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**INNOVATIVE ACTIVITY DEVELOPMENT AT TECHNICAL  
UNIVERSITY (RUSSIAN CHARACTERISTIC ASPECTS,  
PROBLEMS AND SOLUTION)**

Alexander Y. Chmykhalo (a), Nikolay A. Vtorushin (a), Alena I. Derkach (b), Alina Y. Shmakova (b)\*

\* Corresponding author

(a) Tomsk polytechnic university, 634050 Lenina Ave., 30, Tomsk, Russia, sanichtom@inbox.ru  
(b) Tomsk State University, 634050 Lenina Ave., 36, Tomsk, Russia

**Abstract**

This study focuses on the identification of actual problems in the development of innovative activity in Russian universities and possible solutions to these problems, taking into consideration the potential of regional innovation systems. The efficiency of the applied approach to the functioning of innovative activity is estimated on the basis of results analysis of research and development (R & D) carried out by the staff of Power engineering Institute of Tomsk Polytechnic University (Russia). The approach to the organization of research and development (R & D) employed in this Institute makes it possible to obtain valuable research findings (articles, patents). However, these findings and data are not in demand and can hardly find their application in the form of innovative production. It is stated that this situation is typical for the University as a whole and is associated with the peculiarities of the functioning of the regional innovation system. It is concluded that it is necessary to search for new approaches in the functioning of innovative activity of university staff and students.

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**Keywords:** Innovation, national innovation system, higher education system.

## 1. Introduction

Nowadays, the need to create in future the economy of innovative type is rapidly recognized by the Russian government. This is due to several reasons such as: state budget dependence on taxes from raw material industry of the economy, modernization of the military-industrial sector, scientific and technological lag of the country, social demand for improvement of the quality of life and so on. The



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complex of these issues underlines the importance of taking further steps in the development of the national innovation system (NIS) of Russia.

Russia derived many elements of the national innovation system from the Soviet Union. State-run institutions played leading roles in its structure: they performed the full range of work related to innovation, from the formation of the order to conducting the research, to the provision issues of innovative products consumers. In the beginning of the 1990s, significant changes occurred in the innovation system of Russia. The most significant change was the elimination of state institutions and enterprises monopoly in the structure of the national innovation system (NIS).

Moreover, some changes happened in the higher education system (HES), which played an important role in the innovation system of the USSR. Instead of state-run enterprises, the growing quantity of graduates of Russian universities preferred to find employment in private companies.

However, still the role of companies that are either fully or partially owned by the government is very significant for Russian economy. Therefore, state-run institutions, enterprises and companies remained the key consumers of innovative production release during the whole period after the demise of the Soviet Union.

In 2011, Russia adopted "Russian Innovative Development Strategy for the period up to 2020" which stated the need to create innovation-based economy. This has made it possible to define new direction of development for the Russian higher education system. It is presented by the necessity of forming a new generation of creatively thinking young professionals, oriented towards innovative activity, and who will not only have the knowledge and skills to work in modern production, but also the desire to create new products, technologies, companies, production, i.e., the economy of innovative type, in which the leading role will be played by companies operating in the field of high technologies.

In this regard, a program called "Project 5-100" was launched, which aims to raise the profile of the Russian higher education and to propel at least five Russian universities to the top hundred universities of the world according to three versions of global rankings: Quacquarelli Symonds, Times Higher Education or Academic Ranking of World Universities. Ultimately, the implementation of this program aimed at improvement of the quality of specialists training in Russia on the basis of the best international practices, the improvement of the efficiency of research and development (R & D), as well as the competitive recovery of economy.

This article reviews the experience of innovative activity of Power Engineering Institute - one of the leading departments of Tomsk Polytechnic University (Russia) in the field of research and development (R & D). By the example of analysis of this Institute activities, it will be possible to identify the most relevant and common problems in the development of innovative activities in the Russian higher education system (HES). The main directions and opportunities of their solution will be analyzed and estimated.

There are a lot of current researches, covering the issues of cooperation between higher education system and governmental agencies, business on innovation development (Chmykhalo, & Abushaeva, 2015). Generally, they cover issues of cooperation between universities and innovation centers operating in the countries of Western Europe, North America, Southeast Asia (Nelsen, 2005; Suh, 2010).

