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ESTIMATION OF THE INTELLECTUAL CAPITAL'S DEVELOPMENT LEVEL OF INSTITUTIONS OF HIGHER EDUCATION OF UKRAINE IN THE CONDITIONS OF KNOWLEDGE ECONOMY

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ABSTRACT

A study of institutions of higher education (IHEs) from the standpoint of their role in the transition to the knowledge economy, identified imbalances and major negative trends that reduce the effectiveness of the above higher education entities, which are the centre of intellectual capital (IC).

Modern empirical studies of IC are concerned with establishing the interaction between its components and performance. At the same time, the peculiarities of such influence in terms of reduction of one of the components of the IC or a sharp decline in activity, which was characteristic of recent research for free economic zones of Ukraine, in particular, the best institutions according to national rankings in 2013-2018.

The study involved a factor analysis (principal components method) of key performance indicators of the selected group of free economic zones. Based on the

results of factor load studies, an integrated development indicator was calculated for the components of the IC for a single free zone. The values of the integrated indicators by elements fluctuated within [-1, 1]. However, the same (either positive or negative) dynamics of integrated indicators of human and innovation capital was observed among freelancers at the same time. At the same time, client capital has almost always had a negative trend.

The practical significance of the method lies in the possibility of conducting a non-financial analysis of the components of the IC, as well as in the absence of subjective interpretation of indicators, which is typical for expert methods with a score scale.

Key words: Capital Development, Capital Recovery, Capital Reduction, Client Capital, Factor Analysis, Human Capital, Institution of Higher Education, Innovation Capital, Quality of Higher Education

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1. INTRODUCTION

In the transition to a knowledge economy, the competitiveness of the state depends largely not on the availability of natural resources, but on the efficient use of human resources. At the same time, higher education is one of the important components of the knowledge economy, and its level is a fundamental factor in its development. In general, the negative trends observed in Ukraine have an impact on the efficiency of institutions of higher education (IHEs), which are both elements of the socio-economic system and economic entities. In particular, along with the negative impact of the demographic crisis and the intensification of labour migration outside the country, they have significantly affected the entire field of education, including higher education (Kasych, 2013). Based on the function of a free economic zone in the socio-economic system of the country, when assessing the development of IC, it is appropriate to take into account the possibility of its reproduction with further improvement of methodological approaches to assessing the components of the intellectual capital free economic zone. Thus, the process of development of intellectual capital (IC) of the leading free economic zones of Ukraine for the period 2013-2018 was chosen as the object of research. The article aimed to present methodological approaches to assessing the development of IHEs IC in the current conditions of economic development of Ukraine (sharp decline in productivity) based on the definition of hypothetical factors with a logical interpretation of the impact of their dynamics on development.

2. METHODOLOGY

Multifactor analysis plays a significant role in many studies, in particular in assessing competitiveness, economic security and human potential (development) at the macro level. It makes it possible to reduce large numbers of material to a few independent and straightforward factors. The principal components method has some advantages over other methods of factor analysis, in that it combines the influence of a significant number of factors into several essential elements. These components explain the primary variance and the highest correlation of the initial indicators. The first principal component determines the direction in the space of the input values of the indicators with the smallest variance.

The second principal component is determined by the orthogonal (opposite) direction of the input values of the indicators that are not included in the first component, to explain most of the residual variance. The separation of the following components depends on the value of the total variation of the previous ones. Thus, the method of principal components can be used as a basis for the methodology of assessing the intellectual capital (IC) of institutions of higher education (IHEs), which is mathematically justified, given the diverse nature and the significant number of factors influencing the development of their intellectual activity.

The methodology for analyzing and evaluating the development of IC using the method of multifactor analysis was developed using the recommendations of Pedro Eu. Et al. (2018), the existing grouping and the procedure for calculating relevant indicators for industrial enterprises (Kozhushko O., 2011), approaches to human development assessment O. Tutova by methods of factor analysis (Tutova O., 2015), as well as the classification of IC components by L. Edvinsson (Edvinsson L., 2009) The source of data collection for analysis were the reports of rectors and heads of departments of the leading free economic zones of Ukraine financial and management reporting.

