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Implementation of applied research and development in conditions of the Slovak universities

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Abstract

The aim of this article is to point out on the level of research and development support within Slovak universities. In the article authors highlight the fact that the indicators evaluating the level of research and development potential of the particular country are greatly influenced by current situation in the area of Slovak research and development support. Recently Slovak academic and science-research institutions are focused on better application of university knowledge and results of research and development into practice, inter alia, by the implementation of institutional support within the universities. In the end of the article, authors therefore present an example of Center for Technology Transfer working at the University of Zilina and its role as the tool for institutional support for applied research.

1. Literature review

In the context of the innovation economy, achievements in the field of science, technology and innovations have become the key factors of economic growth. Due to these reasons, the success of any country in today's global economic system is determined by the research level of its economy. [10] Authors of the paper describe the level of research and development (R&D) support in the Slovak Republic (SR) using the indicators commonly implemented in statistics and annual reports of government institutions (e.g. the Ministry of Education, Science, Research and Sport of the SR; the Ministry of Economy of SR), state agencies (Statistical Office of SR) as well as various international institutions (WIPO, etc.). Two indicators used in this paper, specifically R&D expenditures and the number of R&D personnel are also used as input data in, so called Frascati Manual - global proposed standard practice for surveys on research and experimental

development. One of the basic input data when assessing the level of R&D is the Gross Domestic Product (GDP), respectively the percentage of invested funds in the GDP of given country. According to S. A. Meo and A. M. Usmani (2014) the investment in R&D is a major factor in determining the contribution that research can make to scientific progress and innovation, and is associated with high rates of research outcomes.
In available literature, it is also possible to find the related statistics - an assessment of the effectiveness of R&D on the basis of revenue arising from the application of the results into practice in relation to subsidies. This type of indicator is used in countries with developed R&D support and active commercialization of R&D results into practice. This type of evaluation is not applicable for the SR at present, as the R&D support used to be underestimated, particularly by private entities.

2. Support of research and development in the Slovak Republic

According to the OECD, research is “experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.” [6] This definition refers to a basic research. On the other hand, applied research is also “original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective”. [6] This article deals, primarily, with applied research conducted at universities to enhance the level of transferring knowledge and technology to companies, and providing young people with research-based skills.
Research along with an experimental development comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society. According to paragraph 2 of the Act no. 172/2005 Coll. on Organisation of State Support for Research & Development as amendment, development is systematic creative work in the field of science and technology using patterns and knowledge gained through the research or based on practical experience when creating new materials, products, equipment, systems, methods and processes or its improvement. R&D requires, first of all, financial support, which affects the budget of the concerned country. Funding of science, research and development in Slovakia belongs to one of the lowest in the European Union. Despite the high growth of the Slovak economy, rise of research, development and innovation lags behind the European average. Expenditures in this area in 2013 in Slovakia were 0.85% of GDP. [8] In contradiction with European trend, in Slovakia strongly prevails support of basic research apart from research funding especially from public sources. In the previous period, Slovakia had problem to increase business involvement in R&D financing. [5]
Sector of the Ministry of Education states that, "within approved Research and Innovation Strategy for Smart Specialisation of the Slovak Republic, the target was to achieve total expenditures on research and development 1.2% of GDP until

2020." Nordic countries support research and development within European countries the most. In 2013 it was Finland (3.32% of GDP), Sweden (3.21%) and Denmark (3.05%). On the other hand, the lowest expenditures below 1% of GDP stated Romania (0.39%), Cyprus (0.48%), Latvia (0.60%), and Bulgaria (0.65%).

A steady growth of R&D financing has been observed in world practice. This trend is determined, first of all, by the leading countries of the world, where absolute R&D expenditures have doubled or tripled over the last 20 years. Relative R&D expenditures of the world's leading countries as a share in their GDP have also shown positive dynamics (Table 1).

