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ASSESSMENT OF THE STRATEGIC POTENTIAL OF AN INTELLECTUAL BUSINESS SYSTEM OPERATING IN A DYNAMIC EXTERNAL ENVIRONMENT

The paper discusses the issues of increasing the efficiency of the functioning of an intelligent business system by reducing its losses by creating an integrated set of models for assessing the level of its current strategic potential and the degree of achievement of its fixed target state. The object of the analysis is an intelligent business system of the IT industry that produces software products, the results of which depend on the well-established abilities of its personnel, who has effective intelligent information technologies. The task of assessing the strategic potential, determined by the totality of available resources (human, material, intellectual) that can be put into action, mobilized to achieve the target state of the enterprise, this calculation is based on estimates of the material and intellectual potential of the business system. We will build a complex of models for determining estimates of material and intellectual potential based on the significance and intensity of the influence of the strengths and weaknesses of the material, human, intellectual resources of the functional zones of the business system. Development of a subject technology for assessing the strategic potential of an intelligent business system, assessing the degree to which it reaches a fixed target state. Obtaining the results can serve as a theoretical basis for creating information technology for assessing the strategic potential of an enterprise in the IT industry.

Keywords: intelligent business system, assessment of strategic potential, target state of the enterprise, material and intellectual potential, hierarchy analysis method, functional areas of the business system.

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ОЦІНКА СТРАТЕГІЧНОГО ПОТЕНЦІАЛУ ІНТЕЛЕКТУАЛЬНОЇ БІЗНЕС-СИСТЕМИ, ЩО ФУНКЦІОНУЄ В УМОВАХ ДИНАМІЧНОГО ЗОВНІШНЬОГО СЕРЕДОВИЩА

В роботі розглядається питання підвищення ефективності функціонування інтелектуальної бізнес-системи за рахунок зниження її збитків шляхом створення інтегрованого комплексу моделей оцінки рівня її поточного стратегічного потенціалу і ступеня досягнення її зафіксованого цільового стану. Об'єктом аналізу є інтелектуальна бізнес-система IT індустрії, яка виробляє програмну продукцію, результати діяльності якої залежать від усталених здібностей свого персоналу, що володіє ефективними інтелектуальними інформаційними технологіями. Завдання оцінки стратегічного потенціалу, що визначається сукупністю наявних ресурсів (людських, матеріальних, інтелектуальних), які можуть бути приведені в дію, мобілізовані для досягнення цільового стану підприємством, полягає в обчисленні його на основі оцінок матеріального і інтелектуального потенціалів бізнес-системи. Побудуємо комплекс моделей визначення оцінок матеріального і інтелектуального потенціалів на основі значимість і інтенсивностей впливу сильних і слабких сторін матеріальних, людських, інтелектуальних ресурсів функціональних зон бізнес-системи. Розробка предметна технологія оцінки стратегічного потенціалу інтелектуальної бізнес системою, оцінки ступеня досягнення нею зафіксованого цільового стану. Отримання результати можуть слугувати теоретичною основою для створення інформаційної технології оцінки стратегічного потенціалу підприємства IT індустрії.

Ключові слова: інтелектуальна бізнес-система, оцінка стратегічного потенціалу, цільове стан підприємства, матеріальний і інтелектуальний потенціал, метод аналізу ієрархій, функціональні зони бізнес-системи.

