

## **Analysis of Training System of Scientific Personnel Based on the Principles of Innovative Management**

**By**

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### **Abstract**

The article proposes a model that allows obtaining quantitative information about the capabilities of the university in the training of scientific personnel, the effectiveness of scientific research, the effectiveness of training doctoral students in a specific scientific specialty (group of specialties, field of science) and provides an opportunity for a comparative analysis of the activities of doctoral students. Also presented is an approach to the analysis of the training of scientific personnel in higher educational institutions, a methodology for assessing the state and prospects for providing personnel in priority scientific areas for the state. In addition, a system for assessing the scientific potential and effectiveness of postgraduate education is presented. It is shown that such assessments can be obtained as a result of surveys conducted among employers (structural divisions of scientific institutions, universities, heads of large scientific enterprises) and doctoral students.

**Keywords:** Higher education, doctoral studies, scientific potential, efficiency, monitoring, training of scientific and pedagogical personnel, academic degree, absolute and relative indicators, research funding.

### **Introduction**

As a result of the implementation of the strategy for the innovative development of the Republic of Uzbekistan for 2019-2021, significant progress has been made in ensuring and stimulating innovative and technological development in the sectors of the economy and the social sphere, including agriculture, energy, construction, education, health. While young scientists were 6.5 thousand in 2018, in 2022 their number was 10.8 thousand, that is, it increased by one and a half times [1]. In developed countries of the world, the training of personnel on educational programs after higher education is gaining mass character. In this regard, doctoral studies have become a full-fledged segment of the educational market. One of the main sides of the popularization is that according to the calculations presented by many scientific researchers both in Uzbekistan and abroad, about 70% of graduates consider obtaining a degree only as a means of increasing competitiveness in the intellectual labor market and do not intend to engage in scientific and scientific-pedagogical activities in the future. Thus, the degree is now losing its purely corporate status. In the scientific literature, it is increasingly expressed that today the degree demonstrates only the ability of its author to “penetrate deeply into the problem, express it in a solvable form, collect and analyze the necessary information, find a solution to the problem and defend this solution before a group of specialists in a critical mood.” In our opinion, the change in the socio-professional position of the scientific degree is, by the way, one of the factors that determines the growth of interest in further education after higher education, and not only for Uzbekistan. When organizing the training of scientific researchers in these new conditions, higher educational institutions have

to establish the necessary balance between scientific research, the quality of which remains the main criterion for awarding a scientific degree, and preparation for a wider range of professional areas of modern knowledge workers (intellectual personnel).

The trends characteristic of most developed countries in the system of post-graduate education in Uzbekistan coincided with the complex and contradictory process of adapting the Institute of education after higher education to the conditions and realities of the period. Over the past 5 years, a significant increase in the number of doctoral students in higher educational institutions of Uzbekistan has occurred against the background of a reduction in the scientific sector of the country, the structure of its disciplines has led to a change in shape, which today does not correspond at all to the structure of the personnel potential of science. Another, most alarming result of the popularization of doctoral studies was a decrease in the quality of dissertations in a number of scientific areas [2]. Thus, the objective needs of modernizing the national system of training scientific personnel today are associated with the need to optimize the structure of disciplines of the doctoral program, as well as to collect funds from the state budget into educational and scientific centers with sufficient scientific potential and resource base for training elite specialists in promising areas of Science, Technology and engineering. The solution of this problem underlies the relevance of the development of methods of comprehensive analysis of information in the field of training and certification of highly qualified specialists, in particular, the creation of an effective system for monitoring doctoral studies of higher educational institutions, which determines and evaluates the presence of the necessary conditions for the qualitative training of specialists and provides

In our opinion, the existing in the educational management system of Uzbekistan in the formalized control of the quality of post-graduate education is associated with the view of doctoral studies as a “slot of dissertations”, both at the level of stereotypes and conventionally enshrined. The most important and practically the only criterion by which the success of the doctoral career is assessed on it is “efficiency”, which is measured by the number of dissertations defended in a timely manner. Thus, the assessment of the quality of training in doctoral studies, in fact, turns out to be concentrated in the system of scientific councils established in the presence of higher educational institutions in which the doctoral student in the relevant specialties operates. Under these conditions, the scientific leaders of doctoral students and their colleagues actually evaluate the results of their work, while the need to ensure the required level of “efficiency” often helps to issue “raw” work for protection, not brought to the appropriate level.

