Global J. Environ. Sci. Manage. 5(SI): 172-179, 2019

Global Journal of Environmental Science and Management
(GJESM)

Homepage: https://www.gjesm.net/

SPECIAL ISSUE PUBLICATION
Presented and selected at the ICCMIT'19 in Vienna, Austria

World informatization in conditions of international globalization: factors of influence

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ARTICLE INFO

Keywords:
Factors of Informatization Development
Informatization Processes
International Globalization
Networked Readiness Index (NRI)

ABSTRACT

The level of information today is decisive in the socio-economic development of the country. The purpose of the article is to identify the most influential factors in the process of developing informatization in the context of international globalization. The assessment of factors influencing world information is based on the following stages: forming incoming information about the state of world information, a methodical approach to assessing the impact of world information, modeling the interrelation of components, the influence of world information as hidden factors in the development of information. Factor and correlation analyses are carried out within each cluster with a single level of information by groups of countries. Based on the calculation of factor loads, the most influential indicators have been determined, which serve as the basis for the formation of the informatization process mechanism in the countries of each cluster group. Accordingly, for example, from Innovations and Improvement Factors the major ones were only for second cluster: Government efficiency and Efficiency of goods market and for third cluster was Global Competitiveness Index. The study allowed to determine the main priorities for the development of information in the context of clusters, formed in accordance with the level of information development in the country of each group. Interpretation of the results allowed determining the most influential factors in the development of informatization of the countries of each group, which is the basis for forming recommendations on organizational measures to increase the level of informatization in the context of international globalization.

DOI: 10.22034/gjesm.2019.SI.19

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
17	1	3

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Note: Discussion period for this manuscript open until October 1, 2019 on GJESM website at the "Show Article.

INTRODUCTION

The state of the IT industry and informatization in the economic development of any country is important. Back in 1977, the special commission of the US Senate made conclusions about the prospects for the development of science and technology, which they will give more attention than any other component of national policy or national programs. It was determined that "in advanced countries, the development of informatization, development and implementation of technological innovations is a decisive factor in social and economic development, a guarantee of economic security". For example, in the United States, the growth of national income per capita due to this factor in recent years is up to 90% (USDS, 2017). Thus, in today's world space, the level of informatization becomes crucial in determining the level of the economy of the country. It is known that the development of country informatization processes depends on the degree of influence of information technology on the development of economy, namely the level of their application. The development of informatization is one of the most important forces contributing to the transformation, modernization and innovation of industries. Informatization accelerates technological innovation, facilitates the transformation and modernization of traditional industries and accelerates the development of new industries (Ping *et al.,* 2013). It is known that the general use of information resources and information technologies in the economy of each country is a distinctive feature of the information economy (Hanna, 2010). Then it is possible to determine the main factors influencing the processes of world informatization. Thus, it may be concluded that the technological readiness of the country for the implementation of information technologies and technical innovations, the level of application of innovations in the country's industrial and economic activity; as well as all issues related to the dissemination, readiness to use the ICT (Information and communications technology) of the country are key factors that determine world informatization development in the conditions of international globalization. The researchers in Wolfson and Volchina (2017) show that issues related to the proliferation, readiness to use country information and communication technologies are key factors determining the development of the process of the world informatization. The scientific article Holovka (2016) considers the holistic vision of the informatization process, which depends on modern information risks in a globalized world (Babenko *et al.,* 2018). The author believes that information security is one of the main factors in the sustainable development of a modern information society. According to Tianqi and Qibin (2013), information and communication technologies today are a significant part of the country's national economy. In connection with the proliferation of informatization processes, scientists identified and conceptualized the concept of a new economy, information society, and knowledge economy. However, at the present stage of development, due to the spread of information technology, there is a problem of their protection. The article of Sazonets and Ali (2018) presents a typical incident scenario for the information system and the most common threats to information security by socio-economic relations between countries. It is developed the scheme of the main types of security threats for the corporate economy information systems and socio-economic relations. The same opinion is shared by other authors Prokopenko *et al.* (2018) who performed an analysis of ICT use in the process of informatization in the industry 4.0. Investigated long-term trends of the expansion of basic information and communication technologies in the period XX - the beginning of XXI century Nagirnaya (2013) confirmed the existence of innovative waves of informatization. At the same time, it is determined the problem of self-restraint of the world information space and the international communicative openness of the countries. Thus, analysis of informatization development process shows that it is made enormous progress. Information processes opened fundamentally new possibilities for a radical change in the direction of information processing tools development, radically changed the information environment. Recently, ICTs have gained steady and rapid development in the world and became the main driver of global economic growth (Jianping and Qian (2013). The authors argue that the level of information development closely relates to Gross domestic product (GDP). It is needed further research to determine the relationship with other macroeconomic indicators. The study of informatization peculiarities and the interconnection of information factors for countries with different