В. Л. ЛИСИЦКИЙ, А. И. СЕМЕНЧЕНКО

ОЦЕНКА СТРАТЕГИЧЕСКОГО ПОТЕНЦИАЛА ИНТЕЛЛЕКТУАЛЬНОЙ БИЗНЕС-СИСТЕМЫ, ФУНКЦИОНИРУЮЩЕЙ В УСЛОВИЯХ ДИНАМИЧНОЙ ВНЕШНЕЙ СРЕДЫ

В работе рассматривается вопросы повышения эффективности функционирования интеллектуальной бизнес-системы за счет снижения её убытков путем создания интегрированного комплекса моделей оценки уровня её текущего стратегического потенциала и степени достижения её зафиксированного целевого состояния. Объектом анализа является интеллектуальная бизнес-система IT индустрии, производящая программную продукцию, результаты деятельности которой зависят от устоявшихся способностей своего персонала, обладающего эффективными интеллектуальными информационными технологиями. Задача оценки стратегического потенциала, определяемого совокупностью имеющихся ресурсов (человеческих, материальных, интеллектуальных), которые могут быть приведены в действие, мобилизованы для достижения целевого состояния предприятием, состоит в вычислении его на основе оценок материального и интеллектуального потенциалов бизнес-системы. Построим комплекс моделей определения оценок материального и интеллектуального потенциалов на основе значимостей и интенсивностей влияния сильных и слабых сторон материальных, человеческих, интеллектуальных ресурсов функциональных зон бизнес-системы. Разработка предметная технология оценки стратегического потенциала интеллектуальной бизнес системой, оценки степени достижения ею зафиксированного целевого состояния. Полученные результаты могут служить теоретической основой для создания информационной технологии оценки стратегического потенциала предприятия IT индустрии.

Ключевые слова: интеллектуальная бизнес-система, оценка стратегического потенциала, целевое состояние предприятия, материальный и интеллектуальный потенциал, метод анализа иерархий, функциональные зоны бизнес-системы.

Introduction. At the present stage of the formation of the information society, there is a significant change in the structure of its productive forces, the relationship between their material and intellectual components. This is explained by the intensive appearance, along with material business systems, of a wide class of intelligent business systems. Existing production business systems are largely dependent on their production capital (material potential). This especially significantly affects their management methods, and methods for assessing their strategic potential. Intelligent business systems that produce intelligent products are completely dependent on the mental abilities of their staff with the latest information technologies (intellectual potential). "Blind" application of methods for assessing the strategic potential of production business systems to the assessing the strategic potential of intelligent business systems may be ineffective. In this regard, it is urgent to develop effective methods for assessing the strategic potential of an intellectual business system (IBS), which operates in a dynamic external environment. The aim of the work is to increase the efficiency of IBS functioning by developing subject

28

Вісник Національного технічного університету «ХПІ». Серія: Системний аналіз, управління та інформаційні технології, № 2 (4)'2020

technology for reliable assessment of the strategic potential of IBS, developing in the direction of a fixed target state [1–3].

Literature review. Literary sources and publications that are used in this article allow us to describe in detail the mathematical apparatus of solving a problem, assessing the strategic potential of an intellectual business system. This is the use of the hierarchy analysis method, strategic management techniques and others.

Formulation of the problem. In process management, an intelligent business system is understood as a set of intelligent business processes (IBP) (main, providing, as well as IBP management, development), which form a certain structure designed to actively achieve a fixed global goal with maximum efficiency [4]. IBS has the resources (human, material, intellectual) that determine its material and intellectual potentials. IBS, as a rule, is based on knowledge, contains a complex of software linguistic and logical-mathematical knowledge management tools for intellectual support of personnel activities, information and knowledge search in an interactive solution in a natural language [3–5]. The IBS structure is dynamic. It develops and changes under the influence of the features of the implemented IBS strategy, its internal complexity and changes in the external environment. It is assumed that IBS has a matrix structure in which the members of the project team are subordinate not only to the project manager, but also to the heads of those structural divisions in which they constantly work. IBS intellectual products are software for the automation of management accounting in trade, catering, and small and medium-sized businesses. The design and development of software is based on its life cycle model, which contains the following steps: analysis; design; development; testing; implementation; escort. It is generally accepted that its resources determine the potential of any enterprise. The strategic potential of IBS is understood as the totality of available resources (human, material, intellectual) that can be put into action, mobilized to achieve the global goal of IBS, determined by its mission. Typically, strategic potential is defined by a multitude of quantitative indicators. Taking into account the features of the IBS subject area, such as the quality and efficiency of decision making; unclear goals; the number of agents involved; chaos, fluctuations and quantization of the behavior of the internal and external environment; the multiplicity of mutually influencing factors; weakness structurefull, uniqueness, non-stereotyped situation, etc. It is difficult to indicate the degree of attainability of the target state based on all indicators [4, 6].

In this regard, an urgent task arises of assessing the strategic potential of the IBS with one quantitative indicator characterizing the degree of its achievement of the global goal.

