INDICATORS OF UNIVERSITY EDUCATIONAL SERVICE DIGITALIZATION

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Abstract. The article highlights the competitive advantages of educational program network form. The authors emphasize that the information openness of a university stimulates the development of both internal and external competitive environments due to the availability of system management knowledge about the basic processes and the openness of academic knowledge located in the academic portfolio. The purpose of the article is to develop the system of qualitative and quantitative indicators of educational service digitalization. The article analyzes and synthesizes the areas of educational service digitalization in Russian universities, and the materials of scientific publications. They set out the modern features of university informatization. Based on the principles of knowledge management, they formulated the goals of a university network information environment development. They proposed the system of qualitative and quantitative indicators of educational service digitalization. By the means of expert assessments qualitative indicators measure transparency, convergence, modifiability, integrativity, progressiveness, coevolution, adaptability, competitiveness, productivity, competitiveness and competence. In the context of groups quantitative indicators (resource, process, result) can be used to calculate the composite integral indicator of educational service digitization and the analysis of innovation efficiency in the "resource-processes-results" model. One of the possible trends of future research may be the measurement of the economic efficiency concerning educational service digitalization.

Keywords: educational services, university, innovation, knowledge management, network information environment, competitive advantage, indicator, digitalization, digital transformation, electronic information educational environment.

1. INTRODUCTION

Educational service as a set of processes, creating value in the form of a certain amount of knowledge, skills and possessions, receives a number of competitive advantages due to specific features in the network information environment. First, it is the achievement of a continuous integrated synergistic effect of a set of knowledge, skills and possession accumulation and transformation into a graduate competence within his professional field. Secondly, the inseparability from the service source and the complexity of teachers' labor standard development determine such economic benefits as the reduction of transformational and transaction costs. And, finally, the inconstancy and the inconsistency of the service determine the need for a constant appeal of corporate and external users to the resources of the network information environment and the interaction in it.

Now it is impossible to accumulate intellectual capital in a closed education system. Therefore, online training and the willingness to use the international education system are a prerequisite for a modern university development [1,2]. Information openness of a university stimulates the development of both internal and external competitive environments due to the availability of system management knowledge about the basic processes, the openness of academic knowledge located in the academic portfolio, the expansion of educational services, the increase of their competitiveness due to accessibility, openness, utility for a consumer and market segment expansion [3,4]. The overcoming isolation and information barriers in the system of higher education in Russia will allow to implement the main trnds of educational service digitization: multi-level education based on a student-centered approach; the introduction of new forms and methods of management, taking into account the trends of the Bologna process; the partnerships with organizations; the establishment of interdisciplinary research groups. The content of these areas confirms the need for integration, structuring and systematization in the context of academic and management knowledge processes within the network information environment [5,6]. Therefore, the university knowledge management system serves as the tool for the introduction of pedagogical, economic, managerial, and institutional innovations during the implementation of educational services [6, 7, 8]. There is a need to improve the indicators of educational service digitalization to assess the effectiveness of innovative processes in the network environment of a university. In this regard, the purpose of the study is to develop a system of qualitative and quantitative indicators of educational service digitalization.

2 METHODS

They used the analysis and the synthesis of educational service digitalization areas in Russian universities, the analysis and the synthesis of scientific publication materials. The network information environment of a university as a set of information systems, information and technical infrastructure, databases, knowledge and users, provides the conditions and the opportunities for an effective management of all activities of the university, international cooperation, the development and the accumulation of intellectual potential, regardless of the geographical location of users. In our opinion, it is possible to distinguish the electronic information educational environment and information analytical environment in its structure. Electronic information educational environment combines electronic educational resources, a set of information telecommunication technologies, technological means and provides the process of educational program implementation as the result of configurational and postfigurative academic knowledge

management. The information analytical environment resulting from the transformation of managerial knowledge contains electronic documents, databases, information and analytical resources and tools to process and analyze them in order to ensure the strategic, tactical and operational management of a university.

3 RESULTS AND DISCUSSION

In general, the digitalization of educational services in Russian universities is carried out by simultaneous automation of the main activity and management sphere in the conditions of information resource, subsystem, task integration with the primary development of the electronic information educational environment [9]. The generalization of the modern development features of university information environment is made in the matrix of SWOT analysis (Table 1).

