

Informational System of Monitoring, Forecasting and Stimulation for Innovation-Oriented Activity of Scientific and Scientific-Pedagogical University Personnel

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Submitted: Oct 30, 2013; **Accepted:** Dec 18, 2013; **Published:** Dec 20, 2013

Abstract: The article presents basic data about creation of multi-purpose computer program which would be able to monitor and evaluate by some criteria the results of scientific and scientific-pedagogical activity of university staff and form criteria to perform such evaluation in accordance with requirements of ISO 9001 "Quality management systems". Realization of such system at a university will allow to accumulate and process data in all spheres of its activity, the results of collective work, qualitative and quantitative characteristics of the staff and having this information at disposal to build different activity indicators of a separate employee and the whole organization. Existing models allowing to calculate different indicators of efficiency of some activity were examined, but the models intended for evaluation of scientific activity and operation of scientific and educational enterprise are unknown to the authors at present moment. In the framework of this projects a model of information system was developed, the methods of application were chosen and program complex and program of implementation into educational and industrial process were elaborated.

Key words: Quality · Qualimetry · Intellectual property object · Patent activity · Indicator · Scientific publication · Informational system · Innovation oriented activity · Criteria examination

INTRODUCTION

By now quality management is gradually becoming a complex system approach which puts together into unified, unique, covering all enterprises, system the best practices of quality management. Quality management turns from specialized service with particular commitments into the philosophy shared by all units of the company, the base of corporate culture created by directors and determining all aspects of activity [1].

In the same time one of the key requirements of new version of standards ISO 9001:2000 is the use of process approach to organization of quality management in a company.

University management can be referred to the most complex and poorly structured tasks of management, which are characterized by:

- High degree on uncertainty of information;
- Availability of great number of different input and output parameters, many of which are qualitative, non-formalized and therefore unable to be measured in numbers;
- Complex, insufficiently explicit criteria of efficiency.

The complexity of the problem is determined by necessity to make many decisions in conditions of uncertainty, in constantly changing situation. Decision-maker faces the problem of necessity to collect huge amounts of information, that is why it is practically impossible to guarantee high efficiency of decisions without systematic application of information technologies in all spheres of university's activity [2].

Quality management system - Quality control system which must check produced goods in any organization [3]. For universities these are educational

services and the results of intellectual activity, protected by the laws of Russian Federation or author's right.

Most part of modern corporative information systems of planning and management include the control module to check the efficiency of activity which has good scalability and powerful computerized means. But such systems cost a lot and can be purchased only by big companies. Besides that they can not perform analysis of efficiency in the spheres where they operate by poorly-formalized categories, for example, in science, arts, culture etc. [4].

Information control system which must monitor data on the staff of a company and form criteria indicators of its efficiency will allow to formalize and generalize the results of employees' activity in any organization, to calculate aggregated values and on the base of such data to form efficiency criteria. Such system approach will allow to process data for calculation of whole-organizational and specialized, qualitative and quantitative, objective and subjective, integral and simple criteria.

The results of activity can be intellectual property objects: scientific published works, PhD theses, methodical guidelines, patents, theses, text-books, programs for ECM (electronic computing machine), data bases etc. On the base of entered data a complex of different indicators will be calculated in order to demonstrate efficiency of company's operation and analytical potential of information system.

Theoretical analysis. At present time many universities of our country try to solve the problem of monitoring and evaluation of innovation-oriented activity of scientists and university teachers. However the review of works of foreign experts [5-8] in the sphere of analysis of efficiency of scientific and research activity discovered the faults of theoretical and practical scientific works. Especially in the sphere of application of the results of evaluation in decision-making process and for development of modern means of support in decision-making which will take into account all particularities of educational institute as specific object of management. In fact there is no methodological base for complex application of such means which must be oriented to accounting and reduction of uncertainty for choosing optimal solution in an university as multi-dimensional hierarchical structure and grounded by appropriate mathematic tools. The problem of informational support of

the processes of decision-making in a universities is investigated insufficiently, which must be done on the base of implementation of complex informational system of a university [9].

Thus, analysis of how our problem has been developed by scientists has shown that many questions of scientometrics and bibliometrics and its application in biblio- and bibliographic theory and practice has not been properly solved - and that was the reason for us to conduct our study.

Information system intended for monitoring of company staff data and formation of criteria indicators of its efficiency will allow to formalize the results of activity of an employees of any organization, to calculate aggregated values and on the base of such data to form efficiency criteria. Such system approach will allow to process data for calculation of whole-organizational and specialized, qualitative and quantitative, objective and subjective, integral and simple criteria [10].

Thanks to such system new opportunities for formation and development of scientometrics in specific university will appear, which will enable, in particular:

- To carry out analysis of results of scientific activity of employees and the whole university;
- To find out most effective areas of focus in which scientific and research works must be done;
- To calculate, with the aid of scientometric indicators, the ranking of scientific organizations and universities;
- To identify criteria and develop strategies for development of scientific and research work and preparation of university staff for nearest future.

