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INNOVATIVE INTELLECTUAL CAPITAL IN THE SYSTEM OF FACTORS OF TECHNICAL AND TECHNOLOGICAL DEVELOPMENT

Purpose. To define the essence and structure of the innovative intellectual capital and substantiate the quantitative indicators for its measurement.

Methodology. During the research, the following general scientific methods of scientific knowledge were applied: system analysis – to clarify the essence of innovative intellectual capital and its structure; a method of analysis and synthesis – to substantiate the components of the innovative intellectual capital index; economic and mathematical methods – to calculate the index value for certain countries of the world.

Findings. The essence of innovative intellectual capital is analyzed as a set of intangible assets of the country, which characterize the real and potential ability of human capital to use knowledge and information for innovative economic growth. Its three structural elements – human, structural, and network social capitals – are identified and characterized. A method of quantitative measurement of innovative intellectual capital is substantiated by representing the same-name index. The value of the innovative intellectual capital indices is calculated in terms of sampling of 26 world countries; its dynamics over three years is shown, and direct relationship between its level and the GDP indicator of the respective country is proven.

Originality. The essence of innovative intellectual capital and its structure is substantiated; the index of innovative intellectual capital is proposed, and its value is calculated for the selected world countries; the direct dependence between its level and the GDP indicator of the respective country is proved.

Practical value. The proposed index of innovative intellectual capital makes it possible to select more effectively the directions of the national economic policy in the field of technical and technological development.

Keywords: *technical and technological system, technical and technological development, innovations, index of innovative intellectual capital*

Introduction. The *21st* century realities show that an integral component of sustainable development of any country as well as its successful positioning in the world economy is the need for a technical and technological base of economic activity to meet the requirements of modern Fourth Industrial Revolution. The processes characterizing the development of this industrial revolution reflect at least three important groups of technologies; the level of their mastering in the national economic practice is being determined today and will be determined in the long-term perspective of the country's position in the global economic space. It can be argued that the potential to create their own scientific and research developments, current effective system for wide implementation of innovations in the field of information and digital, biotechnologies and nanotechnologies in economic practice forms the real and potential ability of the world countries to take an active part in the processes of Industry 4.0 in the coming decades.

Nowadays, there is a significant differentiation of similar technological potential in the world countries while forming technical and technological inequality of the world economy. First, there is a relatively small group of technological countries-leaders that have concentrated a significant part of scientific and technical achievements and are implementing them actively in all spheres of social life, thus providing significant long-term competitive advantages in the international markets. Secondly, a large group of countries has been formed, which are trying to catch up with the leaders by supporting the innovative principles of the development of national economies and wide involvement of foreign technological innovations. Finally, there are outsider countries that today are unable to ensure technological modernization of their national economic systems, preserving their socioeconomic and technological backwardness.

As modern practice shows, one of the key reasons for the existing technical and technological inequality of the world economy is different ability of national economic systems for innovative development based on the use of main resource of a post-industrial society – scientific knowledge. The production of new knowledge, ensuring the continuity of invention processes, transformation of inventions into innovations and their distribution to all social spheres are mandatory components of the post-industrial stage of human development and a characteristic of a modern model of the knowledge-based economy. Such an economy is based, first of all, on the intellectual capital of society, effective use of which contributes to sustainable economic growth and increasing level of public welfare. It can be stated that the quality of intellectual capital is one of the determining indicators of the social development level, which will reflect the development stage of some country and its place in the world economy. That is why analysis of the current state of the country's intellectual capital is important from a theoretical and practical viewpoint to understand the current and forecast technical and technological levels of society, its opportunities to move on the basis of innovative growth.