Subject technology for assessing strategic potential. The levels and mutual influence of its material and intellectual potentials determine the strategic potential of IBS. Each of these potentials depends on the intensity of the influence of the strengths and weaknesses of the resources of the IBS functional zones (marketing; production; research work (innovation); personnel;

finance; management; external economic activity; other functional areas) on the degree to which the IBS target state is achieved. The intensity of the influence of the strong, weak sides of each functional area is determined by its significance and forecast probability and its manifestation on the time interval $[0; T]$ with duration T. It is assumed that $\underline{U} \leq U \leq \overline{U}$, where $\underline{U}$ is the bottom limit, $\overline{U}$ is the top limit of the probability of a side appearing during the movement of the IBS to the target position. The Importance of strengths and weaknesses is determined by its contribution to assessing the level of IBS potential. In the following, the material potential of IBS is understood as the totality of the available material and human resources of the IBS functional zones that can be activated, mobilized to achieve the global goal of IBS. Similarly, the intellectual potential of IBS is understood as the totality of the intellectual and human resources of the IBS functional areas that can be activated, mobilized to achieve the global goal of IBS. The level of Strategic Potential (SP) IBS is determined by dependence

$$SP = \varphi(MP, IP), \tag{1}$$

where MP is the level of material potential of IBS, IP is the level of intellectual potential of IBS. It is assumed that

$$MP_p \leq MP \leq MP_o \,, IP_p \leq IP \leq IP_o \tag{2}$$

where MP_o, IP_o is an optimistic assessment of the material and intellectual potentials of IBS and MP_p, IP_p is a pessimistic assessment of the material and intellectual potentials of IBS.

An optimistic assessment is manifested under the condition that the weaknesses of the resources of the functional zones are manifested with a probability equal to $U = \underline{U}$. A pessimistic assessment is manifested under the condition that the strengths of the resources of the functional zones are manifested with a probability equal to $U = \underline{U}$. In an optimistic assessment, strengths are manifested with probability equal to $U \in [\underline{U}, \overline{U}]$. In the case of a pessimistic assessment of potentials, weaknesses appear with the probability equal to $U \in [\underline{U}, \overline{U}]$. In reality, strengths and weaknesses are manifested with probability equal to $U \in [\underline{U}, \overline{U}]$. In this case, the material potential is determined by the formula

$$MP = \varphi_1(MP_o, MP_p), \tag{3}$$

and intellectual potential is determined by dependence

$$IP = \varphi_2(IP_o, IP_p), \tag{4}$$

In addition to U, the second factor affecting the IBS potential level is the significance of the i strengths and weaknesses of the resources of the IBS functional zones:

α_i is significance of the i–th strength of the material and human resources of the functional zones of IBS, $i = \overline{1, n_1}$, n_1 is the number of strengths;

β_i is significance of the i–th weaknesses of the material and human resources of the functional zones of IBS, $i = \overline{1, n_2}$, n_2 is the number of weaknesses;

Вісник Національного технічного університету «ХПІ». Серія: Системний аналіз, управління та інформаційні технології, № 2 (4)'2020

29

γ_i is significance of the i–th strength of the material and human resources of the functional zones of IBS, $i = \overline{1, m_1}$, m_1 is the number of strengths;

θ_i is significance of the i–th weaknesses of the material and human resources of the functional zones of IBS, $i = \overline{1, m_2}$, m_2 is the number of weaknesses;

Taking into account the introduced designations, complex estimates are found:

- optimistic assessment of material potential MP_o is found [7, 8].

- pessimistic assessment of material potential MP_p [7] is

$$MP_p = 1 - \sum_{i=1}^{n_2} \beta_i \left(U_i - \underline{U_i} \right) / \left(\overline{U_i} - \underline{U_i} \right), \qquad (6)$$

- optimistic intellectual potential IP_o [7] is.

$$IP_o = \sum_{i=1}^{m_1} \gamma_i \left(U_i - \underline{U_i} \right) / \left(\overline{U_i} - \underline{U_i} \right), \qquad (7)$$

- pessimistic intellectual potential IP_p [7] is

$$IP_p = \sum_{i=1}^{m_2} \theta_i \left(U_i - \underline{U_i} \right) / \left(\overline{U_i} - \underline{U_i} \right). \qquad (8)$$

Considering the additive nature of dependences (5–8), in determining PM and IP according to (3, 4), the geometric mean value MP_o and MP_p, IP_o and IP_p is used.

$$MP = \left(MP_o \cdot MP_p \right)^{1/2}, \; IP = \left(IP_o \cdot IP_p \right)^{1/2} \qquad (9)$$

Assessment of strategic potential is defined as the geometric mean value of PM and IP.

