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INTELLECTUAL CAPITAL AS A KEY FACTOR OF BUSINESS PROCESSES AT MINING ENTERPRISES

Introduction

During the 21st century the general traditional business paradigm has transformed into the phenomenon called "knowledge economy". This new paradigm is defined by the prevalence of such concepts as: intellectual capital, knowledge capital, knowledge management, intangible assets and information technologies. Thus, the tendency of increasing importance of knowledge assets in global manufacturing environment is evident [Bont01]. These concepts are descriptors of the mentioned paradigm, where knowledge becomes an essential part of economy and the main strategic resource of innovativeness and productivity growth as well as of performance and sustainable competitive advantage of organizations [Bont01, ChLe07, HoSh00, Hsu09]. The Economics Institute of Washington, D.C., in its recent study of knowledge economy, has stated that "The economic value of the nation's productivity depends more upon employees' skills and knowledge and business problem solving aptitude than it does upon the market value of the firm's commercial output" [DiKa99].

For the clear understanding of knowledge economy, taking into account the previous researchers' results [PoSn04, GuPe99, Rosl00], this phenomenon could be conceptualized as: goods and services, based on knowledge-intensive structures, and forms of business activities that correlate with up-to-date required pace of high-technological and scientifically-progressive innovation; strongly rely on intellectual and problem-solving capabilities (in the form of employees' knowledge, experience and skills; brands; competitive advantage; patents; customer relations; human capital; research and development; trademarks) and stipulate the company efficiency increase, more often attributable to positive synergy from leveraging knowledge and informational and-social engagement effects.

For the description of the knowledge economy paradigm and intellectual and problem-solving capabilities the term "intellectual capital" (IC) will be used in this research.

1. Intellectual capital in the knowledge economy paradigm

This notion was first used by the economist John Galbraith in 1969 [MAIN11] and, according to the International Federation of Accountants, was structured and presented as the economic value of three categories of company's *intangible assets* [ZeAB12]:

- *human* capital: consists of the talents and skills of all employees and managers of the company;
- *organizational* (structural) capital: composed of processes, systems and organizations offering the possibility to accumulate, store and transmit its knowledge; synergies developed within the organization contribute significantly to the innovation of the company;
- *relational* (consumer, client) capital: the goodwill and relationships that the company has with its customers.

Each category of intellectual capital includes sub-categories (Table 1), which may be present or absent in the general structure of IC depending on the type of enterprise's activity.

Table 1

Structure of intellectual capital

Human capital	**Organizational capital**	**Relational capital**
1	2	3
employees' competence	*internal capital*	*external capital*
Knowledge capital • "Know, what" • "Know, why" • "Know, how" • "Know, who"	Intellectual property • Copyright • Patents and licenses • License agreements • Trademarks	Investors • Owners • Mergers and acquisitions
Professional competence • Talent • Abilities • Skills • Speed	Structural capital • Project teams • Systems, processes • Nets, databases • Computer equipment • Technologies • Organizational structure	Distributors' network Suppliers' network

Table 1 cont.

1	2	3
Communicative skills • Behavior • Personal qualities • Trust • Motivation • Leader skills • Entrepreneurial skills	Business processes • Management philosophy • Software • Trade secrets • Organizational culture	Strategic partners Shareholders
Business skills • Innovativeness • Originality • Adaptability • Ability to solve problems	Market capital • Brand • Image • Reputation • Mission, vision • Strategy • Leadership	Customers • Customer loyalty
	Development capital • Professional competence • Innovativeness • Flexibility • Research and development	Employees Board of directors

In 1996 economist Brooking claimed that the process of transformation into the information-age technology of media, communications etc. has provided enormous intangible benefits to organizations. Economist Standfield [Stan99] states that the obvious impact of intangibles, such as knowledge technology and intellectual property, causes the loss of the confidence in decision-making ability, based only on traditional tangible data.

In 1998, Arthur Andersen organized an international survey of the measurement of intangible capital [Bont01], most of the results of which as well as possible correlate with our current opinion:

- the majority of respondents are sure that IC reporting would *increase*;
- most respondents agreed that knowledge measurement could *improve organizational performance evaluation*;
- almost the half of respondents assured that the information, which they were able to get in the *process of measuring,* is not less important than the results of measurements themselves;
- finally, it was suggested that IC measurement would be more useful as an internal management tool than as an external communication with shareholders or investors.

