

INTEGRATED ASSESSMENT OF ORGANIZATION'S KNOWLEDGE POTENTIAL

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Abstract. Knowledge became a vital resource to all economy subjects after humans had become capable to catalyze the creation and spreading of knowledge in the 20th century. It became urgent to be capable of measuring and assessing knowledge to enhance this resource purposefully and well-grounded. Although quite a lot of scientific articles, as well as more popular publications, analyze various aspects of knowledge management, but the problem of knowledge assessment is yet to be solved. Although plenty of scientists have researched the theoretical and practical problems of assessing organization's knowledge potential for a few decades, a unified and single methodology of assessment has not been accepted. The outcome of our research is the original concept for determining knowledge potential, essentially based on new principles. An assessment of the factors making a real impact helped in building a model including such components as employee's knowledge potential, knowledge potential synergy, and organization's environment. The quantitative specifications of the above introduced components have been prepared. Practical application of the model has been researched by an experiment and theoretical modelling.

Keywords: organization, knowledge potential, synergy, integrated assessment, model.

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1. Introduction

States and organizations invest large sums of money into the creation of mind power platforms. While these processes carry on, the society has stepped into a new stage of development where networks of complicate structures and different depths of knowledge form (Adekola *et al.* 2008; Tvaronavičienė, Kalašinskaitė 2010). In this society there is a need to conceptualize the knowledge potential of human that was acknowledged by scientists in the 20th century as the most important resource that conditions both personal and organizational success, effectiveness of investments, economy expansion as well as the power of states. Employees, organizations and even states are compared in the aspect of knowledge (Brauers, Ginevičius 2009; Ginevičius, Ginevičienė 2009).

It is important to stress that purposeful and well-grounded management of knowledge potential relies on knowing how to measure, assess or calculate it (Kaklauskas *et al.* 2009). Although there are quite a lot of scientific studies as well as more popular publications on various aspects of knowledge management, but professional and scientific material on organization's knowledge potential assessment is very scarce. While suitable instrumentalities' which let to assess knowledge potential of organization is not created, the managing of this resource can't be effective. This situation encouraged us to carry out a research on knowledge potential assessment by summarizing other scientists' research results on this topic and preparing a quantitative model for integrated assessing the potential of knowledge in organization.

2. Building a new concept model for organization's knowledge potential assessment

The exact quantitative adaptation of models for assessment of organization's knowledge potential has not been developed. According to D. Bell (1973), A. Toffler (1980), J. Bivainis (1991), P. Drucker (1993), I. Nonaka and H. Takeuchi (1995), W. C. Kim and R. Mauborgne (1999), A. Armstrong and P. Foley (2003), N. Paliulis and J. Raudeliūnienė (2006) the need for such investigations is caused by changing social structure. The analysis of scientific papers identifies numerous works which assess the competency and knowledge of organizations and employees, as well as analyze the knowledge management and application by organizations. The following works can be considered as more distinct in the area of knowledge management: *Wissepsmanagement Forum Organization's knowledge management process assessment guide* (2003); *assessment methods of jobs and office positions* by A. Šileika *et al.* (2004); "Knowledge measurement and interviewer bias" by K. Fink (2005); "Organizational competency management" by T. Ley (2006); *organization's knowledge culture creation and development model* by O. Stan and K. R. Kandadi (2006); *organization's knowledge assessment model* by E. Jonhson (2007); and *organization's knowledge management model* created by The Knowledge Company, Inc. (2009). Comparison of models analyzed in Table 1 summarizes models used to assess knowledge in the organization.

After examining the results of model comparison (Table 1) it becomes clear that models analysed do not meet modern requirements and must be improved in many ways. Only two models provide the assessment result in quantitative expression, only one model is entirely orientated towards an individual, none of the models analyse synergy in the context of knowledge, and assessment factors in all models provoke doubt on the expedience of application when knowledge contents are concerned, and application of all models is complicated.