Noting the current situation, we do not at all call for expert assessments of the quality of dissertations to be replaced by a certain set of formal criteria characterizing this quality. Of course, a formalized assessment of the results of scientific and educational activities cannot replace both the results of the assessment of dissertations by a qualified expert community and the assessment of the competence of dissertations by employers. At the same time, it would be wrong to apply an individual approach to the assessment of a particular dissertation work to the system for monitoring the quality of doctoral programs. If in the first case the most important thing is the quality of scientific work and the irreducible qualification of the applicant for a scientific degree for official criteria, then in the second case we will talk about the results of the research activity of a higher educational institution, which can be easily measured, and the sum of a number of averaged indicators

This article proposes a model of formal assessment of the scientific potential and effectiveness of doctoral studies, which is suitable for monitoring, research and comparative analysis of the activities of doctoral students of higher educational institutions in specialties of

the direction of Exact and Natural Sciences.

## **Analysis of Literature on the Topic**

Graduate school is necessary, first of all, for the realization of scientific and creative potential, and only then for the acquisition of new highly specialized knowledge. If you decide to connect your life with teaching and research, then the necessary step will be the introduction to graduate school. Postgraduate studies are the path to future PhD. Successful completion of Graduate School opens up great opportunities not only for increasing social status, but also for building a successful scientific and pedagogical career, which is in great demand in today's labor market [3].

Thanks to the creation of a single scientific and educational space in higher educational institutions in developed countries of the world, adaptation to the world intellectual labor market in accordance with the requirements of a knowledge-based society, graduate school is going through a period of rapid changes. At the same time, a whole group of problems accumulated in the system of training highly qualified personnel worries many scientists, which is reflected in numerous critical articles published by influential scientists, teachers of higher education, as well as representatives of higher educational institutions, as well as in the governing bodies responsible for increasing the scientific and pedagogical shift.

On the one hand, some problems were the result of the severe economic crisis of the 1990s, which led to an increase in the gap between different generations of researchers. The decline in the prestige of scientific work in Russia; the aging of scientific and pedagogical personnel; the weakening of the interest of young people in scientific and pedagogical activity, on the other hand, there are problems arising from the situation [4].

T. Shodiev believes that " the recognition of intellectual knowledge as one of the main factors in economic growth necessitates the revision of the issue of resource scarcity and the inability to recognize the limitation of the expansion of GDP. Knowledge is a source of new innovations and production efficiency, technological development is a source of international competitiveness, human and physical capital.

Indeed, the current globalization processes are taking place as a result of the transformation of the country's economy into a knowledge-based economy, and knowledge and Technology Act as the "heart" and "mind" of global changes" [5].

V.A. Sadovnichy's reasoning that " not everything in education can be attributed to market principles, accordingly education is a payment – oriented service, knowledge is a product, and the student is a buyer " [6] shows that the role of knowledge in society is very important. Gozhenko K.N. in his doctoral dissertation, he makes the following considerations: "in a post-industrial society, real control over production and resources cannot be given by either capital or land or labor. Knowledge is and remains the main economic resource. Knowledge reigns over traditional factors of production (land, labor and capital), which do not disappear, but become other state factors. ... In the knowledge economy, production is based on knowledge, not labor. ...

B. Sh.Usmanov believes that the competitiveness of prepared specialists and highly qualified scientific personnel in the country and the World Intellectual Property Market and the quality of personnel are also inextricably linked with the effectiveness of Education in universities and management of the process of science. In particular, the training of Masters

and, consequently, the issuance of Joint (two) diplomas, the activation of international mobility (mobility) of students and professors, the holding of distance education and videoconferents on the basis of joint educational programs with foreign universities of high scientific potential will also increase the competitiveness of the trained personnel[7].