After more than two decades of IC existence, it is still considered to be an *elusive* phenomenon [Choo08, SACh13]. IC researchers outline three stages of intellectual capital investigation [DuGa13]: the first stage (began in late 1980s) is focused on the revelation of importance of IC in "creation and management of sustainable competitive advantage" [PeGu00]; the second stage examines the impact of IC on corporate performance and value creation and develops various models of measuring, managing and reporting of IC; the present stage is critically examining IC in practice [DuGa13].

2. Problem statement

Still researchers have yet to conclude how to account the intellectual capital in the best way and how to track its influence on financial and technical indices of enterprise's activity [BrCo00]. Hence, the fact that the list of different methodologies for structuring, evaluation and reporting of IC is growing [Powe01, ChBo02] from our point of view provides direct evidence of the difficulty of solving the problem of proper *conceptualization of the nature of company's knowledge assets* and definition of *the most weighty components of intellectual capital* in the total volume of enterprise's assets.

3. Intellectual capital evaluation

The question of evaluation of separate components of intellectual capital is very controversial and complex. There are two general methodologies of evaluation: the first includes surveys and qualitative indices and the second one is conducted with the help of quantitative methods.

The most widespread type of quantitative evaluation is the *indicators method*. There exist a big number of indicators that characterize particular components of IC, the choice of which depends on the objectives of the research conducted. Analysis of papers on the question of IC evaluation has allowed to create a list (Table 2) of the most frequently used indicators (Garanina, e-resource).

Table 2

Indicators for the evaluation of IC components

IC structure	Indicator	Use in empirical research
1	2	3
Human capital	Number of employees	(Edvinsson, Malone, 1997; Liebowitz, Suen, 2000; Marr, Adams, 2004)
	Wages fund	(Pulic, 1998; Firer, Williams, 2002; Tseng, Goo, 2005; Edvinsson, 1997; Sveiby, 2001)

Table 2 cont.

1	2	3
Human capital	Gain per employee	(Stewart, 1997; Liebowitz, Suen, 2000; Tsan, 2004; Wu, 2004; Chen, 2004)
	Net profit per employee	(Brennan, Connell, 2000; Dzinkowski, 2000; Tsan, 2004)
Relational capital	Gain	(American Society of Training…, 1999; Van Buren, 1999; Brennan, Connell, 2000; Dzinkowski, 2000; Tsan, 2004; Chen, 2004; Marr, 2004)
	Advertising expenses	(Edvinsson, Malone, 1997; Tsan, 2004; Wu, 2004; Chen, 2004)
Organizational (structural) capital	Expenses/Gain	(Edvinsson, Malone, 1997; Roos, Roos, 1997; Stewart, 1997; American Society of Training…, 1999; Van Buren, 1999; Tsan, 2004)
	Expenses per employee	(Edvinsson, Malone, 1997; Chen, 2004)

In the process of analysis of econometrical models, one of which will be described below, the author took an attempt of using different combinations of indicators to evaluate the components of intellectual capital. As a result the list was created, which includes a number of indicators, both chosen from the table above and added by the author in the process of investigation (Table 3).

Table 3

Indicators used in the research

Indicators	**Abbreviation**	**Measuring units**
Wages fund	WF	Thousands of UAH
Expenses on research and development	ERD	Thousands of UAH
Residual value of intangible assets	VIA	Thousands of UAH
Expenses per employee	EE	Thousands of UAH per person

3.1. Statistical data

Hypotheses verification was conducted with the use of data of 5 Ukrainian *mining enterprises*: Poltava Ore Mining and Processing Plant ("Poltava Mining"), Northern Ore Mining and Processing, Southern Ore Mining and Processing Plant, Central Ore Mining and Processing Plant, Ingulets Ore Mining and Processing Plant. All of them fulfill a complete cycle of producing domain raw materials – iron ore concentrate and iron ore pellets.

Calculations include data of public financial accounting for the period from 2006 to 2013, which is presented on the websites of State Statistics Service of Ukraine (e-resource) and Stock Market Infrastructure Development Agency of Ukraine (e-resource).

Net profit (measured in thousands of UAH) was chosen as the *resulting indicator,* representing the outcome of enterprises' annual activity.

Average statistical data, taken form the above-mentioned resources, are given in the Table 4.