In current studies on the development of innovation and education, the preference is given to the use of the systematic approach to the analysis of the development and production of innovations (Freeman, 1987; Lundvall, 1992, 1998, 2003; Nelson, 1988), which will also be applied in this study.

Power Engineering Institute of National Research Tomsk Polytechnic University (TPU, Russia), the activity of which is analyzed in this article is a typical example of the branch of modern university activity. It combines research and development (R & D) with educational and training activities focused on students. That is why a positive solution to the problems in the development of innovative activity in such branches can serve as the basis for distribution of experience and boost the development of innovations in universities as well as in some regions of the country.

In the course of this research, we will try to answer the following questions:

Why the innovative activity of Power Engineering Institute of Tomsk Polytechnic University is not developed enough? The use of what new approaches could help to foster innovation in Power Engineering Institute and at the university as a whole?

The results of this research will help to make a certain contribution to the development of knowledge about the innovation system of Russia and its regional and institutional peculiarities.

The structure of the work consists of the following sections:

Section 1 provides an introduction and justification of the study.

Section 2 gives an idea about the theoretical basis of the work.

Section 3 describes the methodology of the study.

Section 4 analyzes the activities of Power Engineering Institute of TPU in the development of research and development (R & D).

Section 5 is devoted to consideration of possible ways to improve the efficiency of innovative activities in Tomsk Polytechnic University (TPU).

## **2. Theoretical background**

A systematic approach, proposed in the framework of the concept of national innovation systems is applied for the analysis of the results of innovation (Lundvall, 1992, 1998, 2003). The national innovation system is represented by a complex of interacting public and private institutions and companies, universities, whose activities are focused on the development, protection and regulation of new scientific knowledge and technology. Although the NIS concept is mainly used for the analysis of large-scale innovation systems like the state or vast territories, a small region may have its own specific characteristics which affect the innovative activity of people. Nationwide factors create the necessary conditions for innovation growth, but they may not be enough to ensure innovation development in every region (Chmykhalo, 2016). Therefore, it is important to take this circumstance into account when formulating the policy for the development of innovation and entrepreneurial activity at the regional level (Sleuwaegena, & Boiardia, 2014).

In recent research in the analysis of impact importance of local factors in the development of innovations, they use various units of analysis, in particular, the 'innovative milieu' (Camagni, 1995), the 'industrial district' (Becattini, 1987), the 'learning region' (Morgan, 1997) and the 'system of innovation' (Cooke, 1998) concepts, which allow considering innovation on various geographic scales, whether it is

the city (Camagni, 2001), the metropolitan region (Diez, 2002), the wider region (Porter, 1998). In our case, we will consider the development of innovations in the University functioning in the metropolitan area, covering the city of Tomsk and territories that form the united Innovation Centre (Chmykhalo, & Hasanshin, 2015).

Many authors emphasize the importance of establishment of specific institutional environment for the development of innovation (Varsakelis, 2001, 2006; Tebaldi, & Elmslie, 2008), paying attention to the role of a university in its creation and development. The literature on these issues indicates that higher education institutions have an impact on the development of national and regional innovation systems by means of two main channels. The first channel is realized through the implementation of university research activities, and the second channel — through the exploitation of the results of teaching and research activities of universities (Etzkowitz, Leydesdorff, 2000). This paper presents an analysis of activity results of Power Engineering Institute of Tomsk Polytechnic University through these two channels of interaction with national and regional innovation systems.

### **3. Methodology of the research**

In this article, we consider one of the examples of innovative activity development in a particular region. The results of the activities of Power Engineering Institute, one of the leading branches of the university in the field of research and development (R & D), are analyzed. The unit of the analysis is a part of the regional innovation system, mainly covering TPU and public corporations, as well as enterprises created with the participation of Power Engineering Institute of Tomsk Polytechnic University (TPU).

One of the key methods of the study is the use of a systematic approach, which creates better conditions for the most complete image of the whole variety of factors that have a significant impact on innovation. The study is based on empirical data on the activities of Power Engineering Institute of TPU (Russia) and the University as a whole, which was presented in the official annual reports for the period from 2010 to 2015 and uploaded on the official website of TPU (<http://tpu.ru/>).

### **4. Activity analysis of Power Engineering Institute of Tomsk Polytechnic University in the field of research and development (R & D)**

Power Engineering Institute is one of the major divisions of TPU. It provides training and retraining of specialists, conducts a wide range of basic and applied research.