Domestic R&D expenditures in countries with economies in transition (% of GDP) Country	**2000**	**2005**	**2010**
Bulgaria	0.51	0.46	0.52
Hungary	0.81	0.94	1.16
Georgia	-	0.27	0.25
Kazakhstan	0.26	-	-
Cyprus	0.24	0.40	0.5
Kyrgyzstan	-	-	0.12
Latvia	-	0.7	0.6
Lithuania	0.59	0.75	0.79
Moldavia	0.18	0.37	0.49
Russia	1.05	1.07	1.16
Serbia	-	0.48	0.76
Slovakia	0.65	0.51	0.63
Turkey	0.48	0.59	0.85
Ukraine	0.96	1.03	0.82
Montenegro	0.13	0.16	0.21
Czech Republic	1.21	1.41	1.61
Romania	0.37	0.41	0.4

Table 1. Domestic R&D expenditures in countries with economies in transition (% of GDP)

R&D potential is centred in the public sector in Slovakia. Slovakia belongs to those OECD countries which have a relatively low representation of public universities in R&D (48% share). As for other Central European economies an important role is played by National Academies of Sciences (to a lesser extent departmental research institutes). [2]

Since 2013 SR implements within Operative programme Research and Development projects of 8 scientific parks which are developed at the universities and are to be finished within 2015. Total amount of irretrievable financial contribution was EUR 280 mil. combined from EU funds as well as from state

budget. Universities contributed to these projects EUR 15 mil. in total from its own sources. This activity significantly affects research development within our universities. Thanks to developed scientific infrastructure our scientists will be able to work with first-rate equipment and materials in new rooms using up-to-date technologies.

3. Success rate indicators of R&D in the Slovak republic

Official documents evaluate the level of R&D potential of the country, according to several indicators where those the basic ones are total number of R&D personnel, number of produced patents or number of submitted domestic and international projects, achieved level of publication activity. In our opinion, these indicators are greatly influenced by current development in the area of R&D support in the country. Currently scientific parks and research centres are built from the EU sources within Slovak universities and the Slovak Academy of Sciences.

3.1. The number of R&D personnel

Main measure of R&D potential of country is complete number of R&D personnel in national economy. Development of personnel number within science and development area in Slovakia had in 2008-2011 increasing trend. Complete number of personnel in 2011 was 28, 596 scientists what represents 1,22 % from total employment. According to statistics, the number of employees in science and researchers are increasing every year. Slovakia records slight increase since 2008 for relative indicators but after 2012 there is a significant reduction.

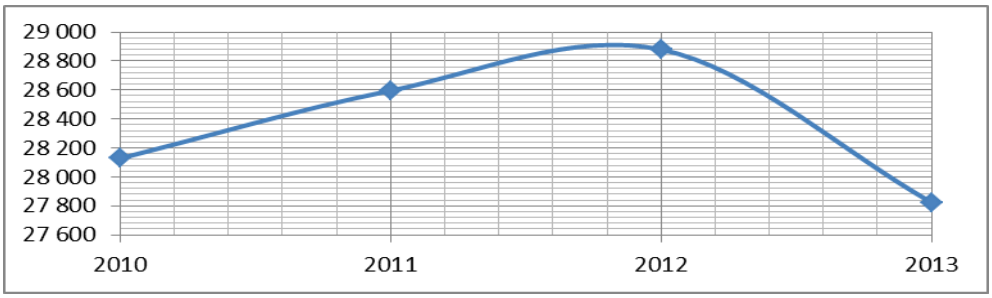

Figure 1. The number of R&D personnel from 2010 – 2013
Source: Statistical Office of the SR (2014)

