

**CHARACTER OF LINKS BETWEEN INDEXES OF ICT AND FACTORS OF
 SOCIO-ECONOMIC DEVELOPMENT OF COUNTRIES**

Rauf Iskanderov

The Academy of Public Administration, Baku, Azerbaijan
 rauf_magistr@aport.ru, rauf_dia@hotmail.com

There was presented an issue of using system-structure modeling to find out links between indexes of development of ICT and factors of socio-economic and scientific and technical development of countries in the research work. The main point of the approach is an idea of independence between indexes according to hide Markov chain and research and evaluation of links between the indexes by calculation cross Shannon's information entropy.

The analysis of multitude of data for research have been realized on the base of the following sources: 1) UN global e-government readiness report - 2005 [3, p. 196-244]; 2) report about size of the shadow economies all over the world (1999-2004) [4, p. 54-57]; 3) report of the Fund For Peace about failed states index scores all over the world [5].

All complex of variables ξ_i , where $I \in \{i\}$ can be divided into three groups of variables – ξ_x, ξ_y, ξ_z and can be presented in the following way [1, p.118]:

$$\delta(\xi_x, \xi_{Y \cup Z}) - \delta(\xi_x, \xi_Y) \equiv \delta_{\xi_y}(\xi_x, \xi_Z) = 0, \quad (1)$$

The formula 1 means independence ξ_x from ξ_z according to the condition of existence of ξ_y , i.e. information about ξ_x can be gotten from ξ_y and adding information of ξ_z doesn't play important role of increasing information about ξ_x . It conditionally enough to draw a graph of links - Q_i of the random variables ξ_x, ξ_y, ξ_z , where $X, Y, Z \subseteq I$. The structure of the random variables $\delta(\xi_i) = (i, \xi_{I \in \{i\}}) = (i, \{\xi_x, \xi_y, \xi_z\})$ can be defined roughly by the graph of the links between elements of the system $\delta_{\xi}(i, Q_i)$.

Taking into account that information entropy can be calculated on the base of an formula $H(\xi_x) = -\sum P(\xi_x) \log p(\xi_x)$ [2, p. 656-715] the character of links between variables $\delta(\xi_x, \xi_y)$ can be presented in the following way [6]:

$$\delta(\xi_x, \xi_y) = \sum p(\xi_x \xi_y) \log p(\xi_x \xi_y) - (\sum p(\xi_x) \log p(\xi_x) + \sum p(\xi_y) \log p(\xi_y)), \quad (2)$$

where $\sum p(\xi_x \xi_y) \log p(\xi_x \xi_y)$ - cross entropy of random variables ξ_x и ξ_y

The calculations of Shannon's information entropy will be simplified if it is assumed that any variable of system $\xi_{I \in \{i\}} = \{\xi_x, \xi_y, \xi_z\}$ divide the system into $R_j^i = \{r_1^i, r_2^i, \dots, r_{q^i}^i\}$ groups, where q^i is a number of value of the variable $\xi_{I \in \{i\}}$. So it is reasonable if the distribution of random variables will be presented as groups of divisions by their frequency of appearance - $P_j(\xi_i) = R_j^i / n$. Using the table of natural logarithms, entropy of variables $H(\xi_x), H(\xi_y), H(\xi_z)$ will be calculated by frequencies of distributions of $P_{j'}(\xi_x), P_{j''}(\xi_y), P_{j'''}(\xi_z)$, where $j'=(1,2,\dots,q^x), j''=(1,2,\dots,q^y), j'''=(1,2,\dots,q^z)$ like this:

$$\delta(\xi_x, \xi_y) = \ln n - \frac{1}{n} \left(\sum_{j'=1}^{q^x} R_{j'}^x \ln R_{j'}^x + \sum_{j''=1}^{q^y} R_{j''}^y \ln R_{j''}^y - \sum_{j'=1, j''=1}^{q^x q^y} R_{j' j''}^{xy} \ln R_{j' j''}^{xy} \right) \quad (3)$$

After finding the features of the links between the multitude of the couples of the random variables by calculating their information entropy we have to distribute them lexicographically and define maximum values among of them - $\delta_{max}(\xi_x, \xi_y)$. The values of the variables δ_{max} characterize a sensibility of the links of the variables: how much the value - $\delta(\xi_x, \xi_y)$ is more so much the link between variables - ξ_x, ξ_y is stronger. So on the base of values - δ_{max} we will draw

the graph of elements of our system.