The structure of Power Engineering Institute comprises the following departments:

Department of Electromechanical Plants and Materials, Department of Electric Drives and Equipment, Department of Industrial Electric Power Supply, Department of Theoretical and General Electrical Engineering, Department of Nuclear and Thermal Power Plants, Department of Steam Generating Machinery Engineering, Department of Theoretical and Industrial Heat Systems Engineering, Department of Heat and Power Process Automation, also it includes various laboratories and centers.

Current research, conducted by the staff of the Institute, is now mainly focused on the implementation of several scientific projects, such as:

- The conduct of applied research and experimental projects in order to create solid fuel gasification plants for energy and industry;
- study of fundamentals of resource-efficient and safe technologies of forest fire fighting with the help of temporal and spatial distribution of water droplets flow of polydisperse formulation with the use of aircraft;
- The development of basic elements of the theory of ignition of essentially inhomogeneous on their structure drops of organic, hydrogen and carbonic fuels;
- The development of the plasmodynamic method based on a unique high-powered spray system of materials for the synthesis of multifunctional coatings based on titanium.

In 2012, all the Departments of Power Engineering Institute, along with other university departments started to develop and implement innovative development programs. The structure of these programs involves the achievement of quantified indicators of 5 groups:

1. Indicators of successful educational activity (e.g., the number of published textbooks, new Double degree programs and so on.)
2. Indicators of Research and innovation (for example, defenses of doctoral thesis, publication of scientific articles)
3. Indicators of human resource development (e.g., the number of research fellowships)
4. Financial indicators (funds raised for programs and grants, sponsorship, etc.).
5. Reputation indicators (e.g., prizes and awards for scientific achievement)

The results of the implementation of this program of Power Engineering Institute of TPU, we can trace in Table 1.

**Table 1.** Results of activity of Power Engineering Institute in the field of research and development (R & D) for the period from 2011 to 2015

	2010	2011	2012	2013	2014	2015
Scientific publications/ among them in WoS, Scopus	233	255	316	448/46	no information available	no information available /210
Doctorate thesis	3	6	5	5	no information available	2
Candidate thesis	19	21	20	24	no information available	12
Funds raised for research and development, mln. of rubles	15,43	31,1	28,7	30,92	no information available	143,727
Contracts with companies, mln. of rubles	186,228	160,0	36,122	88,313	no information available	139,379

Describing the range of customers in the field of research and development (R & D), conducted by Power Engineering Institute, it may be noted that the Russian government acts as a main customer. For example, the customers may be presented by various public organizations and companies, such as: the Russian Science Foundation, the federal target program “Russian Foundation for basic research” and others. The institute scarcely focuses on the needs of other potential users, except the government. At the same time, the staff of the Institute initiated the establishment of a number of joint with the university companies (at least 7 out of 43 associated companies at the end of 2013) for the realization of scientific information and patents. However, the results of these companies activity are insignificant.

According to the results of 2014, the total income of small innovative companies established with the participation of TPU was only 310.2 million rubles (about \$ 5 million.). At an average, each company brought to TPU only about 7 million rubles (around \$ 100 thousand.). Thus, the total income of companies established with the participation of employees of Power Engineering Institute would be about 70 mln rubles (about \$ 1 million.).

At the same time, dividends received by TPU from all associated companies in 2014 amounted to the sum of 275 thousand rubles (according to the "Consolidated financial statements in accordance with International Public Sector Accounting Standards" from December 31, 2014). The dividends received from companies established with the participation of employees of Power Engineering Institute, as estimated, may not exceed the amount of 50 thousand rubles (less than \$ 1 thousand.)

Despite the significant expenses that Power Engineering Institute spends on research and development (R & D), the income from the intellectual property is also very low. In 2015, the total income from intellectual property (patents) amounted to only 757 thousand rubles (just over \$ 10 thousand.). The share of Power Engineering Institute remained unknown, because it is not shown in publicly available reports. But even the general university result is not satisfactory, taking into account that the financing of the research only in Power Engineering Institute was more than 143 million rubles (\$ 2 million more.) in 2015.

