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EVALUATION OF THE INTELLECTUAL CAPITAL LEVEL AS A BASIS OF COMPETITIVENESS INCREASING

In times of rapid technological changes and a high level of competition, the main resource for increasing the competitiveness of the enterprise is the transformation of economically meaningful knowledge at the enterprise into intellectual resources that can be capitalized. The transformation of intellectual resources into intellectual capital (IC) and its efficient management create conditions for activating the processes of production, distribution and use of knowledge within the enterprise, which gives impuls to the development of innovation activity [1].

Intellectual capital requires research and analysis, since it is a dominant lever that provides superiority and enterprise development, greatly strengthens its position on the market and creates competitive advantages.

There is a significant number of approaches to estimating the level of intellectual capital. However, today there is no single and universal method for determining the level of IC.

The authors are proposing such a mathematical model for estimating IC as described below in the article.

A mathematical model for estimating IR in an enterprise that demonstrates a functional relationship between intellectual capital and factors that influence on it, is proposed as follows:

$$L \xrightarrow{F_1} X \xrightarrow{F_2 F_3 F_4} R, F = (F_p), p = \overline{1,4};\ X = F_1(L), L = (l_c), c = \overline{1,C};$$
$$X = (x_{k,i}), k = \overline{2,4}, i = \overline{1,n}, n = 10;$$
$$R = (r_j), j = \overline{1,J};\ J = 3; F_2 = f(x_{2,1}, \dots, x_{2,n}),$$
$$F_3 = f(x_{3,1}, \dots, x_{3,n-1}), \qquad F_4 = f(x_{4,1}, \dots, x_{4,n-1}),$$

where F_1 is a function of the reflection of the set L of the initial input parameters to the set X of the estimation parameters [2];

F_2 is a functional assessment of human capital, which depends on parameters such as $x_{2,1}$ – the indicator of inventive activity; $x_{2,2}$ – indicator of scientific (engineering) technical support; $x_{2,3}$ – educational level indicator; $x_{2,4}$ – indicator of fluidity of highly qualified personnel; $x_{2,5}$ – indicator of updating of knowledge; $x_{2,6}$ – level of intellectual capitalization; $x_{2,7}$ – indicator of moral climate; $x_{2,8}$ – indicator of corporate culture; $x_{2,9}$ – indicator of progressiveness of the philosophy of the enterprise and its compliance by the staff; $x_{2,10}$ – indicator of the staff motivation level.

F_3 is a functional of organizational capital evaluation that takes into account the following parameters: $x_{3,1}$ – indicator of progressivity of structures; $x_{3,2}$ – indicator of equipment providing with modern means of communication; $x_{3,3}$ – indicator of organizational capital autonomy; $x_{3,4}$ – indicator of the level of modern software support; $x_{3,5}$ – indicator of evaluation of intellectual property objects; $x_{3,6}$ – indicator of legislative opportuneness to business; $x_{3,7}$ – the indicator of capitalization of the company; $x_{3,8}$ – the indicator of patenting and licensing; $x_{3,9}$ – indicator of the using of innovative technologies in the organization of the labor process.

F_4 is a functional of consumer capital estimation, which takes into account the parameters: $x_{4,1}$ – indicator of intensive order growth;

$x_{4,2}$ – indicator of extensive order growth; $x_{4,3}$ – indicator of average size of the account of a regular customer; $x_{4,4}$ – indicator of the formation of consumer capital; $x_{4,5}$ – indicator of reputation and image of the enterprise; $x_{4,6}$ – indicator of efficiency of the logistic chain; $x_{4,7}$ – indicator of the effectiveness of the intermediary component; $x_{4,8}$ – indicator of the efficiency of the supplier component; $x_{4,9}$ – indicator of repayment of loans aimed at the development of consumer capital.

The authors have systematized and supplemented a series of indicators (1)-(27), which are components of the mathematical model of IC estimation, presented above.

1. Indicator of inventive activity ($x_{2,1}$). It characterizes the ability to generate new knowledge (technical and technological decisions) that can become the basis of innovation [3]:

,

where l_1 – the number of inventions (rationalization proposals);

l_2 – the number of scientific (engineering) staff.

2. Indicator of scientific (engineering) support ($x_{2,2}$). It characterizes the potential of the personnel of the enterprise to solve engineering, scientific and applied problems [3]:

,

(2)

where l_3 – the number of highly skilled workers.

3. Indicator of educational level ($x_{2,3}$). It characterizes the educational level of the personnel of the company [3]:

,

where l_4 – the number of persons with higher education corresponding to the profile of the enterprise;

l_5 – staff of the enterprise.