Table 4

General statistical characteristics of the data excerpt

Mining enterprises	Net profit	Wages fund	Expenses on research and development	Residual value of intangible assets	Expenses per employee
Poltava Mining	376 839,63	350 865,55	1 882,52	23 581,75	593,93
Northern Mining	3 155 967,38	354 608,45	10 312,71	18 889,88	604,71
Southern Mining	2 483 117,25	318 824,94	5 431,12	502,50	421,16
Central Mining	1 543 720,25	262 733,64	3 679,49	17 243,00	370,01
Ingulets Mining	4 358 111,38	321 917,15	5 459,10	4 439,75	480,45

3.2. The research model

The regression model, used for the research, allows to reveal the dependence and the tightness of connection between the above-mentioned IC indicators and the net profit (NP) of 5 ore mining and processing plants.

The model that characterizes the connection between IC indicators and the resulting indicator can be presented in the *equation*:

$$y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 \quad (1)$$

where $x_1 - x_4$ – independent variables: wages fund (WF), expenses on research and development (ERD), residual value of intangible assets (VIA), expenses per employee (EE); $b_1 - b_4$ – parameters of the regression, belonging to each independent variable; *a* – intercept of the equation.

Results of regression models evaluation are given in Tables 5-9.

To analyze the significance of independent variables t-statistics is used, for the verification of model adequacy we use F-statistics. The coefficient of determination (R^2) indicates the proportion of response variation "explained" by the variables in the model.

To check the significance of independent variables in the model we formulate the following *hypotheses*:

$$H_0^1 : b_1 = 0, H_0^1 : b_1 \neq 0,$$
$$H_0^2 : b_2 = 0, H_0^2 : b_2 \neq 0,$$
$$H_0^3 : b_3 = 0, H_0^3 : b_3 \neq 0,$$
$$H_0^4 : b_4 = 0, H_0^4 : b_4 \neq 0.$$

If the "zero" hypothesis is rejected and the alternative one is accepted, we introduce the assumption that the net profit of an ore mining and processing plant depends on the particular indicator of intellectual capital.

If the *inequality*:

$$t > t_{crit} \tag{2}$$

is fulfilled, we reject the "zero" hypothesis and accept the alternative.

Table 5

Statistical evaluation of Poltava mining

Index	**Evaluation of the regression parameters**			
	WF (x_1)	ERD (x_2)	VIA (x_3)	EE (x_4)
Paired correlation coefficient	0,331	-0,017	-0,052	0,366
t-statistics	-2,330	2,160	-0,196	2,488
t critical	2,145			
F-statistics	4,891			
F critical	4,347			
R^2	0,677			

The regression equation has the following form:

$$y = 694\,715{,}20 - 6{,}10x_1 + 167{,}95x_2 - 0{,}56x_3 + 2\,558{,}83x_4 \tag{3}$$

Table 6

Statistical evaluation of Northern mining

Index	**Evaluation of the regression parameters**			
	WF (x_1)	ERD (x_2)	VIA (x_3)	EE (x_4)
Paired correlation coefficient	0,809	0,762	-0,236	0,688
t-statistics	1,446	2,669	1,171	-0,023
t critical	2,145			
F-statistics	29,086			
F critical	4,347			
R^2	0,926			

The regression equation has the following form:

$$y = -7\,719\,425{,}67 + 26{,}6x_1 + 106{,}40x_2 + 20{,}02x_3 - 55{,}85x_4 \tag{4}$$

Table 7

Statistical evaluation of Southern mining

Index	Evaluation of the regression parameters			
	WF (x_1)	ERD (x_2)	VIA (x_3)	EE (x_4)
Paired correlation coefficient	0,716	-0,651	0,275	0,740
t-statistics	-0,328	-0,347	-0,107	2,221
t critical	2,145			
F-statistics	4,356			
F critical	4,347			
R^2	0,586			

The regression equation has the following form:

$$y = 4\,544\,406{,}58 - 21{,}88x_1 - 95{,}85x_2 - 146{,}93x_3 + 12\,415{,}53x_4 \quad (5)$$

Table 8

Statistical evaluation of Central mining

Index	Evaluation of the regression parameters			
	WF (x_1)	ERD (x_2)	VIA (x_3)	EE (x_4)
Paired correlation coefficient	0,394	0,623	0,517	0,297
t-statistics	1,367	2,349	2,164	-2,165
t critical	2,145			
F-statistics	8,141			
F critical	4,347			
R^2	0,777			

The regression equation has the following form:

$$y = -1\,920\,988{,}26 + 15{,}54x_1 + 224{,}28x_2 + 39{,}70x_3 - 5\,753{,}23x_4 \quad (6)$$

Table 9

Statistical evaluation of Ingulets mining

Index	Evaluation of the regression parameters			
	WF (x_1)	ERD (x_2)	VIA (x_3)	EE (x_4)
Paired correlation coefficient	0,560	0,617	-0,296	0,528
t-statistics	0,383	1,627	1,163	-2,348
t critical	2,145			
F-statistics	4,418			
F critical	4,347			
R^2	0,638			

The regression equation has the following form:

$$y = -4\,747\,737{,}14 + 25{,}47x_1 + 682{,}22x_2 + 288{,}80x_3 + 8\,535{,}14x_4 \quad (7)$$

3.3. Results of the research

Considering the *F-statistics* we can state that regression models, describing interdependencies between IC components and the net profit for all 5 enterprises are adequate.