Since the values of input i-indicators for the components of the IC of a single free economic zone could fluctuate in relatively large intervals and have different units of measurement, they were linearly normalized according to the recommendations (Herv Abe Abdi, 2010), in particular:

stimulatory factors that positively affect the development of IC according to formula (1):

$$\tilde{x}_{ib} = 2 \times \frac{x_{ia} - x_i^{min}}{x_i^{max} - x_i^{min}} - 1 \quad (1)$$

and disincentives that have a negative impact on the development of IC according to formula (2):

$$\tilde{x}_{ib} = 2 \times \frac{x_i^{max} - x_{ia}}{x_i^{max} - x_i^{min}} - 1 \quad (2)$$

where $\tilde{x}_{ib}$ is the normalized value of the input i-index ($i = \overline{1, A}$ for the b-period of observation ($b = \overline{1, A}$;

x_{ib} is the base value of the input i-index for the b-period of observation ($b = \overline{1, B}$);

x_{ib}^{max}, x_{ib}^{min} is respectively the maximum and minimum value of the i-index for all periods observation b ($b = \overline{1, B}$).

The matrix of normalized input values will have the following formalized form:

for human capital evaluation indicators (3):

$$\tilde{x}_{Лib} = \begin{bmatrix} \tilde{x}_{Л11} & \dots & \tilde{x}_{ЛA1} \\ \dots & \dots & \dots \\ \tilde{x}_{Л1A} & \dots & \tilde{x}_{ЛAB} \end{bmatrix} \quad (3)$$

for indicators for valuing capital relations (4):

$$\tilde{x}_{Bia} = \begin{bmatrix} \tilde{x}_{B11} & \dots & \tilde{x}_{BA1} \\ \dots & \dots & \dots \\ \tilde{x}_{B1A} & \dots & \tilde{x}_{BAB} \end{bmatrix} \quad (4)$$

for organizational capital valuation indicators (5):

$$\tilde{x}_{Oia} = \begin{bmatrix} \tilde{x}_{O11} & \dots & \tilde{x}_{OA1} \\ \dots & \dots & \dots \\ \tilde{x}_{O1A} & \dots & \tilde{x}_{OAB} \end{bmatrix} \quad (5)$$

According to the results of factor analysis by the method of principal components of matrices of normalized values separately for each element of IC input normalized indicators $\tilde{x}_{ib}$ are transformed into new *iy*-indicators with different factor loads by *y*-factors. Within a certain *m*-component of IC based on the maximum factor loads for each *iy*-indicator was calculated its weighting factor (6):

$$\mathrm{V}_{iym} = \frac{N_{iym} \times Dar_{iym}}{\sum N_{iym} \times Dar_{iym}} \quad (6)$$

where $V_{iym}$is the weighting factor of the input i-th indicator with the maximum value of the factor load, which is included in the y-factor (main component) of the m-component of IC, $i = \overline{1, A}$, $\sum V_{iym} = 1$, where A is the number input *i*-indices of the m-component of IC; N_{iym} – the maximum value of the factor load of the input i-index, which is included in the y-factor (main component), characterizes the value of the i-indicator for the y-factor (main component); Dar_{iym} – fractions of the total variance of the y-factor (main component), which grouped the input *i*-indices of the *m*-component of IC with a factor load greater than 0.7 (with a strong correlation by Pearson's criterion).