1. Monitoring the activities of complex social structures, such as doctoral studies, should be based on the separation of a relatively small number of key indicators, usually called “order parameters”, among the large number of parameters that characterize this structure [8]. Since the training of highly qualified specialists in doctoral studies should be inextricably linked with the scientific activities of the units of higher educational institutions, when choosing the parameters of the procedure, it is necessary to ensure the monitoring of the state of the entire system of higher educational institutions “training of scientific personnel”. In this case, it is necessary to offer adequate, but very simple methods for practical use, which are useful for a quantitative analysis of the state and prospects for the development of doctoral studies, as well as for monitoring their activities by higher educational institutions and comparing them with the performance indicators of other higher educational institutions.

2. The choice of the object of analysis is an important opportunity that ensures the effectiveness of the analysis of the activities of doctoral students of higher educational institutions. Currently, two different approaches to the separation of education by monitoring and order are included:

- institutional assessment, in which the object of research is a full-fledged higher education institution [9];
- “specialized ” assessment, in which, as an object, a certain specialty, a group of relevant specialties or a field of science is manifested [9].

The choice of one approach or another is largely determined by the purpose of the research being carried out. It should also be noted that the features of training and certification of highly qualified personnel in disciplinary disciplines [10, 11] as well as the need to timely ensure the development of Personnel potential in priority scientific and technical areas at the present stage of modernization of Education determine the feasibility of using “specialized” assessment of doctoral students of higher educational institutions of Uzbekistan. Indeed, doctoral studies are conducted in certain specialties and programs, and not in a whole university. The quality of training in any higher educational institution may vary depending on the scientific specialty, therefore, the effectiveness of the average grades obtained when analyzing various subject areas is considered low.

3. The assessment and allocation of higher educational institutions known to us by order in most of the systems of Uzbekistan, the parameters are grouped in accordance with the structure of the resources of the following higher educational institutions:

- personnel (intellectual);
- material (material and technical);
- information;
- financial;
- social (socio-cultural).

Of course, all of the listed resources are important in the training of highly qualified scientific personnel, but there is no need to carefully study all the components of this complex for the analysis of doctoral activities and potential, since the scientific specialties that have

undergone the beginning of the licensing procedure should have the most necessary minimum of material, informational and socio-cultural resources. In our opinion, the most important elements of the resource potential that determine the quality and effectiveness of training highly qualified scientific personnel are personnel and financial resources.

4. In the development of the Monitoring model, we proceeded from the league “in creatively active scientific communities – as a rule, in large educational and scientific complexes integrated with state academies of Sciences and a leading network scientific organization, it is necessary to concentrate resources on supporting doctoral studies” in modern realities [12, 13].

***Selection and grouping of criteria and indicators:*** The expressed requirements for the development of a doctoral monitoring system justify the selection of criteria and indicators that reflect the characteristics of the source, process and results of the activities of higher educational institutions in the field of training scientific personnel. The proposed model used two types – absolute and relative indicators. Absolute indicators characterize the quantitative side of the conditions, scope and scientific potential of training scientific personnel in a particular field of knowledge. In the system of relative indicators, the size characteristics of the objects being compared do not matter, and in some respects, the qualitative differences of the objects being compared will be more clearly expressed.

Module 1 is intended to describe the potential of training scientific personnel in a particular scientific direction (specialty, group of specialties, subject areas).

Module 2 gives an idea of the effectiveness of the research activities of scientific and pedagogical personnel and doctoral students working in this direction, as well as the effectiveness of the system of training and attestation of relevant scientific personnel. The list of indicators used in each module is reflected in Table 1.

**1-table** *List of indicators to use*

Indicator designation	Expression of the indicator
<i>Module 1. Absolute indicators</i>	
1.1.1.a	Number of researchers and teachers involved in the implementation of funded research
1.1.2.a	The number of doctors of science participating in the training of highly qualified scientific-level personnel
1.1.3.a	The number of members of the Academy of Sciences of Uzbekistan, real and corresponding members, honored figures of the Republic of Uzbekistan, holders of State Awards, government awards and awards of the president of the Republic of Uzbekistan, honored personnel of Higher Education, honorary employees of higher professional educational institutions
1.2.1.a	Annual volume of financing of research work
1.3.1.a	Number of applicants and doctoral students for the degree of candidate of science
1.3.2.a	The number of doctoral students and applicants studying by order of enterprises and organizations within the framework of agreements on international scientific cooperation participating in joint scientific research with Institutes of the Academy of Sciences of Uzbekistan, enterprises of advanced technologies.
<i>Module 1. Relative indicators</i>	
1.1.1.o	The share of doctors of science among scientists and teachers participating in the funded implementation
1.1.2.o	The ratio of the number of doctors of Science under 50 and candidates of Science under 40 to the total number of doctors and candidates of science



