

---

UDC 519.87

## The process of automating the rating of Russian universities

Oxana N. Romashkova, Ludmila A. Ponomareva, Igor P. Vasilyuk

*Department of Applied Informatics, Moscow City University  
29 Sheremetevskaya str., Moscow, 127521, Russia*

Email: ox-rom@yandex.ru, ponomarevala@bk.ru, ipvkod@mail.ru

*The relevance of the study* is determined by the need to create an automated system for monitoring activities and determining rating indicators of universities in order to improve the efficiency of the control and regulation of the functioning of the Russian universities.

*The aim of the study:* modeling the processes of determining the rating indicators of universities and the formation of requirements for the information system for the center of the rating assessment of universities.

*Scientific novelty of research:* modeling of processes of rating processing of universities, formation and forecasting of rating estimates and on the basis of mathematical models implemented in the intelligent modules of the information system, the ability to integrate the system into the management information system of the University.

The authors conducted a study of information systems that carry out rating evaluation on various indicators of higher education institutions. The functional requirements for the developed information system for the rating evaluation center of higher education institutions were formulated.

**Key words and phrases:** rating assessment, information system, University performance indicators.

Copyright © 2019 for the individual papers by the papers' authors. Copying permitted for private and academic purposes. This volume is published and copyrighted by its editors.

In: K. E. Samouylov, L. A. Sevastianov, D. S. Kulyabov (eds.): Selected Papers of the IX Conference "Information and Telecommunication Technologies and Mathematical Modeling of High-Tech Systems", Moscow, Russia, 19-Apr-2019, published at <http://ceur-ws.org>

## 1. Introduction

In the post-industrial economy, the processes of knowledge generation, the formation of intellectual capital and the introduction of the results of intellectual activity into production are of particular importance. On this basis, one of the main subjects of the economic system is the University as the main producer of knowledge. The University not only affects the environment, but also itself is influenced. To determine the mechanisms of mutual influence, it is necessary to try to explore the mechanisms of generation of scientific knowledge. From this point of view, it is extremely difficult to analyze the capital's higher education institutions: on the one hand, they exploit the resources of the entire country, on the other – affect the national economic system as a whole. Therefore, the object of this study is selected regional universities, the relationship of which with the local economic system is more obvious.

Higher education can contribute to the economy of the region in various ways: to provide employment, increase consumer spending and revenues from outside the region at the expense of students and teachers of the University. However, the most important role of the University as a subject of the regional economic system is to generate knowledge, which is an important resource in the digital economy. The popular model of the University contribution was proposed by G. Itskovits. This model, known as the triple helix, is based on the University – business – state partnership. In the future, new components were added to the model: civil society and public institutions, then the natural environment and environmental institutions. S. Hill developed a model of involvement (engagement) of the University in the regional socio-economic system. At the moment, a single methodological approach to the analysis of the impact of regional higher education systems on economic growth has not been developed. However, based on the analysis of the performance indicators of universities development it was revealed that an important mechanism of interaction between the University and the socio-economic system of the region is the unified rating system of the University.

The results of this work are important for future theoretical and applied research, as well as for decision-making in the field of regional economic and educational policy.

In March 2013, the President of the Russian Federation instructed to develop a national rating of Russian universities [1, 2]. Currently, more than 100 rating systems are known in the world [3]. Out of those, around 20 are the most famous [4, 5]. But all of them solve problems characteristic of the national specifics of the country in which they are created. In 2016, the first national Russian rating “three missions of universities” was developed [6, 7].

The first analysis of the rating indicators was carried out in September 2017. 34 indicators were taken into account, combined into five groups: “Education” (40% of the contribution to the result of the University in the ranking), “Science” (30%), “Internationalization”, “Sustainability and development potential”, “Distance education” (10%) [8]. According to the developed system, it is planned to rank not only Russian, but also foreign universities — universities of Japan, China, Brazil, India, Iran, Turkey and CIS countries. The developed evaluation system includes only measurable indicators [9, 10].