Determining the integrated indicator of the development of a single m-component of the IC of a separate free economic zone for the annual period provided for the calculation of indicators for *iy*-indicators (for input *i*-indicators grouped by *y*-factors with factor loads more significant than 0.7) by formulas (7-9):

$$V_{iy\mathrm{H}} \times \tilde{x}_{\mathrm{H}ib} \quad (7)$$

$$V_{iy\mathrm{R}} \times \tilde{x}_{\mathrm{R}ib} \quad (8)$$

$$V_{iy0} \times \tilde{x}_{0ib} \quad (9)$$

where $V_{iy\mathrm{H}}$, $V_{iy\mathrm{R}}, V_{iy0-}$ – respectively the weight of the iy-indicator of human capital, relations capital and organizational capital, $i = \overline{1, A}$, where A is the number of i-indicators used to estimate the m-component of IC ($\sum V_{iym} = 1$); $\tilde{x}_{\mathrm{H}ib}$, $\tilde{x}_{\mathrm{R}ib}$, $\tilde{x}_{0ib}$ - normalized values of input and indicators of human capital, relations capital and organizational capital (information, innovation, process), respectively, within [-1, 1] for a certain observation period b.

The matrix of indicators for iy-indicators can be formalized as follows:

for human capital (10):

$$iy\mathrm{H} = \begin{bmatrix} V_{1y\mathrm{H}} \times \tilde{x}_{\mathrm{H}11} & \dots & V_{Ay\mathrm{H}} \times \tilde{x}_{\mathrm{H}A1} \\ \dots & \dots & \dots \\ V_{1y\mathrm{H}} \times \tilde{x}_{\mathrm{H}1B} & \dots & V_{Ay\mathrm{H}} \times \tilde{x}_{\mathrm{H}AB} \end{bmatrix} \quad (10)$$

for capital relations (11):

$$iy\mathrm{R} = \begin{bmatrix} V_{1y\mathrm{R}} \times \tilde{x}_{\mathrm{R}11} & \dots & V_{Ay\mathrm{R}} \times \tilde{x}_{\mathrm{R}A1} \\ \dots & \dots & \dots \\ V_{1y\mathrm{R}} \times \tilde{x}_{\mathrm{R}1B} & \dots & V_{Ay\mathrm{R}} \times \tilde{x}_{\mathrm{R}AB} \end{bmatrix} \quad (11)$$

for organizational capital (12):

$$iy\mathrm{o} = \begin{bmatrix} V_{1y0} \times \tilde{x}_{011} & \dots & V_{Ny0} \times \tilde{x}_{0A1} \\ \dots & \dots & \dots \\ V_{1y0} \times \tilde{x}_{01B} & \dots & V_{Ny0} \times \tilde{x}_{0AB} \end{bmatrix} \quad (12)$$

When normalizing the input i-indices, some of them may become zero, so to prevent zero values of integrated indicators of iy-indices and, as a consequence, the most integrated indicator of the development of a single m-component of IC for their calculations was used normalized additive convolution. Given the above, for each observation period b, the annual assessment of the integrated indicator for a single m-component of the IC of a particular free economic zone was carried out within [-1,1] by formulas (13-15):

$$\mathrm{I}_{\mathrm{H}b} = \sum_{i=1}^{A} V_{iy\mathrm{H}} \times \tilde{x}_{\mathrm{H}ib} \quad (13)$$

$$\mathrm{I}_{\mathrm{R}b} = \sum_{i=1}^{A} V_{iy\mathrm{R}} \times \tilde{x}_{\mathrm{R}ib} \quad (14)$$

$$\mathrm{I}_{0b} = \sum_{i=1}^{A} V_{iy0} \times \tilde{x}_{0ib} \quad (15)$$

where I_{Hb}, $\mathrm{I}_{\mathrm{R}b}$,$\mathrm{I}_{0b}$are, respectively, integral indicators of development of the m-component of IC for a certain b-period of observation for a separate IHEs (-1≤I_m≤1).