1.1.3.o	The ratio of the number of actual and corresponding members of the Academy of Sciences of Uzbekistan, honored scientists of the Republic of Uzbekistan, holders of State Awards, government awards and awards of the president of the Republic of Uzbekistan, honored workers of Higher Education, honorary employees of higher professional educational institutions to the total number of doctoral students and applicants
1.2.1.o	Annual volume of financing per scientific and pedagogical staff
1.3.1.o	The number of background doctors and candidates of science corresponding to one preparing specialist (doctoral student, applicant)
1.3.2.o	Percentage of doctoral students with a master's degree in the profile of scientific work in doctoral studies
<i>Module 2. Relative indicators</i>	
2.1.1	The number of articles published by scientific and pedagogical personnel per year in specialized scientific publications in Uzbekistan and abroad
2.1.2	The number of presentations with lectures of scientific and pedagogical personnel at international and national conferences (congresses, symposia, seminars) corresponding to one scientific and pedagogical staff per year
2.2.1	The number of academic degrees awarded to doctoral students, doctoral students and employees corresponding to one scientific and pedagogical staff
2.2.2	The percentage of doctoral students who defended their PhD. thesis no later than two years after completing doctoral studies in the number of applicants
2.3.1	Average number of articles published in leading scientific journals and publications in Uzbekistan and abroad on the topic of the dissertation (when counting on one doctoral student)
2.3.2	Average number of speeches of doctoral students with lectures at international and Republican conferences (congresses, symposia, seminars) on the topic of the dissertation (when counting on one doctoral student)
2.3.3	The share of doctoral students carried out within the framework of which the dissertation research is funded (scientific and technical programs, grants, order-based, etc.).
2.3.4	In the total number of doctoral students specializing in this scientific direction, the share of winners of the competition for scholarships of the president of the Republic of Uzbekistan and the Government of the Republic of Uzbekistan over the past three years - laureates of international and Republican competitions.

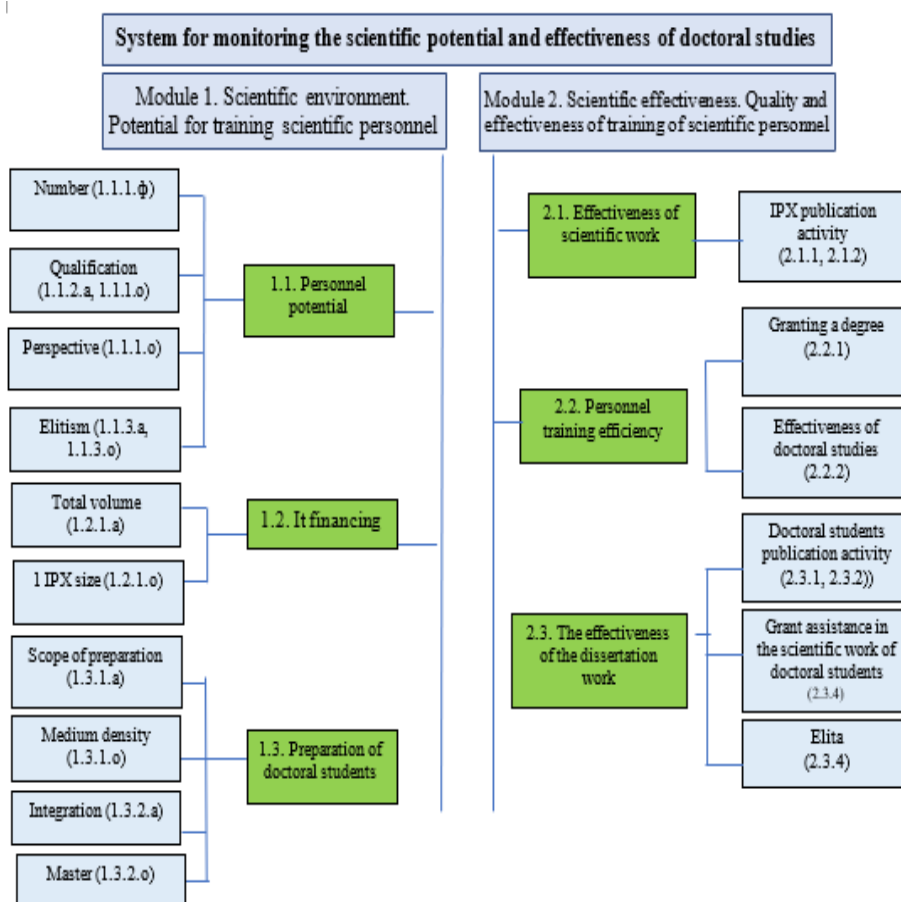
To analyze the scientific potential and effectiveness of doctoral studies, it is proposed to use six absolute and fourteen relative indicators, the next of which, as a rule, are not semantic analogues of absolute indicators. Let's briefly dwell on the proposed indicators. The structure of the Monitoring system is reflected in Figure 1.

