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Priority directions of investments into development of the systems of organizational knowledge of industrial business entities

Abstract

The article is devoted to the substantiation of the priority investment directions at modern industrial business entities in the conditions of knowledge-based economy. The analysis of scientific works as for investments in knowledge, organizational knowledge, intellectual capital and intangible (intellectual) assets has been conducted. As a result of such theoretical analysis there were distinguished three main directions of investments in the development of the system of organizational knowledge at microeconomic level: vocational education and training of employees, science and innovations, information and communication technologies. It has been suggested to use such indicator as Index of organizational knowledge for the purpose of assessment of the state of the system of organizational knowledge at microeconomic level in dynamics for several years. The comparison of the dynamics of the values of this index and the dynamics of the amount of investments of industrial business entities in three mentioned directions are proposed as a basis for making investment decisions. The methodical approach to the choice of priority investment directions in the development of the systems of organizational knowledge of industrial business entities has been elaborated in the article. This methodical approach is designed to optimize investments of industrial business entities in the conditions of knowledge-based economy.

Keywords: directions of investments, knowledge-based economy, industrial business entities, system of organizational knowledge.
JEL Classification: J310, O160.

Introduction

The current trends of economic development in developed countries are characterized by the formation of knowledge-based economies. Investments into knowledge development at all economic levels become the source of socio-economic growth. One of the most important components of economic complex of Ukraine, which owns a significant share in the sectoral structure of gross value added, is the industry. One more reason why the investment policy of industrial business entities (IBEs) has a significant impact on the further development of the Ukrainian economy is because the largest share in the structure of capital investments by sources of investment belongs to enterprises and organizations' own funds.

The purpose of the article is to develop a methodical approach to defining the priority directions of investments into the development of the system of organizational knowledge (SOK) of IBEs in the conditions of knowledge economy. To achieve this aim the folowing tasks were solved: firstly, the interdependence between the categories "knowledge", "organizational knowledge", "intellectual capital", "intangible (intellectual) assets" was considered. Substantiation of these categories is the significant precondition for the elaboration of recommendations as to investment in the development of the SOK; secondly, the main stages of methodical approach to the choice of priority investment directions to the development of SOK of IBEs were developed.

The calculation of the Index of organizational knowledge (IOK) of IBE made it possible to determine the impact of investing in the given directions on its dynamics by years. The degree of such impact was the classification feature for division of IBEs into groups. Practical recommendations as to priority directions of investments into the development of SOK were made for each IBEs group.

1. Literature review

The development of knowledge-based economies is today the urgent and widely recognized concept of economic development in many countries of the world. The main driving force of such economies is investment into their main resource – knowledge. *Topicality* of the theme is confirmed by the results of the scientific researches. According to OECD (2005), "investment in knowledge has grown more rapidly than investment in machinery and equipment since the mid-1990s in most OECD countries". According to Lin, Chuang L., Chang M. and Huang (2011) "the role of knowledge is becoming more and more important as the human economy developmental stage enters the so-called knowledge economy". From the point of view of OECD experts (OECD, 2013) "business investment in knowledge-based capital is increasing and is already a significant source of growth". Wenzhe (2011) has an opinion that "in view of the

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characteristics of the knowledge-based economy business investment innovation should emphasize in investment in knowledge capital". Schilirò (2010) notes that "investing in knowledge becomes the ideal strategy to increase the productive capacity of capital goods, labor and natural resource inputs, and it is considered one of the main causes of the deep transformations in the structure of modern economies and also a strategic engine for the long run growth". Modern authors recognize the importance of investment in knowledge at the level of enterprises (investments in the system of organizational knowledge). But still there is not fully solved problem of unanimous understanding of directions of such investments. Many questions are caused by different interpretations of categories adjacent to the category of "organizational knowledge".

Solution of *the first task* requires the investigation of the interdependence between the concepts "knowledge", "organizational knowledge", "intellectual capital", "intangible (intellectual) assets". The investigation of the investment directions to the development of the SOK is closely connected with these concepts. Affinity of these concepts was described in the works of Blackler (1995), Bollinger (2001), Bontis (1999), Gibson (2001), Grant (1993), Spender (1993) and others. But there is no common point of view as to interdependence between these concepts. Revealing of this interdependence allows solving the first task of the research.

The second task stipulates the investigation of the existing approaches to the investment into the development of SOK. Many authors considering the same directions of investments in the development of SOK at the level of IBE, refer them to investments in knowledge, or intangible assets, or intellectual capital. For example, Walsh, Enz and Canina (2008) suggested to distinguish the next directions for investments in intellectual capital: systems capital (operational knowledge), customer capital (brand and marketing knowledge), and human capital (knowledge from both service and professional employees). These authors do not make a clear distinction between the concepts of knowledge and intellectual capital. Youndt, Subramaniam and Snell (2004) investigated investments in intellectual capital, by which they understood "the sum of all knowledge an organization is able to leverage in the process of conducting business to gain competitive advantage". These authors underline that the development of organizational knowledge is based on strategic investment decisions as for formation of human, social or organizational intellectual capital. As the main directions of investments in these three forms of intellectual capital they suggest human resource management, information technologies and research and development. But their research does not present any distinguished form between knowledge and intellectual capital as well. A similar list of directions of investments is also offered by Wenzhe (2011), who uses the concept of knowledge capital and asserts that "companies should focus on the investments in the human resources management, information management, innovation management and the development of core products". The OECD (2013) experts single out three main groups of intangible assets in conformity with classification of Corrado, Hulten and Sichel (2005) as investment priorities: computerized information, innovative property and economic competencies. In this case there has not been definite clear distinguished form between knowledge-based capital and intangible assets. Taking into account the above mentioned, further study and systematization of directions of investments in the development of the SOK of IBEs is acquiring topical importance.