Literature review. It is believed that J. K. Galbraith was the first to consider the problem of intellectual capital from a scientific point of view. Using the term "intellectual activity" and considering the outlines of new industrial society, he emphasized that power in such a society belongs to people who possess various technical knowledge and skills – technocrats (Galbraith, 1967). At the same time, the primacy of the analysis of the intellectual capital essence in the literal sense of this term is attributed to L. Edvinsson and M. Malone, who, com-

paring the economic structure with a standing tree, argued that intellectual capital represents the roots of an organization, the hidden conditions of its development (Edvinsson, Malone, 1997). Modern interpretation of this phenomenon was introduced by T. Stewart, who saw the essence of the organization's intellectual capital as its sum of knowledge, information, intellectual property, and experience that can be used to create wealth and, therefore, ensure the organization's competitiveness (Stewart, 1997).

It is in this context that intellectual capital is considered by modern researchers, who reduce this phenomenon to the amount of knowledge of company employees, the use of which (through a certain organization of combining individual knowledge into a system) can increase the results of this company and ensure the creation of new value. Thus, for example, the well-known national researcher of the labour relation problems O. Grishnova defines intellectual capital as "... the intellectual abilities of people in combination with the material and non-material means created by them, which are used in the process of intellectual activity by a person individually or within a certain team and increase the efficiency of work and income" [1].

It should be noted that during the first decades, study on the essence of intellectual capital was reduced exclusively to the level of a separate enterprise (organization). It was at the enterprise level that the first attempts at its quantitative measurement were launched, the most famous example of which is the Scandia Navigator model proposed by L. Edvinsson (Edvinsson, Malone, 1997). Subsequently, the principles of the evaluation methodology, initiated in this model, were transferred to the level of national economy to measure the national intellectual capital. In our opinion, the most important achievements in this direction are represented by the study on the intellectual capital of Israel [2] as well as assessment of the intellectual capital of 40 countries of the world, conducted by L. Edvinsson and K. Lin [3]. Along with that, currently there is no unanimity in economic science both in the interpretation of the essence of this phenomenon and its structural components and in relation to the methodological principles of assessing the quantitative parameters of intellectual capital at the micro- and macro-levels. Considering this, the problem will remain relevant both for economic theory and economic practice.

Purpose. The purpose of the research is to identify the essence and structure of innovative intellectual capital and substantiate quantitative indicators of its measurement.

Results. As it has been already emphasized, the objective reality of a current stage of human development is a significant technical and technological inequality between the world countries, which determines different technical and technological as well as economic competitiveness of the national economic systems in the global economy. The countries lagging behind in technological rivalry (including Ukraine) need the development of a science-based strategy for their own technological progress, which would form conditions for technological modernization of national economies based on the innovative principles.

We believe that from a theoretical viewpoint, in order to understand the essence of technological development, it is necessary to use a systematic approach, which involves clarifying the essence of a technical and technological system. Its structural elements include "... facilities, as a set of various artificial material means of human activity, technology, as a way of transforming matter, energy, information in the process of human activity, and, in fact, the person himself, who possesses certain professional abilities regarding the use of facilities and technology while producing life goods and services. These three structural elements of a technical and technological system are compatible, their interaction within the framework of a defined production and economic activity is characterized by the stability of connections and has integrative properties, since each individual element without the other loses its system qualities, and finally, the system has its own organization, which determines its stability in relation to the influence of external factors" [4]. The compatibility and sustainability of this system, i. e. systemic connection between facilities, technology and people are ensured by another functional element – routines, as the normal and predictable patterns of human behaviour. Thus, a technical and technological system is a set of interconnected routine processes and actions that arise from the interaction of facilities, technology, and people; the development of this system is a change in their characteristics under the influence of internal (endogenous) and external (exogenous) factors [4].

Focusing in this analysis on internal factors of the development of a technical and technological system, we emphasize that its viability and improvement are largely determined by the correspondence and non-contradiction of its structural elements. In the history of economic development, there are many examples when the level of available intellectual capital did not correspond to the advanced models of the equipment and technology involved, which made their productive use impossible. The *21st* century practice also proves that large-scale technical and technological modernization without national intellectual capital corresponding to modern technologies is doomed to failure. Therefore, without its adequate improvement, it is impossible to increase the overall technical and technological competitiveness as a set of certain characteristics that form the country's competitive advantages in the world economy.