The *coefficient of determination* (R^2) for all enterprises is higher, than 0,50 and it varies from 0,59 to 0,93, which testifies a rather strong "exploratory" power of the regression model for all 5 enterprises.

Parameters of regression models ($b_1 - b_4$) in each equation show how the resulting indicator (net profit) will change (increase of decrease – depending on "–" or "+" before the parameter) if the particular variable $x_1 - x_4$ decreases per 1 unit. Thus, the higher a parameter's value is the more influence (negative or positive) it has on the resulting indicator.

After analyzing values of the above-mentioned parameters ($b_1 - b_4$), we created the matrix of their ranks (Table 10), where rank "*1*" goes to the most influential variable (with the highest value of parameter "*b*") and "*4*" – to the least influential variable (with the lowest value of parameter "*b*"). The variable with the lowest rank is considered to have the greatest influence on the net profit change.

Table 10

Rank matrix of independent variables

Mining enterprises	Expenses per employee (x_4)	Expenses on research and development (x_2)	Residual value of intangible assets (x_3)	Wages fund (x_1)
Poltava Mining	1	2	4	3
Northern Mining	2	1	4	3
Southern Mining	1	3	2	4
Central Mining	1	2	3	4
Ingulets Mining	1	2	3	4
Total rank	**6**	**10**	**16**	**18**

The rank matrix allows to line up the IC indicators (independent variables of the regression) in the following descending order of their influence:

1) expenses per employee;
2) expenses on research and development;
3) residual value of intangible assets;
4) wages fund.

These results are supported by verification of the inequity (2):

1) for the variable x_4 (expenses per employee) it is fulfilled at 4 of 5 ore mining and processing plants (Tables 5, 7, 8, 9);
2) for the variable x_2 (expenses on research and development) it is fulfilled at 3 of 5 ore mining and processing plants (Tables 5, 6, 8);
3) for the variable x_3 (residual value of intangible assets) it is fulfilled at 1 of 5 ore mining and processing plants (Table 8);
4) for the variable x_1 (wages fund) it is fulfilled at 1 of 5 ore mining and processing plants (Table 5).

Thus, we can see that the change of net profit significantly depends both on enterprise's expenses, calculated per one employee, and on the amount of expenses on research and development, carried out by an enterprise. On the other hand, dependence of net profit from the residual value of intangible assets is much lower, as well as from the total wages fund.

Received results allow us to distinguish from all the IC indicators only those, which we define as the most influential and which we will use for the further analysis and evaluation of intellectual capital and its elements: expenses per one employee and research and development expenses.

Conclusions

The task of conceptualization of the nature of company's knowledge assets was completed by means of a detailed structure of intellectual capital components, which can be used for an enterprise of any type of activity.

The task of defining the weightiest components of intellectual capital was conducted with the help of the quantitative method of indicators. The degree of these indicators' influence on the net profit was examined with the help of regression model.

The results obtained allow to create theoretical and practical recommendations as for: increasing the role of intellectual capital in enterprise's operation process; increasing the outcome of IC exploitation; decreasing and/or optimizing expenses etc.

The urgency of the research is stipulated by: the swift growth of intellectual capital relevance in the economic society; the lack of research which connect IC with mining enterprises, especially the open-cut ones.

The next stage of the author's research in the sphere of IC usage at mining enterprises has a qualitative nature and will include surveys and questionnaires.

References

[Bont01] Bontis N.: Assessing Knowledge Assets: A Review of the Models Used to Measure Intellectual Capital. „International Journal of Management Reviews" 2001, Vol. 3, No. 1, pp. 41-60.

[BrCo00] Brennan N., Connell B.: Intellectual Capital: Current Issues and Policy Implications. „Journal of Intellectual Capital" 2000, 1(3), pp. 206-240.