degrees of socioeconomic status will help to develop the correct strategy of the world informatization. With this objective in previous studies, the main clusters of the countries were determined according to the criterion of their level of informatization process development (Babenko *et al.,* 2017). This study has been carried out in V. N. Karazin Kharkiv National University in 2018.

MATERIALS AND METHODS

Consider more carefully the mathematical methods and models that are used in the analysis and forecasting of various socio-economic phenomena, in particular, the process of world informatization (Tong *et al.,* 2010). When solving relevant socio-economic processes, the researcher often confronts with the multiplicity of their description. Methods of multidimensional analysis are the most effective quantitative tool for the study of socio-economic phenomena, which are described by a large number of characteristics. These include cluster analysis, correlation analysis, and others. Cluster analysis is a method that most reflects the features of multidimensional analysis in classification and grouping, correlation analysis studies communication. Sometimes the approach of cluster analysis in literature is called numerical taxonomy, numerical classification, etc. (Babenko and Perepelitsia 2018). It is known that in tasks of socioeconomic forecasting, there is successful and promising combination of cluster analysis with other quantitative methods (for example, with correlation or factor analysis) (NRI, 2016). Correlation (two-dimensional) tables are used for the table image of the pair connection and the definition of their "tightness". It allows calculating the linear correlation coefficient. In the correlation table, it is possible to display only a pair of links, that is, the link of the resultant sign to one factor. To compile a correlation table of pair communication, there is a table in which the groups of one (for example, productive) signs are deposited in rows, and groups of other (now factor) signs are placed in columns. The cells in this table indicate the number of units, which have a certain value of one or another attribute. The results on the lines (n_y) will show the number of units in each group of the resulting attribute (if it is placed in rows). Column results (n_x) will show the distribution of the factor trait. In a cell, in which the results in a row are consistent with the results in a column, there is the number of observations using Eq. 1.

$$\sum n_y = \sum n_x = N \quad (1)$$

An indicator called the empirical correlation relation can measure the «tightness» or the strength of the connection between two signs. This indicator is called empirical, since it can be calculated based on the usual grouping on the factor and result indicators that is, based on the correlation table. The empirical correlation relation is derived from the rule of making dispersions, according to Eq. 2.

$$\sigma^2 = \overline{\delta}^2 + \overline{\sigma}^2 \quad (2)$$

Where, σ^2 - total dispersion; σ^2 - intergroup variance; $\overline{\sigma}^2$ - intragroup (secondary to partial) dispersion. The intergroup dispersion is a measure of oscillation due to a factor characteristic. The average of the partial dispersions is the measure of oscillation due to all other (except factor) features. Then the ratio shows the fraction of the oscillation that occurs at the expense of the factor sign in the general oscillation. The square root of this relation is called the empirical correlation relation as Eq. 3.

$$\eta = \sqrt{\overline{\delta}_x^2 / \sigma^2} \quad (3)$$

Hence, the rule that the greater the intergroup dispersion, the stronger the factor affects the variation of the resultant characteristic. Component ratios of dispersions are calculated according to the correlation table using Eq. 4.

