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**Conference on Land Economy and Rural Studies Essentials****PRACTICAL EXPERIENCE OF TRAINING OF  
POSTGRADUATES EMPLOYED AT INDUSTRIAL ENTERPRISES**

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**Abstract**

The article discusses the issues of increasing the efficiency of postgraduate studies, which can be achieved by attracting graduates of universities to postgraduate studies while working at industrial enterprises and conducting scientific research on problems arising at the place of work. The experience of Kazan National Research Technological University in holding a competition for research projects of graduate students "TechnoStart" is described, the purpose of which is to support talented graduate students who are able to solve applied problems for industrial enterprises. Postgraduate students applying for participation in the competition must submit a project aimed at solving the technological problem of a manufacturing enterprise and enlist the support of an industrial enterprise. The winners of the competition receive a grant in the form of an increased scholarship from the university and from a partner enterprise (50:50). The result of the work is new knowledge (dissertation), highly qualified personnel, a solved technological problem of the enterprise, the result of intellectual activity (RIA) (intangible asset / license) and the perspective of new joint projects (grants) with the enterprise.

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*Keywords:* Dissertation defense, industrial enterprise, innovative development, postgraduate training, R&D, university-enterprise cooperation



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## 1. Introduction

The Russian Federation has seen a significant decline in the number of graduate students over the past 10 years (RBC, 2020). Such negative tendencies in the training of scientific personnel are associated with a general imperfection of the training program for postgraduate students; low scholarship support for students; high density of the training schedule. This makes it difficult to combine training with work (Bekova & Jafarova, 2019); insufficient connection of science and industry and research topics with enterprise problems limits the career prospects of future candidates of science outside the scientific environment.

The publications of the world scientific community note the expediency of training graduate students with a focus on solving the problems of enterprises and the need to increase the employment of future candidates of science in the industrial sphere (Smith et al., 2014). The university and the enterprise are considered as partners in research commercialization of the results and postgraduate studies as a source of highly qualified specialists, influencing the growth of industrial innovations, increasing the productivity of production processes, developing an innovative infrastructure and building an effective economy (Higher Education Commission, 2013).

Several options are proposed for organizing the training of graduate students to increase their readiness for the implementation of scientific developments. Postgraduate training programs, regardless of the field of study, are saturated with disciplines related to commercialization, fundraising, entrepreneurship, attracting venture capital, etc. Such training is advisable for the subsequent creation by graduate students of small enterprises, innovative start-ups, etc. Research councils such as the UK are developing the idea of an “entrepreneurial researcher” capable of creativity and risk, ready for dynamic market changes (VITAE, 2012). R&D departments of enterprises are considered as a career option for a graduate, but the main emphasis is on opening their own companies (Allan et al., 2009).

Examples of successful interaction of university graduate students with the business environment and knowledge-intensive companies in the interests of developing the knowledge economy are given. The importance of the transition from mass training of graduate students to individual training is noted through interaction with companies and with the government and through the implementation of a model of grant support for projects (Williams et al., 2013). In these publications, the emphasis is on the development of new business by graduate students, but the organization of training for graduate students already employed at industrial enterprises is practically not studied. Another area of research is the quality of postgraduate training programs and their impact on a career at an enterprise, the importance of the personal qualities of students, the institutional environment. The role of a leader in the success of a graduate student is noted (Hadi & Muhammad, 2019).

The cooperation with enterprises is seen as a job opportunity, which makes it necessary to change the training programs for graduate students in accordance with the labor market; the leading role of representatives of enterprises in changing the structure, content and quality of postgraduate training is indicated. The need for employer participation in the development of training programs is noted (Tran, 2016). Indicators of the quality of programs are being developed; indicators are used for assessing the quality of postgraduate student training and their impact on employment and career (Brits & Steyn, 2019). Such publications do not provide examples of the participation of postgraduate students in specific

research projects of industrial enterprises, do not consider models of the cooperation "university-enterprise" in terms of the formation of topics and coordination of postgraduate research.

The closest to the topic of this article is the study of the experience of China in the preparation of graduate students in the framework of the cooperation "university-enterprise", when employees of enterprises form research topics on production problems for universities, to increase the pace of industrialization and introduce new scientific and technical solutions (Wang & Tang, 2013). It is important that the enterprise and the university participate in the appointment of the head (mentor) of the graduate student, in the formation of the topic and plan for the implementation of the applied project by the graduate student, in the coordination of the preparation of the thesis and defense, in the provision of laboratory or industrial equipment for research, etc. Examples of the cooperation between Shandong University of Technology and Shandong Lu Yang co., Ltd. are given (production of ceramic fibers) and a postgraduate student on the territory of this enterprise gives the case of the implementation of a research project. It is indicated that for a research topic that is significant for the company, a student chooses specific theoretical courses that he studies at a university (Cheng-he et al., 2013).

