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Milivoje Radenković
Andrej Novović

Address
Belgrade, Jove Ilića 154
Tel./fax. 381 11 3950 868
E-mail: manage@ fon.bg.ac.rs
http://management.fon.bg.ac.rs

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ICT as Crucial Component of Socio-economic Development

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Veljko Jeremić, Aleksandar Marković, Zoran Radojičić
Faculty of Organizational Sciences, University of Belgrade

The aim of this paper is to present new ideas in evaluating socio-economic development of countries. Since Internet connectedness and IT literacy are very often introduced as indicators of socio-economic development, ICT infrastructure is of huge research interest. The World Bank's ICT at glance database published annually presents essential data about every country's ICT indicators. However, no composite indicator of ICT infrastructure is presented. Aim of our paper is to present a composite indicator which synthesizes a number of indicators into one value. With this approach, countries can be ranked according to their ICT development. Moreover, useful insights will be provided for the developing countries and a path for enhancing their ranking will be elaborated.

1. Introduction

The measure of a country's welfare is one of the most critical and highly debated issues in economic research [1]. Certain researchers [2] address the hypothesis that GNP (or GDP) per capita cannot be considered as being the only indicator of the performance of a country since it does not capture the overall well-being of its population. Nevertheless, it is very common to rank countries according to their GDP (or GNP) in the current literature on the subject. One potential improvement is the World Bank's Human Development Index (HDI), which is based on a country's per capita GDP, life expectancy at birth and adult literacy rate [3]. However, this instrument has seen much disagreement; in particular, it is a simple weighting of each variable and the usual high correlation between GDP and certain background variables [3]. Besides the abovementioned issues, the real problem concerning the HDI is a small number of variables (just three) incorporated into the ranking process. Moreover, the HDI does not take into account an essential component of modern economies – ICT. Several papers emphasize its importance by incorporating the Internet connectedness and IT literacy as key indicators of socio-economic development. There are several reasons for this approach. Many previous research articles pointed out that people's ability to handle information is crucial for their future success [4]. These skills – known as IT literacy – can be considered a 21st-century form of literacy [5]. In today's globalized world, it is virtually impossible to imagine any business process without IT experts. Further on, whole range of our daily activities (shopping, banking) is dependant upon the Internet. The supper fast broadband, numerous WiFi access points, all of them are characteristics of wealthy and powerful countries. Consequently, it is essential to elaborate this indicator as hugely important in determining countries' welfare. In a line with this, the intention of this work is to examine the development level of the countries' ICT infrastructure. Therefore, the goal is to determine not only which countries are ICT leaders but also which indicators are crucial for rank determining.

2. The i-distance method

The ranking of specific issues is quite often carried out in a way that can seriously affect the process of taking exams, entering competitions, the UN participation, medicine selection and many other subjects [6, 7, 8, 9]. A key argument for applying the I-distance method is that this approach is capable of synthesizing many variables into one numerical value. This has proven to be quite useful since all the variables have a different type of measurement each [6, 7]. I-distance is a metric distance in an n-dimensional space. This method has been proposed and defined in various publications that have appeared since 1963 by B. Ivanovic [10]. Ivanovic created this method to rank countries according to their level of development on the basis of several indicators. Many socio-economic development indicators have been considered in the use of this method and the problem has been how to use all of them in order to calculate a single synthetic indicator which will represent the rank.

For a selected set of variables $X^T = (X_1, X_2, ..., X_k)$ chosen to characterize the entities, the I-distance between the two entities $e_r = (x_{1r}, x_{2r}, ..., x_{kr})$ and $e_s = (x_{1s}, x_{2s}, ..., x_{ks})$ is defined as:

$$D(r,s) = \sum_{i=1}^{k} \frac{|d_i(r,s)|}{\sigma_i} \prod_{j=1}^{i-1} \left(1 - r_{ji.12...j-1}\right) \quad (1)$$

where d_i *(r,s)* is the distance between the values of the variable X_i for e_r and e_s, e.g. the discriminate effect,

$$d_i(r,s) = x_{ir} - x_{is}, \quad i \in (1, ..., k) \quad (2)$$

σ_i the standard deviation of X_i, and $r_{ji.12...j-1}$ is a partial coefficient of correlation between X_i and X_j, $(j<i)$, [10, 11].