Module 1. Scientific environment. The potential for training scientific personnel. In the assessment of the personnel component of scientific potential, in contrast to the institutional assessment of higher educational institutions, the study of the entire scientific and pedagogical personnel Corps of the CPSU is more than enough. At the same time, it is necessary to analyze the characteristics of not only scientific leaders of doctoral students, but also a wide range of researchers – scientific personnel and teachers who are involved in the implementation of research projects in this scientific direction (specialty, group of related specialties, field of Science) and make up the “scientific environment” in which the formation of The subject of analysis should be the number of scientific and pedagogical personnel, qualifications (academic level, scientific services) and “prospects”.

It is impossible to ensure the quality of training of scientific personnel “of high quality”, that is, isolated from competitive science. Therefore, the presence of stable financing of scientific projects is both a prerequisite and an important indicator of the scientific level of work performed. To assess this component of the resource base, it is advisable to use indicators that make it possible to assess the total amount of funding for research in this area and its specific value (when calculating for one scientific and pedagogical personnel).

The study of the factors of the effectiveness and quality of training in post-graduate education in an expert assessment method [14] showed the need to introduce indicators characterizing the scale of training of scientific personnel, the continuity of Master's and doctoral programs, as well as the role of integration processes in the training of specialists in

this direction.



**Figure 1.** Structure of the system for monitoring the scientific potential and effectiveness of doctoral studies

Module 2. The effectiveness of scientific research. Quality and effectiveness of training of scientific personnel. As mentioned above, the quality of doctoral dissertation work is largely determined by the level of research projects carried out by scientific communities in which the training of young scientists takes place. Foreign experience in assessing the effectiveness of scientific activity is mainly associated with measuring the level of demand for Scientific Products (factors of influence of journals, citation index of publications). However, the use of these indicators as a method of formal assessment of the effectiveness of Uzbek scientists today seems problematic for a number of reasons (for example, [15]). In addition, the inertia of the formation of the flow of responses to publications (several years) excludes the possibility of using the Citation Index to assess the quality of doctoral students' scientific products.

## Materials and Methods

Another common indicator for assessing the scientific contribution of a scientist is the total number of publications in leading specialized scientific publications. Although, according to the information model of the development of science [16], the number of publications is not a criterion for the effectiveness of the researcher's work, in a number of well-known works in the sociology of Science, a correlation was found between the publication activity of authors, the citation of publications and personal contributions to the development of science. In our opinion, articles published in leading specialized scientific journals make the results of the work accessible to the mass and scientific community, help to establish the priority of the

authors and can be a confirmation of innovation, a high scientific level of work and thus a reliable sign of the quality of scientific products of scientific and pedagogical personnel and doctoral students.