From the theoretical point of view, most researchers consider intellectual capital as a certain set of knowledge and skills, i. e. intangible assets of either a separate organization or the country as a whole. However, its structural content differs significantly depending on the methodology chosen by scientists for their own research. With regard to the activity of a separate organization, the point of view of T. Stewart is the most widespread in the economic literature; he proposed to distinguish three key components in the intellectual capital of the organization – human, organizational, and consumer (client) capitals. According to the researcher, a human capital is characterized by those features of the company employees that allow them to perform certain production functions and define them as individuals. It is about their knowledge, practical skills, ability to creativity, intellectual activity as well as dominant moral values. An organizational capital characterizes the company functioning as a whole and, according to its structure, is formed from patents, license agreements, technologies, management systems, hardware and software, organizational structure and culture. In turn, a consumer (customer) capital unites a system of relations developed in the organization with counterparties, and, first of all, with consumers (Stewart, 1997). This structuring of intellectual capital emphasizes the need to maintain certain balance between its components.

In L. Edvinsson's Scandia Navigator model, which has also become quite widespread in the economic science, an intellectual capital is divided into the human and structural ones. In turn, the latter is represented by means of four more components – organizational, client, innovation, and process capitals (Edvinsson, Malone, 1997).

Along with this, interpretation of the structure of this phenomenon, represented by Israeli scientists in the national report based on the results of analysis of the country's intellectual capital, has become widespread in the economic field. The authors widened the structural capital composition, including such components as process and market capitals as well as the renewal and development ones. The process capital included information systems, hardware, software, databases, laboratories, national infrastructure, and focus on management. The market capital in the report refers to those general assets that are manifested in the nation's relations with the in-

ternational market (loyalty and satisfaction from strategic customers, existing brands, etc.). Under the capital of renewal and development, those capabilities of the state and real investments are considered, which are aimed at future economic growth and increasing competitiveness in the relevant markets. Renewal and development assets include investments in research and development, patents, trademarks, start-up companies, etc. [2].

Grishnova O. singles out human (cognitive), structural (organizational), and consumer capitals in the intellectual capital structure. Contrary to the traditional approaches to the content of consumer capital, she proposes for its composition to include the information about economic counterparties and the history of relations with them [1].

The represented definitions of intellectual capital as well as singling out its structural components show the lack of unanimity among the scientists in the sphere of economy regarding the essence of this phenomenon and its main characteristics. All this makes it impossible to obtain objective results characterizing the technical and technological development of various world countries. As a number of studies point out, the factors of socioeconomic development, one of which is actually the technical and technological component, can be analyzed only relying on a methodology based on principles shared (with relative agreement) by those scientists who carry out scientific research in this area. Consequently, we have to decide, firstly, on the level of analysis and, secondly, on the methodology of its implementation.

Speaking about the technical and technological development of the world countries, attention should be focused on the national level; therefore, a concept of national intellectual capital should be used. In our opinion, it should be considered, first of all, as a set of intangible assets of the country, which reproduce the real and potential ability of human capital to use knowledge and information for innovative economic growth. Since in modern conditions such extended reproduction and anticipatory development of the country is possible only in terms of innovative components, we consider that it is appropriate to talk about the innovative intellectual capital of society. Structurally, it should include three components – human, structural, and network social capitals.

This structural construction of the innovative intellectual capital is determined by a specific functional role of each individual component in ensuring the socioeconomic development of society on the innovative basis. The first component is human capital. It characterizes the totality of knowledge, skills, and health acquired by people during their lifetime, which form their ability for social activity. It is this component that forms the conditions for the very possibility of creating innovations.

