programmes are a key tool for building a knowledge-based economy. These are high-budget projects within which innovative technologies, products and processes meeting the needs of the economy are developed, and future research directions in the areas of strategic importance for the growth of innovation performance and competitiveness of the national economy are generated. The subject matter of strategic programmes results from the scientific and innovation policy of a country and complies with national priorities indicated in strategic documents [2, 6]. The importance of such programmes stems from the fact that they enable significant scientific and utilitarian results to be achieved, and they also constitute an effective mechanism for the execution of research activity and the implementation of its results in industry [10].

Along with strategic research programmes generated by individual PROs, the most commonly applied mechanisms stimulating knowledge and technology transfer in Poland, are government and industry commissioned programmes, and national research programmes, as they offer financial support for the execution of research projects stimulating Poland's sustainable economic growth, facilitate the development of innovations, and help PROs engage a full range of stakeholders in cooperative efforts to accelerate their diffusion [19]. The most recent Polish national research programme aimed at knowledge transfer and innovation commercialisation support is the Innovative Economy Operational Programme (POIG) for the 2007-2013 within which numerous strategically important research programmes are executed (e.g. the "Innovative Systems of Technical Support for

Sustainable Development of Economy" Strategic Programme coordinated and executed by the Institute for Sustainable Technologies – National Research Institute in Radom, Poland). The POIG facilitates the creation of science-business consortia and clusters, promotes networking between the R&D sector and industry, and underlines the importance of knowledge and technology transfer intermediary organisations (i.e. technology parks, university technology transfer offices and business incubators).

When it comes to mechanisms of knowledge and technology transfer to practical market applications, defined as processes that move knowledge and technology from source to recipient on commercial terms [14, 18], Polish PROs seem to be generally in favour of sale and licensing. A lot of attention has in the recent years been paid to the industrial implementation of innovations by means of the creation of spin-off ventures, however this form of bringing research results to the market is not yet widely applied by either Polish universities or PROs. The matter of the creation of spin-off companies is governed by nationally or institutionally applied policies. By right of national legal mandates introduced, research organisations in most EU Members States and the USA are free to establish their own, internal policies concerning the creation of spin-off ventures, while in Poland, the issues of commercialising research results by means of innovation-based enterprises is regulated by governmental acts (i.e. the Public Funds Act 2009, the Law on Higher Education 2011, the Act on Research Institutes 2010). The creation of spin-offs from Polish universities is regulated by the Law on Higher Education (2011) as per which Polish universities cannot be directly involved in the creation and functioning of businesses and in order to commercially disseminate their research results can establish Academic Entrepreneurship Incubators or TTOs, which being separate business entities in form of LLCs or joint-stock companies can have profits in newly created ventures [22]. As far as PROs are concerned, their functioning is regulated by the Act on Research Institutes of April 30, 2010 [1] which states that PROs are allowed to diffuse research results, create capital companies, purchase shares and stock in such enterprises and attain income from them, but only with the supervisory ministry's (the Ministry of Science and Higher Education) official consent, without which they cannot engage in this form of business activity [20]. Apart from legislative barriers (i.e. different rules applied to different pillars of the Polish R&D sector (universities, Polish Academy of Sciences institutes and public research organisations)) the transfer of knowledge and technology by means of spin-off venture creation in Poland is additionally hampered by numerous organisational, financial, psychological and behavioural factors that stem from the underdeveloped culture of innovation and the lack of entrepreneurial drive and thinking among Polish researchers [7]. Realising the importance spin-off companies have for knowledge and technology transfer processes, Polish government has recently become extremely engaged in the issues of this commercialisation mechanism. As a result a number of programmes and projects stimulating scientific entrepreneurship have been proposed. They are either directed at providing support in the area of innovation commercialisation, with particular attention paid to legal and organisational aspects of new business creation processes and know-how exchange (e.g. the already finished Way to Entrepreneurial Programme within the POIG), or offer financial support for PROs

intending to establish spin-off ventures for the commercialisation of their research results (e.g. SPIN-TECH programme by the National Centre for Research and Development).

The non-commercial channels for knowledge and technology transfer applied by Polish PROs include patent applications, publications, scientific conferences and industry-oriented technology fairs. The exchange of know-how and experience between the R&D and business sectors is also stimulated by the creation of special regional economic zones and clusters, the establishment of cooperation networks and the activity of such intermediary organisations as technology parks and incubators.