[ChLe07] Chang S., Lee M.: The Effects of Organizational Culture and Knowledge Management Mechanisms on Organizational Innovation: An Empirical Study in Taiwan. „The Business Review" 2007, Cambridge, Vol. 7, No. 1, pp. 295- 301.

[ChBo02] Choo C., Bontis N. (eds.): The Strategic Management of Intellectual Capital and Organizational Knowledge. Oxford University Press, Inc., New York 2002.

[Choo08] Choong K.K.: Intellectual Capital: Definitions, Categorization and Reporting Models. „Journal of Intellectual Capital" 2008, Vol. 9, No. 4, pp. 609-638.

[DiKa99] Di Stefano P.J., Kalbaugh G.E.: Intellectual Capital. „Rough Notes" 1999, 142 (7), pp. 94-95.

[DuGa13] Dumay J., Garanina T.: Intellectual Capital Research: A Critical Examination of the Third Stage. „Journal of Intellectual Capital" 2013, 14(1), pp. 10-25.

[Gara] Garanina T.: Intellectual Capital Structure and Value Creation of a Company: Evidence from Russian Companies. „Open Journal of Economic Research". Available at: http://www.academypublish.org/paper/intellectual-capital-structure-and-value-creation-of-a-company.

[GuPe99] Guthrie J., Petty R.: Knowledge Management. „Company Secretary", January 1999, Vol. 9, No. 1, pp. 38-41.

[HoSh00] Houghton J., Sheetan P.: A Primer on the Knowledge Economy. Centre for Strategic Economic Studies, Victoria University, Australia 2000.

[Hsu09] Hsu H.: Managing the Information Technology: Knowledge Transfer in Virtual Teams. In: M. Lytras, P. Ordonez de Pablos (eds.): Knowledge Ecology in Global Business: Managing Intellectual Capital. Information Science Reference, New York 2009.

[MAIN11] Muhammd Y., Abdul M., Iftikhar A., Naila T.: Structuring Intellectual Capital as an Element of Virtual Organization in the SME Clusters. 3rd International Conference on Advanced Management Science, Singapore. IPEDR Vol. 19.

[PeGu00] Petty R., Guthrie J.: Intellectual Capital Literature Review: Measurement, Reporting and Management. „Journal of Intellectual Capital" 2000, 1(2), pp. 155-176.

[PoSn04] Powell W., Snellman K.: The Knowledge Economy. „Annual Review Sociology" 2004, 30, pp. 199-220, School of Education and Department of Sociology, Stanford University, California.

[Powe01] Power M.: Imagining, Measuring and Managing Intangibles. „Accounting, Organizations and Society" 2001, 26, pp. 691-693.

[Rosl00] Roslender R.: Accounting for Intellectual Capital: A Contemporary Management Accounting Perspective. „Management Accounting" 2000, 78(3), pp. 34-37.

[SACh13] Shamsuddin A., Abidin Z.Z., Choo H.C.: An Evidence-based Taxonomy of Intellectual Capital − Malaysian Perspectives. „International Journal of Business, Economics and Law" 2013, Vol. 2, Iss. 1 (June).

[Stan99] Standfield K.: Knowcorp. Available at: http://www.knowcorp.com, 1999.

[www1] State Statistics Service of Ukraine. Available at: http://www.ukrstat.gov.ua.

[www2] Stock Market Infrastructure Development Agency of Ukraine. Available at: http://smida.gov.ua.

[ZeAB12] Zehri Ch., Abdelbaki A., Bouabdellah N.: How Intellectual Capital Affects a Firm's Performance? „Australian Journal of Business and Management Research" 2012, Vol. 2, No. 08, pp. 24-31.

KAPITAŁ INTELEKTUALNY JAKO KLUCZOWY CZYNNIK PROCESÓW BIZNESOWYCH W PRZEDSIĘBIORSTWACH EKSPLORACJI

Streszczenie

W artykule wyjaśniono zjawisko „gospodarki wiedzy" i scharakteryzowano jego ważność. Zdaniem autora kapitał intelektualny jest kluczowym czynnikiem paradygmatu nowej ekonomii. Ponadto przedstawiono szczegółową strukturę komponentów kapitału intelektualnego. Uzasadniono potrzebę oceny wpływu zasobów intelektualnych na rezultaty ekonomiczne przedsiębiorstw. Pięć przedsiębiorstw górniczych na Ukrainie zostało wybranych do realizacji modelu regresji, co pozwoliło na uzyskanie ilościowych charakterystyk wpływu szczególnych wskaźników kapitału intelektualnego. W artykule określono najbardziej istotne komponenty intelektualne.