4. The indicator of variability of the personnel of high qualification ($x_{2,4}$). It characterizes the degree of stability (workability) of highly skilled staff [4]:

,

where l_6 – the number of highly skilled staff fired during the year.

5. Indicator of knowledge update ($x_{2,5}$). It characterizes correspondence of the level of staff knowledge with modern requirements (the state of retraining and professional development of staff) [4]:

,

where l_7 – the number of highly skilled staff who have increased their qualification or retrained during the last 3-5 years.

6. Indicator of intellectual capitalization level ($x_{2,6}$):

, (6)

where l_8 – the level of capitalization of profit which is over norm;

l_9 – equity.

The level of capitalization of profit which is over norm:

$$l_8 = \frac{l_9 \times (l_{10} - l_{11})}{l_{12} + \frac{1}{l_{13}}}, \quad (7)$$

where l_{10} – profitability of equity;

l_{11} – normative profitability of equity;

l_{12} – current income norm;

l_{13} – estimated term of intellectual resources using;

– rate of capital return.

7. The indicator of the moral climate in the team (integral ratio of relations) $x_{2,7}$ reflects the quality of the system of relations formed in the team [5]:

, (8)

where l_{s_m} – expert points of the *m*-th expert on the *s*-th estimated partial criterion;

–the maximum possible point on the estimated criterion;

M – the number of interviewed persons; $S = \overline{10,13}$.

To determine the indicator of the moral climate is used a set of partial indicators: l_{14} – the level of conflict in the team; l_{15} – respect in the team; l_{16} – mutual assistance in the team; l_{17} – psychological comfort in the team.

To estimate partial indicators, a point from 1 to 3 is used, where 3 is a high value of the indicator; 2 – the average value of the indicator; 1 – low value of the indicator.

8. Indicator of corporate culture ($x_{2,8}$). The corporate culture is rated by a 5-point system. The indicator of corporate culture ($x_{2,8}$) is determined on the basis of the obtained estimates. To determine the actual state of corporate culture you need to use the formula [6]:

, (9)

where 5 and 10 – constant values that characterize weight of $x_{2,8}$;

l_{18} – the average score of the 5-point system.

Scale for estimation of corporate culture: $x_{2,8} = 0$ – the low level corporate culture of the enterprise; $x_{2,8} = 0{,}25$ – the level of enterprise culture is lower than average; $x_{2,8} = 0{,}5$ – the average level of

corporate culture of the enterprise; $x_{2,8} = 0,75$ – the level of corporate culture is higher than average; $x_{2,8} = 1$ – the high level of corporate culture of the enterprise.

9. Indicator of progressiveness of enterprise philosophy and its compliance with personnel ($x_{2,9}$). The philosophy of the enterprise is a system of values and beliefs regarding the functioning of the enterprise, as well as a set of principles and rules of relations within the team formed at the enterprise.

10. Indicator of the staff motivation level ($x_{2,10}$). This indicator demonstrates the effectiveness of the personnel-oriented motivation system chosen by the enterprise [6]:

, (10)

where l_{19} – rate of satisfaction with the conditions of the workplace;

l_{20} – rate of satisfaction with management;

l_{21} – rate of psychological climate estimation in a team;

l_{22} – rate of satisfaction assessment with the content of labor;

l_{23} – rate of professional development;

l_{24} – rate of development of employee qualities and personal potential;

l_{25} – rate of satisfaction with non-material motivation;

l_{26} – rate of satisfaction by material motivation;

l_{27} – rate of awareness of employees about the system of motivation;

l_{28} – rate of satisfaction of social needs;

l_{29} – rate of estimation of external factors of influence.

This ratio should indicate how satisfied employees are with the implementation of the motivational mechanism in the enterprise. The indicators $l_{19} – l_{29}$ represent average values of the studied criteria $l_{19} – l_{29}$, obtained during the questioning of highly skilled workers of the firm. are formed on the basis of the answers received during an expert survey of employees of enterprises.

11. Indicator of progressivity of structures ($x_{3,1}$):

, (11)

where l_{30} – the number of structures constructed using progressive materials and techniques;

l_{31} – total number of structures.

The value of the indicator should be close to 1, which means a high level of progressiveness of the enterprise structures.

12. Indicator of equipment providing with modern means of communication ($x_{3,2}$):

, (12)

where l_{32} – the number of modern means of communication at the enterprise according to expert estimation;

l_{33} – the total number of means of communication at the enterprise.

The value of the indicator should be close to 1, which means a high level of equipment with modern means of communication. Also, the level of equipment with modern means of communication can be estimated by comparing it with the level of enterprise-leaders in the market or industry.

13. The coefficient of organizational capital autonomy ($x_{3,3}$):

,

where l_{34} – the number of own innovative products, technologies and services of the enterprise;

l_{35} – the total number of innovative products, technologies and services in the enterprise.