According to the calculations of integrated indicators according to formulas (13-15), the corresponding matrices of built-in indicators of development of m-components are constructed according to the observation periods b for each HEIs separately (16):

$$\mathrm{I}_{ma} = \begin{bmatrix} I_{H1} & I_{R1} & I_{01} \\ \dots & \dots & \dots \\ I_{HB} & I_{RB} & I_{0B} \end{bmatrix} \quad (16)$$

To determine the integrated indicators of IC development in general for a certain IHEs by years of observation, the data on the level of development of IC components (integrated indicators without normalization from the matrix (16)) are subject to factor analysis by principal components and converted into new *mz*-indicators. For each *mz*-indicator (with factor loads more significant than 0.7) its weighting factor (17) is calculated:

$$V_{zm} = \frac{N_{zm} \times Dar_{zm}}{\sum N_{zm} \times Dar_{zm}} \quad (17)$$

where V_{zm} is the weight of the integral index of the m-component of the IC with the maximum value of the factor load, which is included in the z-factor (main component), where $m = \overline{1,3}$ is the index of the component of the ($\sum d_{zm} = 1$); N_{zm} is the maximum value of the factor load of the integral index of the m-component of the IC, which is included in the z-factor (main component); Dar_{zm} is fractions of the total variance of the z-factor (main

component), which grouped the integral indices of the m-component of IC with factor loads greater than 0.7.

The weights of the integrated indicators for the m-components of the IC (d_{zm}) can be interpreted as the degree of development of a component in the overall assessment of the IC. The ratio of these coefficients for the components of the IC shows their value and the level of influence on the development of its overall development. Therefore, the calculation and control of these coefficients can serve as a methodological tool for implementing the provisions on the balanced development of all its components and the priority in building the latter depending on the chosen strategy of the free economic zone.

The calculation of the annual values of the integrated indicator of IC for each IHEs provided for the definition of integrated indicators for the b-period of observation (18-20):

$$V_{zH} \times \mathrm{I}_{Hb} \tag{18}$$

$$V_{zR} \times \mathrm{I}_{Rb} \tag{19}$$

$$V_{zO} \times \mathrm{I}_{Ob} \tag{20}$$

where $V_{z\mathrm{H}}$; V_{zR}; V_{zO} are respectively, the weighting factor of the *mz*-index or integral of the m-component of the IC ($\sum d_{zm} = 1$); $\mathrm{I}_{\mathrm{H}b}$, $\mathrm{I}_{\mathrm{R}b}$, $\mathrm{I}_{\mathrm{O}b}$ – respectively integrated indicators of human capital, relations capital and organizational capital according to b-periods (years) of observation $-1 \leq \mathrm{I}_{\mathrm{m}} \leq 1$).

According to the results of calculations of indicators for the a-period of observation (18-20), a matrix of their values for each IHEs (21) is formed:

$$mz = \begin{bmatrix} V_{z\mathrm{H}} \times \mathrm{I}_{\mathrm{H}1} & \dots & V_{z\mathrm{H}} \times \mathrm{I}_{\mathrm{H}B} \\ V_{z\mathrm{R}} \times \mathrm{I}_{\mathrm{R}1} & \dots & V_{z\mathrm{R}} \times \mathrm{I}_{\mathrm{R}B} \\ V_{z\mathrm{O}} \times \mathrm{I}_{\mathrm{O}1} & \dots & V_{z\mathrm{O}} \times \mathrm{I}_{\mathrm{O}B} \end{bmatrix} \tag{21}$$

Given the annual values of indicators for the components of IC in the matrix (21), the assessment of its integrated indicator for a certain IHEs (I_{IC}) and b-periods of observation was carried out within [-1; 1] by normalized additive convolution (22):

$$\mathrm{I}_{\mathrm{I}C} = V_{zH} \times \mathrm{I}_{Hb} + V_{zR} \times \mathrm{I}_{Rb} + V_{z\mathrm{O}} \times \mathrm{I}_{\mathrm{O}b}. \tag{22}$$

The use of additive convolution is based on the results of numerical simulation of initial effects, according to which the similarity of additive and multiplicative convolution is manifested when it becomes impossible to instantly change the original effect according to the change of input resources, i.e. when the integration step becomes less input resource (Shevchenko V., 2014). Such tendencies characterize the influence of factors on the level of IC development.