Why the results of innovative activity of the Institute are not commercially successful? In order to find the causes of this situation, we have used the results of innovative activity study presented by Henry Edisona, Nauman bin Ali, Richard Torkar (Edisona H., Ali bin N., Torkar R., 2013). They have distinguished a number of key indicators of innovation. These metrics can be classified into following major categories: R & D-based measures, revenue based measures, IPR-based measures, innovation counts-based measures, process measures, survey measures, investment-based measures.

With the help of this methodology for the evaluation of Power Engineering Institute innovative activity, it is possible to single out several key reasons why investments made in research and development (R & D) do not have a positive effect on the development of innovative activities. The reasons for this situation may be the following:

- Generally, the efforts of employees and administration of Power Engineering Institute and TPU are primarily focused on research and development (R & D). The largest bulk of financial, human, material and other resources are spent on its implementation. The direction associated with the search for a possible market for results of R & D is not considered as a priority area, because the state-owned companies and organizations are regarded as major consumers, which are R & D results monopolists;
- In innovative development programs of Power Engineering Institute, there are no measures that would have been used to increase the revenue from the implementation of research and developments carried out by the staff of the Institute. Neither in the organizational structure of the Institute, nor in the TPU structure, there are no consulting divisions or companies that could carry out this work;
- IPR-based measures are an important part of the work of employees of the Institute. However, since the cooperation between TPU and the University, the staff is organized in such a way that the main beneficiary party is the University, the authors of patents practically have no motivation in expanding the range of potential users;

- In Tomsk region, there are no infrastructure of innovation projects financing (business angels, venture capital funds), which would be interested in financing of projects in power industry, Smart-grid, and so on. Nowadays, the most investment attractive area for Russian business is presented by companies operating in the field of IT, and Internet technologies. In addition, the best part of companies created with the participation of employees of Power Engineering Institute and TPU has the registered capital of 10 to 50 thousand rubles (less than \$ 800). The administration of the Institute does not plan to expand the possible sources of funding associated with the use of TPU companies through IPO, which limits their opportunities for development (Ivanova, & Mertins, 2015);

- Currently in the Institute and TPU, there are no opportunities to investigate the market for innovative products, as well as to hire people to perform such important functions as human resources management, marketing. To a large extent, this result is due to the state policy in the sphere of education. In particular, in 2014, TPU stopped students' enrollment for education in such areas as: "Advertising and public relations", "Customs", "Human Resource Management" and «Foreign Area Studies".

Moreover, the vast majority of graduates of Power Engineering Institutes and TPU as a whole find their employment in existing companies, among which state-owned companies dominate. This limits opportunities for new companies to recruit qualified staff in Tomsk region.

Thus, inability to implement these steps on the formation of innovation continuum, starting from the idea to create a commercial product, reduces the possibility of success of innovative activities of the Institute and the University as a whole.

## **5. Conclusions and policy implications**

The lack of significant progress in the creation of innovation-based economy is a crucial problem of great concern for Russia. Particular concern was caused by the fact that in Russia, the range of innovative goods and services consumers is not wide enough. Existing customers, for example, educational institutions or health facilities, are not independent and more likely to choose the products of famous foreign companies with guaranteed quality, rather than the products of Russian innovative relatively unknown companies.

We believe that the search for solutions to the problems of innovative activity development in Russian technical universities is firstly needed at the regional, University and its divisions' level. For this purpose, we believe that it is necessary to undertake the following:

1. To create a consulting center (university or regional) to explore the market and to search for consumers of innovative production, released by Tomsk Polytechnic University.

2. To create development programs of innovative companies established with the participation of TPU in order to attract potential investors. Currently, public information about the companies associated with TPU is very limited and does not allow potential investors to make an adequate representation of the scope and prospects for their activities.

3. To make the possibility of participation of potential investors in innovative enterprises capital created by the University. To take steps to introduce Russian companies to stock market for funding through the IPO.

4. The lack of significant progress in Power Engineering Institute of TPU and in the University as a whole in the field of innovation production largely depends on the lack of people, who know techniques of business organization and who have a high level of organizational and management culture. That is why, the development of innovative activity in the university departments involved in the creation of innovative products is impossible without staff training in the field of HR management, foreign trade, marketing, organizational and corporate culture, and so on.

The experience of Tomsk Polytechnic University in the innovation development once again shows that the modern university, which is aimed at achieving success in the field of R & D, is in need of not only the divisions and departments that train specialists in the field of natural sciences and engineering, but also experts in the field of humanitarian and socio-economic sciences.

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