International Journal on Emerging Technologies **10**(2a): 160-164(2019)

ISSN No. (Print) : 0975-8364
ISSN No. (Online) : 2249-3255

Evaluation of the Effectiveness of the University Electronic Information and Educational Environment

***Adel Shamsiev*[1] *and Evgeny Babin*[2]**
[1]*Department of Civil Law, Family law, Kazan Federal University, Russia.*
[2]*Department for Economics and Company Management,*
Kazan National Research Technical University named after A. N. Tupolev – KAI, Russia.

(Corresponding author: Adel Shamsiev)
(Received 05 May 2019, Revised 16 July 2019 Accepted 25 July 2019)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: The authors presented a comprehensive approach to assessing the effect and measuring the economic efficiency of implementing the university's information system. A system of indicators - measuring instruments of produced, accumulated and used academic knowledge is proposed. The use of a balanced scorecard methodology allowed us to propose and test a methodology for assessing the organizational, social, economic and resource effects of a university's information system. As a result, the authors formulated a conclusion about the orientation of the university's electronic informational and educational environment towards customer relations, revenue growth, and innovative processes, while there is a weak orientation towards achieving a social effect. The authors draw attention to the process approach to calculating the economic effect, based on the specifics of educational services. A system of measures of economic efficiency and net discounted income from the implementation of an information system has been developed and tested. Attention is drawn to the appropriateness of calculating net present value by discounting the amount of cost savings resulting from the implementation of an information system. A promising direction for the development of this study may be to assess the network effect of the electronic information and educational environment of the university with the help of quantitative and qualitative characteristics of knowledge capital.

Keywords: information system of the university, academic knowledge, knowledge capital, the economic effect, the network effect, balanced scorecard, the net present value.

I. INTRODUCTION

To justify the feasibility of financial investments in the electronic information and educational environment of the university, it is necessary to assess the effect and measure the economic efficiency of the implementation of the information system. Three types of the effect of the information system are distinguished in publications [1-2]: organizational, forming the ability to achieve the organization's goals and adapt to the external environment; social, creating the conditions for personal development and fulfillment of needs [3]; economic, expressed in the reduction of direct and indirect costs, in the growth of services and the redistribution of resources.

In the electronic informational and educational environment of the university, two more effects are obvious: informational, expressed in the accumulation of explicit and implicit academic and managerial knowledge; resource defined by new resources or reimbursement of scarce ones [4-6]. The measurement of academic knowledge allows us to evaluate the dynamics of their accumulation and efficiency of use, to develop a mechanism of material incentives for teachers. The key quantitative criteria for the economic effect are: the formation of new sources of income, the reduction of transformation and transaction costs, the decrease in the need for capital costs, the increase in asset turnover. Qualitative criteria for the economic effect include: increasing the "intelligence" of management activities, optimizing planning, increasing the market attractiveness of educational and other services, expanding information competence, creating a unified cooperation environment. The purpose of this study is to develop an integrated approach to assessing these effects and measuring the economic efficiency of the university's information system.

II. METHODS

Evaluation of the information effect can be performed on the basis of measuring the produced, accumulated and used academic knowledge (Table 1).

The application of the Balanced Scorecard System (BSC) methodology [7] made it possible to propose a system of performance indicators that measure effects by components: finances (economic and resource effects); consumers, internal processes (organizational and social effects); learning and growth (social effect) (Table 2).

The traditional approach to assessing the economic effect of the introduction of information technology is based on methods for assessing the effect of investment projects and calculating the generalized cash flow of a project [8]. We believe that it is advisable to differentiate the economic effect of implementing an information system in terms of process groups :$E = E_{educ} + E_{science} + E_{manag}$, where E_{educ} – the effect of the introduction of IT in educational activities; $E_{science}$– the effect of the introduction of IT in research; E_{manag},– effect of introducing IT into management processes and supporting processes.