The construction of the I-distance is iterative. It is calculated through the following steps:

1. calculate the value of the discriminate effect of variable X_i (the most significant variable, which provides the largest amount of information on the phenomena needed to be ranked);
2. add the value of the discriminate effect of X_2 which is not covered by X_1;
3. add the value of the discriminate effect of X_3 which is not covered by X_1 and X_2;
4. repeat the procedure for all variables [12, 13].

This I-distance fulfills all 13 conditions for defining the measures of distances and has proven useful in overcoming differences in measures. It is essential to point out that the I-distance method requires a standardization of all data. Sometimes it is not possible to achieve the same sign mark for all variables in all sets, therefore a negative correlation coefficient and negative coefficient of a partial correlation may occur. Thus, the use of the square I-distance is even more desirable [3, 4, 11, 12], which is given as:

$$D^2(r,s)=\sum_{i=1}^{k}\frac{d_i^2(r,s)}{\sigma_i^2}\prod_{j=1}^{i-1}\left(1-r_{ji.12...j-1}^2\right) \quad (3)$$

In order to rank the entities - countries in this case- in the observed set using the I-distance methodology, it is necessary to fix one entity as a referent: an entity with a minimal value for each indicator. The ranking of the entities in the set is based on the calculated distance from the referent entity.

3. Results

In this paper, attention is being focused on examining and measuring the ICT industry in the 26 members of the European Union (due to a lack of data, Malta has not been analyzed) and other 10 developed and developing countries (including Serbia). All of the input data were obtained from World Bank [14]. In order to rank the countries, the following 14 variables have been used:

Table 1. *Indicators for determining ICT development level*

Access	Telephone lines (per 100 people)
	Mobile cellular subscriptions (per 100 people)
	Fixed Internet subscribers (per 100 people)
	Personal computers (per 100 people)
Usage	Internet users (per 100 people)
Quality	Fixed broadband subscribers (% of total Internet subscribers)
Affordability	Residential fixed line tariff (US$/month)
	Mobile cellular prepaid tariff (US$/month)
	Fixed broadband Internet access tariff (US$/month)
Trade	ICT goods exports (% of total goods exports)
	ICT goods imports (% of total goods imports)
	ICT service exports (% of total service exports)
Applications	E-government Web measure index
	Secure Internet servers (per 1 million people)

The results achieved through the use of the I-distance ranking method are presented in Table 2. The Netherlands topped the list according to the I-distance method. Tthe top of the list is occupied by the European countries. It is not surprising at all, since Europe has much more homogenous population and their constant commitment to ICT values is easily understood. All of them have huge percentage of Internet users, computers and telephone lines are accessible to almost everyone, and even the number of secure Internet servers is increasing. All of these factors result in top positions for European countries. On the other hand, China and India are at the bottom of the list. This is a very interesting finding. India has emerged as an ICT power in the last decade. However, ICT is a priviledge of a small number of citizens. A far greater percentage of population is not in a position to benefit from the constant development in the field of ICT. With only 4.5 Internet users per 100 people (while the Netherlands has 87), it is obvious that only a small part of India is embracing the rapid development of ICT. For all the others, ICT is out of reach. Very similar conclusions can be drawn in the example of China. Also, Serbia is very low ranked. It is quite obvious that Serbia is still far away from the EU development goals and has to improve all indicators of the country's welfare. This is particularly the case with ICT variables, since 43.7% of the population have never used a computer (EU-27 average is 26%) and 54.1% have never used the Internet; EU-27 average is 30% [15, 16]. These indicators are far from the EU standards and Serbia definitely has to focus its attention on ICT. It is clear that there are several regions in Serbia where the use of ICT is by far more widespread than in the other regions. For instance, the capital, Belgrade, and the northern part of Serbia (Vojvodina region) are significantly more advanced than the south Serbia. Moreover, "IT Park" is being developed in Indjija (Vojvodina region) and Government realizes the need for ICT investments as a crucial component of economic growth.