Therefore, assessing knowledge potential becomes vital in modern managing of an organization. The outcome of our multiyear research is a model (Fig. 1) essentially based on an original concept, and consisting of the following parts: 1) employee's knowledge potential assessment; 2) knowledge potential synergy assessment; 3) organization's external medium assessment.

Table 1. Comparison of the models assessing an organizations’ knowledge potential

Criteria of comparison	Authors of models							
	K. Fink	E. Johnson	O. Stan, K. R. Kandadi	R. Smith	T. Ley	“Wisess- management Forum”	“Workitect, Inc.”	“The Knowledge Company, Inc.”
Presentation of result in quantitative expression	0	1	0	2	2	1	0	0
Orientation towards an individual	1	1	1	1	1	1	2	1
Identification of knowledge synergy	0	0	0	1	0	0	0	0
Suitability of assessment factors	1	1	1	1	1	1	1	1
Applicability	1	1	1	2	0	1	1	1
Versatility	0	0	0	2	0	1	1	1
Acceptability of expenditure	0	0	1	2	0	2	1	1
Objectiveness of results	1	1	1	0	1	1	1	1

Notes: Model estimates according to criteria: 0 – non satisfactory; 1 – partly satisfactory; 2 – completely satisfactory

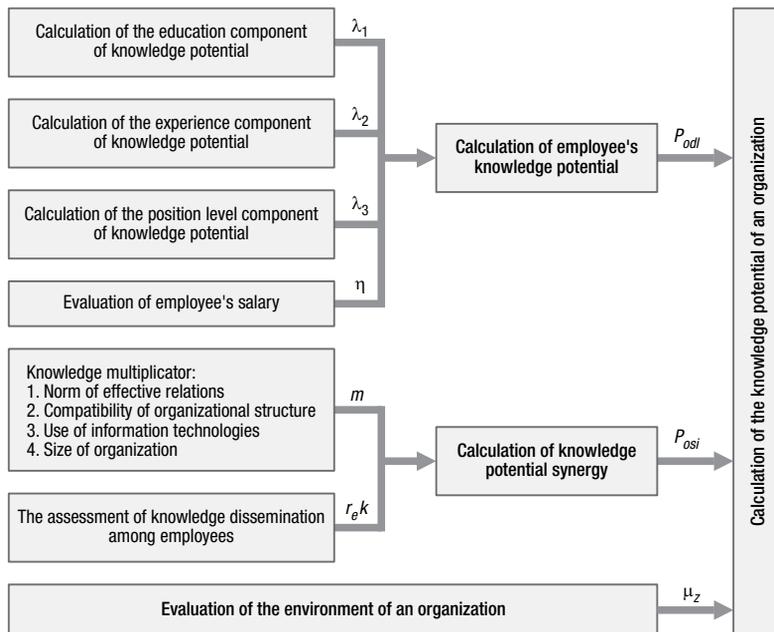


Fig. 1. Principle scheme of organization’s knowledge potential integrated assessment

Firstly, it is aimed at creating a collective medium where all employees are able to find the gaps that might be filled with their knowledge potential. Secondly, the synergy is created when employees interplay in the organization medium.

Synergy arises not only when two complementary persons with different skills cooperate. Synergy arises when different types of knowledge are combined and we call it the synergy component of knowledge potential. Thirdly, the more effective external relations the organization can maintain, the more knowledge it is able to absorb into itself and disseminate this knowledge within the organization via the internal relations.

3. Assessment of employee's knowledge potential

In assessing the knowledge potential of an employee as a member of an organization, it is necessary to evaluate his actions in a certain complicated organization's internal medium, which is common to all the employees. In our opinion, the main factor that reveals an employee's knowledge potential is the complexity of the work that the employee does. The more complex is the work, the greater knowledge potential is necessary to accomplish it.