The relevance of this study is associated with the need to solve the problems of insufficient attractiveness and effectiveness of postgraduate studies in Russia, in particular through the cooperation between universities and industrial enterprises, including the preparation of postgraduate students already working at enterprises.

## **2. Problem Statement**

The problem is the lack of theoretical models and experience in the practical implementation of the cooperative interaction "university-enterprise" in the training of postgraduate students who are also employees of enterprises.

## **3. Research Questions**

The study provides answers to the following research questions:

- What are the qualitative and quantitative changes in the training of postgraduate students that have occurred in Russia in the period from 2013 to 2019?
- What are the qualitative and quantitative changes in the training of postgraduate students that have occurred at KNRTU (Kazan) in the period from 2013 to 2019?
- How is the interaction carried out with industrial enterprises in the preparation of postgraduate students, employees of enterprises?

## **4. Purpose of the Study**

The main purpose of the study is to present a model of the interaction "university-enterprise" in the course of training postgraduate students and the experience of Kazan National Research Technological University (KNRTU) and Moscow Automobile and Road Construction State Technical University (MARSU) in training postgraduate students who simultaneously work at industrial enterprises. Achievement of the goal was ensured by the consistent solution of tasks:

- Revealing the prerequisites for enhancing the interaction "university-enterprise" for high-quality training of postgraduate students.
- Presentation of retrospective data on the performance of postgraduate studies in Russia in general and at KNRTU in particular.
- Development of a conceptual model of the interaction "university-enterprise" in the preparation of postgraduate students employed at industrial enterprises.
- Formation of cases demonstrating the positive experience of training postgraduate students at KNRTU in cooperation with the enterprise that is the place of work of the graduate student.

## 5. Research Methods

The following theoretical and empirical research methods were used:

- 1) Theoretical research included analysis, synthesis, generalization of scientific knowledge on the appropriateness of the interaction "university-enterprise" in the preparation of postgraduate students.
- 2) Research materials are scientific publications on the research problem.

Empirical research included a qualitative and quantitative assessment of the performance indicators of postgraduate studies for the period of 2013-2019.

The study of indicators was carried out for Russia as a whole according to statistical data presented in the collections of the Higher School of Economics "Indicators of Science" and "Indicators of Innovation Activity". A retrospective analysis of the performance indicators of postgraduate studies at KNRTU and MARSU was carried out according to the reports of university rectors posted on the official websites of universities. Histograms of admission to graduate school, graduation from graduate school (including performance) in Russia; the level of innovative activity of industrial production and the level of technological innovation in the Russian industry; the number of postgraduate students, the effectiveness of postgraduate studies at KNRTU and MARSU, etc. for 2013-2019 were obtained using Excel tools.

Conceptual modeling was carried out to build a block diagram of the interaction "university-enterprise" in the interests of training postgraduate students working at an industrial enterprise.

- 3) We used the results of theoretical studies to identify the prerequisites for enhancing the interaction "university-enterprise" for high-quality training of postgraduate students, as well as the practical experience of the authors of this study with postgraduate students employed at industrial enterprises.
- 4) The generalization of the practical experience of KNRTU and MARSU with postgraduate students, in particular those employed at industrial enterprises, served as the basis for the formation of cases.

The cases used examples of the positive experience of training postgraduate students at KNRTU and MARSU in cooperation with enterprises, research topics and organization of the interaction "university-enterprise".

## 6. Findings

### 6.1. The feasibility of strengthening the interaction "university-enterprise" for high-quality training of graduate students

Publication activity on the preparation of postgraduate students in Russia is associated with a gap in scientific research carried out in universities and innovative activities for the implementation of technological innovations in industrial production. In a study, Kutuzov et al. (2011) noted the importance of training personnel in accordance with the demands of the labor market, especially when financing education by the state, which remains the main source of providing training for graduate students in public universities. The expediency of personnel training is demonstrated, taking into account the requests of industrial enterprises, the implementation of joint R&D aimed at obtaining new products or at the innovative development of existing industries.

The model of the interaction "university-industrial enterprise" is based on the principles of mutual utility and consists in the joint development of training programs, the conclusion of partnership agreements, the reading of individual courses by the enterprise, the involvement of students in joint projects, the provision of the research and industrial infrastructure by the enterprise, etc. (Kutuzov et al. 2011). It is indicated that the training of graduate students in the cooperation "university-enterprise" will accelerate the transition from a raw-material model of the Russian economy to an innovative economy, will allow one to modernize technologies and build up intellectual capital (Tikhonova, 2016).

