

A system of Assessment Indicators of the Development Level of Information Economy

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Abstract. The paper presents the analysis of the system of indicators mostly used in the assessment of the development level of information economy. Basic methodological approaches associated with their development and analysis are considered. Some recommendations are given to eliminate existing problems in this area.

Keywords: information economy, information society, indicators, development index, economical indicators

Introduction. Nowadays, information, technology and knowledge have become the main driving force and the competitiveness factor of the economy of the countries. Stimulated by their influence and wide range application, the need for development assessment of the economy of information society is of great importance. Although a series of indicators for realizing qualitative and quantitative assessment of the formation rate of high technologies, as well as ICT in various fields has been developed, some of them have methodological imperfections. The development of recommendations for the solution of the main problems of the current problems and the analysis of computational methods of the indicators system is very significant in terms of objective assessment of the development level of the information society and the information economy.

1. The essence and characteristics of the Information Economy. At present, the notions as postindustrial society, information society, information economy, knowledge economy, innovation, economy and so on are used to characterize the modern development of society and economy. Although these terminological notions sound differently, they do not differ essentially too much. Thus, all of them characterize recently formed society and its newly emerging economy. Distinguished characteristics of the new economy include: 1) dependence mainly on the scientific and technical technological achievements of the productivity, and on the intensity of information and management; 2) transition to the information production rather than material production; 3) profound changes in the organization of the production process; 4) globalization of the economy; 5) revolutionary nature of the technological changes, and so on.

Successful development of the information society depends primarily on the development of the new economy, as well as the information society based on information and knowledge, modern technologies and innovations.

The information economy implies the economy in which production, processing, preservation, and dissemination of a large part of the information and knowledge of the gross domestic product (GDP) are provided, and more than a half of

the employees participate.

Formation of information and knowledge economy both nationally and internationally is closely connected with the globalization. Recently, information and knowledge economy has become the subject of researches.

2. The measurement of the development level of researches on IE. Since the mid-twentieth century, a number of studies have been conducted in the assessment of the formation and evolution of the information economy. Initially, the researches carried out in 1962 by Frits Machlup and in 1977 by Marc Porat in this field attracted more and more attention [1]. Frits Machlup's Studies the "knowledge production" can be considered as one of the first attempts of detailed statistical analysis in this area. These studies provide conceptual basis for the research of both quantitative and qualitative aspects of information based on the knowledge. F.Machlup defined the components of the "knowledge economy" and measured its share in the gross national product (GDP). According to him, in 1958, 29% of GDP in the U.S. was due to the knowledge production.

In 1977, M.Porat studied the activities of the U.S. economy based on information on behalf of the U.S. Department of Commerce. Using Machlup's approach to the assessment of the formation and evolution rate of the information economy of the U.S., Porat thoroughly studied accounting system of the national income for 1967, as well. Moreover, unlike Machlup, Porat distinguished information sector into the "first" and "second" sectors.

Thus, Machlup used "final demand" and Porat "extra income" in the estimation of GDP. Machlup's method is based on the measurement of GDP according to the realization of the final product, and the Porat's method according to the incomes.

Porat's methodology was used for the study of the information economy by the Organization for Economic Cooperation and Development (OECD) in the nine members of the organization in 1978 to 1979.

One of the possible models of IS statistics was proposed by the OECD in 2005. OECD proposes the model consisting of three stages of IS development: e-training, e-intensity and e-impact. Monitoring of such broad and complex field requires the use of a large number of indicators.

3. Establishment stages of indicators system and its requirements. A number of composite indicators (CI) are widely used to measure modern development of society and the economy.

According to the official definition of the OECD, *composite indicators* (CI), occur in a combination of a single index

measured on the basis of multidimensional criteria of separate indicators.