Table 1: Measuring instruments of academic knowledge in the electronic information and educational environment of the university.

S. No.	Indicators	Content of indicators
Indicators of the demand for explicit knowledge		
1.	Number of calls to electronic educational resources	The total number of user requests by discipline
2.	Number of calls to databases of analytical information	The total number of user requests by sources of information
3.	The number of accesses to the resources of the electronic library	Total number of user hits by resource type
4.	The number of calls to electronic articles, monographs of university employees	Total number of user hits per semester by publication type
5.	The volume of traffic per employee, GB/person	The total annual traffic of the university (the sum of incoming and outgoing information flows) /number of employees
6.	Citation of publications	Number of citations of publications
7	Foreign students share	Number of foreign students/Total number of students
8	The proportion of foreign citizens among the scientific and pedagogical workers	The number of foreign citizens among the CPD/Total number of CPD
Indicators characterizing the amount of accumulated explicit knowledge		
1.	The number of units of resources in the electronic library	The total number of fund units by resources and their volume
2.	The number of electronic educational resources	The total number of resources in the context of disciplines, types, their volume
3.	The number of scientific publications of employees in scientific citation systems Scopus and Web of Science	The total number of scientific publications in the context of research areas, types and their volume
4.	The number of databases of analytical information, periodicals	Total Subscription Resources
5	Citation of publications	Number of citations of publications published over the past 5 years and posted on Scopus and Web of Science
Indicators characterizing the production of explicit knowledge		
1.	The number of scientific publications of employees posted in the academic repository	The total number of scientific publications in the context of research areas and their volume
2.	The number of scientific publications of students posted in the academic repository	The total number of scientific publications in the context of research areas and their volume
3.	Number of webinars and online conferences held	Number of events and registered participants
4.	Number of developed electronic educational resources	The total number of electronic resources in the context of disciplines, types of resources and their volume

The economic effect of the introduction of information technology in educational activities is directly related to the cost of teachers: $E_{educ} = (T_0 - T_1)\cdot f + (t_0 - t_1)\cdot f \cdot Q - C_c \cdot P - C_o$, where T_0, T_1 – time spent on student learning before and after implementation, f – average cost of labor PPP per unit time, t_0, t_1 – time spent on monitoring the knowledge of one student before and after implementation, Q – number of students, C_c – expenses for the development and (or) acquisition, installation of an information system or its component, P – coefficient of the calculation horizon, based on the expected period of use of the information service, C_o – operating costs.

The economic effect of the introduction of information technology in research activities is proposed to be determined by the formula:

$E_{science} = \sum_{i=1}^{n}((T_0 - T_1)\cdot f)\cdot p_i - C_c \cdot P - C_o$, where $(T_0\text{-}T_1)$ – reduction of time spent on project implementation, p_i – expert assessment of the probability of the outcome of a scientific project, f –the average cost of labor for scientific staff per unit time.

The integral indicator of saving management costs from the use of the process-modular approach is proposed to be determined by the formula:

$E = \sum_{i=1}^{n}\sum_{j=1}^{m}(Z_0 - Z_1) - C_c \cdot P - C_o$, where, Z_0- the cost of performing the entire amount of work on the j_{th} control function of the i_{th} process when manually processing information.

$Z_0 = T_0 \cdot f \cdot (1+\gamma)$, $T_0 = N \cdot L$, where, T_0 – the complexity of the management function, N - is the average complexity of the document, hours, L - is the number of documents to be processed, f - is the average cost of labor of an employee engaged in management, per unit time, γ - is the coefficient of additional wages and deductions; Z_1 - the cost of performing the entire amount of work on the j_{th} control function of the i_{th} process in automated information processing; C_c– operating costs; C_o - capital expenditures, P - coefficient of the horizon of calculation.

