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**Article**

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# Methodological Aspects of Estimation of ICT-Based Economic Development

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***Abstract.*** *This article is dedicated to methodological aspects of estimation of ICT-based economic development. İnformation economy development and formation trends in leading foreign countries are analyzed. A comparative analysis of the strategies and trends that form the information economy of Azerbaijan with the developed countries is carried out. In the article comparative analysis of different indicator systems in accordance with formation and assessment of development level of information and knowledge economy is given. Some recommendations about the elimination of problems existing in this field are given. A methodic for calculating Gross Domestic Product (GDP) which forms at the expense of information and knowledge is suggested. A composite index and forming indices, subindices, and indicators system of information and knowledge economy are developed.*

***Keywords:*** *ICT-based economy; information and knowledge economy; indicators system; economic indicators; composite index; subindices; ICT, and e-services; high-tech park.*

## Introduction

Information and knowledge economy (IKE) formed as a result of it reveals itself as the next stage of economic development. In recent years, developed countries make the rapid transition into the new type of economy based on modern ICT technologies, information, and knowledge. Transition into the new economy is characterized with changing in the nature of traditional productions areas, shifting the information into the major production resource, and economic system to be the main development factor. The economic health, the level of economic development of a country is increasingly tied to the sustainability of information economy. And the information economy is characterized with changing in the nature of traditional productions areas, shifting the information into the major production resource, and economic system to be the main development factor. In recent years developed countries invested heavily in the sphere of information and communications technology (ICT). This process is to maintain their competitiveness in the global information economy. The emerging of the economy is pursuing through enhancement and promotion of their ICT.

The processes of digitization have a significant impact on the globalization of economic relations and the development of a new economy.

Technological development and innovations act as a long-term driving force of economic increase. Information and knowledge become the main development factor of society. The fields of production of knowledge and information products play an extremely important role in the development and competitiveness of the countries going from the industrial development stage to post-industrial stage. In other words, nowadays development of the countries highly depends on the development of science-intensive fields, including technology innovations.

The factors of global character have influenced the processes going on in all fields of national economy. The development concept "Azerbaijan 2020 - a look into the future" (Azerbaijan Government, 2015), as well as the Strategic Roadmaps of the National Economy (Center for Analysis of Economic Reforms and Communication, 2017) indicates the main directions of the country's development.

In order to transform the economy of the country into the economy based on efficiency, a transition to the stage characterized by the advantage of innovations must be provided. At the same time, the purposeful improvement of the structure of the economy is one of the main issues. In the period of formation of the Global information society (IS), accepted as the development ideology of the third millennium information, technology and knowledge have become the competitiveness sustainability factors of the most world countries. Serious need for analytical analysis and assessment of the level of innovative economy developing as a result of their wide implementation appeared. For the implementation of quantitative and qualitative evaluation of the application of high technologies, including ICT in different sectors some indicators system was developed by international organizations. They have some methodological defects and application difficulties. That is why for objective assessment of the development level of information economy in the countries there is a need for the development of indicators system in different levels. Creation of calculating methods of these indicators and development of suggestions and recommendations about eliminations of the existing issues in this sector is also one of the important problems.

A strong linkage exists between the production and use of ICT and the development of a sustainable information economy. It contributes to economic growth of emerging economies. A sustainable information economy depends upon the production of ICT goods and services and the diffusion and use of ICT in other sectors.

At present, a new economy is being formed in Azerbaijan, which is based on information, knowledge, and modern technologies.

## Research design and methodology

In this research work, development level of the economy on the basis of ICT is taken. The components, structure, existing problems, estimation indicators of the new information economy, structure, formation and development tendencies of information economy in foreign countries are revealed. Multilevel indicators have been proposed for the assessment of the level of economic development. Formation and development tendencies of information economy in leading foreign countries are taken into consideration. Systematic analysis, the theory of algorithms, correlation and regression analysis are used to investigate the considered issues. Additionally, the systematic approach, the theory of information, and the theory of fuzzy sets have also been applied to the process. Multi-criterion optimization methods, economic-mathematical modeling, and econometric analysis methods are used in the explanation of the analysis and evaluation methodology, in the calculation of indicators and indices. Mathematical statistics, correlation and regression methods are used in the conducting of economic analysis. Official statistical data and empirical assessments are used in the research process. Computer software packages and analytical statistical methods are applied in the obtained results.