According to the International Labor Organization Geneva Scheme (1950), the complexity of the work is determined by evaluating the requirements for the specific job position, i.e., employee's education, professional experience, and level of position. They as important factors determining employee's knowledge potential are analyzed by J. Bivainis (1991), P. Drucker (1993), V. Dubinas (1995), I. Nonaka, H. Takeuchi (1995), A. Šileika *et al.* (2004), O. Stan and K. R. Kandadi (2006), Knowledge Company, Inc. (2009), World Bank (2008). All these factors are detailed using quantitative methods in our earlier investigations (Bivainis, Morkvėnas 2010).

Assessment of education component of knowledge potential. Employee's knowledge potential determined by the employee's level of education can be calculated as follows:

$$V_1 = B + \sum_{c=1}^t (p_c - l_c) h_c \text{ [score]}, \quad (1)$$

where: B – score for employee's highest acquired education; p_c – score for employee's additionally acquired education in the level c ; l_c – score for employee's acquired education that enabled him/her to acquire additional education in the level c ; h_c – number of additionally acquired educations in the level c ; t – number of educational levels.

The basis of these calculations is the cumulative vector (Table 2), based on the score distribution according to our calculations of educational levels (Bivainis, Morkvėnas 2010). Under different conditions, the cumulative vector can be recalculated using our proposed methodology.

Assessment of occupational experience component of knowledge potential. Employee's knowledge potential, determined by employee's occupational experience, can be calculated as follows:

$$V_2 = [\log_{40}(1 + d_s) + \psi(\log_{40}(1 + d_b) - \log_{40}(1 + d_s))] 100 \text{ [score]}, \quad (2)$$

where: d_s – employee’s work experience in the sector; d_b – employee’s overall work experience; ψ – relative importance of the overall work experience compared to the work experience in the sector.

Assessment of occupation level component of knowledge potential. Employee’s knowledge potential, assessed from the employee’s position level, can be determined as follows:

$$V_3 = \sum_{a=1}^{\sigma} \varphi_a \kappa_a \quad [\text{score}], \quad (3)$$

where: φ_a – evaluation of the employee’s position a in score; κ_a – quantity of hours worked in the employee’s position a ; σ – number of positions held by employee in the organization.

Assessment of employee’s salary as indicator of the employee’s ability to use his/her acquired knowledge potential. The salary also allows to quantitatively compare the knowledge potential of employees from different organizations. In Formula 4, the employee’s knowledge potential is multiplied by the employee’s salary coefficient (η_i) (see Formula 5), and the knowledge potential (P_{odl}) of all the employees of organization l is determined according to Formula 6.

$$P_{di} = \eta_i \sum_{j=1}^3 \lambda_j V_{ij}, \quad (4)$$

$$\eta = \frac{u_0}{u_v}, \quad (5)$$

$$P_{odl} = \sum_{i=1}^n \eta_i \sum_{j=1}^3 \lambda_j V_{ij}, \quad (6)$$

where: λ_j – importance of factor j ; V_{ij} – score of factor j considering employee i ; u_v – average salary (brutto) in the labor market; u_0 – employee’s salary (brutto) in an organization; n – number of employees of an organization.

Table 2. Cumulative vector of the knowledge potential distribution according to the level of education

Education	Score
1. No education	0
2. Elementary education	12.18
3. Basic education (10 grades)	22.97
4. Secondary education	31.30
5. Professional education	36.95
6. Bachelor’s degree (obtained not from a University)	48.71
7. Bachelor’s degree (obtained from a University)	67.7
8. Masters degree	73.51
9. Doctors’s degree	100.00

In order to ascertain the importance of factors determining the knowledge potential of an employee, we conducted a research. The importance was evaluated applying the AHP (*Analytic Hierarchy Process*) (Saaty 1980). The evaluation characteristics of factors by their importance, as determined by experts, are provided in Table 3.