But, revealing the list of directions of investment does not solve the problem of investment into the development of SOK. According to Bratiany and Orzea (2012), investments in knowledge will lead to higher productivities and efficiencies but the correlations are not any more linear, since knowledge processing is by its own nature highly nonlinear. It means that the simple increasing of the volumes of investment into the development of SOK as to the mentioned directions not always leads to the expected result. Similar point of view was expressed by Fontaine and Lesser (2002), who argue that "while some organizations have reaped significant benefits from their investment in knowledge efforts, others have run into noteworthy challenges". In the opinion of Chen and Edgington (2005) "to maintain competitive advantage, a firm's investment decisions related to knowledge creation are likely to be strategic in nature. However, strategic investments usually have an element of risk linked to uncertain and deferred investment benefits". To decrease such risks it is advisable to develop the ways of choosing the priority investment directions to the development of SOK.

2. Methodology

To achieve the goal of the article scientific research methods are used in the work. Solution of the *first task* of the research is based on the analysis of literary sources. Solution of the *second task* requires different methods.

The first stage of the methodical approach, that is theoretical substantiation of the directions of investments in the development of the SOK of IBEs, is grounded on the analysis of literary sources.

The second stage – collection of secondary information – is realized with the desk research of IBE reports.

The third stage – calculation of the IOK of IBEs in the dynamics by years – is fulfilled with the methods of sums and sums of grades. Taking into consideration the widely tested at the level of countries of the world approach to diagnostics of the state of the knowledge economy based on Knowledge Assesment Methodology (KAM) (World Bank Group, 2012), the work proposes to take it as a basis but adapt it to the level of IBE. The components by which the Knowledge Index is calculated by KAM are as follows: innovation system, education, information and communication technologies. The above given indicators are used at the macro- and mega economic level for comparative analysis between the countries of the world regarding the degree of knowledge economy development. However, at the microeconomic level the use of these indicators unchanged is impossible. This paper offers to accept as a basis the components of assessment of the SOK similar to the above given methodology. It is advisable to choose vocational education, science and innovation and information and communication technologies as the key components at the microeconomic level. However, the choice of partial indicators to show the status of the SOK by each of the components is necessary to adapt to the level of IBE. The key components of IOK and indicators that characterize them are given in Table 1. Application of the method of desk research of reporting of IBEs allowed to form a set of input data for the calculation of the above indicators by each of the components. Following the procedure of normalization of values of all listed in Table 1 indicators and their placement in a range from 0 to 10 points for 34 IBEs each of the subindexes of IOK (S_{ir}, S_{ve} and S_{ict}) is calculated by Formula 1:

$$S = 1/k \sum_{i=1}^{k} u_i^N, \quad (1)$$

where k – the number of partial indicators that form subindex, u_i^N– normalized value of i partial indicator.

Table 1. Components of IOK of IBEs and partial indicators, which are forming them

Components of IOK	Partial indicators used for calculation of IOK
Professional and educational	the proportion of employees with basic and incomplete higher education among all employees; the proportion of employees with complete higher education among all employees; the proportion of employees who have gone through vocational training and advanced training among all employees; the proportion of employees who have gone through on-the-job training among all employees who have gone through vocational training and advanced training.
Innovative and scientific	participation of enterprise in internal and external research developments; acquisition of other external knowledge; creation of organizational and marketing innovations; market introduction of innovations; the number of new technologies acquired by enterprise; the number of introduced by enterprise innovative products and new manufacturing processes; the number of applications and acquired protective documents for objects of intellectual property rights; the proportion of the volume of sales of innovative products in total sales; the proportion of employees with academic degrees, inventors and innovators among all employees of enetrpise.
Information and communication	number of computers per 10 employees; number of computers with access to the Internet per 10 employees.

After calculating subindexes values we calculate IOK by Formula 2.

It is suggested to introduce an IOK as an integral index which reflects the state of the SOK of IBEs. The IOK calculation is proposed to do by Formula 1 which is similar to the formula in KAM (World Bank Group, 2012), under which it is calculated as the average of three subindexes:

$$IOK = (S_{ir} + S_{pe} + S_{ict})/3, \quad (2)$$

where S_{ir} – innovation and research subindex, S_{pe} – professional and educational subindex, S_{ict} – information and communication subindex.

On the *fourth stage* of the methodical approach the method of principal components was used to determine the degree of impact of investments in each of the three directions on the dynamics of IOK of IBEs.

The method of principal components is used in the cases when it is necessary to exclude the input redundancy to single out the most important factors affecting a particular outcome, and confirm the importance of influence of these factors. The input matrix (A) of parameters proposed for transformation using the method of principal components into the new combination of parameters includes the following indicators: x_1 – own expenditure on scientific and technical work; x_2 – the cost of research and development made by co-performers; x_3 – the cost of internal research and development (R & D); x_4 – the cost of purchasing of external R & D; x_5 – the cost of acquisition of other external knowledge; x_6 – other costs on innovation; x_7 – costs associated with the rights protection of intellectual property rights (IPR) and their use; x_8 – the cost of software and databases; x_9 – the cost of computer repair services; x_{10} – the cost of services of computer programming, consultancy and related

services, information services; x_{11} – the cost of purchasing computers and computer equipment; x_{12} – the cost of vocational education and training of employees. The value of each indicator has been analyzed in dynamics for 2007-2012.

All input data of matrix A are presented without gaps. The resulting vector is IOK (we designate it as q). The representation F matches the integrated vector q_i with each row a_i^T of the matrix A and is built by the method of principal components: $F: A \rightarrow q$.

The conversion of rotation meets the criterion of the largest information content Rao (according to this criterion the largest information content is the minimum value of the sum of squares of the distances from objects images to their projections on the first principal component) (Rao, 1968). All calculations were performed using the software package STATISTICA 10.0.

The essence of *the fifth stage* of the methodical approach is grouping of IBEs according to the degree of influence of each direction of investments on the dynamics of the IOK. Method of a simple analytical grouping was used for this purpose.

On *the sixth stage* it was made positioning of IBEs in the system of axes: Values of IOK/Amounts of investments in three directions within each group using graphical method. Elaboration of practical recommendations for each group of IBEs as for development of SOK on the basis of priority directions of investments has been made with the use of logical method.