$$SP = (MP \cdot IP)^{1/2} \qquad (10)$$

When defining values $\alpha_i, i = \overline{1, n_1}$, $\beta_i, \; i = \overline{1, n_2}$, $\gamma_i, i = \overline{1, m_1}$, $\theta_i, \; i = \overline{1, m_2}$, it should be mind that the functioning of IBS in the process of moving to the target state is determined by the multidimensional nature of business processes, their interconnection, dynamics, the multiplicity of participating agents, randomness, poor structure, etc. This leads to the emergence of new discrete structures with a new quality and influence on the process of achieving a global goal. It is advisable to use the method of analysis of hierarchies for study the influence of strengths and weaknesses on the achievement of the target state [9]. The basis of AHP is a hierarchy, which is a system of levels, each of which consists of elements and factors. The task in the language of hierarchy is to determine the intensity of the influence of lower-level elements on the focus of the problem. In an optimistic assessment of potentials, the focus of the problem is to increase the degree of achievement of the global goal. In a pessimistic assessment of potentials, the focus of the problem is to reduce the degree of achievement of the global goal. Fig. 1 shows the hierarchy for determining significance of α_i, $i = \overline{1, n_1}$ and $\gamma_i, \; i = \overline{1, m_1}$.
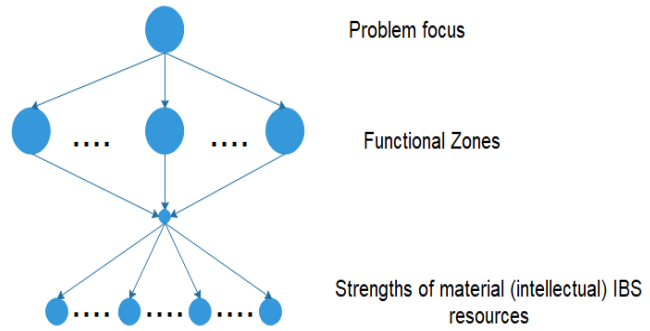

Fig. 1. Hierarchy for an optimistic assessment of the material (intellectual) potentials of IBS

Fig. 2 shows the hierarchy for determining the significance of $\beta_i, i = \overline{1, n_2}$ and $\theta_i, \; i = \overline{1, m_2}$.
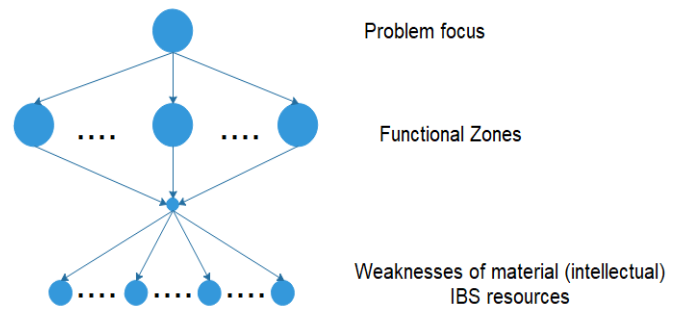

Fig. 2. Hierarchy for pessimistic assessment of material (intellectual) potentials of IBS

To implement the procedure for determining α_i, β_i, γ_i, θ_i a group of experts is created from numbers experienced IBS specialists who fill out questionnaires for the corresponding elements of the hierarchy (fig. 1, fig. 2). On the grounds of the completed questionnaires, a generalized matrix of pairwise comparisons is formed. Based on this matrix, local and global priorities of the elements of the lower and middle levels of hierarchies are determined. The global priorities of the elements of the lower level of hierarchies (fig. 1, fig. 2) determine their significance. The expert method determines the predicted values of U, $\underline{U}$, $\overline{U}$ for each strong and weak side [8, 10].

The results obtained make it possible to determine MP_o, MP_p, IP_o, IP_p, using dependencies (5–8), then using dependence (9) to determine MP and IP. Based on dependencies (10), the strategic potential of IBS is estimated.

As a result of the described technology, the value SP of the strategic potential of an intelligent business system is received. Fig. 3 shows the geometric interpretation of the SP, as the length of the side of the squares, with the area $M = MP \cdot IP$ [11, 12].

The use of an expert procedure using the technology of the hierarchy analysis method to evaluate the significance of the strengths and weaknesses of the material, human, and intellectual resources of the functional areas of the business system is supposed to be operated by the expert with qualitative concepts (more, much more, etc.) [12, 13].