3. Knowledge and technology transfer at the Institute for Sustainable Technologies – National Research Institute

3.1. Organisation's profile, strategy and mission

The Institute for Sustainable Technologies – National Research Institute (ITeE-PIB) in Radom is a public R&D institution conducting both basic and applied industry-oriented research and implementation tasks in the following strategic research areas: innovation and knowledge transfer, surface engineering, tribology, control systems, IT, prototype and experimental production, mechatronics, environmental technologies, systems research, textile technologies, and vocational education and training. The Institute's activity is mainly financed from the execution of development programmes, grants and national R&D research programmes commissioned by the Polish government (the Ministry of Science and Higher Education and the Ministry of Economy) (65%), contract research for industry (25%), however the latter is still growing. The remaining 10% is constituted by international research projects and programmes [4].

The Institute has great experience in the execution of strategically important R&D programmes in the domain of national innovativeness and competitiveness that include contract research commissioned by the Polish government and administrative bodies, grant projects and targeted projects that have finished with the successful implementation of their results. The Institute also has great experience in the execution of strategic research programmes within which numerous Polish academic and non-academic centres and enterprises (particularly from the SME sector) participate. The examples of such programmes include, inter alia, The PW-004 Multi-year Programme "Development of Innovative Systems of Manufacturing and Maintenance 2004-2008" or the "Innovative Systems of Technical Support for Sustainable Development of Economy" Strategic Programme for the 2010-2014 period currently executed within the Innovative Economy Operational Programme and co-financed from EU structural funds. Within the 28 years of its functioning, the Institute has come a long way to become a modern, prestigious and a widely acclaimed research institute that specialises in the execution of research that aims at the development of advanced product and process technologies that can stimulate Poland's sustainable economic growth [4]. The Institute's development strategy is constantly being adjusted to fit into the

Polish economic reality and the EU policy. The originality of the Institute's approach to conduct scientific and R&D activity lies in the interdisciplinarity of both scientific and technical aspects, which results in the multiplicative application of the solutions developed.

3.2. Knowledge and technology transfer at the ITeE-PIB: model

The transfer process at the ITeE-PIB has a centralised form and is governed by the heads of individual departments as well as the Institute's administrative bodies, who aided by the marketing and promotion department participate in the organisation, management and the execution of the innovation commercialisation process. The organisation of the patent procedure is the only aspect of the transfer process that is not undertaken by the Institute's employees themselves. Patent application forms are sent to external legal advisors specialising in IP law, who then take over the responsibility for the entire patenting procedure. In the case of sale or licensing of research results that are not protected by IP rights, the researchers themselves draw the contracts with the end users of innovations, which before signing are verified by the legal adviser employed at the Institute.

All the solutions developed at the ITeE-PIB are disclosed to the marketing department responsible for their promotion and dissemination. A new mechanism that the marketing department has lately introduced in order to increase the effectiveness of promotion and as a result implementation of technological solutions developed at the Institute is the Technological Platform [10] for R&D business cooperation and dissemination of research results and a newsletter emailed to potential clients.

Currently, works on the development and implementation of a new model of knowledge and technology transfer at the ITeE-PIB are being carried out[1] (Figure. 1).

[1] The model constitutes the scope of the author's PhD dissertation (work in progress)