- Composite indicators are not easily built, and includes the following stages [3,4]:
- *Theoretical Basic.* Development of the theoretical basic provides selection the combination of indicators included into the composite indicators.
- *Data selection.* The indicators shall be selected on the basis of their analytical stability, measurability, comprehensiveness and interconnection.
- *Multifactor analysis.* The study system shall clarify the general structure of the indicators, assessment of data collection suitability and selection of the methodology.
- Impitiation of missing data. Different approaches shall be considered for the impitiation of missing data.
- *Normalization.* The possibility of indicators' comparison shall be normalized.
- *Weight and sum up.* The weight shall be calculated in accordance with the importance of each indicator, and summed up for the final index based on the developed methodology.
- *Reliability and sensitivity tests.* The reliability of composite indicators shall be tested in terms of the inclusion or removal mechanisms of individual indicators, mechanisms of normalization, selection of weights.
- *Back to real data.* The composite indicators shall be transparent and be able to break into indicators and quantities.
- *References to other variables.* Relations of the composite indicators with other ones, as well as the relations based on regression shall be clarified.
- *Visual description.* The composite indicators shall be visualized or presented in different ways.

4. *The major indicators system used for the measurement of IS and IE.* To assess the competitiveness rate of the economy based on knowledge and information of countries, the United Nations Organization (UN), World Bank (WB), the World Economic Forum (WEF), the International Institute for Management Development (IMD) and International Telecommunication Union (ITU) and other international organizations have developed a number of indicators [2]. Some of them are given in Table 2.

Table 2. Some widespread systems of composite indicators

No	Composite indicator signs	Composite indicator names	Composite indicator developer	Composite indicator development date
1	ISI/IDC	Information Society Index	IDC	1997
2	ERI/EIU	E-Readiness Index	EIU/IBM	2000
3	NRI/WEF	Networked Readiness Index	WEF	2002
4	KEI/WB	Knowledge Economy Index	WB	2005
5	IDI/ITU	ICT	ITU	2009

		Development Index		
6	GIİ/İNSEAD	Global Innovation Index	İNSEAD/İnd. conf.	2007
7	GCI/WEF	Global Competitiveness Index	WEF	1979
8	WCY/IMD	World Competitiveness Yearbook (WCY)	IMD	1989

İnternetdə aparılmış sorğular nəticəsində Kompozit indikatorların reytingində ilk yerləri uyğun olaraq Networked Readiness Index (NRI/WEF), ICT Development Index (IDI/ITU), E-Readiness Index (ERI / EIU), Knowledge Economy Index (KEI/WB) tutmuşdur.

Network Readiness Index (NRI). This index has been developed jointly by the World Economic Forum (WEF) and the Business School for the World (INSEAD), and is considered a tool to measure the countries' ability to take advantage of ICT to promote its economic competitiveness [10]. The index includes four main sub indexes, which consists of 53 indicators and 10 groups of indicators: Environment, Readiness subindex, Usage subindex, Impact subindex.

NRI-ni təşkil edən 53 parametrin 53%-i kəmiyyət, 47%-i isə keyfiyyət göstəriciləridir. Bu göstəricilər ayrı-ayrı ölkələrdə işləyən şirkət rəhbərlərinin sorğuları əsasında tərtib olunur və 1-7 qiymət şkalasında qiymətləndirilir.

E-readiness index (ERI). The index [9] annually analyzes the ability to take advantage of ICT to promote the countries' economic competitiveness and living standards of the citizens. The proposed method consists of six constituent elements: communication and technology infrastructure, business atmosphere, social and cultural atmosphere, legal atmosphere, state policy and strategy, to be adopted by the community and business.

ICT Development Index (ICT). [6, 8]. This index proposes a model reflecting the three-stage process of development of the transition to information society and knowledge economy. The index includes 3 subindexes, as "Introduction to ICT", "ICT use", "ICT skills".

Knowledge Economy Index (KEI). This index has been developed within the framework of the International Bank Knowledge for Development Program, and is a part of the methodology for the assessment of knowledge [6,11].

Global Competitiveness Index (GCI). Since 1979, competitiveness rate of more than 130 countries has been carried out through this index [6.13]. This index was improved in 2004, and makes of both the quantity (1/3 variables) and the quality (2/3 variables) indicators.

World Competitiveness Yearbook (WCY). This cumulative index was developed by the International Institute for Management Development [6,7]. The index is grouped on 329 indicators of 4 key factors as economical activity, management efficiency, business efficiency and infrastructure, and it measures competitiveness of the countries.