The calculation of the relative indicator of economic efficiency of the implementation of the information system is proposed to be performed as follows:

$$\tilde{E} = \frac{E}{C_c \cdot P + C_o}$$

The first way to calculate net present value is to discount the annual economic effect: $NPV = \sum_{t=0}^{T}(R_t - C_t)\frac{1}{(1+E)^t}$, where R - Results achieved at step "t"; C_t – the costs of the acquisition, development and operation carried out at the same step; T - period of operation, T = 5 years; E - is the discount rate. The second calculation method involves discounting the amount of cost savings as a result of the implementation of the information system and the value of the costs of operating the software modules, while subtracting the costs of acquiring and

developing the software module in the first year of operation: $NPV = \sum_{t=0}^{T}(R_t - Co_t)\frac{1}{(1+E)^t} - C_c.$

Table 2: Balanced system of indicators of the effect of the introduction of the university information system.

Criteria	Recommended Performance
Finance	
Revenue growth (VAR1)	The volume of educational and other services using the electronic information and educational environment The share of income from attracting new students Share of income from research, consulting and other services provided via the Internet
Cost and risk reduction (VAR2)	Reducing labor costs by optimizing headcount Reduce publishing costs with an electronic repository The share of stable sources of income attracted through the electronic information and educational environment
Assetuse (VAR3)	The release of working time of senior administrative personnel by automating the management process Increased intensity of use of computer equipment
Consumers	
Market share (VAR4)	Share of new educational and other services using electronic information and educational environment The share of consumers in the target segments of the educational services market Target Consumer Share
Conservation of demand (VAR5)	Number of partner organizations Number of newly attracted partner organizations Increased commitment of students, research customers
Consumer attraction(VAR6)	The volume of educational services and scientific work provided to new consumers Consumer cost reduction Increasing customer base of consumers Attractive educational services for new consumers
Satisfaction of demand (VAR7)	Customer feedback
Customer Relations(VAR8)	Reduce service time Service Availability Any time Individualization of training Increasing the service value of a service
Image and reputation(VAR9)	University reputation University branding
Internal processes	
Innovative processes (VAR10)	Number of new services Number of new learning technologies Number of new educational resources Number of new scientific developments Payback on the introduction of new technologies, the development of new resources
Keyworkflows(VAR11)	The ratio of time independent and classroom work Number of graduates Number of under performing
Learning and Growth	
Job satisfaction (VAR12)	Reliability, speed, completeness, availability of information Professional Communications Knowledge Exchange
Labor productivity (VAR13)	Income from educational services in the electronic information and educational environment per employee Income from scientific developments and other services in the electronic information and educational environment per employee
Employee motivation (VAR14)	The amount of teacher resources hosted in the repository Number of students using electronic resources The number of scientific developments of teachers made in the electronic educational information environment

III. RESULTS AND DISCUSSION

Each of the 14 criteria of a balanced scorecard was evaluated by experts (155 teachers and students) on a scale of 1 (the criterion is not implemented) to 7 (the criterion is obvious). An analysis of the main components made it possible to identify four factors that have eigen values greater than unity, corresponding to the four components of a balanced scorecard (Table 3).

Table 3: A table of eigen values of factors.

Value	Eigen values (Extract: Main components)			
	Eigen values	Total dispersion %	Cumulative Eigen values	Cumulative %
1	3,734489	26,67492	3,73449	26,6749
2	2,965260	21,18043	6,69975	47,8554
3	1,648794	11,77710	8,34854	59,6325
4	1,504765	10,74832	9,85331	70,3808
5	0,943059	6,73614	10,79637	77,1169
6	0,814184	5,81560	11,61055	82,9325
7	0,684135	4,88668	12,29469	87,8192
8	0,482119	3,44370	12,77681	91,2629
9	0,393895	2,81353	13,17070	94,0764
10	0,289184	2,06560	13,45988	96,1420
11	0,224011	1,60008	13,68390	97,7421
12	0,180485	1,28918	13,86438	99,0313
13	0,089070	0,63621	13,95345	99,6675
14	0,046550	0,33250	14,00000	100,0000

Table 4: Factor load matrix.