Russian postgraduate studies are characterized by insufficient efficiency: less than 60% graduate with a postgraduate diploma, and up to 13% of those who enrolled defend their dissertations on time according to the training plan (Bekova & Jafarova, 2019). Indeed, the change in the procedure for the preparation of graduate students in 2013 (Order of the Ministry of Education and Science of Russia of No. 1259, 2013), which allows graduate students to graduate without defending a thesis, with the issuance of a document confirming the completion of postgraduate studies, led to a sharp reduction in defenses. Currently, the need to return to the mandatory procedure for the protection of postgraduate students is being emphasized (Bednyi & Chuprunov, 2019).

Insufficient financial support for postgraduate studies from the state determines the high employment of students outside the university. Thus, up to 90% of postgraduate students are employed, full-time outside the university - 34%, but only 17% are associated with R&D in their working career outside the university (Bekova & Jafarova, 2019). It is noted that the opportunities for career development simultaneously with training in graduate school or after it, the accumulation of practice-oriented research experience, the use of modern research equipment, as well as the involvement of the leader, are the basis for the successful defense of a graduate student (Bekova, 2020).

Discussions are underway about the transition from the scientific degrees "Candidate of Technical Sciences" adopted in Russia to the degree "Candidate of Engineering", the preparation of which is inseparable from the topic of the future development of industry. It is assumed that such a postgraduate student will be an engineer of a new formation, will possess advanced production technologies in his field of knowledge, computer engineering, and provide innovative breakthroughs for enterprises (Rudskoy et al., 2017). It is noted that postgraduate studies should have a target orientation; postgraduate programs

need to be coordinated with specific enterprises; graduate degrees should be transformed into professional degrees for the specific area of work of the graduate (Bednyi, 2017a). The forms of the interaction "university-enterprise" include joint training programs; targeted training for the enterprise; monitoring of problems and perspective plans of the industry; monitoring the demand for research engineers; participation of enterprises in quality control of graduates; practical work at the enterprise (Syupova & Bondarenko, 2014).

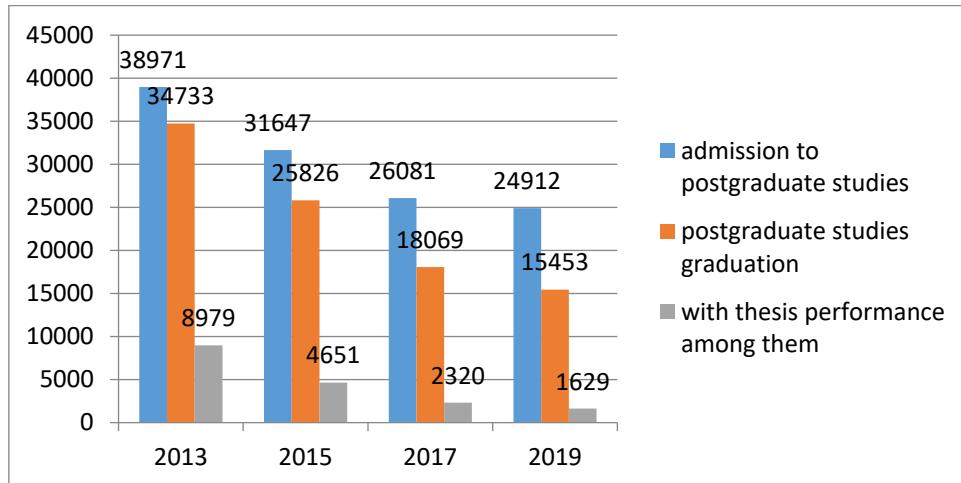
It is recommended that postgraduate training programs be oriented towards the future professional activities of the graduate; it is necessary to train research engineers capable of transferring science-intensive developments into industrial technologies. The model of industrial postgraduate schools proposed in the publications is based on the interest of employers in training personnel in the framework of their practice-oriented research. Joint research and development projects are considered as a source of financing for the training of postgraduate students (financing by an enterprise and mixed financing within the framework of grants is possible). The training program at the university should include the courses required by the employer (Bednyi et al., 2018).