The creation of an information system for monitoring and evaluating the rating of universities is part of the task of developing a national rating.

*The object of the study* are indicators and management processes for universities.

*The subject of the research* is the process of developing an information system for the rating evaluation center of higher education institutions (IS REHEL).

## 2. Theoretical Study

Continuous monitoring of the state of affairs in the system of education and science is necessary to compile the ranking of universities. Connections with both internal elements of the system and with external objects should be implemented in the best way [11, 12].

Currently, there is no unified national information system for rating evaluation of universities. But almost all universities have electronic educational environments, management information systems, developed communication networks that implement coordinated management of all structural units for the effective organization of the educational process, conduct all types of training, scientific activity [13–15].

To analyze the level of automation of the rating assessment centers of higher educational institutions, five rating information systems were selected, presented below:

- “From the rating of Samara state University of Economics”;
- “Altai state technical University”;
- “IP rating estimation of activity of the academic units of the University of Economics Vladivostok (VGUES)”;
- “Is planning and reporting of the work of VGUES teachers”;
- “And the rating of teachers of the Amur state University. Sholom Aleichem.”

The information system “is Samara state University of Economics” was developed by the University staff to improve the efficiency of the educational process. The system is based on the platforms ASP NET, MS SQL-server 2003. Because of this, its deployment does not cause problems on almost any device.

Possibilities of information system “IC Rating of Samara state University of Economics”:

- calculation of individual student rating;
- automatic tracking of absenteeism and achievements;
- technology ADO.NET to work with database;
- easy system migration as there is no binding to the registry;
- calculation of the rating of the Department and teachers;
- calculation of the overall rating of automation of the University.

Lack of information system “IC Rating of Samara state University of Economics”:

- obsolete platform MS SQL-server 2003.

Information system “Altai state technical University (AltSTU)” was created by teachers of Altai state technical University named after Polzunov. The system includes two modules. One calculates the rating based on the potential-predicts how it will change after the introduction of any changes. The second calculates the current rating.

The capabilities of information systems “Altai state technical University”:

- prediction of the rating taking into account the changes;
- monitoring the activity of students and teachers;
- personnel assessment;
- tracking publications;
- calculation of chairs rating
- calculation of the overall rating of scientific potential.

Disadvantages of information system “Altai state technical University”:

- no support for modern systems above Windows 7.

The IP rating estimation of activity of the academic units of the University of Economics Vladivostok created by the students of this University, and used to control the activities of the departments in it. The system uses a web interface and a MySQL-based database.

Possibilities of information system “is of rating estimation of activity of educational divisions of economic University of Vladivostok”:

- control of the Department;
- calculation of the rating of the Department;
- calculation of faculty rating;
- calculation of the rating of the student.

The lack of an information system of “IP rating estimation of activity of the academic units of the University of Economics Vladivostok”:

- designed only for structural units and can not give a General picture of the state of the University.

Is planning and reporting work of teachers VGUES created for Vladivostok state University of Economics and service. Allows you to monitor the activities of the Department. The capabilities of information systems “is planning and reporting work of the teachers of VSUES”:

- calculation of individual student rating;
- control of the Department;
- calculation of the rating of the Department.

The lack of an information system “is the planning and reporting work of the teachers of VSUES”:

- functionality is limited only by the processes of the Department.

From the rating evaluation of teachers of the Amur state University. Sholom Aleichem was created to control the activities of teachers of the Amur state University. Sholom-Aleichem. The system has a Web interface.

Possibilities of information system “is evaluation of the rating of teachers of the Amur state University. Sholom Aleichem”:

- calculation of individual rating of the teacher;
- calculation of the rating of the Department;
- monitoring of scientific achievements;
- calculation of rankings by year.

The lack of information system — control activities only at the level of the Department.