Variable	Load Factor (Varim. ref.) Extraction: Main components (Marked loads >, 70)			
	Factor 1	Factor 2	Factor 3	Factor 4
Revenue growth	0.13	0.91	0.11	0.03
Cost and risk reduction	0.10	0.96	0.28	0.37
Asset use	0.03	0.77	-0.00	0.06
Market share	0.77	-0.15	0.07	-0.27
Conservation of demand	0.87	-0.04	0.19	0.23
Consumer attraction	0.81	0.16	0.15	-0.20
Satisfaction of demand	0.77	0.15	-0.22	-0.27
Customer Relations	0.71	0.31	-0.24	0.32
Image and reputation	0.72	0.09	-0.17	0.59
Innovative processes	0.17	-0.09	0.81	0.21
Key workflows	-0.03	0.34	0.82	-0.17
Job satisfaction	-0.30	0.48	-0.01	0.34
Labor productivity	-0.04	0.12	0.06	0.89
Employee motivation	-0.18	0.11	0.48	0.49
Total dis.	3.55	2.39	1.87	2.05
Total share	0.25	0.17	0.13	0.15

Table 5: The annual economic effect of the implementation of the information system. Other costs, rub. Acquisition and development costs.

Activities	Labor costs, RUB		Other costs, RUB		Acquisition and development costs			Operating costs, RUB	Economic effect, RUB	Э̃
	Before implementation	After implementation	Before implementation	After implementation	Total, RUB	(*P*)	Per year, RUB			
Educational	2783000	2125200	660400	169600	260000	0,2	52000	140000	956600	4,98
Research	1662500	950000	15000	15000	185000	0,76	142500	50000	358750	1,86
Managerial	1848000	1152000	15000	8000	350000	0,2	70000	215000	418000	1,47
Total	6293500	4227200	690400	192600	795000	X	264500	405000	1733350	2,59

Note: labor costs and other costs are given in terms of those sub-processes in which information technologies are implemented.

Table 6: Net present value from the implementation of the information system.

Activities	1 year	2 year	3 year	4 year	5 year	Total, RUB
Calculation method 1						
Educational	901602,3	849766,5	800910,9	754864,2	711464,9	4018608,8
Research	338124,4	318684,6	300362,5	283093,8	266817,9	1507083,2
Managerial	393968,0	371317,6	349969,5	329848,7	310884,7	1755988,5
Total	1633694,7	1539768,7	1451242,9	1367806,7	1289167,5	7281680,5
2nd calculation method						
Educational	690612,6	895959,1	844447,8	795898,0	750139,5	3977057,0
Research	439410,9	377535,8	277338,2	261393,2	246365,0	1602043,1
Managerial	109943,5	433500,0	408576,8	385086,5	362946,7	1700053,5
Total	1239967,0	1706994,9	1530362,8	1442377,7	1359451,2	7279153,6

As can be seen from table 6, the second method of calculation gives a slightly smaller amount of net present value.

The factor load matrix (Table 4) made it possible to single out those criteria that have the greatest relationship with this factor.

The criteria that are most closely related to the first factor: market share, maintaining demand, attracting consumers, satisfying demand, customer relations, image and reputation characterize the “Consumers” component. Criteria: revenue growth, asset use, cost and risk reduction characterize the component of "Finance". Criteria: innovative processes, basic work processes, characterize the third factor - the component “Internal processes”. The fourth factor is characterized by the labor productivity criterion; there is no close relationship with the criteria “job satisfaction” and “employee motivation”.

The results of calculating the annual economic effect, the relative indicator of economic efficiency and the net present value from the implementation of the information system are presented in Tables 5 and 6.