3. Results and discussion

3.1. Substantiation of interdependence between concepts "knowledge", "organizational knowledge", "intellectual capital", "intangible (intellectual) assets. Before considering the possible directions of investments in the development of the SOK of IBEs, it is appropriate to define the relationship between the concepts of "knowledge", "organizational knowledge", "intellectual capital" and "intangible/intellectual assets". These concepts are closely related and linked. The authors, revealing the content of those concepts define one through another, or, alternatively, often give them the same definition.

Tsoukas and Vladimirou (2001) note that "organizational knowledge is the capability members of an organization have developed to draw distinctions in the process of carrying out their work, in particular concrete contexts, by enacting sets of generalizations whose application depends on historically evolved collective understandings". Jones and Leonard (2009) say that "organizational knowledge is the collection of knowledge which exists in the organization that has been derived from current and past employees. This knowledge is "owned" by the organization in that the organization can take this knowledge and codify it in some way to preserve it within the organization itself even when an employee has left the company". One more point of view says that "knowledge may be viewed from a unified perspective; it circulates in the organization, creating knowledge assets and influences the performance of the organization" (Moballeghi, M., Moghaddam, G.G., 2011). This definition of knowledge belonging to the organization stresses that they are the sources of formation of knowledge assets. In turn, the concepts of knowledge assets and knowledge are used in determining the nature of intellectual capital. So, for example, Edvinsson and Sullivan (1996) assert that intellectual capital is knowledge that can be converted into value. Marr and Schiuma (2001) consider that intellectual capital is composed of all knowledge-based assets, distinguished between organizational actors (relationships, HR) and infrastructure (virtual and physical). Tolstobrov (2010) considers the transformation of intellectual capital into intellectual assets to be the most important task of management of the latter. So the concept "knowledge" is used for determining all other concepts studied in the paper. This paper suggests to accept as a basis the following correlation between the concepts studied above:

- intellectual capital is the part of organizational knowledge which is identified and can be assessed using quantitative and qualitative indicators at the present time based on results of preliminary work of the business entity;
- intellectual assets are part of intangible assets and commercialized part of intellectual capital and organizational knowledge that are actively working to achieve the goals of IBE and provide it with the income in the present and in future periods.

This interdependence is represented in Figure 1.

Thus, the most original and broad concepts among those named are "knowledge" and "organizational knowledge". The main purpose of the development of the SOK is receiving of economic and social benefits as a result of forming intellectual assets through the process of commercialization of organizational knowledge. So, the directions of investment into organizational knowledge, intellectual capital and intellectual assets are very significant for the development of the SOK. These directions will be considered below. Under the SOK we understand the sum of related with carriers organizational knowledge and the interconnections between them as well.

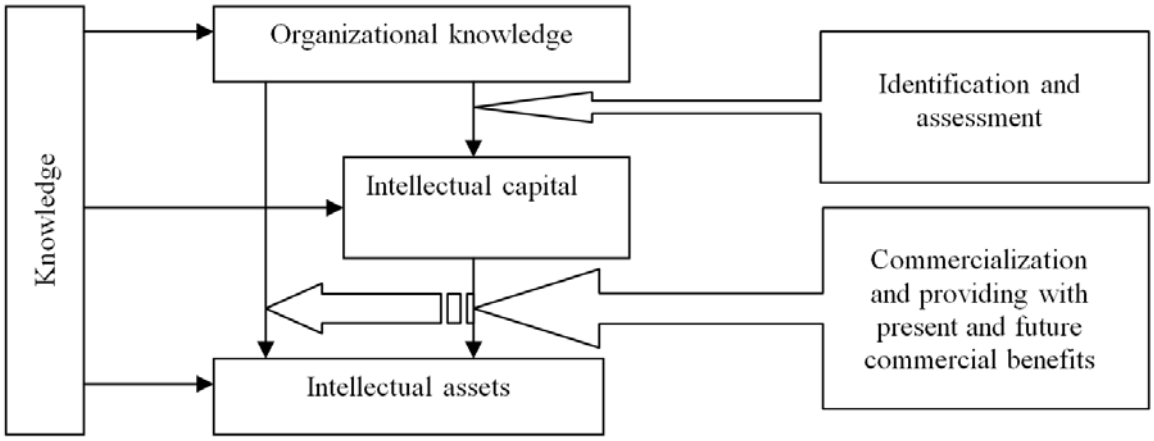


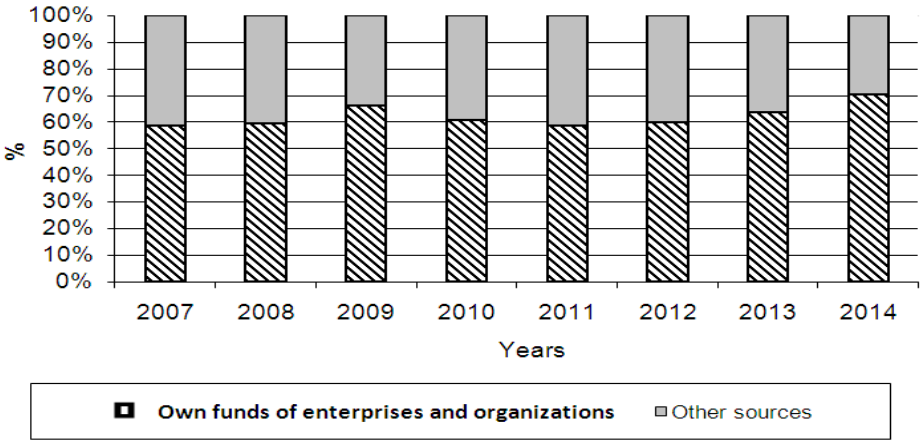
Fig. 1. Interdependence of concepts "knowledge", "organizational knowledge", "intellectual capital", "intellectual assets"

4. Stages of methodical approach to the choice of priority investment directions in the development of the SOK of IBEs

As it was noted above investment in organizational knowledge does not always lead to the expected result. For achieving positive social-economic effects of such investment and for creating conditions for the development of SOK the presented methodical approach has been developed (Figure 2, see Appendix).