$$\sigma_y^2 = \frac{\Sigma y^2 n_y}{N} - \overline{y}^2; \quad \delta_x^2 = \frac{\Sigma(\overline{y}_i - y)^2 n_x}{N} \quad (4)$$

Where, $\overline{y}_i$ - partial averages; $\overline{y}$ - general average; n_y - results on the basis of y; n_x - results on the basis of x; $N = \Sigma n_x = \Sigma n_y$ - number of observations. The same relation is retained for conditional values $y = y'$ obtained by numerical transformations y.

The empirical correlation ratio varies from 0 to 1. If it is zero, this means that the factor sign on the correlation relationship does not affect. If η = 1, then the resultant characteristic completely depends on the factor. If the empirical correlation is small, close to one, then there is a close connection between the factor and the resultant traits. If this fraction had (close to zero), then there is a weak link between them. Existing methods of assessing the level of world informatization in conditions of international globalization are

fragmented, as they analyze partial indicators. During the research, is advanced the hypothesis about the existence of peculiarities of the informatization development by groups of countries with similar level of development. In developing this technique, it is suggested to take into account individual differences in the values of the analyzed indicators of individual countries based on economic-mathematical modeling with the use of tools of multidimensional statistical analysis, namely cluster analysis. For further study of the factors influencing the level of world informatization in terms of informatization development in conditions of international globalization, a correlation analysis is necessary.

RESULTS AND DISCUSSION

Based on data for 2017 for the specified indicators NRI та GCI (Global Competitiveness Index) (NRI, 2016, GCR, 2017), was established homogeneity of the countries in their aggregate by the Ward method using the statistical package Statgraphics Centurion (NRI, 2016). By dint of computed cluster analysis, 4 clusters are allocated, the dendrogram of which is shown in Fig. 1. The visual analysis of the dendrograms shows that the four clusters of the main classes of world countries grouping should be considered according to the system of attributes, which are characteristics of world informatization in the conditions of international globalization. Characteristics of each world countries cluster by their informatization level are shown in Table 1.

As it can be seen, the first cluster is the most representative. It includes 53 countries of the world, accounting for 35.1% of all countries. The second cluster consists of 48 countries, is 31.79%. The third cluster in terms of countries number is considerably inferior to the first two and contains 28 countries (18.54%). The fourth cluster includes 22 countries, and it is the smallest cluster with a share of 14.57% of all countries in the world.

Table 1: Clusters characteristics of world countries according to informatization level*

Cluster number	Number of countries included in the cluster	Countries distribution by clusters,%
1	53	35,10
2	48	31,79
3	28	18,54
4	22	14,57