As a result of the study of the subject area, the authors analyzed the information systems of universities, which have the function of assessing at least one criterion included in the formation of the rating of the educational organization: the rating of students, departments, teachers, departments, etc. The results are presented in table 1.

On the basis of the analysis of information system, carrying out various ranking, the conclusion was made about necessity of development of complex information system for the rating assessment of the universities.

### **3. Problem Statement**

Develop a model of functioning of is information system for the rating evaluation center of higher education institutions, which should provide [16, 17]:

- loading of input data on educational institutions subject to analysis;
- the formation of a system of evaluation indicators and criteria support the changes (increase in the number of indicators and benchmarks or to exclude them);
- adaptability to changes in the rating evaluation rules of higher educational institutions;
- extension based on the performance results of a University by automating processes missing;
- automated calculation of the rating of educational institutions based on the data of the criterion assessment;
- interactive graphical representation of the rating calculation results for further analytical work of the specialist. The authors have studied information flows that occur during training [18–20].

### **4. The Functioning Model is Information System for the Rating Evaluation Center of Higher Education Institutions**

Development of the model of the processes of formation of the rating of the educational organization was carried out with the help of the tool CA ERWin Process Modeler [21].

CA ERWin Process Modeler supports three modeling methodologies: IDEF0, IDEF3 and DFD [22].

For the study of the subject area was chosen methodology IDEF0 (Integration Definition for Function Modeling), in which the business process is represented as a set

Table 1

Comparison of Educational Process and Educational System [9]

|  | From the rating of Samara state University OF Economics | Altai state technical University | Is of a rating estimation of activity of educational divisions of economic University of Vladivostok | IC planning and reporting work of the teachers of VSUES | And from the rating evaluation of teachers of the Amur state University. Sholom Aleichem |
|--|---|----------------------------------|--|---|--|
| Calculation of student's rating              | +   | +                                | +  | +   | +  |
| The calculation of the rating Group          | +   | +                                | +  | -   | -  |
| The calculation of the rating of the Faculty | +   | +                                | +  | -   | -  |
| Calculation of the rating of the Department  | +   | +                                | +  | +   | +  |
| Calculation of the rating of teacher         | +   | +                                | +  | +   | +  |
| Evaluation of technical equipment            | +   | +                                | -  | -   | -  |

of elements-works that interact with each other, as well as showing information, human and production resources consumed by each work.

Figure 1 shows the top-level context diagram of the business process model in IDEF0 notation.

Input interface arcs are: modernization plans, data on technical and information equipment, performance reports, educational programs, data on publication activity, data on personal achievements.

The output interface arcs are: a report on the rating assessment of the educational organization, the rating assessment of the educational organization by indicators.

Administering the interface arcs are: Regulatory documentation and Federal educational standard, the Legislation of the Russian Federation [23, 24].

The mechanisms of implementation are: inspector, rating specialist.

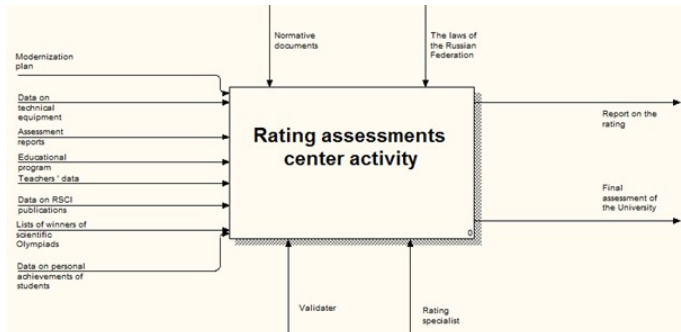


Figure 1. Context diagram top-level

Further decomposition of the central functional block was carried out. The resulting A0 level decomposition diagram is shown in figure 2.