## The stage of the formation of ICT-based economic development

Analysis of the economic characteristics of the post-industrial era shows that this era can be called information economy era as well. The information economy is the comparatively newly formed term. Those close to the meaning are definitions like "post" and "neo-industrial society", "knowledge economy", "new economy" and so on. In recent years "new economy" which is used in scientific literature, is also used as a synonym of the development stage of the post-industrial economy. Different researchers attempted to explore different aspects of this stage of the economy (Alguliyev, Aliyev, & Abbasova, 2017; Fathollahi, Momeni, Elahi, & Sajjad Najafi, 2015). There are many fields of "new economy" relating to different spheres of activity. Its characteristic features are: more investment contribution of intellectual human capital in comparison with the material elements; high specification and uniqueness of intangible assets; relatively much innovation composition in the activities of companies; the pace of innovation of production on average is higher than in real economy; updating of production technologies or products and services is continuous. "New economy" as a term is accepted as a synonym of the post-industrial stage of development. The successful formation of the information society, first of all, depends on formation and development of a new economy based on information and knowledge, modern technologies and innovations, and also information economy (Alguliyev et al., 2017). Information economy – is economy where a big part of the gross domestic product (GDP) is provided in production, processing, maintaining and distribution spheres of information and knowledge and more than half of the able-bodied employees participate in this activity.

## The information economy and ICT development tendencies of various countries

The U.S. is a leader in the field of formation of the information economy. The U.S. developed comprehensive, multilevel system of national innovation in this area, which can be even regarded as the world standard. The U.S. carried out its implementations in the fields of science and innovation, education, the development of ICT, risk financing, the development of the information economy, which meets requirements of the legal framework, as well as a variety of related activities. Due to the tax regulation mechanisms of American tax policy, the U.S. investment in informatics tools increased by 4 times each decade, and the labor productivity averagely by 2.1 % (OECD, 2014).

28 % of all research and experimental-design work in the U.S. (R&D) are conducted with the financial support of the state (European Commission, 2018). The significant role of the state in the formation of information market is associated with a high capital-intensive of the whole software and innovation activity.

The state support for newly established enterprises includes reducing state barriers, ensuring their access to credit resources, preferential tax for small and medium businesses. First of all, the American experience in the information and telecommunication industry should be especially noted in the field of antitrust regulation. Investment of billions of dollars in R&D sphere is strongly influenced by the state monopoly policy.

According to the scale of costs of R&D, logistics and human resources in recent decades, the United States left behind all other countries. In 2011, the total costs incurred by the US to R&D amounted to $ 499 billion (3.7% of GDP). This amounts to approximately 42% of total cost of research and development of Organization for Economic Cooperation and Development (OECD) member countries (OECD, 2014). Scientific and technical potential of the U.S. is concentrated higher in some states - California, Michigan, Massachusetts, and Pennsylvania.

Israeli high-tech revolution is the basis of the country's economic development. Breakthrough in the field of high-tech in the country was due to the massive import of "human capital". An impact on the world high-tech products market is the characteristic of the Israeli economy. The Israeli government adopted a package of new programs to promote technological innovation. Under the programs, the government-owned insurance company provided investment funds at risk with investment guarantees up to 70% of their initial capital. Thus, the high-tech exports increased by $ 21 billion in 2011. At the same time, the share of high-tech products in total exports (up to 57% in 2011) increased significantly (IndexMundi, 2018).

Japan Basic Law on the information society came into force in January 2001. According to this law, the state program "e-Japan", which provided conversion of the country into the world's leading information state, was implemented (Aliyev, Shahverdiyeva, & Abbasova, 2016; Li & Gao, 2003). The program particularly focused on investing funds in the creation of networks with high bandwidth applications,

R&D, the use of the Internet at the state enterprises, training of more professional human resources, etc. In early XXI century, international competitiveness of Japan is associated with the development of the Internet and overall economic liberalization. The new methods were adopted for GDP measurement, which benefits from software, new technology, services, healthcare, infrastructure and other advantages more precisely.

The Republic of Korea established its national policy for science and technology according to the "general innovation" program. The national innovation system was expected to be the most important factor in the development of the national economy of the country. The development of information areas, such as the production of special displays for digital information transmission, intelligent robots, digital contents and etc. have become a priority of the national economy. The success of South Korea in this field is due to the publicity of telecommunications market. Long-term development strategy of the telecommunications market is to provide high-speed Internet access. The antitrust policy of South Korea contributes to the development of video-information transmission technologies via the Internet. This, in its turn, contributes to the competitive advantages of South Korean manufacturers in the field of mobile devices provided with Internet access (Bock, Field, Zwillenberg, & Rogers, 2015).

According to this indicator Chinese lagged behind the U.S. and Japan. China distinguishes for its highly developed Internet, and it is supported and controlled by the state directly. Including the Internet, information technology, first of all, is developed to present China's export products to the world market. China is the largest export economy in the world. In 2016, China exported $2.06T and imported $1.32T, resulting in a positive trade balance of $736B. In 2016 the GDP of China was $11.2T and its GDP per capita was $15.5k (IndexMundi, 2018). The Chinese government supports the distribution of Internet technologies in most advanced areas of industry, in order to improve the management quality and competitiveness efficiency.