Table 3. Synthesized evaluation characteristics of factors by their importance

Factors	V_1	V_2	V_3	λ_j
V_1	1.00	0.52	3.14	0.34113
V_2	2.14	1.00	4.29	0.54303
V_3	0.34	0.25	1.00	0.11584

4. Assessment of knowledge potential synergy in organization

In order to evaluate the synergy of knowledge potential of an organization, it is first necessary to determine the amount of knowledge disseminated among the employees. The determination of the amount of knowledge disseminated among the employees in the model is calculated from the average knowledge potential of an employee (k_v) per one relation:

$$k_v = \frac{P_{odl}}{r_t}, \tag{7}$$

where: r_t – maximum amount of relations among the employees within an organization. Knowing what the average knowledge potential of an employee is per one relation, the second step is to determine the number of effective relations (r_e) that form among the employees of an organization. We suggested two different methodological variants for performing this step.

Method based on theoretical norms accepted in a theory of management. For theoretical calculations, the norm of effective relations $r_n = 5$. Then:

$$r_e = \begin{cases} \frac{n(n-1)}{2}, & \text{when } n \leq 6, \\ r_n \frac{n}{2} + r_a, & \text{when } n > 6, \end{cases} \tag{8}$$

where: r_a – number of random relations.

The number of random relations among employees within an organization is calculated as follows:

$$r_a = \left(1 - \frac{1}{n}\right)(n-6). \tag{9}$$

Method based on the detailed analysis of an organization's management structure, which determines the existing relations between the employees within a division, as well as relations between the employees from different divisions.

Because the multiplier law applies to knowledge, the amount of disseminated knowledge is multiplied by the knowledge multiplier. To determine the knowledge multiplier (m), the following parameters are used: 1) norm of effective relations; 2) compat-

ibility of organizational structure; 3) informational technology employment coefficient; 4) size of an organization.

1. First of all, it is important to note that when there is a large number of employees, knowledge is not exchanged between each of the employees. When knowledge dissemination takes place among employees, the knowledge multiplier depends on the number of effective relations maintained per one employee. The management theory indicates that the number of relations that can be maintained effectively by an employee, is limited because upon expansion of the number of those relations part of them become ineffective. Therefore, knowledge can be multiplied as many times as is physically possible. Scientific literature indicates that an employee can effectively maintain 4 to 6 relations, and this number is considered the norm. The amount of disseminated knowledge ($r_e k_v$) within an organization can be multiplied r_n times.

2. Concerted structure of an organization enables the employees to effectively receive, disseminate, and create knowledge. Whether an organization's structure is concerted or not is revealed by a very important characteristic of an organizational structure – subordination. The norm of subordination has been determined by V. A. Graičiūnas (1937) – a rational number of employees, subordinate to the manager is 4 to 6. L. F. Urwick (1943) score out that a manager cannot directly control the activities of more than 5 to 7 employees. In our opinion, there exists another characteristic, more precisely determining the compatibility of an organization, i.e., the average number of effective relations per one employee (r_v), as the effective work of employees is no less important than that of managers. Determined norms (the model uses the results of the work of V. A. Graičiūnas (1937)) apply to both managers and employees, i.e., the norm of effective relations (r_n) is equal to 4–6 relations. The average number of effective relations per one employee is calculated by dividing the number of effective relations by $n/2$ (because 2 employees participate in one relation):

$$r_v = r_e \cdot \frac{n}{2} = \frac{2r_e}{n}. \quad (10)$$

To evaluate the compatibility of the organizational structure, the compatibility coefficient (m_s) of organizational structure has been calculated:

$$m_s = \begin{cases} 1, & \text{when } r_v = r_n, \\ \frac{r_n}{r_v}, & \text{when } r_v > r_n, \\ \frac{r_v}{r_n}, & \text{when } r_v < r_n. \end{cases} \quad (11)$$

3. Another factor stimulating the synergy of knowledge potential is the ability of the employees to apply information technologies. The coefficient (m_t) of the employees' ability to use information technologies is calculated as follows:

$$m_t = \frac{1}{100} \beta, \quad (12)$$

where: β – the percentage of the organization's employees able to use the Internet.