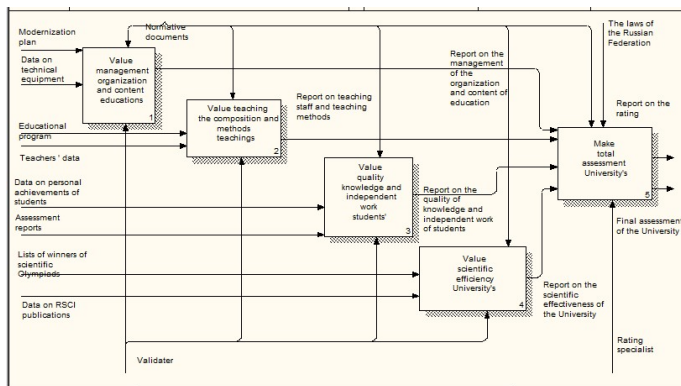


Figure 2. Diagram of the decomposition level A0

The study identified the following business processes: to assess the management of the organization and content of education, to assess the teaching staff and teaching methods, to assess the quality of knowledge and the independent work of students, to assess the scientific effectiveness of the educational organization, to form a rating assessment of the educational organization.

The function blocks described above are further decomposed. The most interesting is the functional block “to form a rating assessment of educational organization”. Its decomposition is shown in figure 3.

To automate the definition of rating evaluation, a diagram describing the sequence of steps in the process of “Forming a rating assessment of an educational organization”, performed in IDEF3 notation, was developed. It is shown in figure 4.

On the basis of the approved program, indicators for work are prepared, the rating of students, the rating of teaching staff, the rating of equipment of the educational organization is determined. Based on the final results, a decision is made to form a rating assessment.

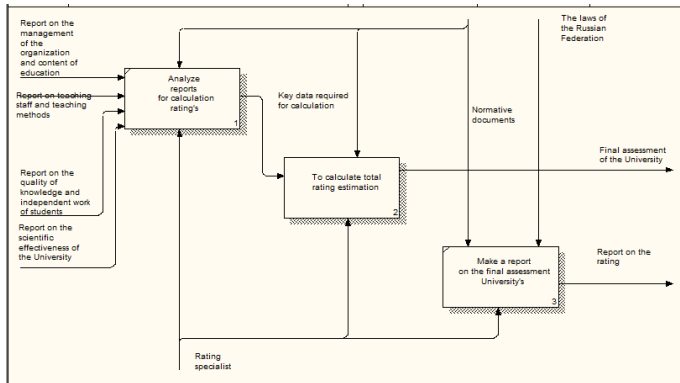


Figure 3. Block decomposition Diagram “to form a rating assessment of an educational organization”

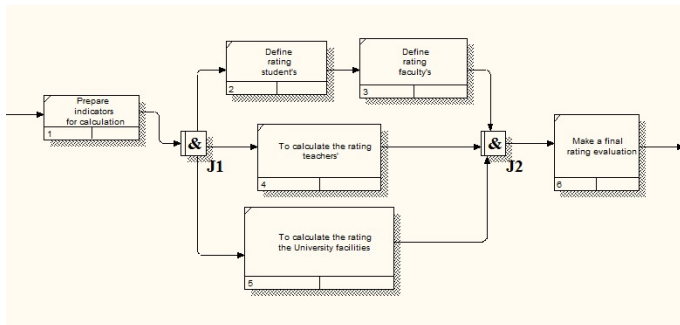


Figure 4. Diagram of the description of the sequence of stages of the process “to form a rating assessment of the educational organization”

On the basis of the performed analysis of the processes of activity of the center of the rating estimation of higher education institutions the functional requirements to the developed is were formed:

1. automate maintenance of the database of indicators of rating of the University;
2. determine the rating of University students;
3. determine the rating of structural units of the University;
4. determine the rating of teaching staff of the University;
5. determine the rating of University equipment;
6. form the rating assessment of the University on the main indicators;
7. report on the rating estimates of universities.