India has made significant progress in the development of the information economy. Approximately 4 million people in the country are engaged in the spheres of service, and 340 thousand in computer companies. IT industry of India is specialized in the field of outsourcing and offshore programming (Aliyev, 2013; Techatassanasoontorn, Huang, Trauth, & Juntiwasarakij, 2011). Offshore programming development is fully supported by the government; India increases its budget for training human resources, R&D, and e-commerce to develop information economy. India is considered to be a sufficiently serious competitor for Central and Eastern European countries specialized in the field of offshore programming, as well as Russia.

In the EU countries (Sweden, Finland, Norway, Ireland, UK) implemented a successful model that combines a high level of human capital, innovation and in information and telecommunications infrastructure. Market economies are characterized by a significant influence of the state on the market mechanism and a strong system of social provision.

India, South Korea, China, Thailand had some success in improving the educational potential of the country. It was the impetus for the development of knowledge-based industries. Moreover, these countries have been able to go with their goods and services to the global information technology market. At the same time, the standard of living here is pretty low, on the order below the standard of living in Singapore or Taiwan. In these countries the low domestic demand for high-tech products, and hence the level of development of information and telecommunications infrastructure. High qualification and low wages specialists form concurrently advantages of these countries (Aliyev, 2013; Budaeva, 2010).

The analysis of development tendencies of various countries in the formation and development of information economy showed, that ICT infrastructure, national innovation system, the development of scientific and service industries, the export of high-tech products, higher potential of education, high-level specialized human resources, and etc. are the key factors in the formation and development of information economy (Table 1) (UNCTAD, 2017).

***Table 1. Information economy and ICT development trends (UNCTAD, 2017)***

| Country or country groups | Development directions | Development trends of ICT industry |
|---|---|---|
| The USA | Computer hardware and software industry NIS | ICT infrastructure, export of hi-tech products and services, human resources and financial support for R&D, tax incentives, antitrust policy, etc. |
| Asia-Pacific countries | Computer hardware and software industry | Human resources, R & D investment, and government regulation |
| Finland, Israel, Singapore | IT industry | Technology infrastructure, R&D, firm strategies, and capital availability |
| China, India, Ireland, Israel, Russia | Software industry | International and domestic demands, national policies, a skilled workforce, technological infrastructure, financial incentives, and R&D investment |
| South Korea | NIS<br>Electronic industry | Export of hi-tech products and services, higher education capacity, human resources, development industries |
| Japan | NİS<br>IT industry | Higher education capacity, ICT infrastructure, development of the industry, investment for the R & D and human resources, etc. |
| Azerbaijan | NİS<br>IT industry | ICT infrastructure, investment for the R & D and human resources, national policies |

**The comparative analysis of development tendencies of various countries**

There is no one-size-fits-all path of information economy development in the world. We consider that there are general issues that are important for developing a sustainable information economy. These countries have additional for building their information economies.

The results claim that sustainable information economy is being formed in Azerbaijan. The improvement and further development of the structural economy are required for it. Besides, Azerbaijan needs coherent taxation, ICT, and human capital policies in order to develop a sustainable information economy.

Infrastructural challenges include uneven physical infrastructure development across regions. Infrastructure issues of the workforce are too small. R&D has low expenditures in the ICT sector. The economic growth of Azerbaijan will depend on an increase in investments and improvement in technology and innovation. A good infrastructure is important to facilitate the work in the ICT sector. Ireland is in the leading position with respect to infrastructure development. The Irish government supports the active involvement of the private sector. China is far more advanced than India with respect to ICT diffusion and infrastructure development. China and India are at a similar developmental stage of ICT. In terms of infrastructure development of China can be attributed to a considerable amount of investment, nationwide developmental strategy. The government strongly intervenes and controls also the development of the economy (Techatassanasoontorn et al., 2011).

In India, the service industry of ICT is concentrated around major clusters including Bangalore, Mumbai, Chennai, Delhi, and Hyderabad (IndexMundi, 2018). In these clusters, the infrastructure has been developed to facilitate ICT sector work. In the rest of India, the ICT infrastructure is insufficiently developed. It lowers the national average indicators and poses a barrier to future growth.

Azerbaijan has made steady progress in the development of ICT infrastructure. Azerbaijan can learn some valuable lessons. It must provide continuous investment in ICT infrastructure. It must pay more attention to the effort in establishing a strong technical and human infrastructure. It must promote balanced nationwide ICT development. The development of information economy in many different countries is the criticality of ensuring the supply of a qualified knowledge workforce. The education was made essentially free in Ireland. It ensured the supply of a skilled workforce.

