

ANNOTATION

dissertations for the degree «Doctor of Philosophy» (PhD) in
specialty 6D070300 – «Information system (by industry)»
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METHODS AND FACILITIES FOR MONITORING UNIVERSITY DEVELOPMENT BASED ON ONTOLOGICAL MODELS

Relevance of the topic. The education system is one of the most important strategic priorities of the state, which is enshrined in the main state documents and programs for the strategic development of the country. Since the independence of the country, the state policy of Kazakhstan in the field of education has been continuously carried out to modernize the higher and postgraduate education system in the State Program for the Education Development in the Republic of Kazakhstan for 2011-2020 (SPED RK), a special role is allocated to improving management in the educational field, SPED RK for 2020 - 2025 years to the development of human resources in the system of education and science.

One of the target indicators for evaluating the results of the work at the university is the increase in rating publications and the increase in the number of universities in Kazakhstan in international university rankings. Currently, universities in Kazakhstan participate mainly in national university ranking programs. But in world university rankings, such as Times Higher Education World University Rankings (THE), QS, US News Best Global Universities Rankings (US News) and Academic Ranking of World Universities (ARWU) participate only national and large regional universities.

To achieve these indicators by a university, it had required the availability of information support for operational analysis and management of university performance indicators in order to make informed management decisions to improve results. An effective tool for organizing systematic monitoring and analysis of the results of the university's activities is information monitoring. A review of existing approaches to monitoring the activities of universities showed that their approaches and applied information systems are based on the analysis of these performance indicators, their comparison with target values, and their visualization. Nowadays, there is no single approach to monitoring issues, just as there is no single specialized information system for monitoring the activities of an educational organization. Theoretical and practical aspects of the implementation of information technologies in educational organizations are considered by Kazakh scientists as Akhmetov B.S., Mutanov G.M., Mamykova Zh.D., Nurgizhin M.R., Balova T.G., Uvalieva I. M., Kubekov B.S., Utegenova A.U. in various areas of university activity. Mutanov G.M., Mamykova Zh.D. engaged in theoretical and practical research on the creation of a corporate information system to support the business processes of the university. Russian researchers Sadovnichya V. A., Vasenina V. A., a group of scientists from M.V. Lomonosov Moscow State University dealing with the development of intelligent systems for the analysis of scientometric data. An analysis of the work of foreign scientists has shown that recently knowledge-based systems have gained

great popularity.

In order to maintain university's position and further their competitiveness, they need to improve their business processes using new methods and technologies that ensure the development and transfer of knowledge in academic, scientific activities, as well as the development of the university as a whole. Having a knowledge management system (KMS) is an important strategy to help universities achieve sustainable competitive advantage.

Thus, the relevance of the topic lies in the need to develop methods and means of information support for the implementation of the tasks of monitoring the activities of universities.

The purpose of the dissertation research is to develop models, algorithms and software tools for systematizing knowledge and analyzing information that characterizes the activities of the university, using ontologies to improve the manageability of the university.

Research objectives:

- explore the existing methods and means of monitoring the activities of the university (development of the university);
- explore models of formalization and description of knowledge based on the ontological approach;
- develop an information model of the university based on the ontological approach;
- develop a mechanism for integrating data from external sources (scientometric databases, websites, etc.);
- to develop an algorithm for monitoring the development of the university (the procedure for the competitive election / re-election of employees in positions that precede the examination and competitive procedures for determining teaching staff) based on descriptive logic and adaptive clustering;
- create the architecture of the university development monitoring system.

Research methods. To solve the tasks set, in this dissertation work, the methods of system analysis, the theory of management of organizational systems, the theory of knowledge management, ontological engineering, the theory of information systems design and methods of data mining were used.

Scientific novelty of dissertation research lies in the fact that for the first time an information model of a university is proposed based on an ontological approach and an algorithm for monitoring, based on logical methods of knowledge extraction and adaptive clustering implemented in a microservice architecture, which improves the processes of monitoring the university development.

The main provisions for defense:

- an information model of the university, developed on the basis of an ontological approach, which allows generalizing and systematizing the available information, integrating data distributed over various document repositories, databases and knowledge bases;
- a method for monitoring the development of a university (determining the trajectory of an employee's development) based on logical methods of knowledge extraction and adaptive clustering, which contributes to more accurate and flexible

personnel management, allowing you to immediately respond to changes in the external environment, which increases the competitiveness of the university.

- microservice architecture of the monitoring system, providing maximum flexibility, speed and scalability

The practical significance of the research results lies in the application of the proposed algorithm and the developed ontological models for interpreting data from heterogeneous sources and monitoring business processes in higher education institutions.