Examples of postgraduate students training for industrial partners are given. So at Nizhny Novgorod University, highly qualified personnel under the industrial postgraduate program are trained for Russian Technologies, Rosatom, Ruselectronics. Postgraduate students carry out R&D commissioned by enterprises and, in addition to a scientific advisor from a university, have a consultant from an industrial partner. In addition, the enterprise agrees on the topic of scientific research, and the leading employees of the enterprises act as teachers in the framework of the postgraduate training program. The career development of such graduates is associated with obtaining a place as laboratory heads, research engineers, project managers at a partner enterprise (Bednyi, 2017b).

The given systematization of scientific publications on the research topic indicates an insufficient disclosure of the aspect of training postgraduate students already employed at the enterprise and combining work with postgraduate studies. However, the generalization of views on building relationships "university-enterprise" has value for developing a model for the training of postgraduate students already working in industrial production.

## **6.2. Retrospective studies of the performance indicators of postgraduate studies in Russia and at KNRTU**

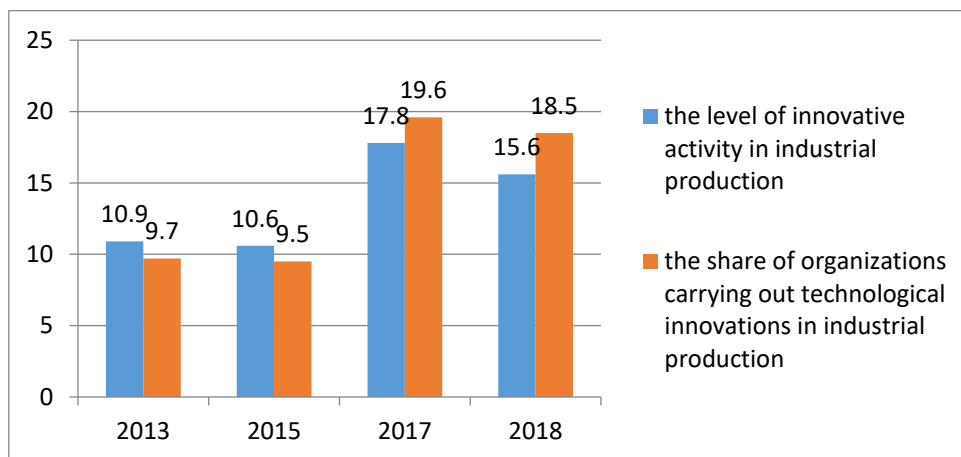
Statistics show a significant reduction in the number of graduate students from 2013 to 2019. Therefore, in Russia as a whole, at the end of 2013, there were 132,002 thousand people in graduate schools, and in 2019 - 84,265 thousand people, which is 1.57 times lower. The dynamics of changes in the indicators of admission to graduate schools, graduation from graduate schools and the performance of dissertations also demonstrate a downward trend (Figure 01).



**Figure 1.** Indicators of postgraduate studies in Russia in 2013-2019, in the number of people (compiled by the authors based on the data of Gokhberg et al., 2021)

According to Figure 01, admission to postgraduate studies in 2019 decreased 1.56 times compared to 2013; graduate school graduation decreased 2.25 times over the same period; the number of graduate students who defended their dissertations decreased 5.5 times. One of the important factors influencing such a significant decrease in the number of graduate students defended is the lack of connection between the research topic and current or future career.

On the other hand, to assess the prospects for including graduate students in R&D carried out jointly with enterprises or by their intention, the assessment of the indicators of the innovative activity of Russian companies is of great interest (Figure 02).

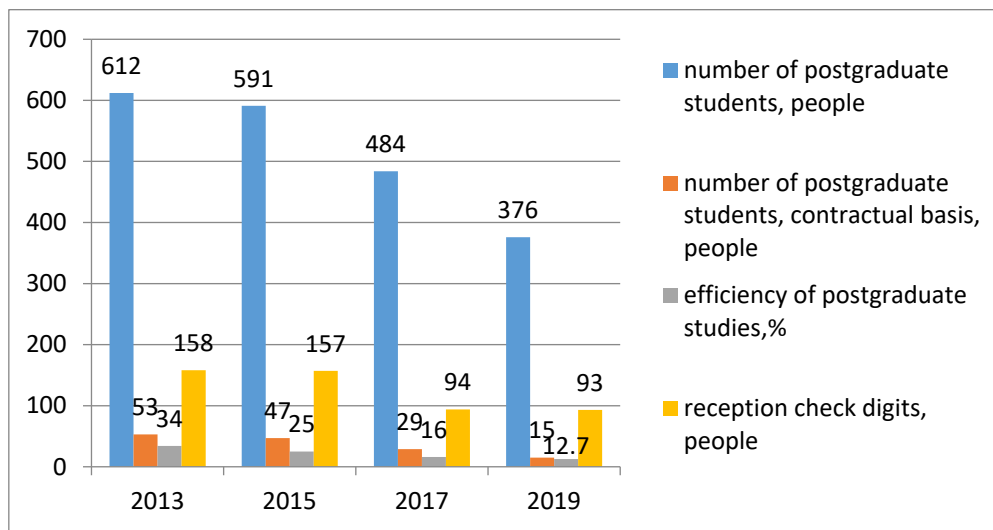


**Figure 2.** Indicators of innovative activity of Russian enterprises in 2013-2018, in % (compiled by the authors according to Gokhberg et al., 2020)