Another unique aspect of the Irish software sector is the close linkage between the academic institutions and industry. China and India have common bases in the supply of skilled workers. Both countries are facing the challenge of skill gaps. The lack of English-speaking proficiency in the ICT workforce is considered one of the biggest disadvantages of China in competing with India. One of the strategies that both nations can leverage is the reverse brain-drain. Each year, a large number of Chinese and Indian college students come to the U.S. and other developed countries to pursue advanced degrees and careers. Therefore, it is important for India and

China to turn the brain-drain into a brain-gain. The challenges China and India are currently facing valuable lessons for Azerbaijan. And Azerbaijan needs to improve the quality and quantity of IT workers, the country must support the growth and value-added contribution of its IT industry. Azerbaijan carefully evaluates the global market trend and its distinctive characteristics to define its own developmental path.

## The situation of economic development on the basis of ICT in Azerbaijan

The national development model is adapted to analyzed development trends of advanced countries. Azerbaijan is a country with emerging economy in Europe and Central Asia. In the region, it has experienced substantial economic growth during the last decade. Azerbaijan has been actively seeking ways to develop its ICT sector. It attracts foreign investment, foster domestic entrepreneurship, and raise its competitive position.

ICT sector in the country was declared a priority in recent years, and many large-scale projects are implemented in this regard. That is why, according to some development indicators, Azerbaijan left behind some leading countries. "The Global Information Technology Report 2014", developed by the World Economic Forum, rated Azerbaijan 49th among 148 countries for its "Networked Readiness Index", which reflects the development of the countries in the field of information technology (World Economic Forum, 2014). Azerbaijan was rated 56th last year. According to this table, Azerbaijan left behind even some leading countries.

It maintains its leading position in the CIS. It is being rated 59th for the number of Internet users per 100 people out of 148 countries, and 46th for the number of Internet subscribers. In addition, due to the innovative ability of the companies, Azerbaijan rated 35th in the world and 1st among CIS. Currently, there are about 1 million Internet users in Azerbaijan 50% of which is broadband users (World Bank, 2014).

Recently, ICT sector has become leading and dynamically developing an area of the economy. Over the years, investment in the industry amounted to approximately $ 2.5 billion. The mobile network has been expanded. The 4G technology was introduced in the country in 2012. There are 110 mobile subscribers per 100 people in the country. Internet channel capacity increased by 12.9 times in last five years and reached 200 Gbit/s, and the size of the Internet services market increased about 4 times (World Bank, 2014).

On February 8, 2013, the first telecommunication satellite of the Republic of Azerbaijan "Azerspace-1" was launched on the orbit, which is the highest technical achievement of the country since its independence. Commercial exploitation of the satellite started, which is capable to provide Europe, Middle East, Central Asia and African countries with telecommunication, Internet, television, and radio broadcasting services.

"Electronic-State" project is carried out in the country successfully, the use of electronic signatures is expanded. "E-state" portal (www.e-gov.az) was launched in order to provide information exchange among information systems of government agencies and to ensure e- services through "single-window" principle. 179 electronic services submitted by 30 state agencies are available for the users. At the same time, service centers "ASAN Xidmat" are organized to provide comfortable and higher quality services to citizens from a single location, with the use of modern innovations, which is highly appreciated by many international organizations and universities, and became the brand of Azerbaijan. High-specialized human resources are trained in ICT to expand national capacity. State Fund for Development of Information Technology and "High-Tech Park" have been established in the country to provide developed and competitive innovative ICT industry with high export potential (Ministry of Transport, Communication and High Technologies of the Republic of Azerbaijan, 2018). These new bodies will contribute to strengthening the economy of the republic of Azerbaijan, attracting foreign investment and expanding ICT products, and so on. Never use letter spacing and never use more than one space after each other.

## Comparative analysis of measurement methods of the level of information and knowledge economy

The review analysis of scientific literature in which existing methods, indicators, and indices are analyzed, is carried out in order to estimate the formation and development level of information and knowledge economy. For this purpose, 122 articles of the US authors, 104 of the English authors, 85 of the Chinese authors, 41 of the Austrian authors, 28 of the Canadian authors, 21 of the German authors etc. which are included to Thomson Reuters base and published in 2010-2017, are round-reviewed.

There are different indices characterizing information and knowledge economy found in scientific literature (UNCTAD, 2017): 1) Economy index, 2) Digital economy and Society index, 3) Global competitiveness index, 4) Global creativity index, 5) Global innovation index, 6) Global ownership index, 7) Technological readiness index, 8) Economic stimulation and institutional conditions index, 9) Poverty and unemployment index, 10) Knowledge index, 11) Knowledge economy index etc.