Figure 2 gives the stages of methodical approach to the choice of priority directions of investments in the development of the SOK of IBEs and the methods and results according to each of the stages as well. All methods used at each stage of the methodical approach are described in the part "Methodology" (see above). The essence and the results of the stages of methodical approach to the choice of priority investment directions in the development of the SOK of IBEs are presented below.

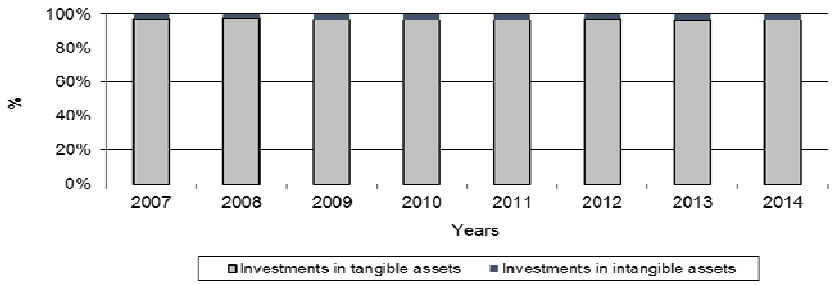
4.1. Theoretical substantiation of the directions of investments in the development of the SOK of IBEs. The Ukrainian statistical reports do not have forms directly containing information on investments in organizational knowledge. However, in part, investments in knowledge and intangible assets are given in the report on the structure of capital investments in Ukraine. Specific to the Ukrainian economy is the predominance in the structure of capital investments of such funding sources such as own funds of enterprises and organizations, as given in Figure 3.



Source: The State Service of Statistics of Ukraine (2012, 2013, 2014, 2015).

Fig. 3. Structure of capital investments in Ukraine by sources of funding in the years 2007-2014

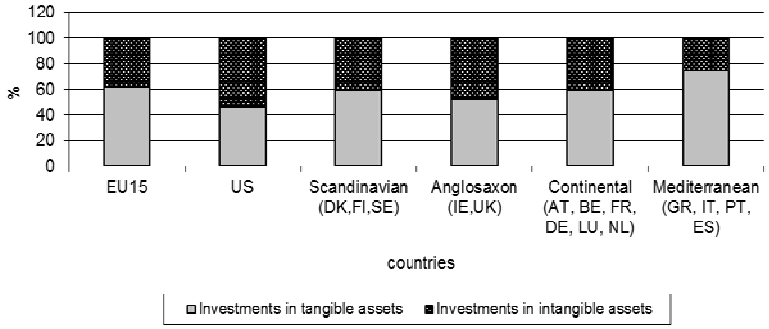
As can be seen from Figure 3, the largest share in the structure of capital investments by sources of investment belongs to own funds of enterprises and organizations. This share prevails over the total share of all other sources of capital investment. With such a structure of capital investment we can make a conclusion that the investment policy of business entities has a significant impact on futher directions of economic development. This again confirms the need to study the most priority directions of investment in the development of the SOK at the level of IBEs. The analysis of the structure of capital investments by type of assets in which funds are invested is of essential significance for this research. Figure 4 shows the ratio of capital investments of business entities of Ukraine in tangible and intangible assets.



Source: The State Service of Statistics of Ukraine (2012, 2013, 2014, 2015).

Fig. 4. Structure of capital investments by types of assets in Ukraine

For comparison, Figure 5 gives the amount of investments in tangible and intangible assets in some countries of the world.



Source: Calculated on the basis of the data presented in: Corrado, C., Haskel, J., Jona-Lasinio, C., Iommi, M. (2013). Innovation and Intangible Investment in Europe, Japan and the US. Discussion paper. London: Imperial College.
Note: Data for the period of 1995-2009 years (average values).

Fig. 5. Structure of investment by types of assets in various countries of the world

Table 2. Approaches to distinguishing of investment directions in development of knowledge, organizational knowledge, intellectual capital and intangible (intellectual) assets

Author	Category under review	Directions (components) of investing in development of the given category
Youndt, Subramaniam and Snell (2004)	organizational knowledge	human resource management, information technologies and research and development
Hwang and Gerami (2007)	knowledge	education, R&D and software
Goforth (2010)		higher education, research and development, computer-based and information systems
Lopes, Martins and Nunes (2005)		education, information and communication technologies
Borrás and Edquist (2015)		innovation and innovative activity, research and development
Walsh, Enz and Canina (2008)	intellectual capital	systems capital (operational knowledge), customer capital (brand and marketing knowledge), and human capital (knowledge from both service and professional employees)
Corrado, Hulten and Sichel (2005)	intangible (intellectual) assets	computerized information, innovative property and economic competencies
The State Service of Statistics of Ukraine (2014)		the right to use natural resources and property, plot of land, rights to commercial designations, industrial property, copyright and related rights, patents, licenses, concessions, software and databases, the cost of exploration of mineral resources, for the services of lawyers, valuers , real estate agents that are associated with the transfer of ownership of not worked out assets, entertainment programs and originals of literary and artistic works

As it can be seen in Table 2, today there is no single approach to distinguishing a clear list of the main directions of investments in the development of knowledge, organizational knowledge, intellectual capital and intangible (intellectual) assets. However, most of the authors recognize such important directions as education, science and innovation (including research and development as their integral part), information and communication technology.

Taking into consideration the results presented in Table 2 it is reasonable to accept as a basis the next main directions of investment into development of the SOK of IBEs: innovative and scientific, professional and educational, information and communication.

4.2. Collection of secondary information as to investment in the development of the SOK and as to the results of activity of IBEs. Investments in the broad sense are defined "as any current consumption of resources committed to obtain future benefits that is income (profit) in the economic aspect and the usefulness (benefit) in the social one" (Iastremska, 2004).

The costs for vocational training and advanced training of employees, science, innovation and ICT are made to form SOK which, in turn, provide the increase of intellectual capital and intellectual assets. The latter are the source of income of the business entity in the future. Therefore, these costs can be considered as investments in the development of the SOK. Table 3 presents the types of costs according to each of three main directions of investment in the development of the SOK of IBEs.