14. Indicator of level of modern software support ($x_{3,4}$):

,

where l_{36} – the number of new or updated versions of software used by the enterprise;

l_{37} – the total number of software that is available at the enterprise.

The value of the indicator should be close to 1, which means the high level of application of modern software at the enterprise. Also, the level of provision of modern software can be estimated by comparing it with the level of leading enterprises in the market or industry.

15. Indicator of evaluation of intellectual property objects ($x_{3,5}$) [7]:

, (15)

where l_{38} – average income at the end of the year;

l_{39} – amount of net profit for the reporting year;

l_{40} – the average annual value of the assets of the enterprise.

16. Indicator of legislative opportuneness to business ($x_{3,6}$):

,

where l_{41} – the number of changes in the legislation that complicate the operation of the enterprise;

l_{42} – the number of changes in the law relating to the business sector.

17. The level of capitalization of the company ($x_{3,7}$). The capitalization of a particular company in the market is determined by multiplying of the number of stocks of the company at their market value [8]:

,

where l_{43} – the number of common issued stocks at the time t;

l_{44} – the market price of common issued stocks at the time t.

18. Indicator of patenting and licensing ($x_{3,8}$). This indicator is estimated by comparing with the level of leading enterprises in the

market or industry. In the absence of patents and licenses, it is equal to 0, if it corresponds to the industry average value, then $x_{3,8} = 0,5$, and in case of exceeding the average level $x_{3,8} = 1$.

19. Indicator of the using of innovative technologies in the organization of the labor process ($x_{3,9}$):

, (18)

where l_{45} – the number of improved or new approaches in the organization of the labor process at the enterprise;

l_{46} – the total number of approaches in organization of the labor process at the enterprise.

20. Indicator of intensive order growth ($x_{4,1}$) is the ratio of the aggregate value of orders executed by regular customers and the aggregate value of orders of client base:

, (19)

where l_{47} – total cost of orders made by regular customers;

l_{48} – total cost of orders for the client base.

21. Indicator of extensive order growth ($x_{4,2}$):

,

where l_{49} – total cost of orders made by new customers.

22. Indicator of average size of the account of a regular customer ($x_{4,3}$):

, (21)

where l_{50} – the average amount of monthly account of the largest regular customer;

l_{51} – average amount of monthly account of the smallest regular customer.

23. Indicator of consumer capital formation ($x_{4,4}$) [9]:

, (22)

where e – type of activities aimed at attracting regular customers (advertising, sales promotion, public relations, direct marketing, etc.).;

E – the number of activities aimed at attracting customers;

l_{52} – expenses of the e-th activity.

24. Indicator of reputation and image of the enterprise ($x_{4,5}$):

$$x_{4,5} = \frac{l_{53} - l_{54}}{l_{55} - l_{56}}, \quad (23)$$

where l_{53} – the number of new customers in the current year;

l_{54} – the number of customers who declined the services of the enterprise in the current year;

l_{55} – the number of new customers in the past year;

l_{56} – the number of customers who declined the company's services last year.

25. Indicator of the efficiency of the logistics chain ($x_{4,6}$) [10]:

, (24)

where l_{57} – time that increases value (time spent on actions that create benefits for potential buyers);

l_{58} – duration of the logistic chain.

26. Indicator of the effectiveness of the intermediary component ($x_{4,7}$):

, (25)

where l_{59} – the number of contracts concluded with the help of intermediaries of the enterprise;

l_{60} – the total number of contracts entered into by the enterprise.

27. Indicator of the efficiency of the supplier component ($x_{4,8}$):

, (26)

where l_{61} – the number of contracts with suppliers;

l_{62} – the number of torn contracts with suppliers.

28. Indicator of repayment of loans aimed at the development of consumer capital (CC) ($x_{4,9}$):

, (27)

where l_{63} – the number of repaid loans aimed at the development of CC;

l_{64} – the number of loans aimed at the development of CC.

The approach proposed by the authors of this article makes it possible, based on the criteria of completeness, minimality and efficiency, to form the set of input and output parameters of the estimation of IC, which allows making such a process accurate, strictly formalized and adequate, since it takes into account a large amount of effective parameters that are not collinear or correlated. The research of the complex economic category “intellectual capital” requires a comprehensive analysis of its components and structural

interrelations between the elements; search of rational methods of its estimation and management by means of mathematical and computer modeling on the basis of mathematical apparatus of artificial intelligence. This is due to the need to take into account a wide range of varied parameters and powerful volumes of expert information. The proposed mathematical model acquires its formalization by means of the theory of fuzzy logic or neural network approach. The latter is easily computerized with the use of such a modern mathematical package as MathLab.

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