We suppose that situation with the number of personnel within research in 2014/ 2015 will change while in 2013 projects of structural funds were launched which brought new work positions in 8 scientific parks and research centres. Scientific parks and research centres bring financial sources for building high-quality competitive laboratories and connected financial sources for wages. This fact

improves on one hand indicators of R&D in country but on the other hand, after end of project much of the personnel will return their previous workplaces or their work agreement will not be prolonged. Reason is simple – scientific parks and research centres will have to be financed to a large extent from its own financial sources. Sources which have to be obtained from commercialization of R&D results, contractual research, domestic and international projects and so on. It is necessary to realize that while within the period of project duration and necessary activities such as construction of buildings and furnishing of laboratories, in most cases, research will start in the period of sustainability. It means that sources on wages for personnel from project will not be available but at the same time it will not be possible to adequately present results of research and development. And of course it is necessary to take into consideration process of protection granting by means of intellectual property (IP). It will be interesting to watch development of this indicator after the completion of science park and research centre projects; if it will be possible to keep it and we will be able to declare the same number of active personnel within scientific field. Linking of new scientists, PhD students and student to new equipment would be a great chance to keep them not only at the University of Zilina but also generally within research. (Note: Statistics for 2014 were not available before conference deadline.)

3.2. Number of granted patents

Slovakia has a relatively low number of granted patents per million inhabitants, thus indicating a low creative activity and capacity of the country to utilize their knowledge with available financial resources and turn them into the potential economic gain.

	2009	**2010**	**2011**	**2012**	**2013**
Granted patents/ registered utility models					
Domestic patents	66	57	50	43	39
Domestic Utility Models	184	196	285	290	228
Foreign	488	319	267	118	76
there of PCT*	448	288	244	96	63
Foreign Utility Models	66	87	92	68	59
Granted Patents	554	376	317	161	115
Registered Utility Models	250	283	377	358	287
PCT Applications from SR	21	27	49	28	32

* There of PCT – foreign applications which entered the national phase under PCT Patent Cooperation Treaty

Table 2. IP indicators (patents, utility models)
Source: [9]

Utility model protection is simpler, quicker and cheaper way to obtain exclusive rights to use technical solution commercially. Technical solution registered by a utility model must be new, must involve inventive activity and must be also applicable in industry. There are the same conditions as the granted patent protection. Institute of utility model is not valid in all countries.

Universities due to insufficient financial resources and the long process of patent granting, protect their technical solutions as utility models or as know-how. This reality is supported by the fact that in the existing practice of universities was a minimum of patents applied successfully in industry. Patent granting is applied especially in cases of possible commercial use of technical solutions abroad, or for the purposes of achieving accreditation outcomes for faculties. In research undertaken from sources of domestic or international projects, patents are submitted depending of the formulated project outcomes and financial resources for protection of IP. This confirms the above mentioned table.

It is necessary to note that most of research at universities is conducted by contract research. Contracts are often treated poorly and unfavourably for the universities. There is no protection of research results at the university and in many cases it is not allowed to publish or use it as practical example at lectures from security reasons. In further research in certain area, scientists have to make a licence contract with research consumer in order to follow their previous research in their further experience.

3.3. Bibliometrics

Bibliometric analysis (bibliometrics) is a tool for evaluating research performance with number of publications and citation data in particular country. The most widely used source of information is Thomson Reuters' database Essential Science Indicators (ESI). One of the most important indicators of evaluation is relative citation index (RCI). RCI has several forms. One of the definitions presents RCI as share of the average number of citations of the country to the average number of citations of the worldwide database. [2] The reached values of indicators in the SR for the period 2008 - 2012 are shown in the following table.

Bibliometric analysis for the period 2008 – 2012 in the Slovak Republic	
Average number of publications per year per 1000 population in observed period	0,53
Average number of citations per year per 1000 population in observed period	1,95
Relative citation index in observed period	0,63

Table 3. Bibliometric analysis for the period 2008 – 2012 in the Slovak Republic
Source: [2]

The value of relative citation index is less than 1 what indicates that the citing, (bibliometric quality) in the SR has a lower level than the world one. Below-average values measured by means of bibliometric analysis are the result of the undersized inputs. This confirms also the SCIMAGO Institutions Rankings World Report in 2012, according to which the scientific performance of universities and Slovak Academy of Sciences concerning to publishing performance is considered unsatisfactory. This evaluation compares institutions that published at least 100 scientific documents of any type in the global Scopus from Elsevier. In the evaluation there are mentioned only 6 institutions from the SR (one of which is Slovak Academy of Sciences as a whole, and 5 universities). This means that no other institution, university, research institute or company published even 100 works (publications) in 2010 in international scientific journals reported in SCOPUS databases. [7] Nevertheless, the SR has achieved a relatively high efficiency of expenditures in terms of the average amount of expenditure and the number of publications in current contents journals database in the 2005 - 2009.