Table 3. Types of costs of IBEs according to the directions of investment into development of their SOK

Directions of investment	Types of costs within each direction
Innovative and scientific	own expenditure on scientific and technical work; the cost of research and development made by co-performers; the cost of internal research and development (R & D); the cost of purchasing of external R & D; the cost of acquisition of other external knowledge; other costs on innovation; costs associated with the rights protection of intellectual property rights (IPR) and their use.
Information and communication	the cost of software and databases; the cost of computer repair services; the cost of services of computer programming, consultancy and related services, information services; the cost of purchasing computers and computer equipment.
Professional and educational	the cost of vocational education and training of employees.

All information as for the mentioned above costs is received through desk research of IBE reports for 2007-2012 years. Taking in this paper as a basis the definition proposed by Alabugin (2005) we note that development of the system is a regular process of transition from its current state to a qualitatively new one. Thus, the development involves the change of the states of the system.

For investigation the change of the states of the SOK it is suggested to research the dynamics of the values of IOK for 2007-2012 years. Calculation of these values is based on the equation 2 (see section 2). The input data for calculation of the IOK were received through desk research of IBE reports.

4.3. Calculation of the IOK of IBEs in the dynamics by years. Results of calculation of IOK for 34 IBEs of Kharkiv and Kharkiv oblast in 2007-2012 are given in Table 4.

Table 4. Values of IOK of IBEs in dynamics by years

	Name of industrial business entity	Values of IOK by years					
		2007	2008	2009	2010	2011	2012
1	Public Joint Stock Company (PJSC) "Kharkiv Machine Building Plant" Svet Shakhtyora"	3.28	3.27	3.78	3.22	3.28	2.89
2	State Company (SC) Plant Elektrovazhmash	3.24	2.30	2.58	2.34	2.17	1.90
3	PJSC "Kharkiv Electrotechnical Plant" Ukrelectromash"	2.32	2.44	2.71	2.95	2.68	4.47
4	PJSC "Plant Yuzhcabel"	3.32	3.33	2.72	2.87	2.90	2.83
5	PJSC "Elektromashina"	2.92	2.50	2.09	1.73	1.96	2.11
6	PrJSC Institute "Ukrorhverstatinprom"	2.71	2.94	2.39	1.85	2.97	1.71
7	PJSC SPE "Teploavtomat"	1.45	2.01	1.70	1.29	1.46	1.19
8	PJSC "Kharkiv Bicycle Plant named after G.I. Petrovskii"	0.63	0.61	1.26	1.28	1.23	1.13
9	PJSC "Plant named after Frunze"	4.39	4.01	4.41	3.96	3.35	3.24
10	PJSC "Avtramat"	3.00	2.89	2.49	2.10	1.75	1.77
11	Kharkiv State Experimental Prosthetic and Orthopedic Enterprisev"	2.75	2.44	3.23	3.53	2.98	3.40
12	PJSC "Kharkiv Tractor Plant named after Ordzhonikidze"	3.53	2.99	3.83	3.18	3.45	2.89
13	PJSC "Turboatom"	3.74	3.45	3.29	3.17	3.06	3.40
14	PJSC "Kharkov Bearing Plant"	3.75	3.72	3.96	4.00	3.61	3.34
15	SC "110 Kharkov Automobile Repair Factory"	2.39	2.27	2.05	4.21	2.48	2.13
16	PJSC Plant "ELOKS"	4.69	4.81	4.51	3.77	3.89	3.27
17	PJSC "Harkivholodmash"	1.37	1.27	1.32	1.19	0.45	0.86
18	State Research-Production Enterprise "Kommunar"	2.95	2.74	3.02	1.75	2.68	2.41
19	Kharkiv State Aviation Production Enterprise	3.85	3.69	3.30	3.06	3.29	2.87
20	SC Kharkiv Transport Equipment Plant	1.48	1.47	0.69	2.22	1.63	0.95
21	PJSC "Volchanskiy Aggregate Plant"	2.67	2.79	2.81	2.42	3.02	2.96

Table 4 (cont.). Values of IOK of IBEs in dynamics by years

	Name of industrial business entity	Values of IOK by years					
		2007	2008	2009	2010	2011	2012
22	"Kharkiv Machine-Building Plant "FED"	3.13	3.99	3.74	3.80	2.88	2.85
23	SC Kharkov instrument Plant named after Shevchenko	4.14	3.61	3.65	3.01	2.67	2.55
24	SC "Plant named after Malyshev"	3.37	2.51	3.25	2.53	2.89	2.48
25	Limited Liability Company (LLC) "BRIG"	1.80	1.97	2.01	1.87	2.12	2.62
26	LLC "SDB Ukrelectromash"	2.09	1.92	1.96	1.85	3.00	2.65
27	PrJSC "HEMZ-IRES"	3.01	2.92	2.45	3.19	2.93	2.90
28	Private Firm "KONS"	1.24	1.41	1.44	1.56	1.81	1.96
29	PrJSC "Finprofile"	2.66	3.49	1.85	1.90	2.47	2.40
30	SC Izyum Instrument Factory	2.20	2.12	1.85	1.57	1.45	1.40
31	PJSC "SPE "Systema"	1.95	1.91	2.11	1.83	1.70	1.92
32	PrJSC "Harkivs'kiy zavod transportnogo ustatkuvannya"	1.68	1.92	1.58	1.19	1.69	1.47
33	Public Utility Company "Railway Carriage Repair Works"	0.94	1.24	1.19	1.04	0.43	0.34
34	LLC "Mashgidroprivod"	0.23	0.44	0.30	0.74	1.33	1.35

The calculated above values of IOK for various IBEs reflect the states of their SOK at certain times. The dynamics of values of these indices will demonstrate the changes of states of the SOK, i.e. its development.

The comparison of the dynamics of IOK values and the dynamics of the amount of investments of IBEs in three directions (science and innovation, vocational education and training of employees, information and communication technology), which correspond to the components of the given index is an important basis for making investment decisions.