Table 1 - The features of domestic university information environment (SWOT-analysis)

External environment Internal environment	**Possibilities:** 1) the attraction of knowledge from the external market environment; 2) the expansion of knowledge management technologies; 3) the increase of educational programs and web users of the university; 4) the introduction of ERP-systems	**Threats:** 1) technological standards that reduce the possibility of inform. environment; 2) the lack of financial, personnel and energy resources; 3) the narrowing the service market target segment
Advantages: 1) the use of knowledge management technologies; 2) the anticipation of the information-educational environment development over the main processes; 3) the integration of information resources, systems and management tasks; 4) modular structure and open architecture of university management software products	«СИВ» FIELD СИ 1, 2 → В 1, 2, 3 СИ 3, 4 → В 2, 4	«СИУ» FIELD СИ 1, 2 → У 2, 3 СИ 3, 4 → У 1
Disadvantages: the focus on the educational process and internal users; 2) the integration of information technologies in existing processes; 3) low efficiency of software product application; 4) a different level of management automation in universities; 5) the use of a mixed automation model	«СЛВ» FIELD В 1 → СЛ 1, 2 В 2 → СЛ 1, 2, 3, 5 В 3 → СЛ 1, 2 В 4 → СЛ 1, 2, 4, 5	«СЛУ» FIELD СЛ 1, 2, 3 → У 1, 2, 3 СЛ 4, 5 → У 1, 3

The field "СИВ" in Table 1 shows, that the use of knowledge management tools in an electronic information educational environment is advisable to attract academic and managerial knowledge from the external market environment and to overcome the narrowing of the educational services market segment. The integration of information resources, systems and management tasks, the modular structure and the open architecture of university management software create the prerequisites for the implementation of ERP systems. "СЛВ" field shows that the attraction of academic and managerial knowledge from the external market environment and the introduction of ERP systems will be able to overcome the focus of the network information environment on the educational process only and the focus on internal users. Due to the introduction of ERP systems, it is possible to overcome a different level of management automation and move from a mixed to a complex automation model. According to "СЛУ" and "СИУ" fields, in order to prevent and eliminate the lack of financial and human resources, to avoid the narrowing of the educational service market target segment, it is necessary to avoid the embedding of information technology components in existing processes, which leads to a low efficiency of software products, to use knowledge management tools and perform the reengineering of basic and management processes.

Following the principle of linking the goals of knowledge management system operation with the mission, the vision and the strategy of the university [6,7], you can specify the following objectives of university single educational space organization, thanks to the tools, technical and technological solutions of the network information environment [8,9]:

- the establishment of interuniversity, interregional, international contacts, the organization of virtual partnerships and research groups;

- the provision of educational program development individualization by the consumers of services of different levels and education forms;

- the organization of partner organization participation in the implementation and the management of educational and research activities due to innovative technologies, in particular, virtual scientific and educational consulting structures;

- the consolidation of the resources necessary for the implementation of education, training and work experience and research;

- the network association of geographically distributed units;

- the integration of educational and research activities through the organization of virtual project groups and structures for the interaction with the external environment during the introduction of developments;

- the transfer of individual knowledge to a corporate organizational knowledge base.

The formulated goals determine the choice of indicators reflecting the resource, process and result groups of educational service digitalization signs (Table 2).

Table 2 - Indicators of educational service digitization in network environment

Groups	Digitization signs	Digitization indicators
Unit 1. Qualitative indicators		
Resource (Q_1)	Transparency	Each sign is evaluated by an expert using the ordinal scale from 1 to 5 (1 - 20% and less, 2 - from 20% to 40%, 3 - from 40% to 60%, 4 - from 60% to 80%, 5 - from 80 % to 100%)
	Convergence	
	Modifiability	
	Performance	
Process (Q_2)	Integrity	Each sign is evaluated by an expert using an ordinal scale from 1 to 5 (1 - 20% or less, 2 - from 20% to 40%, 3 - from 40% to 60%, 4 - from 60% to 80%, 5 - from 80 % to 100%)
	Progressiveness	
	Coevolution	
	Adaptability	
Result (Q_3)	Competitiveness	Each sign is evaluated by an expert using an ordinal scale from 1 to 5 (1 - 20% or less, 2 - from 20% to 40%, 3 - from 40% to 60%, 4 - from 60% to 80%, 5 - from 80 % to 100%)
	Productivity	
	Rivalry	
	Competence	
Unit 2. Qualitative indicators		
Resource (K_1)	The provision of a unified system for electronic educational resource development*	The share of annual update (P) of e-learning products: d=(P-15)/(50-15)*
	The availability of network interaction with service consumers	The share of educational programs implemented with the participation of organization specialists
	The availability of technical training tools	The share of classrooms equipped with computer and projection equipment
	The availability of individual educational planning system *	The share of students covered by individual planning*
	The availability of software	The share of academic disciplines with the use of application software
	The availability of computers with Internet access	The share of computers with Internet access used in training
Process (K_2)	The availability of demand for electronic educational resources	The share of students accessing e-learning resources
	The availability of demand for electronic library resources	The share of students accessing electronic library resources
	Conditions for educational program implementation	The share of interactive classes
	The availability of demand for research	The share of students participating in interactive research projects
	The use of distance learning technologies	The share of students using distance learning technologies
	The use of corporate portal	The share of students using the corporate portal for training purposes
	The use of network technologies and the Internet	The share of students who participated in network events with partner organizations (webinars, etc.)
Result (K_3)	Service diversification	The share of new educational programs
	Target market segment saving	The share of educational programs implemented by the orders of partner organizations