The range of characteristic values of the integrated indicator of IC development as a whole and its components for an individual free economic zone is accepted according to features of normalization of input and-indicators within [-1, 1] (Table 1).

Table 1 Scale of relative values of the integrated indicator of IC and its components by levels of development

The value of indicators	The relative level of development of IC and its components
−1.0	The lowest (basic) level
from – 1.0 to 0.5	Critically low
from 0.5 to 0.25	Low
from 0.25 to 0.25	Average
from 0.25 to 0.5	Moderate average
from 0.5 to 1.0	High
1.0	Maximum level

The obtained results of calculations of the integrated indicator of IC by the method of the main components of the factor analysis reflect its relative character on periods of supervision for separate IHEs. From the point of view of conducting a comparative analysis of the values of integrated indicators of IC development of different free economic zones for a certain period of observation, the obtained results can only indicate a difference in the dynamics of change of factors.

3. RESULTS

The methodology for determining the ratings of the TOP-200 universities of Ukraine provides for the calculation of an integrated indicator, which depends on the indices of quality of scientific and pedagogical potential, quality of education and international recognition. Starting from 2015-2016, this methodology was improved by introducing an additional criterion "Innovative activities of universities" in assessing the quality of scientific and pedagogical potential. Besides, for the analysis of international recognition of universities began to take into account their participation in the programs "Horizon 2020", TEMPUS, Erasmus + and others. These innovations in the ranking have strengthened such a factor as the "intellectual component" through the assessment of innovation and development of research and teaching staff. This fact has increased the value of relevant databases for the study of IC development. Therefore, for the objects of research from the academic rating "Top-200 Ukraine" in 2018 were selected classical and technical universities, which have at least half the value of the integrated indicator of the first ranking position (42 points with the best result of 84.74 points) (Rating of HEIs TOP-200 Ukraine), which made it possible to investigate the most significant manifestations of the influence of the factors of development of IC domestic free economic zones. Such universities included:

6 classical universities – assessment of the integrated performance indicator according to the rating of 2018: Taras Shevchenko National University of Kyiv (Taras Shevchenko NUK) – 80.59; V. N. Karazin Kharkiv National University (V. N. Karazin KhNU) – 48.95; Lviv Polytechnic National University (LPNU) - 44.66; Sumy State University (SumDU) – 42.37; Ivan Franko National University of Lviv (IFNUL) – 42.28; National University of "Kyiv-Mohyla Academy" (NaUKMA) – 42.26

and 3 technical universities - assessment of the integrated performance indicator according to the rating of 2018: National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (NTUU "KPI named after Igor Sikorsky") – 84.74; National Technical University "Kharkiv Polytechnic Institute" (NTU "KhPI") – 44.70; Dnipro University of Technology (DUT, until 2016 – National Mining University) – 42.69.

Technological (sectoral) free economic zones according to the academic rating "Top-200 Ukraine" in 2018 have much lower integrated rating indicators, among which the top five include institutions with an integrated performance of at least 30 points in 2018, namely: National Metallurgical Academy of Ukraine (NMetAU) – 38.86; National University of Food Technologies (NUFT) – 35.30; Kharkiv National University of Radio Electronics (NURE) – 33.10; Ukrainian National Forestry University (UNFU) – 31,19; Kyiv National University of Technology and Design – (KNUTD) – 30.94.