4.4. Determination of the degree of impact of investments in each of the three directions on the dynamics of IOK of IBEs with the use of Method of principal components. Application of the method of principal components has allowed to reveal that the first principal component causes 57.8% of the dispersion of parameters x_1–x_7 (minimum value of factor load of given parameters was 0.8), the second principal component determines 22.5% of the dispersion of x_8–x_{11} (minimum value of factor load in this group of parameters amounted to 0.75) and the third principal component is determined 16.9% of the dispertion of parameter x_{12} (factor load with a value of 0.95).

Thus, the method of principal components was used to reveal three main factors influencing the dynamics of IOK.

Authors suggest to identify these factors as directions of investments in the development of the SOK, namely: investments in research and innovation (innovative and scientific direction), investments in information and communication technologies (information and communication direction), investments in vocational education and training of employees (professional and educational direction).

Conducted with using the software package STATISTICA 10.0 the calculations allow finding the principal components vector and rotation transformation matrix W such that $q = Aw$, where w – one of the columns of the matrix W. The properties of the vector of principal components are such that it is the most decorrelated with dispersion equal to eigenvalues (λ_i), and compares the input influences with the resulting characteristics with the largest informational content.

So, with the use of the method of principal components we can calculate the degrees of influence (v_i) of each of the directions of investment on the resulting vector q (i.e. IOK) by the formula: $v = W\lambda$. The values of these degrees of influence given in percentage for 34 IBEs of the Kharkiv and Kharkiv region are shown in Table 5.

In addition, it is appropriate to consider that with the significant amounts of investment in a particular direction, the degree of impact of these investments on the dynamics of IOK may be low. At the same time, with little investments in any of the directions the degree of its influence on the dynamics of these index can be high.

Table 5. The degrees of influence of investments in three directions on the development of the SOK

№	Name of industrial business entity	Degree of influence (%) on the development of SOK investments in directions:		
		innovative and scientific	professional and educational	information and communication
1	Public Joint Stock Company (PJSC) ''Kharkiv Machine Building Plant "Svet Shakhtyora"	31	36	32
2	State Company (SC) Plant Elektrovazhmash	34	30	36
3	PJSC "Kharkiv Electrotechnical Plant "Ukrelectromash"	35	36	29

Table 5 (cont.). The degrees of influence of investments in three directions on the development of the SOK

№	Name of industrial business entity	Degree of influence (%) on the development of SOK investments in directions:		
		innovative and scientific	professional and educational	information and communication
4	PJSC Plant "Yuzhcabel"	33	35	32
5	PJSC "Elektromashina"	36	33	31
6	PrJSC "Institute Ukrorhverstatinprom"	27	37	36
7	PJSC SPE "Teploavtomat"	30	36	34
8	PJSC "Kharkiv Bicycle Plant named after G.I.Petrovskii"	36	37	27
9	PJSC "Plant named after Frunze"	35	36	29
10	PJSC "Avtramat"	28	37	35
11	Kharkiv State Experimental Prosthetic and Orthopedic Enterprise	36	37	27
12	PJSC "Kharkiv Tractor Plant named after Ordzhonikidze"	34	35	31
13	PJSC "Turboatom"	35	37	28
14	PJSC "Kharkov Bearing Plant"	29	36	35
15	SC "110 Kharkov Automobile Repair Factory"	35	37	28
16	PJSC Plant "ELOKS"	56	9	35
17	PJSC "Harkivholodmash"	35	31	34
18	State Research-Production Enterprise "Kommunar"	32	35	33
19	Kharkiv State Aviation Production Enterprise	32	35	33
20	SC Kharkiv Transport Equipment Plant	31	36	33
21	PJSC "Volchanskiy Aggregate Plant"	34	31	35
22	"Kharkiv Machine-Building Plant "FED"	36	34	30
23	SC Kharkov instrument Plant named after Shevchenko	33	35	32
24	SC "Plant named after Malyshev"	34	36	30
25	Limited Liability Company (LLC) "BRIG"	33	32	35
26	LLC "SDB Ukrelectromash"	33	35	32
27	PrJSC "HEMZ-IRES"	34	36	30
28	Private Firm "KONS"	31	35	34
29	PrJSC "Finprofile"	32	35	33
30	SC Izyum Instrument Factory	36	34	30
31	PJSC "SPE "Systema"	28	37	35
32	PrJSC "Harkivs'kiy zavod transportnogo ustatkuvannya"	54	11	35
33	Public Utility Company "Railway Carriage Repair Works"	28	37	35
34	LLC "Mashgidroprivod"	31	35	34

4.5. Grouping of IBEs according to the degree of influence of each direction of investments on the dynamics of the IOK. The results, presented in Table 5, make it possible to prioritize investments in a particular direction for each of the IBEs and unite the latest into the groups. Thus, in 74% of cases the greatest influence on the development of the SOK is done by investments in vocational education and training of employees. In 18% of cases the priority is the impact of investments in research and innovation. And in 8% of cases investments in information and communication technologies to the greatest extent influence the development of the SOK.

The first group, characterized by the maximum impact of investments in vocational education and training on the development of the SOK includes the following IBEs: 1, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 18, 19, 20, 23, 24, 26, 27, 28, 29, 31, 33, 34. The second group, characterized by the maximum impact of investments in science and innovation on the development of the SOK includes the following IBEs: 5, 16, 17, 22, 30, 32. The third group, characterized by the maximum impact of investments in information and communication technologies on the development of the SOK includes the following IBEs: 2, 21, 25.

4.6. Elaboration of practical recommendations for each group of IBEs as for development of SOK on the basis of priority directions of investments. After the unification of IBEs into groups using a simple analytical method of grouping it is advisable to submit the obtained group in graphical form and develop recommendations for each of the groups about priority directions of investments in the development of the SOK. Figures 6, 7 and 8 give graphical comparison of the average values of IOK for 2007-2012 and the relative values of the amount of investments in science and innovation, vocational education and training of the employees and information and communication technologies for three groups of IBEs.