IV. SUMMARY

The results of the study can be summarized in several conclusions. The advantage of the BSC methodology is a mixed approach based both on assessing the economic effect and on the assessment of organizational, social and resource effects. The application of the principal component method to the BSC methodology revealed that the university’s electronic information and educational environment is oriented towards customer relations, revenue growth, and innovative processes, but at the same time its “weak link” is the achievement of a social effect. Adequate accounting and statistical measures are required in each group of academic knowledge and in each component of the BSC. From the point of view of the correspondence in time of the reflection of the costs of acquiring and developing the information module, the second method of calculating net present value is more appropriate in accounting.

V. CONCLUSIONS

Thanks to the exchange of knowledge, they accumulate and improve processes at the university. An open model of academic knowledge increases the scale of network interaction and consumer value of knowledge [9, 10]. The larger the scale of the network, the more useful it is for the consumer, the network effect enhances all other types of effects and ensures their synergy. Due to network interaction, transaction costs and unit transformation costs are reduced [11, 12]. The University's networked electronic information and educational environment allows us to build an effective value chain for educational services, in which the production of each subsequent unit of educational services increases the usefulness of all similar services produced before. The network effect is manifested in increasing the productivity of information and in increasing the capital of knowledge, which can be determined by comparing the value added by management and the weighted average cost of capital [13]. The problem of assessing the network effect with the help of quantitative and qualitative characteristics, as well as the assessment of investments in knowledge capital - in the value of employees who have organizational knowledge, and the assessment of the value added by management, is the subject of further research.

ACKNOWLEDGEMENTS

The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

A REFERENCES

[1]. Konina, O.V., Nanetadze, E.D. (2019). Managing a modern university: The role of business processes in the structure of establishments of higher professional education. *Advances in Intelligent Systems and Computing*, Vol. *726*, pp. 1053-1059.

[2]. Reikhanova, I.V., Bukina, Y.V. (2019). 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*, Vol. *726*, pp. 957-963.

[3]. Drucker, P. F. (1992). The new society of organizations. *Harvard Business Review*, Vol. *22*(5), pp. 95-104.

[4]. Borba, M.C., Chiari, A.S.S., de Almeida, H.R.F.L. (2018). Interactions in virtual learning environments: new roles for digital technology. *Educational Studies in Mathematics*, *98*(3), pp. 269-286.

[5]. Vega-Hernández, M.-C., Patino-Alonso, M.C., Galindo-Villardón, M.P. (2018). Multivariate characterization of university students using the ICT for learning. *Computers and Education*, 121, pp. 124-130.

[6]. Ivanova, V., Mertins, K., Alexandrova, M., Baranov, P. (2017). Soft skills and moodle. MATEC Web of Conferences, 141, 01056.

[7]. Bénet, N., Deville, A., Naro, G. (2019). BSC inside a strategic management control package. *Journal of Applied Accounting Research*, Vol. *20*(1), pp. 120-132.

[8]. Rien Brouwers, WimKoetzier. (2015). Basics of Financial Management. Noordhoff Uitgeversbv Groningen, Houten, The Netherlands. 427 p.

[9]. Grant, R. M. (1993). Towards a knowledge-based theory of the firm. *Strategic Management Journal*, Winter Special Issue, No.17, pp. 109-122.

[10]. Gutiérrez-Porlán, I., Román-García, M., Sánchez-Vera, M. M. (2018). Strategies for the communication and collaborative online work by university students. *Comunicar, 26*(54), pp. 91-99.

[11]. Barney, J.B. (1986). Strategic factor markets: expectations, luck and business strategy. *Management Science*, Vol. *32*, No.10, pp.1231-1241.

[12]. I.V. Yolkin, E. N. Babin. (2017). The model of managerial knowledge of a Higher Education Institution within network environment. *Revista Publicando*, 4, No 13. (1). pp. 1057-1072.

[13]. Strassmann, Paul A. (1996). The Value of Computers, Information and Knowledge, URL: www.strassmann.com