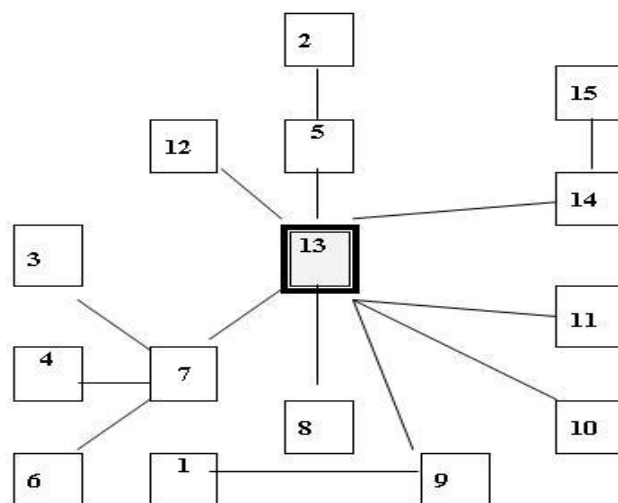
After keeping away insignificant statistic variables for realizing our research we have following 15 variables: 1) education index (human capital index), 2) mounting demographic pressures, 3) rise of fractionalized elites, 4) uneven economic development along group lines, 5) progressive deterioration of public services, 6) suspension or arbitrary application of the rule of law and widespread, 7) security apparatus operates as a "state within a state" 8) web measure, 9) telephone index 10) internet users index, 11) personal computers (pc) index, 12) e-government readiness index, 13) telecommunication infrastructure index, 14) e-service delivery by stages (v-stages), 15) e-participation index.

Having 15 sorted variable of 175 countries with help of following constants- $\ln(n=175) = 5.1648$, $1/n = 0.0057$ the calculation of the entropy of all couples of variables on the base of the formula 3 will be simplify. Let us to have a look at symmetric matrix of values was gotten by calculation of cross entropy of all 15 variables (table.2).

Table 2. A table of the values of the cross entropy of all 15 variables of 175 countries

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1														
2	,23													
3	,13	,31												
4	,13	,34	,33											
5	,28	,44	,26	,26										
6	,15	,34	,43	,31	,32									
7	,17	,33	,46	,37	,35	,41								
8	,22	,35	,31	,36	,37	,35	,38							
9	,31	,40	,27	,28	,48	,36	,36	,44						
10	,29	,37	,26	,26	,45	,35	,34	,50	,55					
11	,26	,37	,30	,30	,41	,35	,36	,54	,52	,60				
12	,30	,39	,28	,35	,39	,35	,38	,54	,58	,52	,53			
13	,28	,39	,27	,31	,50	,36	,40	,56	,61	,65	,63	,58		
14	,18	,26	,18	,20	,28	,18	,26	,30	,31	,32	,32	,47	,34	
15	,10	,14	,14	,13	,17	,13	,19	,17	,20	,19	,18	,23	,21	,36

As a result of the selection we have the following couples which help us to draw our graph (pic. 1): 1 → 9; 2 → 5; 3 → 7; 4 → 7; 5 → 13; 6 → 7; 7 → 13; 8 → 13; 9 → 13; 10 → 13; 11 → 13; 12 → 13; 13 → 14; 14 → 15.



Pic. 1. The graph of sensible links of the 15 variables

As we can see from picture 1 the telecommunication infrastructure index have got sensible strong links with web measure index, telephone index, internet users index, personal computers (PC) index and among ones just telephone index have got interdependence from education index (human capital index). Additionally as a result of our research was gotten following interesting combinations of sensible links between variables: 1-9-13, (3,4,6)-7-13, 2-5-13, 13-14-15, (8,10,11,12)-13 (pic.1).

Literature

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