*Calculations by authors based on cluster analysis

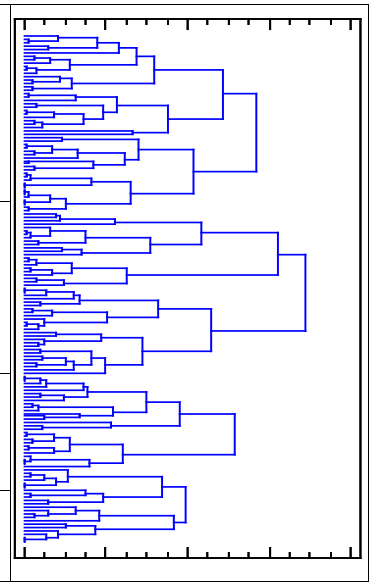
Albania, Argentina, Armenia, Azerbaijan, Bhutan, Bosnia and Herzegovina, Brazil, Bulgaria, Cape Verde, China, Colombia, Croatia, Dominican Republic, Ecuador, El Salvador, Guinea, Guyana, Honduras, Guinea, Honduras, Hungary, India, Indonesia, Iran , The Islamic Republic of Iran, Jamaica, Kazakhstan, Kenya, Kuwait, Kyrgyzstan, the Democratic People's Republic of Korea, Lebanon, Macedonia, Mexico, Moldova, Mongolia, Montenegro, Morocco, Peru, Philippines, Poland, Romania, Russian Federation, Rwanda, Serbia, Seychelles, Sierra -Leone, Slovakia, South Africa, Sri Lanka, Thailand, Trin DBP and Tobago, Tunisia, Ukraine, Vietnam	
Algeria, Angola, Bangladesh, Belize, Benin, Bolivia, Botswana, Burkina Faso, Burundi, Cambodia, Cameroon, Chad, the Ivory Coast, Egypt, Ethiopia, Gabon, Gambia, Ghana, Guatemala, Guinea, Haiti, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mozambique, Myanmar, Namibia, Nepal, Nicaragua, Nigeria, Pakistan, Paraguay, Senegal, Suriname, Swaziland, Syria, Tajikistan, Tanzania, Timor-Leste, Uganda, Venezuela, Yemen, Zambia, Zimbabwe	
Australia, Austria, Belgium, Canada, Denmark, Estonia, Finland, France, Germany, Hong Kong, Iceland, Ireland, Israel, Japan, Korea, Luxembourg, Malaysia, Netherlands, New Zealand, Norway, Qatar, Singapore, Sweden, Switzerland, Taiwan , China, United Arab Emirates, United Kingdom, United States of America	
Bahrain, Barbados, Brunei Darussalam, Chile, Costa Rica, Cyprus, Czech Republic, Italy, Jordan, Latvia, Lithuania, Malta, Mauritius, Oman, Panama, Portugal, Puerto Rico, Saudi Arabia, Slovenia, Spain, Turkey, Uruguay	

Fig. 1: Dendrogram of world clusters according to informatization process

Consequently, based on the performed cluster analysis, the major groups of world countries were identified, which differ in informatization development levels. A quantitative analysis of attribute characteristics mean values for each of the four calculated clusters indicates that the difference between groups of countries is more than doubled. Thus, it can be argued that the current world informatization level in conditions of international globalization is characterized by unevenness and heterogeneity. Based on correlation analysis, it was determined the correlation indices, which are quantitative characteristics of the relationship of the investigated features. GCR, 2017 is proposed system of result indicators, which included subindeks for the readiness and use of ICT in the country, its environment and the impact of ICT, technological readiness of the country, innovations and improvement factors provided by Eurostat and the European Commission. They are the main characteristics that form informatization development level. The analysis of sub-indices additive value, which characterizes country`s informatization development, did not show any contradiction with the results of the cluster analysis. This conclusion also confirms the assumption of the use of the proposed system of key indicators on the basis of certain sub-indices influencing country's informatization. Thus, it is obtained a reasonable system of indicators on the basis of which further calculations will be made, namely: x_1 – sub-index "Technological Readiness", x_2 – sub-index "Innovations and Development Factors", x_3 – sub-index "ICT Environment", x_4 – sub-index "ICT Readiness", x_5 - sub-index "ICT Use", x_6 - sub-index "ICT Influence". It is investigated whether there is a connection (and to what extent it is "tight") world informatization level between its socio-economic status. To do this, there are defined indicators of informatization development and separate macroeconomic features of countries. As the result indicators are ICT sub-indices, factors are separate macroeconomic indicators, determined from Eurostat (2018) (Table 2). A quantitative analysis of attribute characteristics mean values for each of the four calculated clusters indicates that the difference between groups of countries is more than doubled. Thus, it can be argued that the current world informatization level in conditions of international globalization is characterized by unevenness and heterogeneity. Based on correlation analysis, it is determined the correlation indices, which are quantitative characteristics of the relationship of the investigated

Table 2: Indicators for determining correlation level of countries informatization development and macroeconomic factors, their conditional designation (GCR, 2017; Eurostat, 2018)