## 5. Conclusions

Functional requirements and model of the information system of automated monitoring of higher education institutions and definition of rating assessment, which has a modular structure, which includes the following components: data collection module

(data universities, individual structural units, branches, departments), classification module, formalization and storage of data, the module determining the rating of the University (generalized or individual indicators), data output module (reports, analytical reports, statistical data). Each module acts as a separate independent subsystem and can be integrated into the management information system of the University. All modules are combined by a program shell, which is a window interface. Each module of the system provides service utilities in the form of guidelines for use.

### References

1. O. N. Romashkova, L. A. Ponomareva, I. P. Vasilyuk, Y. V. Gaidamaka, Application of information technology for the analysis of the rating of university, in: CEUR Workshop Proceedings 8. "ITTMM 2018 — Proceedings of the Selected Papers of the 8th International Conference "Information and Telecommunication Technologies and Mathematical Modeling of High-Tech Systems", 2018, pp. 46–53.
2. E. Prokhorov, L. Ponomareva, E. Permyakov, M. Kumskov, Fuzzy classification and fast rules for refusal in the qsar problem, *Pattern Recognition and Image Analysis (Advances in Mathematical Theory and Applications)* 21 (3) (2011) 542–544.
3. M. Kumskov, E. Smolenskij, L. Ponomareva, D. Mityushev, N. Zefirov, The systems of structure descriptors for solving the problems of "structure-activity" for organic compounds, *Reports of the Academy of Sciences* 336 (1) (1994) 64–66.
4. O. Romashkova, T. Ermakova, Monitoring the quality of education in secondary organizations with the use of modern means of Informatization, *Bulletin of the Russian University of friendship of peoples. Series: Informatization of education* (4) (2014) 10–17.  
URL <https://elibrary.ru/contents.asp?issueid=1345001>
5. A. Samuylov, D. Moltchanov, Y. Gaidamaka, S. Andreev, Y. Koucheryavy, Random Triangle: A Baseline Model for Interference Analysis in Heterogeneous Networks, *IEEE Transactions on Vehicular Technology* 65 (8) (2016) 6778–6782. doi:10.1109/TVT.2015.2481795.
6. A. Drozdova, A. I. Guseva, Modern Technologies of E-learning and its Evaluation of Efficiency, *Procedia — Social and Behavioral Sciences* 237 (2017) 1032–1038.
7. V. S. Kireev, Development of fuzzy cognitive map for optimizing e-learning course, *Communications in Computer and Information Science* 706 (2017) 47–56.
8. E. Ovchinnikova, S. Chiskidov, Problems of development and application of interactive educational modules in learning, in: *Science, education, society: trends and perspectives the Collection of scientific works on materials of the International scientific-practical conference: in 7 parts. OOO "Ar.Consult"., 2014, pp. 80–85.*
9. L. Ponomareva, L. Kodanev, Development module of the corporate information system "Educational environment of the University" based on cloud technologies, in: *Computer science: problems, methodology, technology the collection of materials of XVII international scientific conference: in 5 t., 2017, pp. 393–398.*  
URL <https://elibrary.ru/item.asp?id=28952199>
10. F. Gasparetti, C. D. Medio, C. Limongelli, F. Sciarrone, M. Temperini, Prerequisites between learning objects: Automatic extraction based on a machine learning approach, *Telematics and Informatics* 35 (3) (2018) 595–610.
11. O. Romashkova, A. Morgunov, Information system for evaluation of results of activity of educational institutions of Moscow, *Bulletin of the Russian University of friendship of peoples. Series: Informatization of education* (3) (2015) 88–95.  
URL <https://elibrary.ru/item.asp?id=24323920>
12. Y. Y. Orlov, D. Zenyuk, A. Samuylov, D. Moltchanov, Y. Gaidamaka, K. Samouylov, S. Andreev, O. Romashkova, Time-dependent sir modeling for d2d communications in indoor deployments, in: *Proceedings — 31st European Conference on Modelling and Simulation, ECMS., 2017, pp. 726–731.*
13. E. Bobrikova, Y. Gaidamaka, O. Romashkova, The application of a fluid-based model for the analysis of the distribution time of a file among users in peer-to-peer