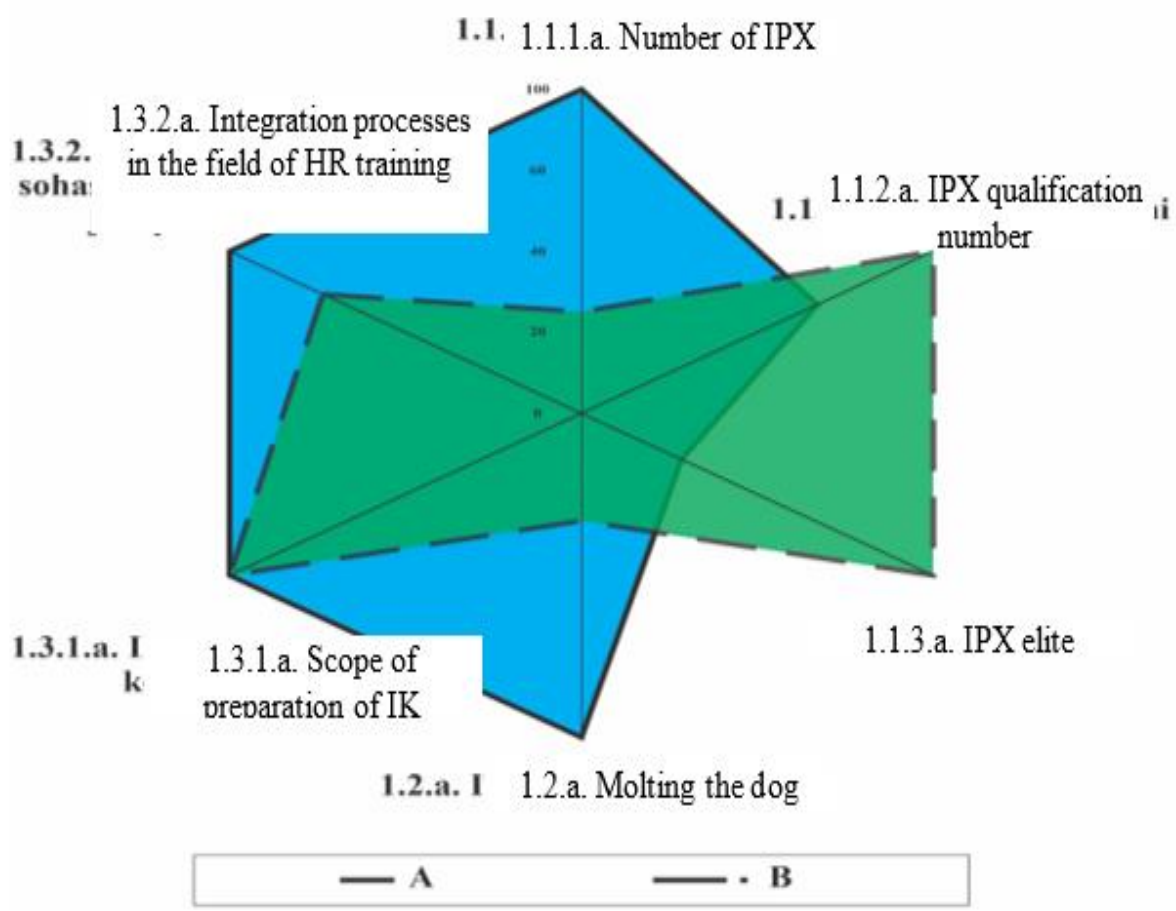
Along with publications, important methods for presenting the results of scientific research are lectures at conferences. At the same time, an adequate assessment of the quality of scientific work can be calculated only in those cases when we were talking about international and Republican conferences at a higher scientific level with the participation of leading specialists in this scientific field. The number of speeches with lectures at such conferences is also an important indicator of the effectiveness of research work.

The effectiveness of doctoral studies is usually estimated by the share of doctoral students who completed their studies with the defense of the dissertation in the general issue of doctoral students in the accounting year. Within the framework of the proposed model, a more "soft" parameter was introduced – "the percentage of doctoral students who defended their Ph. D. thesis no later than two years after graduating from doctoral studies in the number of enrollments", which corresponds to the current trends in assessing the time required for the preparation of a qualitative dissertation research. At the same time," at the entrance "normirovka (by the number of doctoral students who have not completed their studies, but entered) makes it possible to assess the effectiveness of doctoral studies, taking into account the fact that doctoral studies are sorted in the educational process.