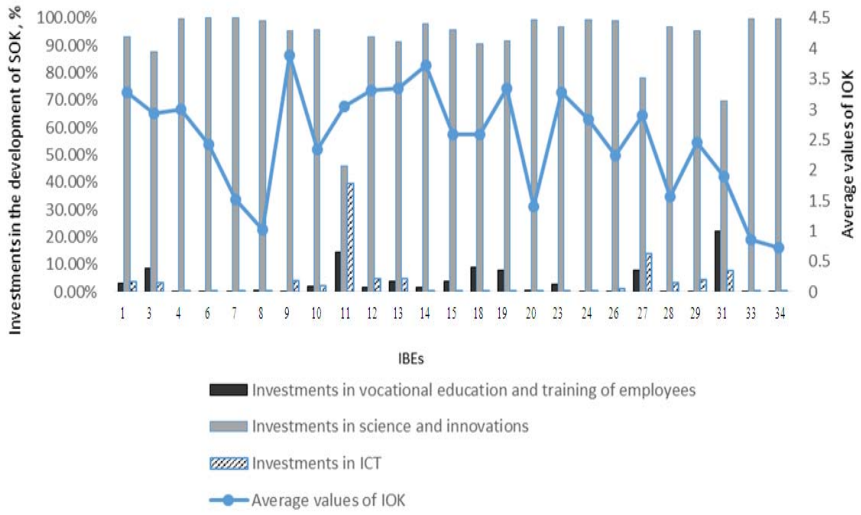


Fig. 6. The comparison of amounts of investments in the development of SOK and average values of IOK for 2007-2012 (for the group of IBEs with priority influence of investments in vocational education and training of the employees on the dynamics of IOK)

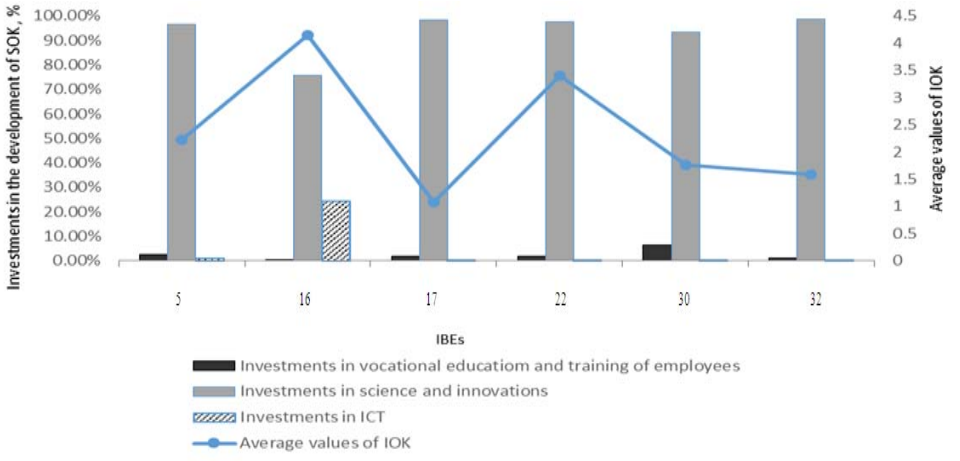


Fig. 7. The comparison of the amounts of investment in the development of SOK and average values of IOK for 2007-2012 (for the group of IBEs with priority influence of investments in science and innovation on the dynamics of IOK)

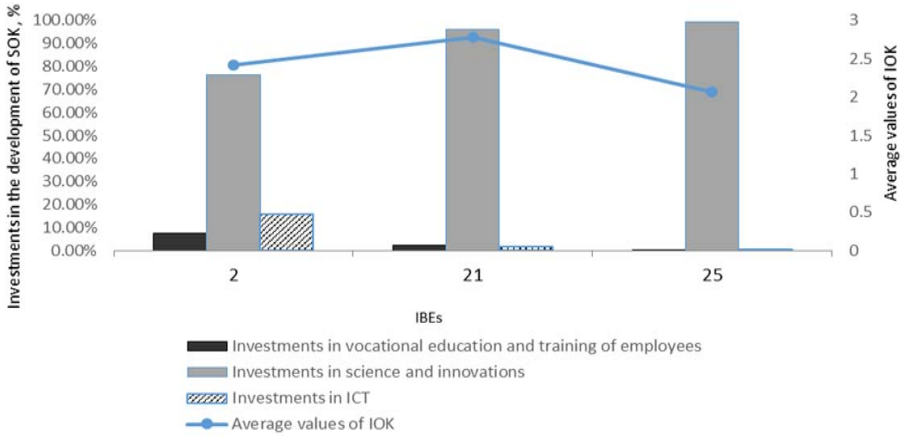


Fig. 8. The comparison of the amounts of investment in the development of SOK and average values of IOK for 2007-2012 (for the group of IBEs with priority influence of investment in ICT on the dynamics of IOK)

As we can see in the given figures, IOK values do not depend on the amount of investments in one or another direction of development of the SOK. Thus, the IBEs group where the greatest impact on the dynamics of IOK is done by investments in vocational education and training of employees, the amount of investment is small compared with the amount of investments in science and innovation.

However, in this group, the range of average values of IOK varies for 6 years from 0.73 to 3.89. At the same time, the amount of investments in science and innovation predominate in almost all IBEs that were studied. However, only in 5 of the 34 IBEs investments in science and innovation do the priority influence on the development of SOK. Three IBEs, that made a separate group, have the priority influence belonging to the investments in information and communication technologies.

Thus, from the given above it can be concluded that when choosing the investment directions in the development of the SOK it is advisable to take into account the priority of the influence of each of the directions. The latter, in turn, causes a list of practical recommendations as to the directions of investments in the development of the SOK for various groups of IBEs.

For the first group of IBEs, the most numerous one, it is recommended to increase investments in vocational education and training of employees. Revealing in more detailed way such investment direction as vocational education and training, it should be noted the need for channeling funds to: initial vocational training, retraining and advanced training; the diagnostics of formal and personal needs of employees in vocational training; monitoring the results of the professional activities of trained staff; determination of the correspondence of professional competencies of employees to organizational competencies; organization of group forms of vocational training, such as workshops, seminars and other forms that contribute not only to the rise of individual level of professional knowledge, but also active exchange of knowledge between employees; introduction of various forms of e-learning.