The second component – structural capital – characterizes the existing infrastructure for the formation, implementation, and development of national human capital in a particular society, or, in other words, the organizational and institutional system of extended reproduction of knowledge and skills of the society members. Innovative activity is impossible without this component as it is impossible to form the necessary level of human capital without knowledge-producing institutes and their assimilation by economic subjects.

Finally, a network social capital is a special intangible asset of society, represented in the form of interpersonal communication of formal and informal nature, relationships created purposefully in the form of compatible projects, alliances, clusters etc. while network structure functioning. As is known, people can exchange knowledge and multiply it only by interacting with each other through different types of social networks. Therefore, human, structural, and network social capitals are functionally interconnected and mutually conditioned.

In addition to determining the structural components, it is important to perform its quantitative measurement. Having indicators that show the development level of each individual component and their combination, we can form a general idea about the level of technical and technological development of each specific country as well as compare them.

To calculate the level of innovative intellectual capital, we suggest using the index method, which helps you determine the influence of individual factors on this indicator in dynamics. Obviously, the composition of these factors, or sub-indices, should reflect the essential characteristics of the key components of our index, i. e. human, structural, and network social capitals.

When developing a methodology for quantitative assessment of any economic processes, we must proceed from systematicity – to ground our studies on the available statistical bases of international organizations that assess systematically various indicators of socioeconomic development. Thus, we get the opportunity to form our approaches on the basis of uniform methodological principles, to analyze and compare the world countries on a significant array of data concerning their economic and institutional development [5].

Relying on such prerequisites, we consider it necessary to use quantitative characteristics of the development of education and higher education from the annual reports of the Global Innovation Index [6–8], and the indicators of the nation's health from the corresponding reports of the World Bank [9] when measuring human capital. As for structural capital, we believe that the most appropriate quantitative indicators for its measurement are provided by the Global Innovation Index of the World Intellectual Property Organization (WIPO). As for network social capital, its value can be obtained by getting the required information from the profiles of countries in the Global Innovation Index as well as from the reports of the World Economic Forum, whose results are the basis for the Global Competitiveness Report [10–12]. In general, a composition of the index of innovative intellectual capital and its components is represented in Table 1.

The numerical values of the proposed sub-indices were used to calculate the indices of innovative intellectual capital of 26 countries of the world for the period of 2018–2020. This set of countries included the ones with different levels of economic development, i. e. by GDP per capita. Another criterion for the selection of these countries was the level of their innovativeness according to the corresponding rating of the global innovation index. Finally, in order to find out the place of Ukraine in technological development among the countries that have gone through the transformation of their economies from a centrally-planned to a market-based one, some countries of the former USSR and Eastern Europe were included in the sampling.

In terms of the study, three quantitative indicators, attaining the form of sub-indices, will be the components of the in-

Table 1

Composition of the components of the innovative intellectual capital index

Subindex	Subindex components	Structural components
Human capital (*HC)*	Education (*HEd*)	Expenditure on education, % GDP Government funding/pupil, secondary, % GDP/cap School life expectancy, years. PISA scales in reading, maths & science Pupil-teacher ratio, secondary
	Tertiary Education (*HHE*)	Tertiary enrolment, % gross Graduates in science & engineering, % Tertiary inbound mobility, %
	Health (*HHl*)	Life expectancy at birth, total (years)