One of the indirect indicators of the quality of dissertation work is the availability of research funding, within the framework of which research is carried out by doctoral students. In this regard, the monitoring system included the indicator "the share of doctoral students carried out within the framework of the ITU (scientific and technical programs, grants, ordered ITU, etc.), for which dissertation research is funded." In addition, the monitoring system provides for an indicator "the scale of the elite of the doctorate", which allows you to use an external assessment of the quality of training of scientific personnel in the number of laureates of international and Republican competitions, winners of scholarships of the president and government of the Republic of Uzbekistan.

The methodology for presenting data is convenient for a comparative analysis of the scientific potential and effectiveness of doctoral studies, as well as for the study of the dynamics of doctoral studies (for example, in self-examination) using a complex graphical representation of the values of absolute and relative indicators. The essence of this methodology lies in the following. All indicators are brought to the same size on a scale of 0-100 (the maximum value of the indicator in the group of comparable objects is taken as 100, and all other values of this indicator are determined in the percentage of this value). The results are presented in the form of stars whose number of Rays  $N$  is equal to the number of indicators, and the angle between the Rays is equal to  $1/N$ . In our case, when visualizing the values of the indicators involved in module 1,  $N = 6$  (for both absolute and relative indicators, which should be considered separately). To present the relative indicators used in module 2,  $N = 8$ . It is possible to build polygons by leaving the values of the indicators along the Rays on a scale of 0-100 and connecting the formed segments, in which the shape of the Polygon reflects the degree of equilibrium of the contribution of all indicators to the final result, while the size of the form conditionally characterizes the integral "capacity" of the research object..

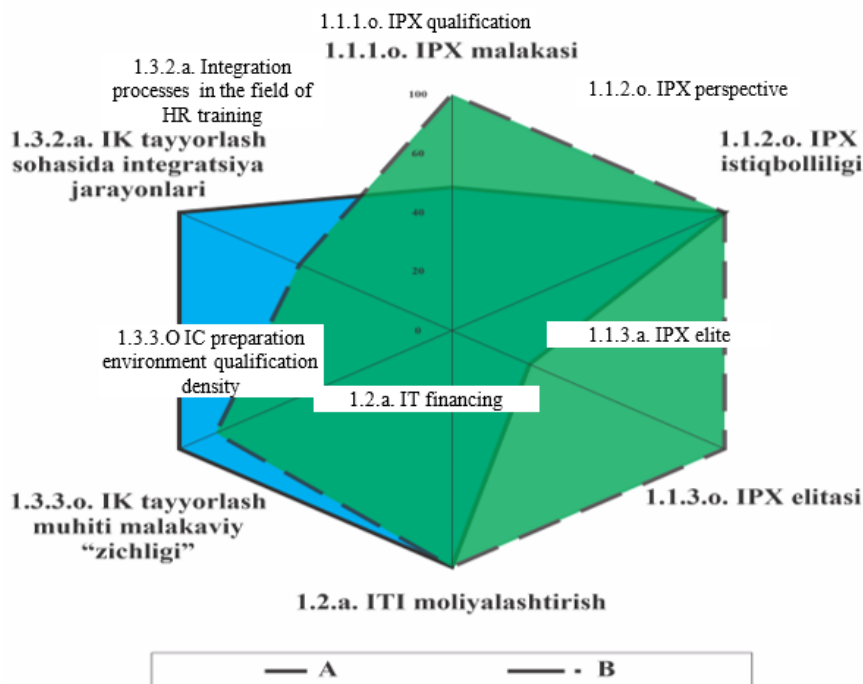




**Figure 2.** *Module 1: system of absolute indicators*

We will describe the functionality of the methodology presented using the example of a comparison of two groups of natural-scientific specialties in the doctorate of Bukhara State University. In this work, mainly in solving the methodological task, we found it necessary to give conditional Signs “A” and “V” to the objects of analysis.