If there a social inquiry is made new analytical opportunities of this system can greatly improve the quality of forecasting of university science development, to find out regional trends of scientific development, to identify leading scientific groups and the most perspective directions of development of science in regions and federal districts, to give grounds in regard to allocation of resources; updating of organizational structure of scientific process participants, the number of staff and necessary number of qualified staff [11].

Scientometrics methods and rankings based on statistics can facilitate formation and confirmation of international status of scientific organization (university) necessary for attracting state and private investments.

MATERIALS AND METHODS

Generalized structural model of the system (Figure 1) includes 4 main enlarged elements: block to control employees' space, block to control activity's results, block to control patents, block to form and calculate the indicators.

Choosing of these blocks was determined by the following grouping of functions of complex information system.

- *Keeping the base of scientific and pedagogical employees of universities engaged into the process of creation of the intellectual property objects, in the context of attribute complex which describes scientific and research activity.* Such description of employees will greatly improve analytical potentialities of information system and increase representativeness of samples and reports. Such attributes are: a division, scientific and educational center where an employee works, scientific school, scientific area. Besides that such approach to introduction of registering staff base will allow to analyze and compare efficiency of work of different scientific and educational centers, divisions of an organizations, to assess personal and collective contribution into development of some scientific area of work.
- *Enlisting of base of intellectual property objects in the context of the employees who take part in their creation.* These objects are as follows: monograph, different kinds of articles, PhD theses, text-books, reference-books, reference and information books, methodical guidelines, books etc. In order to describe every object the whole combination of universal bibliographic attributes is used which will allow to assess intellectual property objects in qualitative and quantitative way. After entering the authors of object the shares of participation and priorities can be accounted. Proposed model of intellectual property objects description will allow easily check the efficiency of separate employees and assess their contribution. While displaying the combination of objects on screen forms a principle of partial grouping with aggregation was implemented.
- *Follow-up of activity connected with formalizing of patents, applications for registration of the programs for ECM/data bases, license contracts.*

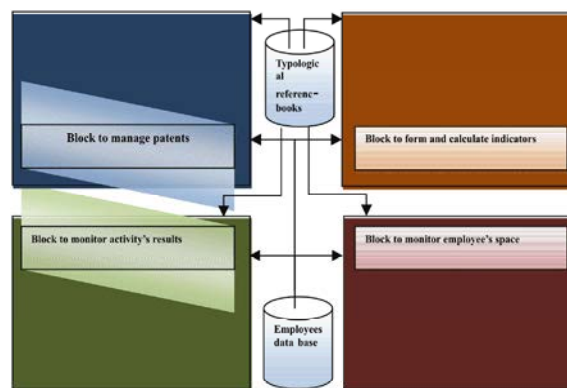


Fig. 1: Generalized structural model

While describing these objects registered data, the list of rights-owners and the list of employee are given. Besides that the system will allow to monitor at all stages of formalization of documents and keep electronic versions of documents in database. Grouping of these intellectual property objects into separate kind will enable to analyze patent activity both of organization as a whole and of separate employees.

- *Search, filtering and reporting.* The following types of search are realized in the system: simple search of an employee, object/patent by its name, extended search by attributes, search by contents. In order to set complex filtering conditions the mechanism of inheritance of parental enquiry is used (for example, firstly we find the list of employee /authors on some conditions and then use filter to sort out the intellectual property objects by specific attributes' parameters). All reports generated by the system can be divided into 2 big groups: standard and arbitrary. Standard reports are: complete list of employee (or the result of filtering), complete list of intellectual property objects (or the result of filtering), complete list of patents (or the result of filtering), patent activity of an organization for a period, patent activity of an employee for a period. In order to set the structure of arbitrary reports macro-language will be used.

The first group of functions will be realized by the block which monitors employees' space.

Block to monitor employees' space is a key element of the system and stands for primary data management. In the structure of the block (Figure 2) 2

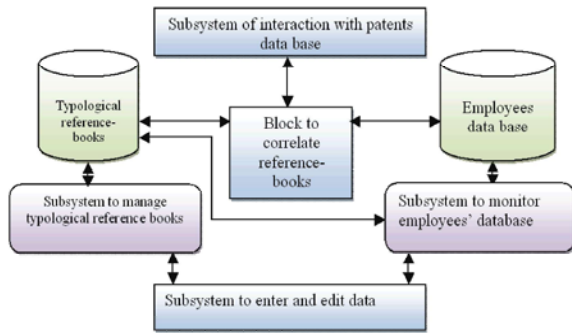


Fig. 2: Block to monitor employees' space

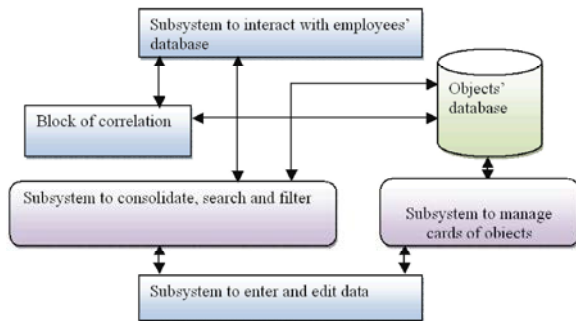


Fig. 3: Activity results management subsystem

main sub-systems can be identified: subsystem to manage typological reference-books, subsystem to manage employees base.