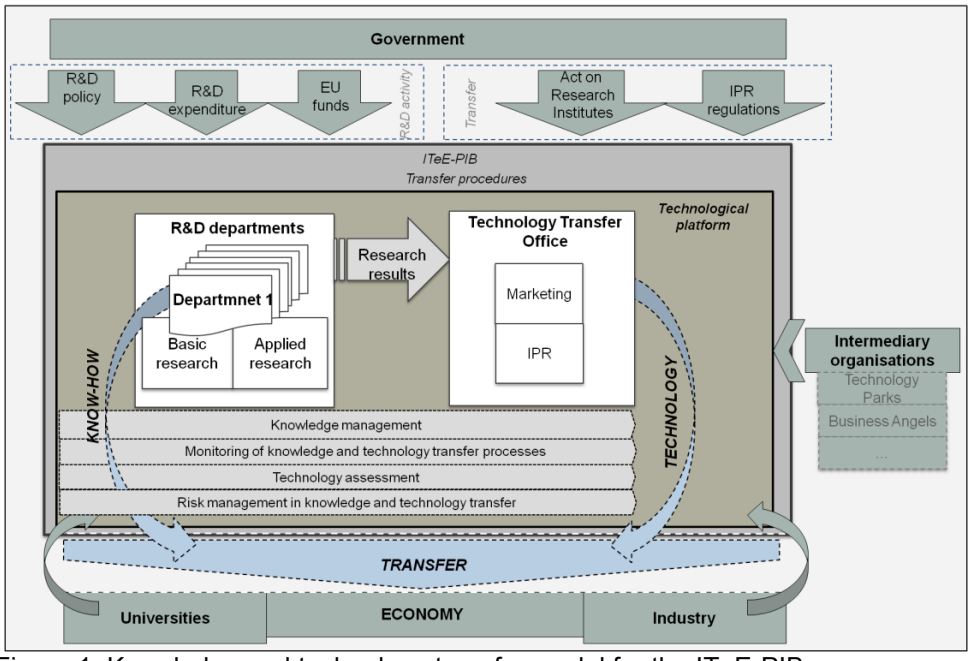

Figure 1. Knowledge and technology transfer model for the ITeE-PIB
Source: Author

The model proposed is based on the outcomes of the analysis of good practices of technology transfer from PROs and universities worldwide (e.g. the Fraunhofer Society, the VTT, the TNO, the MIT, the Oxford University, the ETH Zurich) but takes into consideration the unique socio-economic condition the Polish PRO functions in. The model assumes the reorganisation of the marketing department and the establishment of a strictly technology transfer oriented structure (TTO) that would be entirely responsible for the execution of the commercial transfer of research results, whereas the transfer of know-how would be undertaken by individual departments. The model stresses the importance of knowledge management, monitoring of knowledge and technology transfer processes, technology and risk assessment, which all should be jointly conducted by the researchers and the employees of the TTO throughout the entire process of innovation development and practical implementation. The model also assumes greater involvement of intermediary organisations in the transfer process and closer, i.e. more open cooperation with other PROs, universities and enterprises. The model has an open structure and the inclusion of additional elements is possible. The structure of the model is composed of two following layers:

- Institutional (in which the institute, TTO and intermediary organisations, as well as government bodies dictating national innovation directions and regulating innovation commercialisation issues, are embraced),
- Procedural (encompassing the Institute's technology transfer procedures supported by the original IT tools facilitating commercialisation of innovations developed at the ITeE-PIB (e.g a complex technology

assessment system, the Technology Platform, or the knowledge transformation and technology transfer monitoring system applied at the individual stages of technology development and dissemination processes).

3.3. Knowledge and technology transfer at the ITeE-PIB: tools and mechanisms

The most common tools stimulating knowledge and technology transfer that are applied at the Institute for Sustainable Technologies – National Research Institute are both national and international R&D projects including for instance the following:

- Multi-year strategic research programmes (e.g. PW-004 Multi-year Programme "Development of Innovative Systems of Manufacturing and Maintenance 2004-2008" or the "Innovative Systems of Technical Support for Sustainable Development of Economy" Strategic Programme for the 2010-2014 period);
- Projects within EU co-financed framework programmes (e.g. Leonardo da Vinci, PHARE, EQUAL, LIFE +)
- Contract research (both for national enterprises and companies abroad (e.g. from China, Ukraine, Germany);

Even though contract research for industry constitutes just 1/4 of the total financing the Institute for Sustainable Technologies – National Research Institute receives, cooperation with the SME sector in particular is of great importance to the ITeE-PIB, and even strategic programmes and projects commissioned by the government are executed jointly by the Institute and numerous business partners. This close cooperation with industry allows for the development of advanced industry-oriented solutions and stimulates their effective transfer into practice. In the 2000 to 2012 period, the Institute has carried out numerous grant projects (ca. 120), commissioned projects (ca. 30), and targeted projects (ca. 80) that have finished with successful and effective implementation of their results [4]. Currently the Institute is engaged in the execution of the "Innovative Systems of Technical Support for Sustainable Development of Economy" Strategic Programme, the outcomes of which will comprise over 170 new technological devices and 90 non-material solutions including evaluation methodologies and innovation commercialisation procedures. So far, 90 material and ca. 60 non-material solutions have been developed within this programme and several dozen have been practically utilised [10].

The Institute specialises in the development of both unit and mass technological solutions in the fields of surface engineering, mechatronics, environmental technologies, tribology, environmental and technical safety technologies, control systems, IT, as well as prototype and experimental production, and system support in the area of system research, knowledge and technology transfer and vocational education. The material research results in form of technologies, systems, test and research apparatus and innovative technological devices are promoted and popularised throughout their entire development stage, so that the market is not

only informed about the research results but is also made aware of the advancement of the R&D activity and can follow the progress of undertaken tasks all the way from the concept stage to the final product. Prior to their transfer, all technologies, systems and innovative devices developed within the scope of undertaken R&D projects, particularly the currently executed strategic programme entitled “Innovative Systems of Technical Support for Sustainable Development of Economy,” undergo a rigid and in-depth assessment so as to prove that they can be turned into manufacturable, marketable and profitable end products [21].