End of Table 1

Subindex	Subindex components	Structural components
Structural capital (*SC)*	Knowledge & technology outputs (*SRk)*	Patents by origin/bn PPP$ GDP PCT patents by origin/bn PPP$ GDP Utility models by origin/bn PPP$ GDP Scientific & technical articles/bn PPP$ GDP Citable documents H index Growth rate of PPP$ GDP/ worker, % New businesses/th pop. 15–64 Computer software spending, % GDP ISO 9001 quality certificates/bn PPP$ GDP High- & medium-high-tech manufactures Intellectual property receipts, % total trade High-tech net exports, % total trade ICT services exports, % total trade FDI net outflows, % GDP
	Intangible assets (*SIA)*	Trademarks by origin/bn PPP$ GDP Industrial designs by origin/bn PPP$ GDP ICTs & business model creation ICTs & organizational model creation
	Research & development (*SRD)*	Researchers, FTE/mn pop. Gross expenditure on R&D, % GDP Global R&D companies, top 3, mn US$ QS university ranking, average score top 3
	Knowledge workers (*SWk)*	Knowledge-intensive employment, % Firms offering formal training, % firms GERD performed by business, % GDP GERD financed by business, % Females employed w/advanced degrees, %
	Knowledge absorption (*SAk*)	Intellectual property payments, % total trade High-tech net imports, % total trade ICT services imports, % total trade FDI net inflows, % GDP Research talent, % in business enterprise
Network social capital (*NC)*	University-industry R&D collaboration (*NCu*)	University-industry R&D collaboration
	Information & communication technologies (*NIK*)	ICT access ICT use Government's online service E-participation
	Social capital (*NSC)*	Social capital

novative intellectual capital index. Each of them reflects certain elements of innovative intellectual capital: human, structural, and network social capitals. These three components combine a certain number of components (sub-indicators): human capital – three; structural capital – five; network capital – three. It is characteristic that the numerical values of all sub-indicators vary from 0 to 100, and the direction of their influence is defined as stimulating, i. e. the larger the numerical value of the sub-indicator is, the higher the qualitative characteristics of the index component of innovative intellectual capital is, and therefore the higher the indexed value in general is.

Since all eleven sub-indicators, application of which helped construct the index of innovative intellectual capital, are characterized by the same dimension and the same stimulating effect, the averaging method with a geometric formula was used for their generalized assessment during the reporting period. The graphic representation of the integral evaluation of the components of the proposed index (*IIIC*) is shown in Fig. 1.

The selected group of countries according to the level of the intellectual capital index is uneven; it means that it should be divided into appropriate clusters. The results of the hierarchical cluster analysis materials are the basis for making a decision on the separation of three clusters. Cluster I is a low level (combines the outsider countries where the values of integral evaluations of indicators are minimal). Cluster II is a medium level (combines the countries with the average values of integral evaluations of indicators). Cluster III is a high level (combines the leading countries with the highest values of integral evaluations of indicators).

According to the results of each grouping of indicators, the clusters contain a different number of countries. It is characteristic that cluster I turned out to be minimal in size and includes only three countries: Uganda, Zimbabwe, and Bangladesh. It is among these countries that in 2018–2020 the minimum values of the human and structural capital components are observed. The number of countries in cluster II varies from 11 to 9; and cluster III contains from 10 to 12 countries. Based on 12-dimensional clustering, 11 countries are included in the group of leaders: Switzerland, Sweden, the USA, Great Britain, the Republic of Korea, the Netherlands, Finland, Singapore, Germany, France, and Japan.

To analyse the structure of the countries' totality according to the value of the innovative intellectual capital index in dynamics, a ranking tool was applied. Its application made it possible to state that in 2020, compared to previous years, the position of the innovative intellectual capital index did not improve in only eight countries, two of which (Great Britain and the USA) belong to the group of leaders according to the clustering results. However, since the ranks of these countries in 2020 are not lower than the number of cluster III, this change cannot be a marker of threats to Great Britain and the USA regarding the loss of innovative intellectual capital. Instead, lack of positive dynamics of the value of innovative intellectual capital index in 2020 for all countries included in cluster I, in the context of extremely high rates of index changes, serves as a marker of entrenched problems with innovative intellectual capital in Uganda, Zimbabwe, and Bangladesh.

The obtained results suggest that the countries with a high *IIIC* level tend to increase it further to maintain high rates of economic growth. In order to test the hypothesis that there is a connection between the values of innovative intellectual capital and the parameters of economic development, the influence of this index on the macroeconomic results of the national economy was investigated. GDP per capita in USD was selected as an indicator of economic development according to PPP PG (GDP_{pc}), and a value of the innovative intellectual capital index (*IIIC*) acted as a factor (predictor). The regression equation is developed on the basis of the values of the variables $IIIC_{18\text{-}20}$ and $GDP_{pc18\text{-}20}$ averaged over the period under study. This selection is explained by the requirement of normality of variables distribution when using parametric methods of a link analysis.