The following recommendations concern the second group of IBEs, where priority is the impact of investments in research and innovation in development of the SOK. Based on the list of the types of investments in science and innovation which are analyzed by the method of principal components, the main directions of investments, which play a crucial role in the development of the SOK of IBEs are: scientific and technical works performed on their own; research and development done by co-perfomers; internal and external research works; acquisition of other external knowledge; acquisition and protection of IPR and their use. The development of innovations based on applied research and development of the SOK are interrelated processes.

Information and communication technologies play a significant role in the development of the SOK. They create conditions for rapid and efficient exchange of knowledge, its spreading within the IBEs, its accumulation and storage on electronic and digital media. For IBEs of the third group, in which the maximum impact on the development of the SOK is done by investments in information and communication technologies, it is recommended to give priority to investment in: software (especially software for collective work, electronic document circulation systems, e-learning systems) and databases (corporate knowledge portals, technologies of intellectual analysis of data); repair services for computers; computer programming services (especially the development of decision making support systems and expert systems), consulting and related services, information services; purchase of computers and computer equipment. The above mentioned technologies and software products are important elements of the infrastructure that promote development of the SOK.

Conclusion

Summarizing the above mentioned several conclusions could be made as to the contribution of the presented paper into the development of economic science.

Firstly, the concepts of knowledge, organizational knowledge, intellectual capital and intangible (intellectual) assets are closely related. We consider knowledge as the most common concept, through which all mentioned above could be identified. The part of organizational knowledge which is identified and can be assessed using quantitative and qualitative indicators at the present time appears as intellectual capital. The part of organizational knowledge and intellectual capital, which provides IBEs with the income in the present and in future period forms intellectual assets. The directions of investment in organizational knowledge as well as intellectual capital and intellectual asssets are very similar and form the conditions for the development of the SOK. The main three investment directions were justified in the paper: innovative and scientific, professional and educational, information and communication.

Secondly, equally with revealing the main directions of investment into the development of SOK the identification of priority of these directions is of great importance. Such identification could be done on the basis of evaluation of the degree of influence of the investment in each direction on the development of SOK. Realization of stages of methodical approach which is elaborated and described in the paper allows making management decisions in conditions of limited resources. Given the fact that in Ukraine own funds of IBEs prevail in the structure of capital investments by the sources of financing, the recommendations developed for optimizing the use of these funds are of interest.

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Appendix

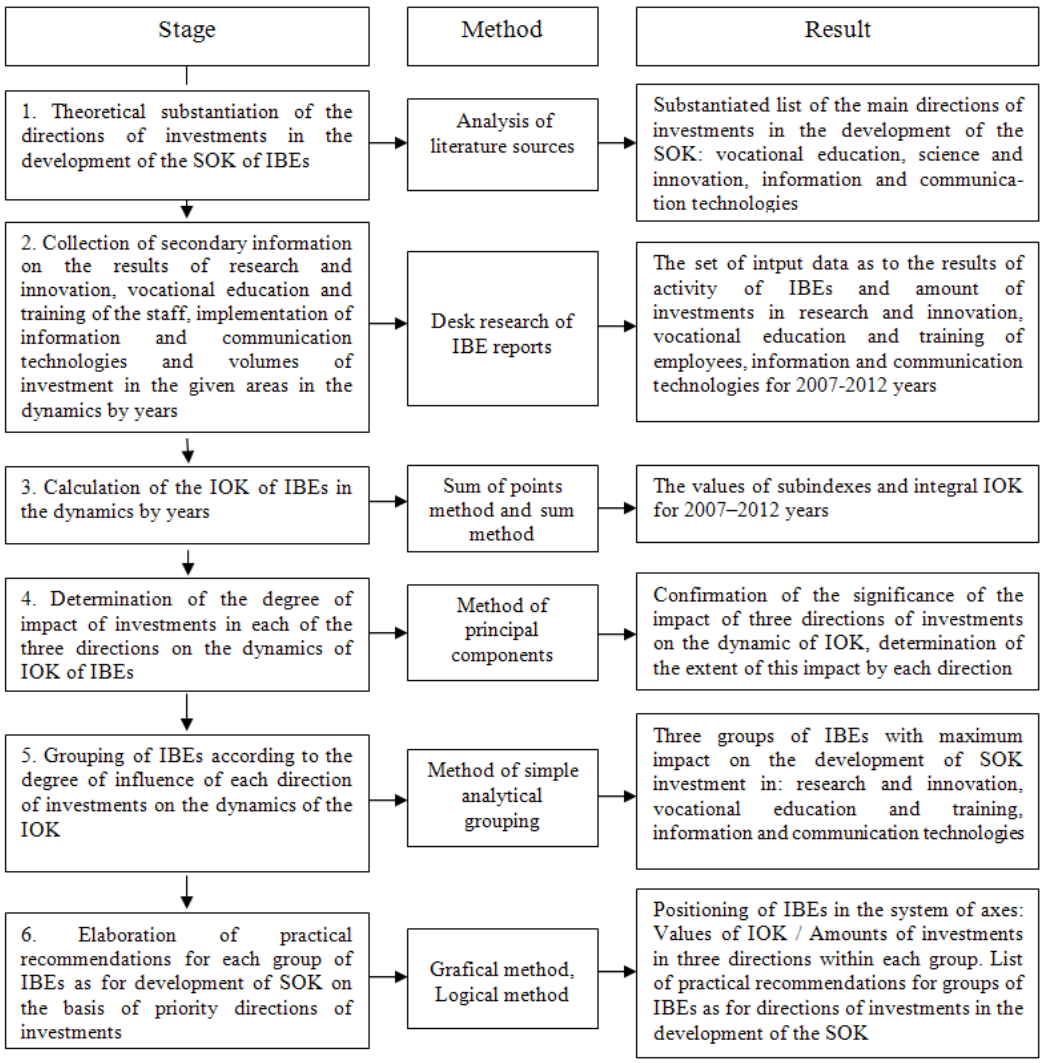

Fig. 2. Methodical approach to the choice of priority investment directions in the development of the SOK of IBEs