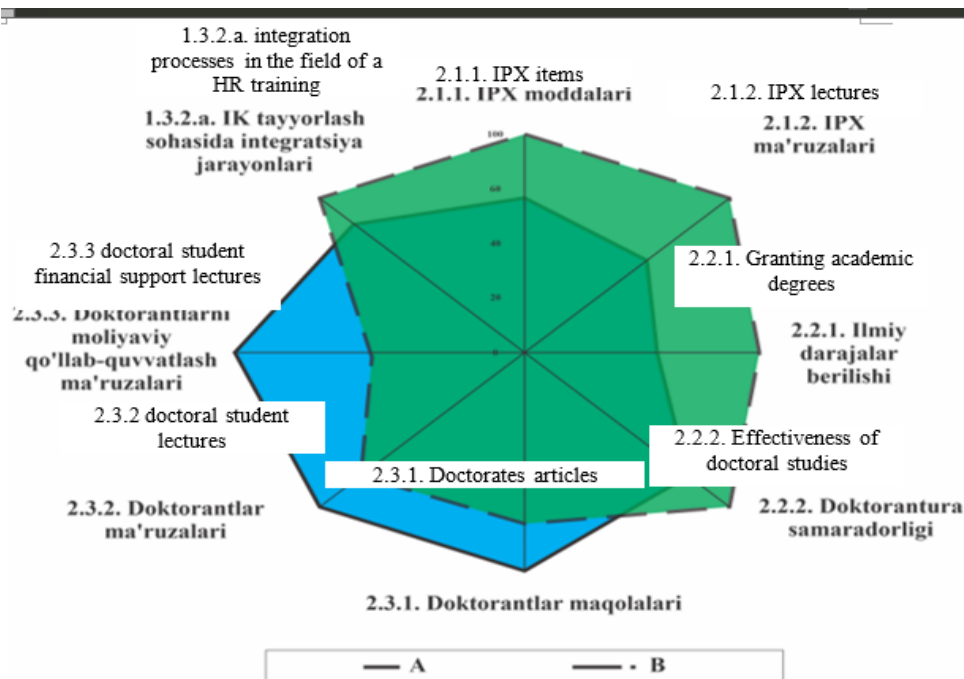
Comparison by absolute indicators (Figure 2) shows that the “capacities” of the objects being compared are close to each other, but the structures of the potential for training scientific personnel (forms of polygons) are seriously different. If such indicators as “ITU financing”, “number of IPX” and “integration processes in the field of training of scientific personnel” have made a significant contribution to the " a " doctoral program, the “V” will lead in terms of indicators reflecting the qualifications and elitism of scientific and pedagogical personnel.



**Figure 3.** *Module 1: relative indicator system*

When switching to relative indicators of the resource base (fig.,3) “A” additional advantages of doctoral studies on the continuity of the levels of training of scientific personnel are revealed (1.3.2.o – ” the share of doctoral students with a master's degree in the profile of scientific work in doctoral studies“), and to a lesser extent - ” density of the scientific environment ” (figure 1.3.1.o - ”the number of doctors and candidates of science corresponding to one preparing specialist”). At the same time, in the normalization by the number of IPX, there is an equalization of the amount of financial support for research work.

Data on the effectiveness of training and the effectiveness of scientific research are presented in Figure 4. As can be seen, despite the better financial support of doctoral studies and the higher level of effectiveness of doctoral research work, " a " doctorate is far behind “V” doctoral studies in terms of IPX degree of scientific activity, number of academic degrees, and doctoral effectiveness.



**Figure 4.** *Module 2: relative indicator system*

Thus, using this methodology in the system of internal monitoring of doctoral studies in a higher educational institution, it is possible to determine the state and trends in the development of scientific potential in various scientific fields, as well as to identify organizational and managerial measures to improve the training of scientific personnel.

## Conclusion

The model considered in the article allows the higher educational institution to receive quantitative information about the potential for training scientific personnel, the effectiveness of scientific research, the effectiveness of training doctoral students in a particular scientific specialty (group of specialties, field of Science) and provides the possibility of a comparative analysis of doctoral studies.

The system for assessing the scientific potential and effectiveness of the indicator, organized on the basis of quantitative indicators, can be supplemented by an expert assessment of the quality and effectiveness of the training of doctoral students. Such assessments can be obtained as a result of surveys between employers (structural divisions of scientific institutions, Higher School, business enterprises of scientific size) and graduates of doctoral studies. The results of questionnaire surveys can be expressed quantitatively using methods of sociology and, if necessary, combined with a system of statistical indicators.

We think that the proposals in the article the approach to the analysis of the training of scientific personnel in higher educational institutions of Uzbekistan can be useful for assessing the state and prospects for the staffing of priority scientific areas for the state.

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