Compliance with the directions of development of science or government programs. The dissertation work corresponds to the priority to developing of science "Information, communication and space technologies" and the Concept for the development science of the Republic of Kazakhstan for 2022 - 2026 in the implementation of the tasks of digitalization of all scientific processes based on Data Science methodologies.

Description of the applicant's contribution to the preparation of each publication. The formulation of the problem, the formalization of all the considered tasks, the search for models and methods, organizing university knowledge and monitoring, as well as the scientific and practical results presented in the dissertation, their analysis, and the formation of final conclusions were carried out personally by the author of the dissertation. 16 scientific papers were published on the topic of the dissertation, 6 of them in scientific journals recommended by the Committee for Quality Assurance in Science and Higher Education of the Ministry of Education and Science of the Republic of Kazakhstan; 8 in proceedings of international conferences, 1 article in a journal included in the Scopus database. Received 1 certificate of state registration of rights to the object of copyright.

The research results approbation. The main results of the dissertation work were reported at scientific seminars of the School of Information Technologies and Intelligent Systems of NJSC "East Kazakhstan Technical University by named D.Serikbayev" at the following republican and international scientific and practical conferences: V All-Russian Congress of Young Scientists "(St. Petersburg, Russia, 2016), "XII th International Conference "PERSPECTIVE TECHNOLOGIES AND METHODS IN MEMS DESIGN" - MEMSTECH 2016" (Lviv, Ukraine, 2016), "The World Engineering Education Forum & The Global Engeneering Deans Concul - WEEF & GEDC 2016" (Seoul , South Korea, 2016), Marchuk Scientific Readings - 2017 (Novosibirsk, Russia, 2017), Computing and Information Technologies in Science, Technology and Education - CITech-2018 (Ust-Kamenogorsk, Kazakhstan, 2018), Ural Symposium on Biomedical Engineering, Radioelectronics and Information Technology (USBREIT)2018" (Ekaterinburg, Russia, 2018), "5th International Conference on Engineering and MIS 20 19- ICEMIS'19" (Nur-Sultan, Kazakhstan, 2019).

The knowledge ontological model of the university developed in this dissertation work was successfully applied, as evidenced by the acts of implementation in JSC "Civil Aviation of Kazakhstan" and the educational process of NJSC "EKTU named by D. Serikbaev".

The structure and dissertation scope. The dissertation consists of an

introduction, three sections, conclusion, bibliography and appendices.

The introduction substantiates the relevance of the research topic, the purpose, object and subject of research, defines the main tasks and methods, scientific novelty, scientific provisions submitted for defense, and the practical value of the work.

In the first section, issues related to the structural model of managing complex systems are considered and investigated, i.e. the university and the main types, principles of monitoring and the algorithm for the formation of indicators and indicators for monitoring the development of the university. A detailed analysis of existing foreign and domestic systems for monitoring the activities of universities was made, the main problems inherent in most of these systems were identified; Ontological models for representing the scientific knowledge of the university are investigated and the choice of the SWRC model is substantiated.

The second section discusses and investigates the development of models and methods for monitoring the development of the university. Described the expediency of developing an ontological model by reusing existing ontologies by merging and composing to create the resulting ontology. The proposed ontology allows generalizing and systematizing the available information, integrating data distributed across various document repositories, databases and knowledge bases, as well as using automated inference to improve search results and gain new knowledge. The developed base of inference rules for unambiguous and accurate identification of employees using a set of statements in the DL ALC language that meet the specified selection requirements is presented. A method for monitoring the development of personnel based on adaptive clustering is described, which contributes to a more accurate and flexible management of university personnel. The influence of clustering parameters on the quality and accuracy of clustering has been studied, and the possibility of using the proposed method in the tasks of monitoring the personnel reserve has been proved, which contributes to more accurate and flexible personnel management.

The third section describes the concept of the university development monitoring system and proposes a microservice architectural solution for the university development monitoring system. The role of data integration in the systems of monitoring the activities of universities is determined and proved as an element of reducing labor costs for initial input, eliminating duplication of data and contributing to obtaining up-to-date data for monitoring the state of the object under study. A functional model of the monitoring system has been developed based on the methodology of structural analysis and system design, which supports the processes of monitoring the activities of the university. As a result of the research, the results of data integration from the scientometric databases Scopus and Web of Science and the experimental results of the method of adaptive clustering of monitoring data for scientific and educational activities were obtained.

In conclusion, the results of theoretical and practical research in the framework of the dissertation work are summed up.

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