The assessment is particularly focused on three aspects of a new technology - the level of its implementation maturity, its commercial potential, and the level of its innovativeness. The results of the assessments, when put together, determine the overall commercialisation opportunity of an innovation, understood as the chance for the innovation to be effectively applied in industry. The assessment is carried out using a model complex technology assessment system [9] and its results can be used at different stages of the innovation development process (e.g. the concept stage, the R&D stage, and the final product stage), which supports strategic decisions concerning its future (whether the development process should be continued or terminated) and decisions concerning the selection of preferred commercial (Table 1) and non-commercial (Table 2) knowledge and technology transfer mechanisms.

Table 1. Mechanisms of commercial knowledge and technology transfer used at the ITeE-PIB

Mechanism	Popularity of application
Sale	+++
Licensing	++
Spin-off	+
Services	++

+++ frequent, ++ moderate, + rare

Source: Author

Table 2. Mechanisms of non-commercial transfer used at the ITeE-PIB

Mechanism	Popularity of application
Scientific publications	+++
Patents	++
Conference presentations	+++
Technology fairs and exhibitions	++
Workshops and seminars for the industry	++
Student internships and workshops	+
Personnel exchange	+
Informational leaflets	+++
Catalogue cards	+++
Technological platform	+++

+++ frequent, ++ moderate, + rare

Source: Author

The authors of the developed innovations propose a mechanism they would be interested in, and then the marketing department verifies their suggestions. The licensing mechanism is mostly applied for ICT solutions (e.g. system for video conferences, web survey system) and research apparatus and test stands (e.g. model test stand for co-combustion of liquid waste with conventional fuels), whereas specialised devices of unit character (not possible to be produced on a mass scale) (e.g. chamber for testing the emission of volatile organic compounds) with high commercial potential are sold. Some of the solutions developed at the ITeE-PIB are intended for research applications only, and therefore they are not subject to transfer on commercial terms. Instead, such test stands are implemented at the ITeE-PIB and used for industry-commissioned investigations, or they are implemented at other R&D centres in exchange for their practical verification and assessment. Currently, works focused on the establishment of a spin-off company in the surface engineering domain, which will provide technological services for industry are also underway.

Scientific publications are extremely important means of non-commercial popularisation and dissemination of research results at the ITeE-PIB and the number of scientific publications greatly influences the outcomes of the assessment of activity of each of the departments of the Institute and the evaluation of achievements of individual scientific employees as well. Additionally, the results of this assessment are also significantly boosted by the number of patents, especially those that are practically applied in industry, the evaluated department holds. Every year several dozen new technological and systems solutions in the area of surface engineering and materials, test research and apparatus, tribology, mechatronics, and environmental and technical safety are subjected to patenting procedures, however not all inventions developed at the ITeE-PIB are patented prior to their practical implementation in industry.

Additionally, all the product and process solutions have their catalogue cards in which their technical specifications, technological requirements and possible areas of application are specified. These cards are all put together in the Institute's catalogue of technologies and are available on the Institute's website. Innovative products developed at the Institute are also fed into the Internet knowledge and technology bases (e.g. the technology base of the Polish Ministry of Economy).

The results of the research executed by the Institute are also popularised in national and international scientific publications, conference presentations, informational leaflets targeting preferred industry sectors or even particular companies, and through participation in technology fairs and exhibitions.

The Institute also organises student internships and workshops (e.g. for the students from the University of Monterrey in Mexico, with which the Institute closely cooperates in the area of tribology).

A technological platform (Figure 2) constitutes an important tool for knowledge and technology transfer at the Institute for Sustainable Technologies – National Research Institute.