- network, in: Selected Papers of the II International Scientific Conference “Convergent Cognitive Information Technologies” (Convergent 2017). CEUR Workshop Proceedings, Vol. 2064, 2017, pp. 55–61.  
URL <http://ceur-ws.org/Vol-2064/paper06.pdf>
14. V. Borodakiy, K. Samouylov, I. Gudkova, E. Markova, Analyzing Mean Bit Rate of Multicast Video Conference in LTE Network with Adaptive Radio Admission Control Scheme, *Journal of Mathematical Sciences (United States)* 218 (3) (2016) 257–268.
  15. I. Gudkova, O. N. Romashkova, V. Samouylov, Determination of the range of the guaranteed radio communication in wireless telecommunication networks of IEEE 802.11 standard with the use of ping program, in: CEUR Workshop Proceedings 8. “ITMM 2018 — Proceedings of the Selected Papers of the 8th International Conference “Information and Telecommunication Technologies and Mathematical Modeling of High-Tech Systems”, 2018, pp. 54–59.
  16. O. N. Romashkova, S. V. Chiskidov, P. A. Frolov, Improvement of information technologies of the decision of problems of management in economic systems, *Modern high technologies* (10) (2017) 63–67.
  17. O. N. Romashkova, L. A. Ponomareva, Model of educational process in high school using Petri nets, *Modern information technologies and it education* 13 (2) (2017) 131–139. doi:10.25559/SITIT0.2017.2.244.
  18. O. N. Romashkova, L. A. Ponomareva, Model of effective management of the United educational system (structure), in: New information technologies in scientific researches materials of the XXI all-Russian scientific and technical conference of students, young scientists and specialists. Ryazan state radio engineering University, 2017, pp. 16–18.  
URL <https://elibrary.ru/item.asp?id=30521101>
  19. V. Naumov, K. Samouylov, Analysis of multi-resource loss system with state-dependent arrival and service rates, *Probability in the Engineering and Informational Sciences* 31 (4) (2017) 413–419. doi:10.1017/S0269964817000079.
  20. G. Gorelov, N. Kazanskii, O. Lukova, Communication quality assessment in speech packet transmission networks with random service interrupts, *Automatic Control and Computer Sciences* 27 (1) (1993) 62–64.
  21. G. Gorelov, O. Romashkova, Influence of Russian, Spanish and Vietnamese speech characteristics on digital information quality, in: IEEE International Symposium on Industrial Electronics Proceedings of the IEEE International Symposium on Industrial Electronics, ISIE'96. Part 1 (of 2). sponsors: IEEE, Warsaw University of Technology. Warsaw, Poland, 1996, pp. 311–313. doi:10.1109/ISIE.1996.548438.
  22. L. A. Ponomareva, V. Kodanov, S. V. Chiskidov, Model of management of process of development of competences in educational organizations, in: New information technologies in scientific research materials of the XXII all-Russian scientific-technical conference of students, young scientists and specialists. Ryazan state radio engineering University, 2017, pp. 20–22.  
URL <https://elibrary.ru/item.asp?id=30521104>
  23. L. A. Ponomareva, O. N. Romashkova, I. Vasilyuk, Conceptual model of changing the rating assessment of the University, in: Methods, mechanisms and factors of international competitiveness of national economic systems. Collection of articles of the international scientific-practical conference: in 2 parts, 2017, pp. 75–77.  
URL <https://elibrary.ru/item.asp?id=30378981>
  24. L. A. Ponomareva, P. E. Golosov, A. B. Mosyagin, V. I. Gorelov, Method of effective management of competence development processes in educational environments, *Modern science: actual problems of theory and practice. Series: Natural and technical Sciences* (9) (2017) 48–53.  
URL <https://elibrary.ru/item.asp?id=30281545>