Forms of a regression equation represented in Fig. 2 approximate qualitatively direct linear dependence $GDP_{pc18\text{-}20}$ on

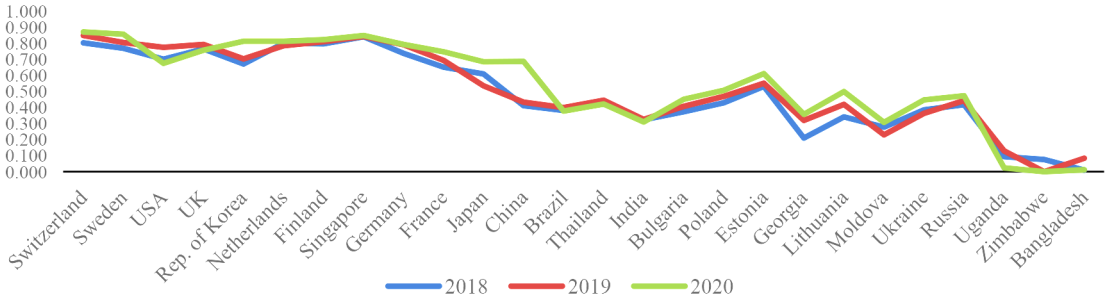
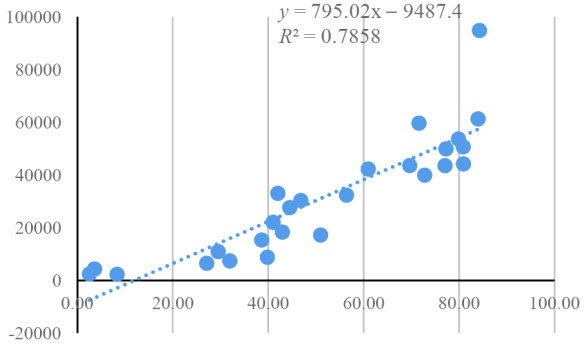


Fig. 1. Dynamics of the index of innovative intellectual capital in certain world countries for 2018–2020



Multiple R	0.8864761
R Square	0.78583987
Adjusted R Square	0.77691653
Standard Error	10697.5102
Observations	26
ANOVA Significance F	1.6752E–09

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	–9487.4	4861.1	–2.0	0.063
X Variable1	795.0	84.7	9.4	0.000

Fig. 2. Regression equation of dependence $GDP_{pc18\text{-}20}$ on $IIIC_{18\text{-}20}$ and its statistic characteristics

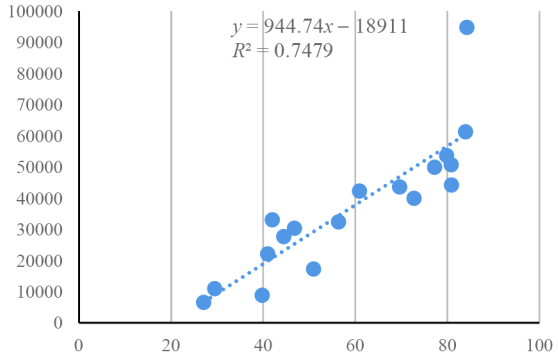
$IIIC_{18\text{-}20}$ by almost 80 %. A regression coefficient turned to be statistically significant *P-value* = 1.67518E–09. The model adequacy is also confirmed by value *Significance F*, being much lower than a critical level ($\alpha = 0.05$), which along with high value of determination coefficient ($R^2 = 0.7858$) and results of the rest analysis makes it possible to recognize the model adequacy. Thus, the hypothesis concerning the direct relationship between innovative intellectual capital and GDP per capita in USD according to PPP PG is verified.