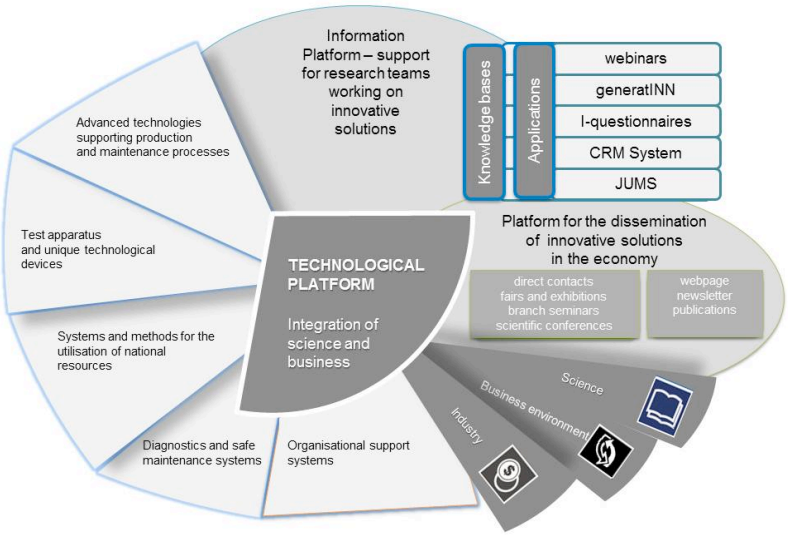

Figure 2. Technological platform developed and implemented at the ITeE-PIB
Source: [10]

The Platform is built of the two following modules:

- the Platform for the Dissemination of Innovation in Industry for the Sustainable Growth of the Economy,
- the PINF – the IT Platform constituting a coherent set of technologies, data, and applications facilitating organisational support for the SME sector.

The Platform is addressed to Polish and international scientific institutions, enterprises, and intermediary organisations. Currently over 40 entities are incorporated into the Platform [4].

The main aim of the Platform is to disseminate information about ITeE-PIB's R&D activity, undertaken implementation tasks, innovative projects and new technologies, particularly those developed within the Strategic Programme. The operation of the platform facilitates cooperation and networking between the R&D and the business sector, and stimulates the exchange of knowledge and the commercialisation of research results. Within the Platform activities associated with the promotion of innovative product and process solutions, the creation of effective structures and mechanisms of transfer of innovations and the assessment of the effectiveness of these structures are conducted [16].

4. Conclusions

The transfer of knowledge and its assets is beneficial for both research organisations commercialising their intellectual property, and companies in which

research results are implemented, and as a result directly contributes to the improved level of a country's innovation performance and competitiveness. Knowledge and technology transfer should therefore become a strategic mission of all PROs and universities, as active participation in these processes would help them generate increased research funding and engage more scientists and business people in the development and diffusion of innovations, and as a result would bring socio-economic benefits, not only to the R&D centres themselves, but also to the entire region or country. The transfer of know-how and its material results from Polish PROs and universities is still not satisfactory and there are numerous obstacles of technical, financial, market, organisational and political nature that impede its effectiveness. However, in the case of Polish PROs, human-related factors have an equally negative (not to say the most negative) impact on the success of the knowledge and technology transfer process. The inefficiency of knowledge and technology transfer processes in Poland mainly stems from the following macro and micro factors (Table 3).

Table 3. Macro and micro factors hampering knowledge and technology transfer from the Polish R&D sector

Macro factors (country)	Micro factors (R&D institution)
– low R&D expenditure; – too much bureaucracy and red tape; – weak alignment of all NIS actors; – low innovation culture; – low entrepreneurial culture; – insufficient innovation support instruments	– communication gap between the R&D and business sectors; – low networking abilities; – ineffective knowledge and technology management; – schedule delays; – complexity, maturity, codification of innovations; – Insufficient people capability (e.g. lack of competence in the field of commercialisation of research results (e.g. lack of skills in negotiations, the application of inappropriate marketing strategies, lack of competence in the field of protection of intellectual property rights, etc.) – Application of inefficient structures and strategies for the management of the technology transfer process,

Source: Author based on [7, 8, 10, 15]

The quality of research and its commercial attractiveness, as well as the availability of a pool of excellent research results, both basic and applied, is another questionable area. Moreover, despite the growing business angel investment and increasing number of VC funds present in Poland these innovation support instruments are still not widely applied and their alignment with Polish PROs and universities is still weak. Despite significant advancement which has taken place in the organisation and management of Poland's NIS in the past 20 years, only recently has the need of a complex and coordinated approach to innovation and technology transfer been acknowledged. A substantial injection of the EU structural funds, in particular between 2007 and 2013, aimed to support innovation at the company level and to create new structures facilitating the flow of know-how between academia and industry, with far less emphasis put on the transfer of knowledge and its assets from PROs. PROs, therefore need to be more proactive when it comes to the transfer of their innovations.

The Institute for Sustainable Technologies – National Research Institute (ITeE-PIB) is striving to improve the effectiveness of the transfer of its knowledge and technology. Several measures aimed at boosting the effectiveness of these processes have already been taken, and as a result of their application numerous technological, process, and system solutions have been practically implemented both by national and international business entities and R&D organisations. It is

expected that with the implementation of a knowledge and technology transfer model, and an expansion of the technological platform, the Institute will exhibit even better effectiveness as far as the commercialisation of research results is concerned.

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