	The expansion of market target segment	The share of newly engaged partner organizations during the year
	Information and communication competence of teachers	The share of teachers using e-learning and distance learning technologies
	The scientific significance of publications	The share of publications in international cited magazines
	The commercialization of research results	The share of commercialized university projects during the year
	The demand for graduates	The share of graduates employed during the first year by study profile

Following the properties of the education system and the mechanisms of distance learning [8,9], the qualitative characteristic of educational service digitization is carried out on the basis of expert assessments according to the scale proposed in table 2. The indicator for each qualitative attribute is defined as the arithmetic average simple element of expert assessments: $\overline{q}_i = \sum_{i=1}^{k} q_i$, k is the number of experts. Then, summing up the indicators - the average expert estimates for each qualitative attribute within each group, expert group integrated indicators (Q_1, Q_2, Q_3) can be calculated: $Q_m = \sum_{i=1}^{n} \overline{q}_i$, n – the number of indicators in the group, according to table 2, n=4. The following thresholds are recommended to assess the innovative nature of educational services: from 4 to 8 - very low, 8-12 - low, 12-16 - medium, 16-20 - high.

Intra-university diagnostics of educational service digitization based on quantitative indicators can be carried out in two stages within the context of study areas, educational units and for the university as a whole.

At the first stage, they perform the comparative analysis of indicators within the group (resource, process, result) by the development of radial closed diagrams according to the indicators for the selected group. At that the form of the radial diagram illustrates the consistency of each group indicator contribution to the innovativeness of the educational service. And the diagram size shows the cumulative significance of the selected group of indicators for the service innovativeness. Such an exploratory analysis makes it possible to identify the “leading” and “lagging” indicators within the selected group and compare their trends for study areas and individual educational units. Also, it is possible to evaluate the cumulative contribution of a selected group of indicators to the total innovative potential of an educational service by the size of a radial diagram in terms of areas of study and departments.

At the second stage, the composite integral indicator of educational service digitization is determined as the sum of group quantitative integral indicators: $K = K_1 + K_2 + K_3$ for the areas of study, individual educational units and the university as a whole. Each group integral indicator (K_m) is calculated as the arithmetic average weighted value of the individual indicators of this group: $K_m = \sum_{i=1}^{n} p_i \cdot k_i$, where p_i is the weight coefficient (the weight) of the i-th indicator, k_i – the i-th indicator of the group. Weights are determined on the basis of pair correlation coefficients (r_{ij}), which estimate the closeness of the relationship between the indicators of this group: $p_i = \sum_{i=1}^{n} r_{ij} / \sum_{i=1}^{n} \sum_{j=1}^{n} r_{ij}$. Each weight represents the ratio of the pair correlation coefficient sum of the i-th indicator to the total sum of the coefficients according to the matrix of pair correlation coefficients. Thus, the greater the weight, the closer the correlation of the i-th indicator with the others, therefore, the greater its share in the total value of group integral indicator. Resource integral indicator (K1) reflects the depth of innovations in the resource potential of study areas and the training units of the university as a whole. The process integral indicator (K2) characterizes the depth of innovation in the processes, and the result (K3) - the final effectiveness of innovations. The comparison of group integral indicators in the sequence “resources-processes-results” allowed to analyze the balance of educational service digitalization in the process model of educational service implementation within the abovementioned cuts. On the basis of a consolidated integral indicator, one can conclude about the digitalization of educational services in the network information environment as a whole.