30

Вісник Національного технічного університету «ХПІ». Серія: Системний аналіз, управління та інформаційні технології, № 2 (4)'2020
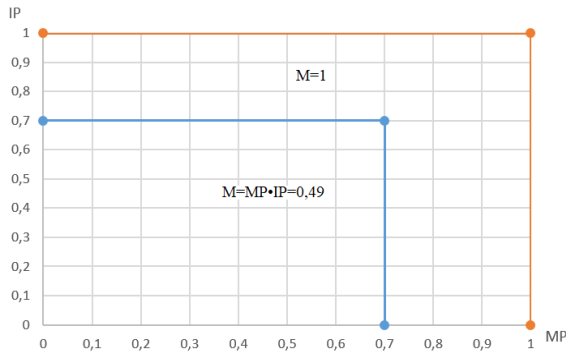
Fig. 3. Geometric interpretation of the strategic potential of an intelligent business system

At the same time, the real reasoning of experts based on natural language cannot be described within the framework of traditional mathematical formalisms. Therefore, when assessing the degree of achievement of the target state by an enterprise, it is advisable to use fuzzy sets. M is considered as a logical variable with the core [0.49, 1]. The function of membership $\mu(M)$ of the "masses" in the set H_o, providing the necessary degree h_o of achievement by the enterprise of the goal, is trapezoidal (fig. 4), where $[AC]$ is the core of $\mu(M)$. $M_o = \{M: h_o \leq \mu(M) \leq U\}$.
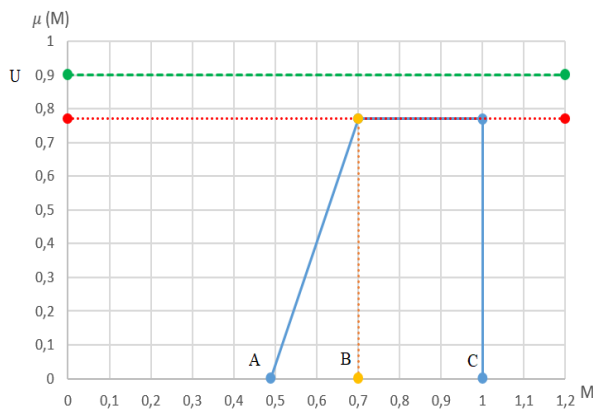

Fig. 4. Membership function parameters

The formula for $\mu(M)$ has the form

$$\mu(M) = \begin{cases} 0, \ M < A, \\ h \cdot \dfrac{SP - A}{B - A}, A \leq M \leq B, \\ h, \ B \leq M \leq C. \end{cases} \qquad (11)$$

In the case under consideration, $A = 0.49$, $C = 1$. Value $B = 0.7$, the value of U is chosen equal to 0.9, $h_o \leq h \leq U$.

The described sequence of actions defines the subject technology for assessing the strategic potential of IBS, which contains the following steps:

• Collection of qualitative and quantitative information about the internal environment of IBS, the material and intellectual resources of its functional zones;

• Identification of the strengths and weaknesses of the material resources of the IBS functional zones;

• Identification of strengths and weaknesses of the intellectual resources of the IBS functional zones;

• Determination of forecast probabilities of manifestation of U, $\underline{U}$, $\overline{U}$ of all IBS strengths and weaknesses;

• Expert procedure for the formation of matrices of pairwise comparisons;

• Determination of the significance $\alpha_i, i = \overline{1, n_1}$, $\beta_i, \ i = \overline{1, n_2}, \ \gamma_i, \ i = \overline{1, m_1}, \theta_i, \ i = \overline{1, m_2}$ of the strengths and weaknesses of IBS;

• Assessment of the material potential of IBS;

• Assessment of the intellectual potential of IBS;

• Assessing the Strategic Potential of IBS.

As a result of the implementation of the developed subject technology, the SP value is obtained. Let the threshold h is specified that defines the minimum acceptable degree of achieving a global goal. If $SP \leq h$, then it is logical to expect that the target IBS state will not be achieved [14].

Conclusions. The proposed subject technology allows us to determine a comprehensive assessment of the strategic potential of IBS, striving to achieve a given target state, to assess the ability to achieve IBS. The proposed subject technology can serve as the basis for creating information technology for assessing the strategic potential of IBS.

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32

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