Analytical calculations were performed based on financial statements and reports of rectors for the period 2015-2018 of these free economic zones. After normalization of the input i-indicators according to formulas (1) and (2) using factor analysis by the method of principal components the transformation of the input i-indicators into the factor y = 1 and the factor y = 2 is carried out. In this case, for all institutions, the indicators of all components of the IC form factors 1 and 2. Based on the normalized values of input and indicators and the results of studies of factor loads based on formulas (13-15) calculated integrated indicators of IC components (Table 2). The results obtained indicate relative changes in the level of development of the components of the IC for all universities in the range from low to medium, except for the high level for 2017-2018 in Taras Shevchenko NUK (0.91) and NaUKMA (0.54).

Table 2 Integral indicators of development of IC components by years and IHE under study

Years	Integrated indicator of human capital development	Integrated indicator of the development of capital relations	Integrated indicator of organizational capital development
Taras Shevchenko National University of Kyiv			
2017/2018	0,4245	0,9125	0,3279
2016/2017	-0,1309	-0,5264	-0,1723
2015/2016	-0,3876	-0,7226	-0,3255
V. N. Karazin Kharkiv National University			
2017/2018	-0,0416	-0,3093	0,0904
2016/2017	-0,0588	0,5242	0,1193
2015/2016	-0,0526	-0,0166	-0,1799
Lviv Polytechnic National University			
2017/2018	0,3842	0,0766	0,2295
2016/2017	-0,0023	-0,2957	-0,1128
2015/2016	-0,4683	0,2500	-0,1708
Sumy State University			
2017/2018	0,0500	-0,1590	0,1831
2016/2017	-0,4225	0,1214	-0,054
2015/2016	0,2251	-0,0093	-0,5277
Ivan Franko National University of Lviv			
2017/2018	0,2857	0,0823	0,2166
2016/2017	-0,2926	0,3092	-0,0366
2015/2016	-0,2058	-0,0817	-0,2042
National University of "Kyiv-Mohyla Academy"			
2017/2018	-0,1037	0,5409	0,3589
2016/2017	-0,1125	0,4127	0,0912
2015/2016	-0,1470	-0,5837	-0,6693

National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"			
2017/2018	0,0415	0,4428	0,4785
2016/2017	-0,0999	-0,2947	0,1024
2015/2016	-0,0913	-0,3064	-0,4278
National Technical University "Kharkiv Polytechnic Institute"			
2017/2018	0,1838	-0,0949	0,2051
2016/2017	-0,0092	0,0420	-0,1737
2015/2016	-0,2630	0,0253	-0,2383
Dnipro University of Technology			
2017/2018	0,0298	-0,0767	-0,1164
2016/2017	-0,0547	-0,1978	0,0566
2015/2016	-0,2105	-0,2230	0,2292
National Metallurgical Academy of Ukraine			
2017/2018	0,4588	0,6809	0,4051
2016/2017	0,0092	0,3204	0,1631
2015/2016	-0,4630	-0,4253	-0,5383
National University of Food Technologies			
2017/2018	0,4838	0,5666	0,6205
2016/2017	-0,0092	0,3299	0,1737
2015/2016	-0,2630	-0,0253	-0,2383
Kharkiv National University of Radio Electronics			
2017/2018	0,5838	0,8086	0,2051
2016/2017	-0,0092	0,3099	-0,1788
2015/2016	-0,2883	-0,0292	-0,2383
Ukrainian National Forestry University			
2017/2018	0,6838	0,5219	0,4452
2016/2017	-0,0199	0,3220	-0,1737
2015/2016	-0,5630	-0,5530	-0,6383
Kyiv National University of Technology and Design			
2017/2018	0,6700	0,6361	0,2712
2016/2017	-0,4906	0,5763	0,0154
2015/2016	-0,6331	-0,7859	-0,2714

Note. Calculated by the authors.

A relatively high level characterizes the development of almost all components of IC in 2017-2018 for technological universities compared to 2015-2016.