4 SUMMARY

In our opinion, guiding by the principles of knowledge management [10,11], the results of SWOT-analysis, the practice of scientific and educational network development [12] during the development of the university network information environment, it is necessary to provide the conditions for the following most important tasks:

- the functional support for the development and the implementation of new educational technologies with the use of e-learning and distance learning technologies, research and innovation projects in order to create a unified educational space;
- the functional support of process management technology improvement that implements the various activities of the university in order to improve the quality, the consistency and the efficiency of management decisions, as well as the efficiency of human and material resource use;

- the use of knowledge management technologies for the accumulation, exchange, use and transformation of academic and management knowledge into formalized organizational knowledge;
- the development and improvement of information and communication competence level among students, faculty, educational support and administrative staff;
- the functional support of the university information openness, the security of the network information environment and the implementation of an open model of academic knowledge;
- the introduction and the improvement of the organizational mechanism that ensures an effective functioning of the network information environment.

The implementation of these tasks will allow to use new approaches for the organization of educational activities and for the university management on the basis of knowledge management.

5 CONCLUSIONS

The massive introduction of new methods and knowledge management tools into practice makes a decisive impact on the digitalization of educational services. The performance of the goals and the objectives for a network information environment creation will help to provide the availability of resources and communications for all users, the expansion of education, science and industry integration possibilities. Thus, the network form of educational program implementation, also with the participation of partner organizations, creates competitiveness, productivity, rivalry and the competence of services due to their transparency, convergence, modifiability, adaptability, integrativity, progressiveness, coevolution and adaptability. The development of new managerial knowledge in the network information environment of the university will be required to measure the effectiveness of network interaction. Intra-university diagnostics of educational service digitalization by the conduct of intra-group comparative analysis of indicators and the calculation of integrated indicator system allows us to develop a set of organizational and management measures to improve the processes at the university..

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References

1. Lester, M. “Innovation and knowledge management: The long view”, *Creativity and Innovation Management*, 10(3), pp. 165-176, 2001.
2. Fernández Hernández, A. “Information framework of intranet portal: An essential component in the information management at the universities | [Arquitectura de información de los portales intranets: Un componente esencial de la gestión de información en las universidades]”, *ACIMED*, 19(4), 2009.
3. Ivanova, V., Mertins, K., Alexandrova, M., Baranov, P. “Soft skills and moodle”, *MATEC Web of Conferences*, 141, 01056, 2017.
4. Bogdanova, M. “Cognitive science: From multidisciplinarity to interdisciplinarity”, *International Journal of Cognitive Research in Science, Engineering and Education*, 5(2), pp. 145-150, 2017.
5. Borba, M.C., Chiari, A.S.S., de Almeida, H.R.F.L. “Interactions in virtual learning environments: new roles for digital technology”, *Educational Studies in Mathematics*, 98(3), pp. 269-286, 2018. .
6. Yolkin, I.V., Babin E.N. «The model of managerial knowledge of a Higher Education Institution within network environment» , *Revista Publicando*, V.4, No 13. (1), pp. 1057-1072., 2017.
7. Reikhanova, I.V., Bukina, Y.V. “Optimization of educational services management in Russia for provision of succession of all levels of education with the help of new information and communication technologies”, *Advances in Intelligent Systems and Computing*, 726, pp. 957-963, 2019.
8. Vega-Hernández, M.-C., Patino-Alonso, M.-C., Galindo-Villardón, M.-P. “Multivariate characterization of university students using the ICT for learning”, *Computers and Education*, 121, pp. 124-130, 2018.
9. Gutiérrez-Porlán, I., Román-García, M., Sánchez-Vera, M.-M. “Strategies for the communication and collaborative online work by university students”, *Comunicar*, 26(54), pp. 91-99, 2018.
10. Nonaka I., Takeuchi H. The knowledge creating company: how Japanese companies create the dynamics of innovation, *Oxford University Press*, New York, NY.1995.
11. Kadochnikova E. I., Ismigilov I. I. “Measurement of cognitive growth factors of regional economy based on panel data “, *Mediterranean Journal of Social Sciences*, 5 (24), pp. 377-382, 2014.
12. Konina, O.V., Nanetadze, E.D. “Managing a modern university: The role of business processes in the structure of establishments of higher professional education”, *Advances in Intelligent Systems and Computing*, 726, c. 1053-1059, 2019.