A separate analysis of these indices shows that the information that provides their structure and content are different. In particular, the elements of economy index (Greenberg, 2015; Makarov & Blatova, 2014; Sudarkina, 2016) include 1) organizational effectiveness and human resources (14 indicators), 2) competitiveness and creativity development of economic structure (11 indicators), 3) ICT infrastructure (8 indicators), 4) innovation (10 indicators). One of the measurement indicators of information and knowledge economy (IKE) is the investment in KE. Experts at UNO OECD evaluate the investment in knowledge as a collection of national expenses for education, R&D and software (Tkachenko, Rogova, & Bodrunov, 2016). The USA (6,6% of GDP) is a leader for this indicator

(OECD, 2014). Of course, this indicator can't reflect the conditions of IKE completely and correctly.

According to the method of European Commission (2013) readiness of formation of IKE in the country is calculated on the basis of the Global economy index (GEI).
GEI = A*Tec + B*SISI + C*Mec
Tec – technological subindex, GISI – State institutional subindex, Mec – subindex of Macroeconomic conditions. A, B, C are the mass ratio of the proper indices and they meet these requirements:

A + B + C = 1,
according to EEC it is accepted that A = 1/3, B = 1/6 C = ½. It should be noted that proper indicators impact on the formation of each subindex. Proper indicators impact on the formation of each subindex. According to a different approach this kind of information base is used in Kazakhstan to evaluate KE level (Ivan, Ciurea, & Zamfiroiu, 2014; Yusuf, 2015): 1) quality of economic regulation, 2) the degree of execution of laws, 3) Royalty and license fees, 4) Publications in scientific and technical journals, 5) Number of patents, 6) The average duration of education, 7) Secondary/higher education coverage, 8) Number of phones/computers, 9) Number of internet users (per 1000). 2013-year method of Russian Statistics Committee under calculating of the part of high technology and science-intensive sector products (SIP) in GDP (Federal State Statistics Service, 2014) is based on the following: HTI – total extra income on high technology economic activity, SII – total extra income on science-intensive activity, TEI – total extra income on all economic activity SIP = (HTI + SII)/TEI

Calculating an integral indicator of IKE can also be implemented on the basis of relevant statistic report indicators (ITU, 2015).
$X_1$ –the expense on research and development, m/person, $X_2$ – the volume of innovative product, $X_3$ – the volume of innovative product for export, $X_4$ – ICT expenses.

In this case, in addition to the per capita indicators, ratio and structural indicators are also taken into account.

Structural indicators. $X_5$ – specific weight of high innovation product, %, $X_6$ – the specific weight of organizations using internet, %, $X_7$ – specific weight of computers with internet access, %.

Ratio indicators. $X_8$ – researcher project staff per 10 thousand employees, $X_9$ – researchers per 10 thousand economically active people, $X_{10}$ – costs of technological innovation per 1 employed person, $X_{11}$ – the number of patents per 100 researchers. Constituent elements of knowledge and knowledge economy index suggested and applied by the World Bank (WB) can be given as in figure 1.

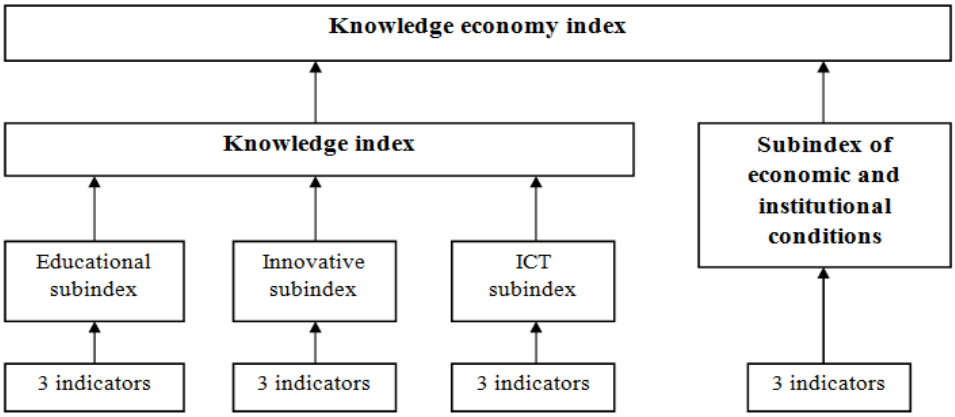


***Figure 1. Formation structure of knowledge and knowledge economy index***

Knowledge economy index is a complex indicator. It is developed by the proper department of WB since 2004. Formation and Calculating of the index are implemented on the basis of methodology of the World Bank.

A rating of 109 content and quality indicators in 4 groups from 146 countries in 2012 was calculated (ITU, 2015; World Bank, 2006). In the I group, indicators like 1) economic development conditions, 2) economic, legal environment, 3) quality of regulation, 4) development of business, 5) initiatives, 6) society's ability to use knowledge are used in the formation of subindex of economic and institutional conditions. In the II group education level, literacy indicators, attitude to education are taken into account in calculating of the Educational index. NIS level, research centers, universities, techno parks, scientists, patents, scientific journals are accepted in calculating of the Innovation subindex in the III group (Alguliyev et al., 2017; Shahabadi et al., 2016). Information such as ICT level, regional infrastructure, information broadcast is required in calculating of ICT index in the IV group. The countries in each indicators group get 1-10 points. 2 common indices are calculated according to methodology:
1) KI – knowledge index. KI is an average of the 3 indices. KI = (EI + II + ICT)/3;
2)KEI – knowledge economy index. KEI is accepted as an average of 4 indices. KEI = (EI + II + ICT + KI)/4, $0 \le KI \le 1$, $0 \le KEI \le 1$.