For example, a publication in the field of natural sciences costs in Slovakia less than half in Denmark and one fifth of the price in Germany. Similar proportions of price and quantity were reported in other fields. Similarly, the cost per one citation is lower than the European average. The overall effectiveness of outputs in comparison with the volume of inputs in the Slovak science cannot be assessed as bad, more to the contrary.

4. Current measures in Slovak Republic for increasing the success in the commercialization of the R&D results at home and abroad

The study, worked out by WIPO in 2010, showed that the Slovakia, as one of the European countries with transitive economy, had not established the measures of state support for innovations. (See table below).

The leading countries of the world are paying more attention to the support which helps in achieving more effective use of IP.

Country	State system for fostering innovations	Bank support for new technologies, support for SMEs	Tax benefits for inventors	Tax benefits for enterprises, including SMEs	Tax benefits for commercial transactions involving IP
Azerbaijan	-	√	-	-	-
Armenia	√	+	-	√	√
Belarus	+	√	+	+	+
Bulgaria	+	+	+	+	√
Hungary	+	+	+	+	+
Greece	+	+	+	+	+
Georgia	+	-	+	-	-
Kazakhstan	+	√	√	√	√
Cyprus	+	+	-	-	-
Kyrgyzstan	+	-	-	-	-
Latvia	-	+	√	√	-
Lithuania	+	+	+	+	+
Moldavia	+	+	+	+	-
Russia	+	+	+	+	+
Serbia	+	+	-	-	-
Slovakia	-	-	-	-	-
Turkey	+	+	-	-	-
Ukraine	+	+	-	+	-
Czech Republic	+	+	√	+	√
Romania	+	+	+	-	-
Israel	√	+	√	+	√

Note: (+) ‑ yes; (-) ‑ no; (√) ‑ no answer

All measures of state support for innovations are aimed, first of all, at achieving more effective use of IP, i.e. at supporting the IP commercialization process. The main issue here is how effective such measures are.

Table 4. Systems for supporting innovations and intellectual property in countries with economies in transition
Source: WIPO (2010)

Currently SR is oriented on the support of technology transfer by building the "National Technology Transfer Support System" through the implementation of the national project “National infrastructure for supporting technology transfer in Slovakia - SK NITT” by the "Slovak Centre of Scientific and Technical Information".
“The project’s primary objective is to propose and put into effect the national infrastructure to support technology transfer, and thus contribute directly to more intensive and efficient state support to research and development.“
Through this project was also created “The National technology transfer portal (NPTT)”, where researchers and administrative workers can find relevant information about the activities in technology transfer (TT) in Slovakia. Similarly, through this national project and mainly the active cooperation of universities and the Slovak Academy of Sciences (SAS) in its implementation, the treatment with IP

and knowledge in these institutions has improved, with emphasis on the protection and effective application in practice.
Equally, it is possible to point out that the most of Slovak universities and science – research workplaces have already accepted internal regulation – directive for the field of IP protection and technology transfer or they are working out some. At the same time Technology Transfer Offices (TTO) are formed near individual academic and science – research institutions targeted on providing commercial application of university knowledge and results of research and development into practice. In some cases TTO are created as one of the university structures, in others there are created independent business subjects where university has its share or has signed a contract on cooperation and through this organisation a commercialisation of IP of the particular university is being created.

University's TTO – main tasks:
From our experience with previous development in the protection and commercialization of IP in Slovak universities, it is possible to define the basic tasks of TTO as follows:

a) Complex support to management of IP rights,
b) Transfer of education and R&D results into the practice.