Global Innovation Index (GII) is calculated on the basis of some generalized indexes [12]. The index reflects the importance of innovation for global competitiveness, and states as a comprehensive assessment of innovation development of the countries. The index was calculated according to 60 indexes in 132 countries in 2010.

5. *The problems associated with the method of indicators system.* Despite the wide dissemination of the composite indexes, there still remain a number of disputable issues regarding the source of attached data, indicators, methodologies, as well as the interpretation of the results issues

Some definite problems regularly occur while assessing development level basing on uncertain indicators. The data is collected on the basis of the information of statistical offices often taking into account the data collection procedure of various countries.

The lack of generally fixed assignments for IS and IE generates the problems in the assessment of the development level.

The development of composite indices, is actually based on accepted theories, empirical analysis and authors' researches.

The names of some of the composite indicators do not reflect the true nature, and comprise marketing character. For example, although the Information Society Index (ISI/IDC) is most promising, sometimes it measures only the level of information infrastructure.

Composite indicators vary according to the number of indicators and subindices. Though, E-Readiness Index (ERI/EIU) includes 100 parameters, it does not provide an exact methodology for the assessment of incomplete indices [2].

NRI/WEF uses the two-level subindices. All composite indices use the same method for the assessment of development level of the countries. Only CSC/Waverman index applies different assessment method dividing the development level of countries into two different groups.

Assessment of composite indices depends on the quality of the used data, as well. Sometimes, the data obtained from authoritative and reliable sources, such as ITU, Eurostat or World Bank, is used for assessment. In some cases, this data is completed by the data obtained as the result of queries, for example, as it is in the composite index of NRI/WEF and ERI/EIU. Transparency of the methodology and data sources is the basis for its inspection. Improper index methodology of ISI/IDC and ERI/EIU prevents the verification of realized studies. NRI/WEF composite index provides the data calculation methodology in details. However, in this index, the data collected as the result of queries does not provide the repetitive verification of the results.

6. *Elimination of shortcomings concerning composite indicators.* To eliminate the problems associated with composite indicators, the methods and approaches have been put forward by the researchers. In these approaches, a number of methods to assess objectively the development level of the countries, and primary composite indicators have been improved.

Researches show that "measurement and sum up" are of basic ones out of the establishment stages of CI, and impact on their quality and reliability. As the method of summing, the application of the weighted product method (WP) is of great importance. The main features of the WP method are associated with a reduction in the information loss as compared to the multiple criteria decision analysis (MCDA) used in the creation of CI. In spite of the superior features of the WP method, its use requires attributing the weight of subindicators in the CI development. To overcome this deficiency, WP method has been advanced and multiplicative optimization method has been proposed for CI development [5].

Besides, Knowledge Economy Index (KEI), ICT Development Index (IDI), Global Competitiveness Index (GCI) and World Competitiveness Yearbook (WCY) and fuzzy clustering methods are used for assessment of the development level of information and knowledge-based economy, and Unified Knowledge Economy Competitiveness Index (UKPI) has been developed [6]. The development of the latter index includes four phases. The first phase includes correlation analysis, i.e. the relationships between the selected indices and testing the strength of these relationships; the second phase includes the Principle Component Analysis (PCA) in terms of testing the similarity of existing indicators and their ability to be reduced in any form; the third phase includes the use of Adaptive Neural Fuzzy Inference System (ANFIS) to ensure the efficiency of new indices to be selected; the fourth phase includes the development of a single Competitiveness Index using indicators of four indices with the method of fuzzy clustering.

Despite of some acceptable defects, this index is based on the method of fuzzy clustering and provides assessment of development level of any country, especially of developing countries, on the basis of the above mentioned indicators, even in the case of absence of one or more indicators.

Conclusion. Implemented analysis and research show, that none of the reviewed indices is capable to comprehensively assess either information society, or information. At the same time, it should be noted that the composite indexes are the most reliable, well-known and accepted tool to analyze and describe modern countries and comprehensive description of their economy. Therefore, the development and improvement of composite indices, which realize accurate and precise assessment of the development level of information and knowledge-based economy of various countries, using development ways, methodologies and experiences of composite indicators of OECD [3] and other organizations, are the requirements of the modern era.

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