Indicator	Conditional designation
Result Indicators	
Sub-index "Technological Readiness" (GCI.B.09)	x_1
Sub-index "Innovations and Improvement Factors" (GCI.C)	x_2
Sub-index "ICT Environment" (NRI.A)	x_3
Sub-index "ICT Readiness" (NRI.B)	x_4
Sub-index "ICT Use" (INR.C)	x_5
Sub-index "ICT Influence" (NRI.D)	x_6
Factor indicators	
Electrification and telephone infrastructure, points	x_7
Government efficiency, points	x_8
Health and elementary education, points	x_9
Child death rate, death rate / 1,000 live births	x_{10}
Expected life expectancy, years	x_{11}
Quality of elementary education, points	x_{12}
Primary education coverage, %	x_{13}
Higher education and training, points	x_{14}
Security level, points	x_{15}
Efficiency of goods market, points	x_{16}
Import as a percentage of GDP,%	x_{17}
Macroeconomic environment, points	x_{18}
GDP, millions of dollars	x_{19}
Export as a percentage of GDP,%	x_{20}
Global Competitiveness Index, points	x_{21}

features. GCR (2017) is proposed system of result indicators, which included sub-index for the readiness and use of ICT in the country, its environment and the impact of ICT, technological readiness of the country, innovations and improvement factors provided by Eurostat and the European Commission. They are the main characteristics that form informatization development level. The analysis of sub-indices additive value, which characterizes country`s informatization development, did not show any contradiction with the results of the cluster analysis. This conclusion also confirms the assumption of the use of the proposed system of key indicators on the basis of certain sub-indices influencing country's informatization. Thus, it is obtained a reasonable system of indicators on the basis of which further calculations will be made, namely: x_1 – sub-index "Technological Readiness", x_2 – sub-index "Innovations and Development Factors", x_3 – sub-index "ICT Environment", x_4 – sub-index "ICT Readiness", x_5 - sub-index "ICT Use", x_6 - sub-index "ICT Influence".

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Based on 2017 data, for all countries grouped into clusters, using the widely used statistic calculations of the software package Statgraphics, it is calculated the correlation analysis defined in Table 2 of productive and factor characteristics. The calculations are carried out separately for each of the four world clusters, adhering to the advanced hypothesis of ambiguity nature of processes functioning associated with countries informatization development within each cluster. The results of the correlation analysis for the group of countries of the first cluster between informatization and macroeconomic indicators for the first group of countries are presented in Table 3. Thus, the level of technological readiness is most closely correlated with the level of development of electrification and telephone infrastructure in the country; to a lesser extent - with the state of higher education and training; and in the minor - with the following factors: the level of health, the expected life expectancy in society, and also, the level of primary education and global competitiveness of the country. Regarding the correlation balances related to the investigated factors, the less close connection with the sub-index "Innovations and Factors of Improvement" is only an indicator of the level of global competitiveness of the country. Largely, this sub-index correlates with the indicators of government efficiency, the efficiency of the goods market, and the country's GDP.

Similarly, based on the results of cluster analysis, it is possible to trace the relationship and its closeness

Table 3: Correlation levels between informatization and macroeconomic indicators for the countries of the first cluster*

Indices	Correlation coefficient value		
	>=0,3	>=0,5	>=0,7
x_1	x_9: 0,3516 x_{11}: 0,4399 x_{21}: 0,4661	x_{14}: 0,678	x_7: 0,7025
x_2	x_8: 0,3763 x_{16}: 0,4299 x_{19}: 0,4057	x_{21}: 0,5601	-
x_3	x_{15}: 0,4203 x_{21}: 0,3091	x_8: 0,5594 x_{16}: 0,6498	-
x_4	x_9: 0,3409 x_{12}: 0,3616 x_{14}: 0,4233	x_7: 0,6548 x_{14}: 0,511	-
x_5	x_{15}: 0,3091 x_{18}: 0,4954 x_{21}: 0,4933	x_7: 0,5171	-
x_6	x_7: 0,3103 x_{16}: 0,3644 x_{18}: 0,4265	x_{21}: 0,5244	-