Fig. 3 considers separately the results of modelling the dependence of GDP per capita on the innovative intellectual capital index for the period of 2018–2020 for the countries characterized by positive dynamics of this index ($D(IIIC) = 1$). For these countries, the regression equation coefficient (944.7) exceeds the value obtained for the entire set of countries (795.0).

Interpreting the results of modelling for the period 2018–2020, we can conclude that along with the increase in the innovative intellectual capital index by 1 %, the value of GDP per capita in USD according to PPP increased by more than USD 795 in the totality of the countries under consideration. A theoretical coefficient of elasticity calculated on the basis of a linear regression equation, helps conclude that with an increase in *IIIC* by 1 %, GDP_{pc} increased by 1.3 %. In the countries where positive dynamics of the innovative intellectual capital was observed, an increase in *IIIC* by 1 percentage point led to an increase in GDP_{pc} by more than USD 944, and each percent increase in *IIIC* resulted in GDP_{pc} increase by 1.5 %.

Therefore, the countries with high qualitative characteristics of innovative intellectual capital demonstrated their positive growth rates of *IIIC* more often compared to other countries. A close direct connection is observed between the innovative intellectual capital of the countries and their economic development, which is expressed by the value of GDP per capita in USD according to PPP PG. A degree of influence of the qualitative characteristics of the innovative intellectual capital on economic development is higher in those countries that demonstrate positive dynamics of the innovative intellectual capital.

Conclusion. Technological inequality is the objective law of the current stage of the world economy development. That makes the countries lagging behind in technological rivalry develop a scientifically based strategy for technological modernization based on innovative principles. Such moderniza-



Multiple R	0.86464
R Square	0.74794
Adjusted R Square	0.73219
Standard Error	11133.2
Observations	18
ANOVA Significance F	3.633E–06

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	–18911.4	8555.5	–2.2	0.042
X Variable 1	944.7	137.1	6.9	0.000

Fig. 3. Regression equation of dependence $GDP_{pc18\text{-}20}$ on $IIIC_{18\text{-}20}$ and its statistic characteristics for a group of countries with positive dynamics of innovative intellectual capital (D(IIIC) = 1)

tion requires the quality of national intellectual capital to match the level of applied equipment and technology. National innovative intellectual capital is a set of intangible assets of the country, which characterize the real and potential ability of human capital to use knowledge and information for innovative economic growth. Structurally, it includes three components: human capital, characterizing the totality of knowledge, skills, and health acquired by people during their lifetime, which form their ability to social activity; structural capital, representing the infrastructure for the formation, implementation, and development of the national human capital; and network social capital, being a special intangible asset of society in the form of interpersonal communication of both formal and informal nature, relationships purposefully created in the form of compatible projects, alliances, clusters etc. during the network structure functioning.

To calculate a level of the innovative intellectual capital development, a same-name index was proposed. The index was built on the basis of 11 sub-indices reflecting quantitatively the essential characteristics of human, structural, and network social capitals. The numerical values of the proposed sub-indices were used to calculate the innovative intellectual capital indices of 26 world countries, selected according to the criteria of the economic development level and the level of their innovativeness for the period of 2018–2020. In this set of countries, three clusters with low, medium, and high values of integral evaluations of the innovative intellectual capital indices were distinguished; in this context, the countries with its high level demonstrated positive dynamics to maintain high rates of economic growth. A regression analysis confirmed the direct relationship between the values of innovative intellectual capital and the value of GDP per capita. The regression results also demonstrate that the influence of the characteristics of innovative intellectual capital on the economic development is higher in those countries that are peculiar for their positive dynamics of innovative intellectual capital.

References.

1. Grishnova, O.A. (2014). Human, intellectual and social capital of Ukraine: essence, relationship, evaluation, directions of development. *Social and labor relations: theory and practice, 1*, 34-40.