Table 2. *The Results of the Square I-distance Method, I-distance Value and Rank*

Country	I-distance	Rank I-distance
The Netherlands	63.253	1
Island	60.240	2
Switzerland	59.878	3
Sweden	58.462	4
Denmark	58.149	5
Luxembourg	55.058	6
Estonia	54.663	7
Great Britain	54.299	8
France	52.905	9
USA	51.082	10
Austria	50.931	11
Hungary	49.781	12
Finland	46.639	13
Spain	45.600	14
The Czech Republic	44.882	15
Belgium	44.266	16
Australia	43.574	17
German	42.550	18
Portugal	41.962	19
Japan	38.362	20
Slovakia	37.898	21
Brazil	37.875	22
Cyprus	35.355	23
Greece	34.010	24
Lithuania	33.302	25
Bulgaria	32.938	26
Slovenia	32.595	27
Poland	30.730	28
Italia	30.123	29
Latvia	29.998	30
Macedonia	26.994	31
Romania	25.071	32
Country	**I-distance**	**Rank I-distance**
Serbia	23.883	33
China	21.760	34
India	17.374	35
Russia	15.399	36

This data set was further examined and a correlation coefficient of each indicator with the I-distance value was determined, the results of which are presented in Table 3 (Pearson correlation test has been used). As it appears, the most significant variable for determining the ICT development is the Internet users (per 100 people), with $r=.861$, $p<.01$. This conclusion is in a line with many previous papers which emphasize the Internet connectedness rate as quite significant for determining a country's development level. In a line with this, it is essential that Serbia and other low-ranked countries should improve the most significant indicators.

Table 3. *The Correlation between I-distance and Input Indicators*

Indicators	r
Internet users (per 100 people)	.861**
Secure Internet servers (per 1 million people)	.764**
Personal computers (per 100 people)	.763**
Fixed Internet subscribers (per 100 people)	.733**
E-government Web measure index	.711**
Fixed broadband Internet access tariff (US$/month)	.671**
Residential fixed line tariff (US$/month)	.654**
Telephone lines (per 100 people)	.642**
Fixed broadband subscribers (% of total Internet subscribers)	.513**
Mobile cellular prepaid tariff (US$/month)	.370*
Mobile cellular subscriptions (per 100 people)	.280
ICT service exports (% of total service exports)	.195
ICT goods exports (% of total goods exports)	.126
ICT goods imports (% of total goods imports)	.066

4. Conclusion

Knowledge economy is becoming the most important factor in the development of the society and regions [17]. As crucial components of knowledge, IT literacy and the Internet connectedness have long been in the focus of research. Some papers have tried to examine the influence of of sociocultural factors on the level of the Internet connectedness [18]. On the other hand, the same author compared the PC Internet connectedness and mobile Internet connectedness [19]. Nonetheless, only a few researchers have tried to explore the interlinkage between the Internet connectiv-

ity and the economic development [20]. As a way to enhance the importance of this indicator, a novel approach has been proposed in this work in which future research on economic and social performance of countries can be based on. By using the I-distance method, a synthesized indicator that incorporates many social and economic indicators can be created. Results presented in this study, clearly show that Serbia has a long way ahead of achieving the European Union development goals and becoming a full member of the EU. In particular, concepts of sustainable development and green IT must be implemented [21, 22]. With only 25.8% of population that own a personal computer and 11.6% the Internet subscribers [14], it is crucial that Serbia should focus its attention on the ICT industry and consequently improve its country welfare.

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