The main group indicators of knowledge economy index include research, development and innovation, technical profession education and instructions index, pre-higher school education subindex, higher education, ICT as the components of Knowledge index. Functional alignment of indicators is realized in 1) economic, 2) technological, 3) social, 4) state directions. As we can see, the country has an average position among the groups of countries approximately analyzed in the assessment from different aspects, on the basis of different indices. And this confirms one more time that still many unused potential opportunities exist in the country.

## The characteristics of regional and sectorial approach to the assessment of the level of IKE

Analyses show that different approaches, indicators, methods, indices etc. exist in the assessment of IKE level. There's disunity in the conduct of comparative analyses. The base groups that will be chosen for comparison don't completely meet the requirements, regional characteristics. That's why during economic analysis of the condition of the formation of IKE it's suggested that from the functional point of view economic development stages should be accepted as agrarian, industrial, information, knowledge, smart technologies.

Besides, guiding developed countries (G7, G10, G20), Post-soviet, former USSR, CIS countries, regional countries, developing countries, countries with similar conditions will be included into the group of the countries chosen for comparative analyses and assessments (Lopez-Leyva & Mungaray-Moctezuma, 2017; Svarc & Dabic, 2017). From this point of view, in particular, countries such as the USA, Great Britain, Germany, France, Italy, Canada, Japan, China, Russia, India, Korea, Turkey, Switzerland, Sweden, Austria, Iran, Malaysia, Singapore, Israel, Ireland, Pakistan, Hungary, Bulgaria, Kazakhstan, Ukraine, Azerbaijan, Belarus, Uzbekistan, Georgia and Armenia are added to the group of the countries chosen for comparison. At the same time, regional levels of the country as Baku, Nakhchivan, Karabakh – Shusha, Sumgait, Mingachevir, Shirvan, Lankaran, Guba, Shamakhi, Gabala, Shaki, and Ganja are accepted as economic-administrative division.

For conduction of economic analyses in a more compact area reconciled to each other, sub-sectors of IKE can also be classified. Taking this into account, sectorial classification of Information and knowledge economy can also be formed as following: Internet; Software engineering and automatization technologies; Digital contents; IT-service, telecommunication; Computing and e-industry; Creative content and digital media; Electronics sector; Military industry; Aerospace and aircraft industry; Management services; Bio, Nano and high technologies; Business and industrial services;

Pharmacology and medical industry; Environment and ecology; Optical industry; Transport and communication; Energy sector; Chemicals and oil chemistry; Scientific research and experimental design works; Scientific technological-intensive service sectors; Education; Media sector.

It should be noted that while carrying out analyses by this division spheres of the Traditional economy shouldn't be forgotten, either. That's why although Agriculture, Industry, Metallurgy, Transport, Construction, Oil-gas, Energetics, Natural resources etc. belong to Traditional spheres they also can be included into the sectorial classification of Information and knowledge economy. Besides, science-intensive sub-sectors of traditional economy spheres and newly formed economic spheres should also be included in the analysis process:

Information-communication technologies in management, production and service processes technologies, irrigation and cultivation technologies, marketing and sales technologies, know-how technologies, innovative technologies, smart technologies.

## Calculating of GDP forming by information and knowledge

To calculate GDP forming by information and knowledge in any country the following marking and methods are suggested.

1. Production and service sectors according to official statistical reports of the country- i = 1,2,…,n
2. GDP of the $i^{th}$ sector – $GDP_i$
3. GDP of the $i^{th}$sector forming by the industrial production – $GDPI_i$; $GDPI_i = I_i*GDP$
4. GDP of the $i^{th}$ sector forming by the service production – $GDPS_i$; $GDPS_i = Si*GDP$
5. GDP of the $i^{th}$ sector forming by the information – $GDPIn_i$; $GDPIn_i = In_i*GDP_i$
6. GDP of the $i^{th}$ sector forming by the knowledge – $GDPK_i$; $GDPK_i = K_i*GDP_i$
7. GDP of the $i^{th}$ sector forming by the technology – $GDPT_i$; $GDPT_i = T_i*GDP_i$

$0 \leq \{I_i, S_i, In_i, K_i, T_i\} \leq 1$

$0 \leq (I_i + S_i + In_i + K_i + T_i) \leq 1$

Weight ratios – $I_i$, $S_i$, $In_i$, $K_i$, $T_i$ are determined on the basis of expert assessment. Their impact on GDP can be assessed in two ways: 1)indirectly by impacting management, organizing, decisions; 2)as a shopping object of technology, information, knowledge or as the last product, technology, service, innovation (Alguliyev et al., 2017; Lopez-Leyva & Mungaray-Moctezuma, 2017; Shahabadi et al., 2016; Svarc & Dabic, 2017).