Subsystem to manage typological reference-books. It stands for managing of reference-books of different attributes and parameters of objects. In regard to intellectual property objects these are: positions, structural divisions, types of employees, scientific degrees, scientific ranks, scientific and educational centers, scientific areas, scientific schools, journals, collections of works, publishing houses etc.

Subsystem to monitor employees base. It contains information about all employees of organization with focuses on output product of their activity (in our project these are intellectual property objects). Presentation can be done both through the cards of separate employees and through general list. Subsystem of reference-books correlation uses typological reference-books while processing the employee attributes.

The second group of functions is realized thanks to block to manage activity's results.

Block to manage activity's results (Figure 3). It contains data on all results of activity which are significant for calculation of efficiency criteria of university employees. In regard to scientists these are

produced intellectual property objects. In order to be more illustrative the objects in the reference-list are grouped by types. For every object a card is formed which contains its description. Every object is associated with a group of employee with description of their contributions and role in the project.

Subsystem to Manage Objects' Cards: Basic functions of this system are as follows: introduction, editing and deleting of intellectual property objects. Every object is correlated with the block managing the space of users through the block of correlation.

Subsystem to Consolidate, Search and Filter: It is intended to manage reference list of intellectual property objects. Its basic functions are: search of object by full or partial inclusion, grouping objects by types with aggregation (this mode can be optional).

Third group of functions is realized by the block which manages patents.

Block to Manage Patents (Figure 4): Its basic function is managing of special intellectual property objects - patents. The system allows to keep base of patent activity of organization in the context of employees and check all stages of patent formalization.

Subsystem to Manage Patent Cards: Basic functions of this subsystem are as follows: entering, editing and deleting of patents. Every patent is correlated with the block managing users' space through the block of correlation. In order to control and manage formalization of patents the card has special containers to be filled with electronic versions of different documents. These containers are intended for every stage of patent's formalization. The list and character of stages depend on patent type. The subsystem which manages patent cards can reproduce downloaded documents in different modes (reviewing, package printing) through the subsystem which manages contents.

The functions of 4th group are realized by the block of formation and calculation of indicators.

Block to Form and Calculate Indicators: It is very important auxiliary block which allows to prepare data for calculation of some criteria of efficiency. This block is distributed over system and its elements are presented in all listed above blocks. Its basic tasks are as follows:

- Search for intellectual property objects both in the context of employees and in the context of objects-results;
- Crossed search of objects by employee with inheritance of searching conditions;
- Forming reports on employees and objects on the base of adjusted templates;
- Search of patents by different criteria;
- Calculation of statistic data on object and patent data-bases.

RESULTS

Experimental Part: Experimental implementation of information system was done on the base of Volgograd State Technical University since November of 2010 in the framework of creation of unified data base on the results of intellectual property of the university and reporting documentation for the Ministry of Education and Science of Russian Federation. At the moment of writing this article the database includes more than 7000 intellectual property objects, they were created by university employees during 2000-2013 period, among them there are 400 theses, monographs - more than 50, text-books - more than 2000, patents for inventions and useful models - more than 100. Since July of 2011 the implementation of module began which stands for keeping patent database, certificates and license contracts, issued by Federal institute of industrial property.

CONCLUSIONS

Presented above system is based on client-server DBMS (data-base management system) which allows to implement it into all divisions of the university connected with production and accounting of intellectual property objects. Implementation of such system in every structural division of university will accelerate the process of entering of objects into database. Besides that in the nearest future macro-language of reporting will be realized which will allow to obtain any data without modification of original code of the system.

The system is an unique uniform program device to manage the results of activity of any organization's staff and formation of criteria indicators for evaluation of its activity in accordance with ISO 9001 "QMS".

The system implemented in specific organization will allow to accumulate and process data about the focuses

of organization's activity, their employees' activity results, qualitative and quantitative characteristics of the staff and on the base of it to form different indicators of activity, both of separate employees and the organization as a whole.

Complex of measures on this project corresponds to ideas of national project "High-quality education" and critical technologies of federal level on prioritized directions of development of science and technologies.

Certificate of state registration of the program for ECM # 2012611387 of 03.02.2012 "Information system of monitoring and forecasting of the results of intellectual activity of scientific and teaching staff of university" was obtained for development of this system.

The work was implemented in the framework of SRW under state contract # P740 dated 12.08.09 "Information systems intended for preparation of specialists in the area of Thermo-energy industry" of the Ministry of education and science of Russian Federation.

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