In order to determine the integrated indicator of IC as a whole by year for each university based on the results of factor analysis, the data in Table 2 were converted into new *mz*-indicators for which according to formula (17) weights were established (Table 3). The ratio of these in Table 3 coefficients reflect the proportions of reproduction of human and structural (variable and permanent) capital or the degree of balanced development of IC in its components. Approximately equal values of these coefficients indicate the proportional development of the components (at the level of 0.33), which according to the analysis is observed in such institutions as Taras Shevchenko NUK, SumDU and NaUKMA. The relatively acceptable ratio of these coefficients in all technical universities, the values of which correspond to the interval [0,32; 0.34].

Table 3 Weight coefficients of integrated indicators of IC components, grouped by z-components (actual values) and reflect the proportionality of their development

Institution of higher education	Weights		
	Human capital	**Capital relations**	**Organizational capital**
Taras Shevchenko National University of Kyiv	0,3329	0,3326	0,3326
V. N. Karazin Kharkiv National University	0,3891	0,4023	0,2085
Lviv Polytechnic National University	0,4097	0,2102	0,3800
Sumy State University	0,3681	0,3338	0,2981
Ivan Franko National University of Lviv	0,3733	0,2413	0,3854
National University of "Kyiv-Mohyla Academy"	0,3339	0,3329	0,3331
NTUU "Igor Sikorsky Kyiv Polytechnic Institute"	0,3398	0,3445	0,3156
NTU "Kharkiv Polytechnic Institute"	0,3209	0,3314	0,3477
Dnipro University of Technology	0,3326	0,3263	0,3411
The National Metallurgical Academy of Ukraine	0,3333	0,3300	0,3367
National University of Food Technologies	0,3332	0,3968	0,2700
Kharkiv National University of Radio Electronics	0,3491	0,3000	0,3509
Ukrainian National Forestry University	0,3608	0,3303	0,3089
Kyiv National University of Technology and Design	0,3200	0,3228	0,3572

Note. Calculated by the authors

Among the technological IHEs studied, the balanced development of the components of the IC, based on the ratio of weights, is observed in NMetAU and KNUTD.

Then, using formulas (18-20), the calculations of integrated indicators for *mz*-indicators were performed, and according to formula (22), the integrated indicator of IC development was determined by years and each HEIs studied (Table 4).

Table 4 Integral indicators of the levels of IC development by years and HEIs, which are studied

Institution of higher education	The value of the integrated development indicator IC -I_{IC}		
	2017/2018	**2016/2017**	**2015/2016**
Taras Shevchenko National University of Kyiv	0,5544 high level of development	-0,2762 low level of development	-0,4789 basic level of development
V. N. Karazin Kharkiv National University	-0,1218 low level of development	0,2128 moderate average level of development	-0,0646 basic level of development
Lviv Polytechnic National University	0,2607 moderate average level of development	-0,1059 low level of development	-0,2042 basic level of development
Sumy State University	0,0199 moderate average level of development	-0,1311 low level of development	-0,0775 basic level of development
The Ivan Franko National University of Lviv	0,2100 moderate average level of development	-0,04871 low level of development	-0,1752 basic level of development
National University of "Kyiv-Mohyla Academy"	0,2649 moderate average level of development	0,1302 moderate average level of development	-0,4663 basic level of development
NTUU "Igor Sikorsky Kyiv	0,3177 moderate average level	-0,1031 low level of	-0,2716 basic level of

Polytechnic Institute"	of development	development	development
NTU "Kharkiv Polytechnic Institute"	0,0988 moderate average level of development	-0,0494 low level of development	-0,1588 basic level of development
Dnipro University of Technology	-0,0548 low level of development	-0,0634 low level of development	-0,0646 basic level of development
NMetAU	0,5545 high level of development	0,2763 moderate average level of development	-0,4789 basic level of development
National University of Food Technologies	0,5697 high level of development	0,2128 moderate average level of development	-0,0646 basic level of development
Kharkiv National University of Radio Electronics	0,5607 high level of development	0,1059 moderate average level of development	-0,2042 basic level of development
Ukrainian National Forestry University	0,5199 high level of development	0,1312 moderate average level of development	-0,5776 basic level of development
KNUTD	0,51532 high level of development	0,03731 moderate average level of development	-0,5522 basic level of development