So, GDP formed by industry, service, information, knowledge, technology across the country (SIGDP, SSGDP, SInGDP, SKGDP, STGDP) will be calculated as follows:

1) country total GDP – TGDP = $\sum_{i=0}^{n} GDP_i$
2) by the industrial production across the country SIGDP = $\sum_{i=0}^{n} GDPI_i$
3) by the service production across the country SSGDP = $\sum_i GDPS_i$
4) by the information production across the country SIGDP = $\sum_i GDPIn_i$
5) by the knowledge production across the country KIGDP = $\sum_i GDPK_i$
6) by the technology production across the country TIGDP = $\sum_i GDPT_i$

**Indices and subindices forming a composite index of information and knowledge economy**

Forming of Composite index information and knowledge economy (CIK) is suggested by indices shown in figure 2.

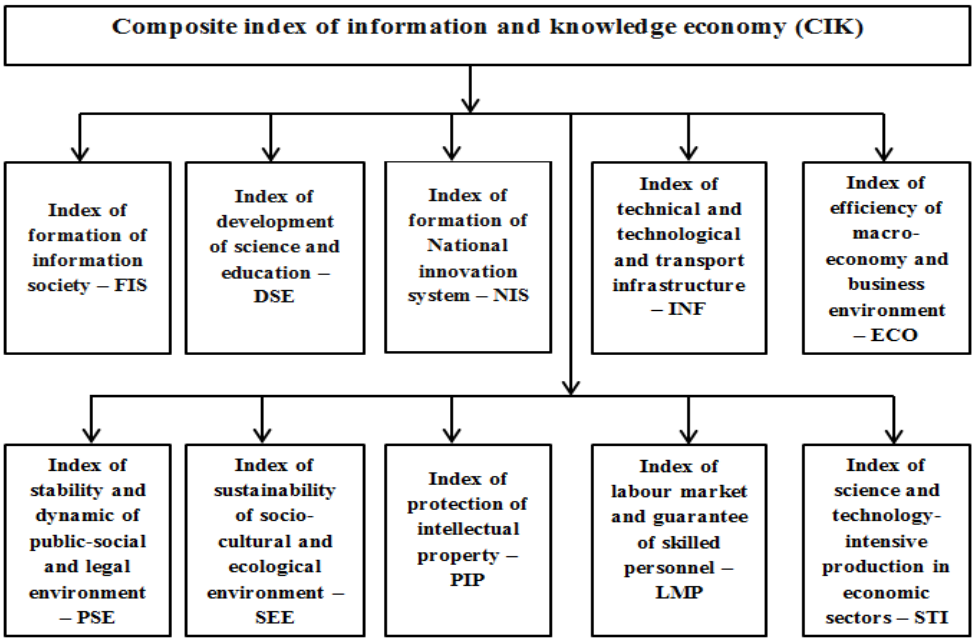


***Figure 2. Indices forming a composite index***

The observations and analyses show that the number of content of subindices and indicators that impact forming those sectorial indices can be expressed as follows:

1. The content of index of formation of the information society (FIS) – 13 subindices and indicators
2. Indicators that impact index of development of science and education (DSE) – 9 indicators
3. Components of the index of formation of national innovation system (NIS) – 13 subindices and indicators
4. Factors that impact index of technical and technological and transport infrastructure (INF) – 5 subindices and indicators
5. Indicators of the index of the efficiency of macro-economy and business environment (ECO) – 12 subindices and indicators
6. Components of the index of stability and dynamic of the public-social and legal environment (PSE) – 6 subindices and indicators
7. Factors that impact index of sustainability of socio-cultural and ecological environment (SEE) – 8 subindices and indicators
8. Indicators forming an index of protection of intellectual property (PIP) – 5 subindices and indicators
9. Factors that impact index of the labour market and guarantee of skilled personnel (LMP) –7 subindices and indicators

10. Indicators forming an index of science and technology-intensive production in economy sectors (STI) – 5 subindices and indicators.