According to Figure 02, enterprises are increasing their innovation activities. Thus, the level of innovative activity in industry increased 1.6 times in 2017, slightly decreased in 2018, but remained 1.4 times higher than that in 2013. Similarly, in 2018 the share of enterprises introducing technological

innovation increased 1.9 times if we compare it to that of the year 2013. Thus, the data indicate a greater expansion of innovative activity in industry, as well as an increase in the number of organizations implementing such innovations. Positive trends in innovative industrial development create prerequisites for the involvement of graduate students in research commissioned by enterprises or carried out jointly with enterprises.

Moving from the general situation in Russia to the dynamics of the indicators of the training of graduate students in individual universities (Figure 03), we can note tendencies that correlate with the all-Russian trend.



**Figure 3.** Indicators of postgraduate studies at KNRTU 2013-2019 (compiled by the authors based on the Rector's report, 2019)

So, at KNRTU, the number of graduate students from 2013 to 2019. decreased 1.63 times; the number of those wishing to study in postgraduate studies on a contractual basis has significantly decreased 3.5 times and the effectiveness of postgraduate studies - 2.7 times over the same period. The effectiveness of postgraduate studies is assessed as the ratio of the number of defended dissertations to the total number of graduate students.

Increasing the effectiveness of postgraduate studies can be achieved by attracting graduates of universities who work at industrial enterprises and are interested in conducting R&D on problems arising at the place of work in postgraduate studies. The need to formalize the structure and content of the "university-enterprise" interaction in the framework of the training of graduate students working at industrial enterprises requires the development of a model for such cooperation.



### **6.3. The model of the interaction "university-enterprise" for the training of graduate students working at industrial enterprises**

The interaction "university-enterprise" for the postgraduate students working at the enterprise is carried out, inter alia, through the Competition of research projects of postgraduate students of KNRTU - "TechnoStart". The objectives of the competition are:

- strengthening the relationship of the university with the real sector of the economy;
- reproduction of the scientific elite of the university;
- increasing the prestige of scientific activity;
- activation of the scientific activity of the departments of the university;
- transformation of knowledge, skills, technologies available in the scientific environment into real applied technical and technological solutions of industrial enterprises;
- development of infrastructure for scientific and innovative entrepreneurship;
- improvement of economic and moral incentives for the introduction of developments in production both for research teams in general and for individual research workers;
- decrease in the share of scientific migration from the university.

Postgraduate students applying for participation in the competition are required to submit a project aimed at solving the technological problem of a manufacturing enterprise and enlist the support of an industrial enterprise. Selection criteria:

- scientific novelty and effectiveness of the proposed solutions;
- the applied nature of the development (confirmed by a letter from the industrial enterprise);
- the proposed solution has global advantages in comparison with competitors and is of potential interest to the sponsor / partner enterprise;
- the achievability of the results of the proposed solutions - the availability of examination results confirming the technical and economic characteristics of the product, which allow them to be compared with the characteristics of similar competitors' products;
- assessment of the groundwork and intellectual property on the subject of the project;
- technical risks;
- commercialization prospects - determination of the market segment to which the product will enter, its capacity, the target group of consumers (buyers) of the product, including on global world markets;
- the estimated profitability of the proposed solution (gross profit, the ratio of the market price of the product to its cost) is significantly higher than the existing profitability in the industry.

The winners of the competition receive a grant in the form of an increased scholarship from the university and from a partner enterprise (50:50). The results of the work are new knowledge (dissertation), highly qualified personnel, a solved technological problem of the enterprise, RIA (intangible asset / license) and the groundwork for new joint projects (grants) with the enterprise.

## 7. Conclusion

Thus, an increase in the efficiency of postgraduate studies can be achieved by attracting graduates of universities who work at industrial enterprises and are interested in conducting R&D on problems arising at the place of work in postgraduate studies. In this case, the experience of Kazan National Research Technological University in holding the TechnoStart competition for research projects of graduate students is interesting, the purpose of which is to support talented graduate students who are able to solve applied problems for industrial enterprises.

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