2. *Israels Intellectual Capital Report* (n.d.). Retrieved from https://innovationisrael.org.il/sites/default/files/The%20Intellectual%20Capital%20of%20the%20State%20of%20Israel.pdf.

3. Lin, C.Y-Y., & Edvinsson, L. (2011). *National Intellectual Capital: A Comparison of 40 Countries*. New York: Springe. https://doi.org/10.1108/14691930810913140.

4. Dubey, Yu.V. (2021). Technical and technological development: essence and trends in the conditions of globalization. *Economic Bulletin of Dnipro University of Technology*, *1*(73), 97-105. https://doi.org/10.33271/ebdut/73.097.

5. Smiesova, V., Pylypenko, A., Ivanova, M., & Karpenko, R. (2019). Economic and Institutional Conditions for Implementation of Economic Interests in the Countries of the World. *Montenegrin Journal of Economics, 15*(4), 75-86. https://doi.org/10.14254/1800-5845/2019.15-4.6.

6. *Global Innovation Index 2018. Energizing the World with Innovation* (2018). Retrieved from https://www.wipo.int/publications/en/details.jsp?id=4330.

7. *Global Innovation Index 2019. Creating Healthy Lives – The Future of Medical Innovation* (2019). Retrieved from https://www.wipo.int/publications/en/details.jsp?id=4434.

8. *Global Innovation Index 2020. Who Will Finance Innovation*? (2020). Retrieved from https://www.wipo.int/publications/ru/details.jsp?id=4514.

9. *Life expectancy at birth, total (years)* (2020). Retrieved from https://data.worldbank.org/indicator/SP.DYN.LE00.IN.

10. *The Global Competitiveness Report 2018* (2018). Retrieved from https://www3.weforum.org/docs/GCR2018/05FullReport/TheGlobalCompetitivenessReport2018.pdf.

11. *The Global Competitiveness Report 2019* (2019). Retrieved from https://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf.

12. *The Sustainable Competitiveness Report, 10th edition* (n.d.). Retrieved from https://solability.com/the-global-sustainable-competitiveness-index/the-index/social-capital/.

Інноваційний інтелектуальний капітал у системі чинників техніко-технологічного розвитку

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Мета. З'ясування сутності та структури інноваційного інтелектуального капіталу, обґрунтування кількісних індикаторів його вимірювання.

Методика. У ході дослідження були використані такі загальнонаукові методи наукового пізнання, як: системний аналіз – для з'ясування сутності інноваційного інтелектуального капіталу та його структури; метод аналізу й синтезу – для обґрунтування складових індексу інноваційного інтелектуального капіталу; економіко-математичні методи – для розрахунку значення даного індексу для окремих країн світу.

Результати. Проаналізована сутність інноваційного інтелектуального капіталу як сукупності нематеріальних активів країни, що характеризують реальну й потенційну здатність людського капіталу використовувати знання та інформацію для інноваційного економічного зростання. Виділені та охарактеризовані три його структурні елементи – людський, структурний і мережевий соціальний капітали. Обґрунтована методика кількісного вимірювання інноваційного інтелектуального капіталу за рахунок представлення однойменного індексу. На вибірці із 26 країн світу розраховане значення індексів інноваційного інтелектуального капіталу, показана його динаміка за три роки й доведена пряма залежність між його рівнем і показником ВВП відповідної країни.

Наукова новизна. Обґрунтована сутність інноваційного інтелектуального капіталу та його структура, запропоновано індекс інноваційного інтелектуального капіталу й розраховане його значення для окремих країн світу, доведена пряма залежність між його рівнем і показником ВВП відповідної країни.

Практична значимість. Запропонований індекс інноваційного інтелектуального капіталу дозволяє більш ефективно обирати напрями економічної політики держави у сфері техніко-технологічного розвитку.

Ключові слова: *техніко-технологічна система, техніко-технологічний розвиток, інновації, індекс інноваційного інтелектуального капіталу*

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