In accordance with the basic tasks, TTO should carry out the following activities through its specialized personnel, as well as through cooperation with external or internal entities aimed at the technology transfer:

a) Management of IP from the first phase – creation of the subject, through its commercialization and development, until the last phase – expiration
b) Support when negotiating the conditions of contracts from IP
c) Projects Support
d) Consulting on the management of IP and technology transfer to SMEs
e) Cooperation with the Industrial Property Office, SCSTI SK, centres for technology transfer from other universities and colleges and so on
f) Operating/management of the incubator.

4.1. Institutional support for applied research in the University of Žilina

At the University of Zilina is currently formed TTO (specifically named Center for Technology Transfer – CTT). Its core tasks and activities are in accordance with the tasks and activities, stated above. This allows researchers to receive support when signing research contracts, writing and administering projects, support in the process of IP protection and its commercialization with an emphasis on support for the creation of spin-off companies and their administration.
TTO also helps researchers in obtaining funds for research, in cooperating with the practice, in contracting research, at the events and competitions, and so on. In case of problems, researchers can also obtain legal advice and support in violation

of their rights. Similarly, through TTO is application of the research results checked during the whole process of IP protection and transfer, respectively throughout the whole lifetime period of the subject of transfer.
In view of the former mistakes associated with the conclusion of research contracts and collaborative projects, there was designed model for adopting new orders of research. Model includes the consultations on legal, economic and technical aspects of the contract, so that rights of the university and researchers were protected. It is also the way how to ensure connection of TTO to the phase of approving orders, contracts signing and also to billing the customer. TTO then obtains an overview of the type of solved research tasks, quality and efficiency of researchers, about R&D potential of university departments, revenues and benefits of research in relation to the costs and of course, it collects information relevant to the protection of IP and its transfer into practice. Researchers on the other side, receive support and assistance in negotiating contract conditions, in communication with partners, in management of IP rights which resulted from the research project. Finally, the TTO is also focused on controlling sources to research. Sources must be properly secured, identified and protected without violation of third party rights.

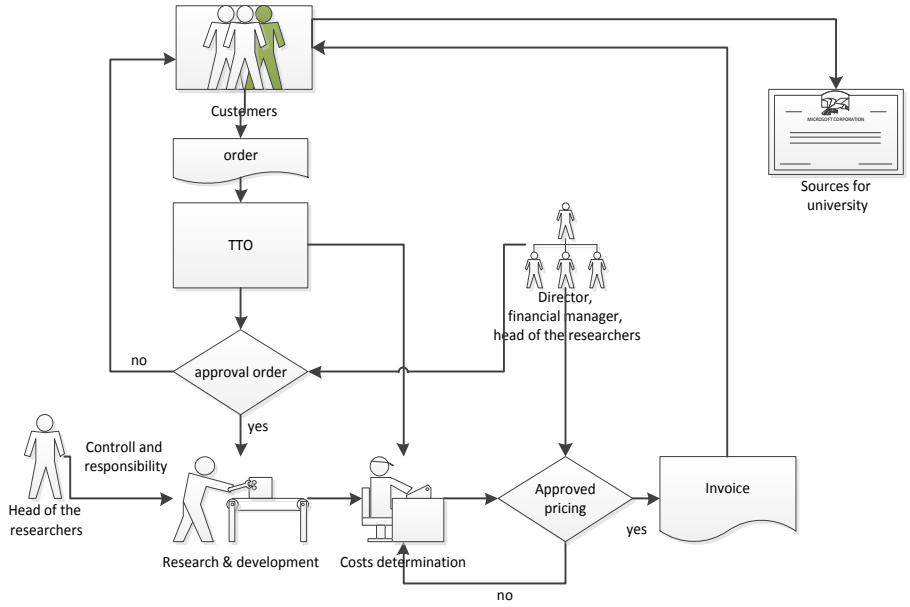

Figure 2. Model for approving new research projects - research orders:

The above diagram shows the involvement of TTO to the approval process of an order, to the cost determination (costs for wages, material costs, cost for IP protection, legal aid, etc.), and so into the price evaluation of research.