*Compiled by the author according to the correlation analysis

between sub-indices of informatization and macroeconomic indicators for other world clusters. It is observed that the sub-indices "Readiness for ICT", "ICT Use" and "ICT Influence" do not have a significant correlation with the macroeconomic factors under study for all four groups of countries, indicating the independence of these indicators from the macroeconomic environment in the context of world globalization. Thus, the analysis of the correlation coefficients allowed determining the quality interrelationship and its degree between countries informatization development and the level of macroeconomic environment development within each group (Table 3).

CONCLUSION

The comparative analysis of the interdependencies of the values of macroeconomic indicators and information factors is made. It is possible to draw a generalized conclusion about Ukraine's development towards the growth of its socio-economic situation. Indicated informatization process of Ukraine in the dynamics is inconsistent, and it takes place against the backdrop of complex behavior of the business environment. Due to lack of effective and consistent state policy of informatization reform, available scientific and technological potential as a driving factor in the aspect of its development is not realized, which affects the rather low development level of Ukraine's informatization. It is researched the approach to the estimation of world informatization processes development in the conditions of international globalization. Thus, based on the data for 2017, it is established the homogeneity of the countries in their aggregate by the Ward method using the statistical package Statgraphics Centurion. Based on the performed cluster analysis, were identified the main groups of world countries, which differ in levels of informatization development. A quantitative analysis of attribute characteristics mean values for each of the four calculated clusters indicates that the difference between groups of countries is more than doubled. Consequently, based on the performed cluster analysis, the major groups of world countries were identified, which differ in informatization development levels. A quantitative analysis of attribute characteristics mean values for each of the four calculated clusters indicates that the difference between groups of countries is more than doubled. Thus, it can be argued that the current world informatization level in conditions of international globalization is characterized by unevenness and heterogeneity. In addition, it is found homogeneous groups of countries with a similar level of informatization development. This led to the assertion that in each group of countries with their characteristic level of informatization development, there are their most influential factors that determine the development of this process. It is calculated correlation analysis. It is executed for each defined group of countries of world informatization. This system is based on the Indices of NRI and GCI. The calculation of the correlation coefficients of the interrelation of these indicators allowed determining the most significant indicators that form the mechanism of world informatization process of each cluster. Interpretation of the obtained results made it possible to determine the most influential factors of world informatization development of each group, which is the basis for recommendations formation of organizational measures for increasing the level of their informatization in conditions of international globalization.

ACKNOWLEDGEMENT

The authors are grateful to V.N. Karazin Kharkiv National University, Ivano-Frankovsk National Technical University of Oil and Gas, Kharkiv Petro Vasylenko National Technical University of Agriculture and Poltava State Agrarian Academy for facilitating the accomplishment of this study.

CONFLICT OF INTEREST

The author declares that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely observed by the authors.

ABBREVIATIONS

%	Percentage
GCI	Global competitiveness index
GCI.B.09	Sub-index "Technological readiness"
GCI.C	Sub-index "Innovations and Improvement Factors"

GCR	Global Competitiveness Report
GDP	Gross Domestic Product
ICT	Information and communications technology
NRI	Networked readiness index
NRI.A	Sub-index “ICT Environment”
NRI.B	Sub-index “ICT Readiness”
INR.C	Sub-index “ICT Use”
NRI.D	Sub-index “ICT Influence”

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HOW TO CITE THIS ARTICLE

Babenko, V.; Perevozova, I.; Mandych, O.; Kvyatko, T.; Maliy, O.; Mykolenko, I., (2019). World informatization in conditions of international globalization: factors of influence. Global. J. Environ. Sci. Manage., 5(SI): 172-179.

DOI: 10.22034/gjesm.2019.SI.19

url: https://www.gjesm.net/article_35475.html