4. In order to evaluate the impact of the organization's size on knowledge multiplication, logarithmic function can be applied (its application is based on our research). The base of the logarithm is the size of the organization (≥ 250 employees), according to the classification of enterprises.

Therefore, the impact of the organization's size on knowledge multiplication is evaluated by a coefficient (m_n):

$$m_n = \log_{250}(n). \quad (13)$$

To sum up, the knowledge multiplier and the synergy of the knowledge potential of the organization's employees is calculated in following way:

$$m = r_n m_s m_t m_n, \quad (14)$$

$$P_{osl} = m r_e k_v, \quad (15)$$

$$P_{osl} = r_n m_s m_t m_n r_e k_v. \quad (16)$$

After adding the knowledge potential of the organization l and the organization's knowledge potential arising from synergy, the result can be obtained as follows:

$$P_{ol} = \sum_{i=1}^n \eta_i \sum_{j=1}^3 \lambda_j V_{ij} + r_n m_s m_t m_n r_e k_v. \quad (17)$$

5. Assessment of organization environment

In assessing the organization's knowledge potential it is important to investigate the influence of the environment on the organization. The more knowledge the environment contains, the more effective external relations the organization can maintain within that environment. The more effective external relations the organization maintains, the more knowledge the organization can absorb into itself, and disseminate that knowledge via internal relations within the organization. The knowledge potential of each organization has to be corrected by a coefficient (μ_z), the value of which depends on the knowledge economy index of the country in which the organization operates:

$$\mu_z = \frac{KEI_z}{KEI_v}, \quad (18)$$

where: KEI_z – knowledge economy index of country z ; KEI_v – the average of the indices of the countries' knowledge economy.

With respect to the level of the knowledge economy of the country in which the organization operates, the knowledge potential is corrected in the following way:

$$P_{ol} = \left(\sum_{i=1}^n \eta_i \sum_{j=1}^3 \lambda_j V_{ij} + r_n m_s m_t m_n r_e k_v \right) \mu_z. \quad (19)$$

6. Verification of the model for assessing organization's knowledge potential

When carrying out theoretical simulation of knowledge potential components in organization, low, average and maximum meanings of informational technology employment and organizational structure compatibility coefficients were chosen. In order the simulation to be more simple other parameters used in model were set as constants (e.g.

knowledge potential of organization (P_{di}) equals 150 score), some of them change according to the number of employees. Results of simulation are given below (Figs. 2–6).

When the number of employees in the organization or its subdivisions is rational (6 employees) and when meanings of coefficients that are used to calculate synergy are maximum, the simulated ratio of knowledge potential synergy and employees' knowledge potential equals 1.62, when the coefficients are average the ratio equals 0.79, and when the coefficients are low it equals 0.28. When the number of employees in the organization increases, knowledge potential synergy and employees' knowledge potential ratio decreases.

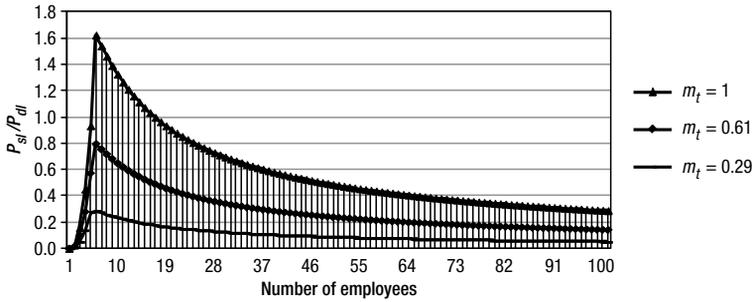


Fig. 2. Ratio between knowledge potential synergy and employees' knowledge potential, when the number of employees is changing (when $P_{di} = 150$ score; $\mu_z = 1$; $\eta = 1$; $r_n = 5$)



Fig. 3. Comparison of an organization's knowledge potential and knowledge potential synergy (when $P_{di} = 150$ score; $\mu_z = 1$; $\eta = 1$; $r_n = 5$; $m_t = 1$; $m_s = 1$)