4. Conclusion

The aim of this article was to point out on the level and support of research and development within Slovak universities. Funding and support are closely connected with first phase of protection and transfer of research and development results into practice. In this phase an independent subject of protection/ transfer subject is being created.
According to the authors, indicators for the level and success of R&D will need to be reviewed with regard to the expected return on funds invested, i.e. application of research results within 2017 - 2020. It will be necessary to determine whether on one hand, the values of these characteristics have been maintained, or rather have been increased or on the other hand, whether the adequate financial return on funds raised from Structural funds was achieved.

It is possible to conclude that our country has made a significant progress, despite indicators of success within research and development in SR insufficiently reflect current situation concerning its contents. University personnel – scientists as well as students perceive process of research and development results transfer into practice in a complex way. Various universities engage them into this process especially when presenting contributions for research consumer and advantages of their solutions in comparison to competition. At the same time specification of research tasks comes about, based on requirements from practice or in accordance with international research calls what changes orientation of research on current economic and social problems. We are able to build first-rate laboratories competing to those abroad through projects of structural funds. Students and PhD students have possibility to work in such laboratories what helps us to keep them at the universities. It supports their entrepreneurship by means of start-ups, they are offered possibility to visit university incubators. Employees – scientists gain overview on treatment with their IP by building effective and transparent transfer processes of research and development results into practice, they build their trust to mother institution and gain additional finance sources and partnerships for their activities.

References

[1] Act no. 172/2005 Coll. on Organisation of State Support for Research & Development as amendment
[2] Agentúra ministerstva školstva, vedy, výskumu a športu SR pre štrukturálne fondy eú (ASFEU). Správa o stave výskumu a vývoja v SR za rok 2012 s vyhodnotením úspešnosti a efektívnosti grantových schém na podporu výskumu a vývoja financovaných z verejných zdrojov. [The Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic for the Structural Funds of EU. The report on the state of research and development for the year 2012]. Bratislava, 2013 Retrieved from:<https://www.vedatechnika.sk/SK/VedaATechnikaVSR/Rada%20vldy/Rok

ovanie%20vlady%20SR%2024.%209.%202013/Stav_VaV_uspesnost/vlastny_material_12.pdf>.
[3] Eurostat: Slovensko dalo na vedu a výskum 0,83 % HDP. Retrieved from: <http://www.euractiv.sk/lisabonska-strategia/clanok/eurostat-slovensko-dalo-na-vedu-a-vyskum-083--hdp-023113>.
[4] Meo, S A., Usmani, A. M. Impact of R&D expenditures on research publications, patents and high-tech exports among european countries. Eur Rev Med Pharmacol Sci. 2014;18(1):1-9.
Retrieved from: <http://www.ncbi.nlm.nih.gov/pubmed/24452936>.
[5] Ministerstvo školstva, vedy, výskumu a športu Slovenskej republiky. Správa o stave výskumu a vývoja v SR za rok 2013. [The Ministry of Education, Science, Research and Sport of the Slovak Republic. The report on the state of research and development for the year 2013]. November 2014.
[6] Organisation for Economic Co-operation and Development. Frascati Manual. Proposed Standard Practice for Surveys on Research and Experimental Development. OECD Publications. Paris, 2002. ISBN 92-64-19903-9.
[7] SCIMAGO Institutions Ranking World Report 2012. Retrieved from: <http://portal.uc3m.es/portal/page/portal/investigacion/rankings_universidades/sir_2012_world_report.pdf>.
[8] Štatistický úrad SR. Ročenka vedy a techniky v Slovenskej republike 2014. [Statistical Office of the Slovak Republic. Yearbook of Science and Technology in the Slovak Republic 2014]. November 2014. ISBN 978-80-8121-333-5.
[9] Úrad priemyselného vlastníctva. Výročná správa 2013. [Industrial Property Office. Annual Report 2013]. KOPRINT, s.r.o. Banská Bystrica, 2014. ISBN 978-80-88994-84-8.
[10] World Intellectual Property Organization. Economic Aspects of Intellectual Property in Countries with Economies in Transition. 2011. Retrieved from <http://www.wipo.int/export/sites/www/dcea/en/pdf/econ_ip_en.pdf>.