## The scientific-methodological basis of development of the system of composite indices on a comparative assessment of IKE

The structure of the system of composite indices (SCI) is suggested in multilevel form. The main level integratively reflects all the lower coming after it and the parameter which characterizes it is called composite index of IKE (IKC). Composite index forms as a result of the assessment and have a leading position in comparative analysis. So that it's as a result of this value that IKE gets proper ratings. Each subindex is evaluated in the [0,10] scale. Weight ratios as first are accepted as 1. The composite index is accepted as the sum of subindices and varies between [0,100]. Besides, calculating of a composite index of IKE can be also functionally noted as follows:
IKC = F(FIS, DSE, NIS, INF, ECO, PSE, SEE, PIP, LMP, STI). F expresses dependence form of the composite index from other indices. Thus it can be noted that scientific-methodological basis of development of composite indices system on a comparative assessment of IKE consists of the following:

- Composite indices are a useful indicator for assessment, analysis, and comparison of development level of society, economy.
- Composite index and indicators form due to a combination of separate indicators measured on the basis of multidimensional criteria.
- Composite index although not directly, but indirectly allows to evaluate the efficiency of IKE, gives ground to conclude on its role in the society, the extent of its part.
- To form composite index, the values of the indices above are suggested to be taken as a basis.
- The following can be noted on the assessment of indices and subindices:
- Average numbers, expert assessment, weight ratios, proper econometric and statistical methods will be used in the calculation of new indices and subindices. Indices, subindices and indicators system on a comparative assessment of IKE is divided into different hierarchical levels.
- The 1st national level consists of a composite integrative index of IKE, firstly 2nd level consists of 10 indices, 3rd level – 83 subindices and indicators, 4th level – 320 indicators of macro/micro nature. Indices and subindices of the 1st, 2nd and 3rd levels are determined on the basis of both expert assessment and the parameters forming the next level.
- 4th level indicators include both official statistics and other external and internal indicators. 4th level indicators mostly serve as a basis for determination of the 3rd and 2nd level subindices by experts. In this case, absolute indicators and their concrete values are used. The approach here is different and can be realized individually in accordance with every concrete situation.
- Indicators system on a comparative assessment of IKE can response to complete provision of the aim in the assessment of the activity of IKE both in regional and international levels.

- The indices and indicators system suggested in such comparative assessment, being a successful model, can meet existing modern requirements in the assessment of the activity of a separate region in Azerbaijan.
- Composite index in the interval [0,100], all 1st level indices and 2nd level subindices in the interval [0,10] have "monotonous increase" characteristics, i.e. the increase of the values shows better conditions while the decrease shows worsening of the conditions.

## Practical importance, implementation and application of results

The economic analyses, summaries, recommendations are given, also methodologies, indices, indicators, criteria, models, methods suggested in the article can be used in different management levels, central executive structures, production and service sectors, development of state programs and strategies, development of action plans. The applied management methods can be used in the activity of different innovative structures. The practical significance of the work is that scientific-practical results achieved on the basis of the suggested methods and models allow increasing of the quality efficiency of the activity results of different management and production and service structures.

The results of the work are regularly used in the development of the indicators system of ICT sphere, implementation of the National Strategy for ICT, State Programs on Socio-Economic Development of Regions and Poverty Reduction.

The scientific-theoretical and practical results of the article can be used in the relevant central executive structures of the Republic. The effective implementation of the suggested models, methods and mechanisms is possible and can create additional opportunities for increasing efficiency in new economic management, diversification, and reconstruction of the economy, the formation of the non-oil sector.

## Conclusion

Research gives reason to note that most of the viewed indices can't apply the assessment of economy comprehensively. Besides, it should be noted that composite and other complex nature indices are one of the trusted and accepted means allowing to analyze and present the whole characteristics of the countries and their economy. That is why the rules, methodology, and requirements of creating composite indicators of influential organizations, different methodological approaches proven in practice should be used effectively. The development and improving the composite indices implementing the accurate and precise assessment of the development level of the economy based on the information and knowledge on a regular basis is the requirement of the modern era. Besides, it is also important to take into account information and accountability characteristics of the organizations operating in the information and knowledge sectors. The essence of the approach reflecting regional and sectorial features is explained by taking these requirements

as the main. According to this approach, the calculation method of GDP forming information and knowledge is suggested. At the same time the quantitative and qualitative content of the composite index of information and knowledge economy, the other indices, subindices and indicators forming it is explained. The stages of explaining and calculating of indices allow to use them as real analysis, planning, and forecasting mechanisms in the future.

The studies prove, that establishing efficient information infrastructure based on free and healthy competition of telecommunication market, the development of ICT sector, including the high-tech sector and the services, investing to R&D and high-tech institutions, expansion of the export of high-tech products, computer literacy of the population, availability of efficient and secure information exchange, training of human resources, government support and the legal and regulatory framework are of great importance for the formation and development of information economy.

Research shows that there is no single model exists for information economy development. Further, globalization requires that the development of a nation's information economy must be closely connected to the global market. The current development rate of the country, taking into account its features, benefiting from the experience of the advanced countries, information society, and economy can be certainly formed and developed in Azerbaijan.

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