Fig. 4. Comparison of an organization's knowledge potential and knowledge potential synergy (when $P_{di} = 150$ score; $\mu_z = 1$; $\eta = 1$; $r_n = 5$; $m_t = 0.61$; $m_s = 0.8$)

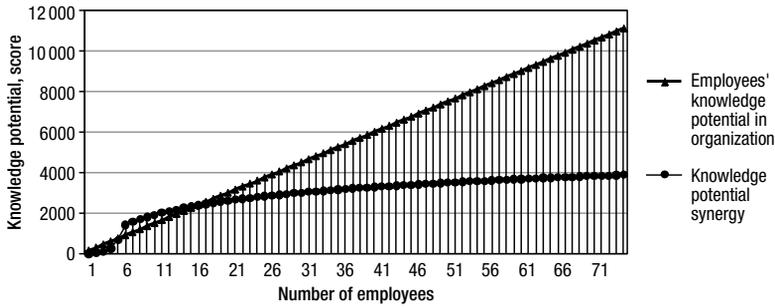


Fig. 5. Comparison of employees' knowledge potential and knowledge potential synergy in organization (when $P_{di} = 150$ score; $\mu_z = 1$; $\eta = 1$; $r_n = 5$; $m_t = 1$; $m_s = 1$)



Fig. 6. Comparison of employees' knowledge potential and knowledge potential synergy in organization (when $P_{di} = 150$ score; $\mu_z = 1$; $\eta = 1$; $r_n = 5$; $m_t = 0.61$; $m_s = 0.8$)

To verify the practical applicability of model of knowledge potential assessment in organization by carrying out an empirical research three different organization were chosen: 1) Department of Cultural Heritage under the Ministry of Culture of the Republic of Lithuania (further mentioned as Department); 2) wood processing company “Inkilas” (further mentioned as Wood Processing Company); 3) consulting company “VEPROC Research and Consulting, Ltd.” (further mentioned as VEPROC).

After analyzing the results of research (Table 4) it was determined that knowledge potential level in VEPROC is high (total 5805 score, 387 score per employee), in the Department it is average (total 21192 score, 202 score per employee), in the Wood Processing Company it is low (total 4787 score, 84 score per employee). The results in a quantitative expression as well as transformed in a relative measure are reliable and easy to compare. In the organizations chosen for the research the knowledge potential synergy and employees' knowledge potential ratio is from 0.08 to 0.87.

This way of demonstrating research results allows one to group organizations according to their knowledge potential, compare them in different aspects, determine the need to increase knowledge potential and sources needed, and find the highest value of organizational knowledge potential and work results.

According to prepared given assessment methodic, the model is easily applied in various organizations. The usage of model is useful because: 1) by putting the model into

practice it is possible to assess knowledge potential in organization quantitatively; to determine the level of knowledge potential and its changes in organization; to make the best decisions that stimulate the spread of knowledge potential in organization by following results of model application; 2) the model can be successively applied when carrying out various research in order to determine knowledge potential in employees and organization. This model can also be applied when carrying out complex research in order to assess knowledge potential in organization group, sector, state and organizations in different countries; 3) state’s knowledge potential assessment database can be created based on this model.

Table 4. Summary of the results of an empirical study

Parameter	Department	Wood Processing Company	VEPROC
Employee’s knowledge potential (P_{dl})	12013 score	2969 score	2077 score
Synergy of knowledge potential (P_{sl})	2210 score	244 score	1819 score
<i>Number of direct relations among employees in different subdivisions (r_s)</i>	191	79	26
<i>Number of effective relations in subdivision (r_p)</i>	219	127	15
<i>Total number of effective relations among employees (r_d)</i>	410	206	44
<i>Average employees’ knowledge potential per relation (p_v)</i>	2.2 score	1.86 score	19.78 score
<i>Average number of relations per employee (r_v)</i>	7.8	7.2	5.86
<i>Management structure compatibility coefficient (m_s)</i>	0.461	0.6944	0.8532
<i>Informational technology employment coefficient (m_i)</i>	0.91	0.251	1
<i>Organization’s size coefficient (m_n)</i>	0.84	0.73	0.49
<i>Knowledge multiplier (m)</i>	2.45	0.636	2.1
Environment knowledge potential level coefficient (μ_z)	1.49	1.49	1.49
Knowledge potential (P_l)	21192 score	4787 score	5805 score
Knowledge potential per employee (P_{dv})	202 score	84 score	387 score