Note. Calculated by the authors

Among classical and technical universities, the values of integrated indicators of IC development for the period 2015-2018 characterize its level as high only in Taras Shevchenko NUK and moderate average in all other universities. The exceptions are V. N. Karazin KhNU and Dnipro University of Technology with negative values of the integrated indicator. The difference in the development of IC of these two universities is that in the first, the dynamics of changes in the indicator is greater than in the second. Thus, in 2015-2016, the integrated index of IC in V. N. Karazin KhNU and Dnipro University of Technology was 0.0646, but a year later the first it was 0.2128, and the second - 0.0634. Higher rates of change in the level of capital development at V. N. Karazin KhNU indicate greater opportunities and effectiveness in the use of intellectual assets of this university.

Positive dynamics characterized the level of human capital development for all universities, despite the generally negative impact of a number of factors, in particular: reduction of the average number of research and teaching staff per economic contract, grant and research (scientific and technical) development. performed at the expense of the budget, as well as the deterioration of the ratio of the number of graduate students (doctoral students) and the total average annual number of full-time research and teaching staff, reducing labour costs in the structure of operating costs. These factors are associated with a slight decrease in the level of human capital development at SumDU in 2016-2017.

Significant growth in the level of development is characterized by organizational capital, which is natural for its component of IC and especially noticeable in the activities of Taras Shevchenko NUK, IFNUL, SumDU, IFNUL, NaUKMA, NTUU "Igor Sikorsky Kyiv Polytechnic Institute", NTU "KhPI".

The worst situation is with capital relations, which has revealed the ability of universities to restore or not lose the contingent of students, as well as to ensure the quality of educational programs. The growth of this component of IC is present only in Taras Shevchenko NUK, IFNUL, NaUKMA and NTUU "Igor Sikorsky Kyiv Polytechnic Institute". Dnipro University of Technology has an increase, but insignificant (in the negative range of values of the indicator), and its decrease – V. N. Karazin KhNU, SumDU, NTU "KhPI".

4. DISCUSSION

Despite the sharp fluctuations in the values of integrated indicators for the components of IC - 0.66 to 0.91, each university has an equally positive nature of human and organizational capital development. However, it is not possible to prove the dependence of human and innovative capital development on the results of the conducted research for all the studied free economic zones due to the limited number of years of observations and the lack of completeness of the data among the input indicators of the analysis. At the same time, this pattern was confirmed by studies of industrial companies (Andreeva & Garanina, 2017) and financial institutions (Ayub et al., 2017).

The proposed method of determining the dynamics of IC development by its components may take into account various combinations of key and additional indicators, in particular, built in a balanced scorecard (Breus S. & Khaustova Ye. 2016). The results of its use can be the basis for the development and forecasting of measures to increase the individual components of the IHE' IC due to the possibility of comparative analysis of indicators or one institution in the dynamics, or their group (Khaustova Ye. & Denysenko M., 2018). To develop predictive solutions for the development of IHE' IC, further research will be associated with determining the possibilities of using linear and nonlinear economic and mathematical models.

5. CONCLUSION

The proposed method of determining the dynamics of development and protection of IC by its components may be in nature and take into account various combinations of key and additional indicators, in particular a balanced scorecard. The results of its use can be the basis for the development and forecasting of measures to increase the individual components of the IC, both public and private free economic zones. It provides for the possibility of conducting a comparative analysis of indicators or one institution in the dynamics, or a group of institutions. The scientific novelty of the method lies in the possibility of conducting the non-financial analysis of IC and its components within budgetary institutions or non-profit organizations, as well as in eliminating the subjectivity of the results, which is characteristic of expert methods with a scale of scores. The expediency of using the possibilities of the factor method to build a model for the development of IHE' IC is a matter of further research.

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