7. Conclusions

The model to assess knowledge potential is orientated towards an individual and involves all components of knowledge: explicit, tacit and synergy. The content of model was structured using factors that till now were poorly analyzed in the context of knowledge but are very important; the factors and their connections’ qualitative characteristics were reduced to quantitative expression.

Such conclusions were drawn after theoretically simulating components of knowledge potential in the organization and carrying out an empirical research applying the created model to assess knowledge potential in different organizations:

- Organization must use means to stimulate synergy, otherwise the knowledge potential synergy dies away rapidly (after simulating the ratio between employees' knowledge potential and knowledge potential synergy, it was from 0 to 1.62, in comparison with results given by empirical research – from 0.08 to 0.87). It was determined that knowledge potential synergy in organization grows slower when the number of employees grows, and the largest amount of knowledge potential synergy per employee is reached when there are 6 employees in the organization.
- Model parameters are easily applied in the organizations assessed. Organization's accounting and statistical data are enough to make the calculations. The results received after assessing the knowledge potential of organizations were transformed into a relative quantity (knowledge potential of organization per employee that shows the level of knowledge potential in organization) and are easy to compare.

Presumptions made after applying the model: to enlarge permanent organization's competitiveness by identifying unused sources of knowledge potential and by developing management of human resources; to bind salary system with employees' knowledge; to make objective decisions on employee change; to observe changes in organization's result and knowledge potential dependence; to form databases that support knowledge management decisions. The model can be easily put into practice by various organizations, and assessment results from different states can also be compared.

Applying the model in the future should be taken into account the importance of factors. In our research the importance of factors are established leading classical understanding of knowledge organization. However in the different phases of economical development the importance of factors could change and must be recounted permanently using suggested methods.

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INTEGRUOTAS ORGANIZACIJOS ŽINIŲ POTENCIALO VERTINIMAS

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Santrauka

Žinios visiems ūkio subjektams tapo ypač svarbios, kai XX a. žmogus sugebėjo iš esmės katalizuoti jų kūrimą ir sklaidą. Tai lėmė greitėjančius įvairių sričių pokyčius, o žinios buvo pripažintos svarbiausiu ištekliumi, lemiančiu individų, organizacijų ir valstybių sėkmę. Kryptingai ir pagrįstai šio ištekliaus plėtrai tapo itin aktualu gebėti išmatuoti ir įvertinti žinias. Nemažai mokslininkų jau kelis dešimtmečius tiria teorines ir praktines organizacijos žinių potencialo vertinimo problemas, tačiau visapusiška ir kompleksinė vertinimo metodologija nesukurta. Mūsų tyrimo rezultatas – originali organizacijos žinių potencialo vertinimo koncepcija, pagrįsta naujais principais. Sukurtą modelį sudaro šios pagrindinės tarpusavyje susietos dalys: darbuotojų žinių potencialo skaičiavimas, žinių potencialo sinergijos skaičiavimas, organizacijos išorinės terpės vertinimas. Modelyje išspręsta skirtingo lygio ir tipo veiksmų integravimo į vieną vertinimo sistemą problema. Šios vertinimo sistemos generuojamas rezultatas išreiškiamas vienu sintezuotu įverčiu (balais). Praktinis modelio pritaikymas buvo patikrintas atliekant empirinį tyrimą ir teorinį modeliavimą.

Reikšminiai žodžiai: organizacija, žinių potencialas, sinergija, integruotas vertinimas, modelis.

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