DEPENDENCE OF INFORMATION AND TELECOMMUNICATION TECHNOLOGY DEVELOPMENT ON ECONOMIC INDICATORS

Galina Gayvoronska, Illia Ganytskyi, Petr Yatsuk

***Abstract**: The article describes an analysis of the relationships between different ICT services indicators and economic indicators. Article also gives view for determining the impact of the economic state of the country on developing information and communication technologies, as well as the influence of the development one information technology on other.*

***Keywords**: telecommunication technologies, ICT indicators, technology development.*

***Keywords classification of ACM**: D.2.9 Management, K.6.3 Life cycle.*

Introduction

Information and communication technology (ICT) - is a sphere susceptible to rapid, continuous and cardinal changes in the entire world. Various international researches show that there is a close relationship between ICT development and the economic condition of the country. Level of telecommunication technologies development (CT) has a big impact on the economic indicators of the national economy as a whole. The main goal of this research was to determine the existence and degree of correlation between the technological and economic indicators to determine the impact of the economic state of ICT development.

To determine the dependence of the technology development level on the economic status, country-specific research performed following indicators:

1. Indicators that reflect the diversity of users simultaneously used terminals and communications equipment:
   - The proportion of households using radio, television, computer with Internet access, using the services of fixed-line telephone, mobile communications;
   - The proportion of individuals using computer as the terminal equipment and a mobile cellular telephone.
2. Economic indicators information and communications services (ICS):
   - The average salary index and the industrial production index.
3. Utilization ICS:
   - Percentage of the population that uses the ICS.

The impact of economic factors on the development of telecommunications

Statistical sample contains the values of above indicators for 53 countries over the period from 2008 to 2012. Source of statistics is Internet resources such as International Telecommunication Union (ITU) [ITU, 2014] and the United Nations Economic Commission for Europe (UNECE) [UNECE, 2014]. Due to the facts that in the given statistics are missing values, they are taken as "0.00". That is why the results of calculations have an error. However, the number of such values is small, and the impact of missing data on the results of the research is insignificant.

To investigate the relationship between ICS economic indicators availability [ITU, 2009] and ICS utilization rates correlation analysis is applied [Bendat & Piersol, 1993]. The main goal of the analysis is determine degree and nature of the relationship between random observations, which are distributed by multivariate normal law. The correlation coefficient characterizes the presence of a linear relationship between the indicators X, Y, and is described by the expression [Astafurova, 2014]:

$$r_{x,y} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 (y_i - \bar{y})^2}} \quad (1)$$

where x_i – values, from sample X; y_i – values, from sample Y; $\bar{x}$, $\bar{y}$ – average values of samples X and Y.

The degree of association between the indicators is estimated using the correlation coefficient calculated using the formula (1) and has a value from -1 to +1. Positive or negative sign near one points to a direct or inverse relationship between values x and y [Eliseeva, 2001].

Average values of the samples X and Y are defined as:

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i = \frac{1}{n}(x_1 + x_2 + \cdots + x_n) \quad (2)$$

$$\bar{y} = \frac{1}{n}\sum_{i=1}^{n} y_i = \frac{1}{n}(y_1 + y_2 + \cdots + y_n) \quad (3)$$

where n – size of the sample.

The lack of normal distribution of the parameters is defined while preprocessing source statistics. In this regard, statistics are calculated by use of nonparametric methods [Hartigan, 1975; Jain & Dubes, 1988; Johnsonbaugh & Schaefer, 2004]. The results of statistics calculations with methods of nonparametric statistics are presented in the form of a matrix in Table 1. The rows describe the main statistical random variables characteristics for the given parameters.

Table 1. The results of statistical indicators calculations

	EE1	EE2	EE3	HH1	HH2	HH3f	HH3m	HH4	HH6	HH5	HH10
SS1	2227,97	109,5	60,17	59,07	74,93	37,73	77,00	46,46	43,47	59,63	79,15
SS2	3750301	449,5	578,7	464,2	872,9	822,5	446,6	887,1	917,9	512,8	311,8
SS3	1936,57	21,20	24,06	21,55	29,55	28,68	21,13	29,79	30,30	22,65	17,66
SS4	6742,50	191,2	94,60	99,60	100,0	94,80	99,30	96,00	97,40	99,70	99,64
SS5	82,10	76,40	8,00	4,58	5,30	0,30	26,30	0,13	0,08	0,90	29,56
SS6	6660,40	114,8	86,60	95,02	94,70	94,50	73,00	95,87	97,32	98,80	70,07
SS7	-	90,80	67,00	82,00	100,0	37,80	85,10	92,00	63,00	-	-
SS8	1287,00	104,9	65,95	60,20	89,61	37,80	85,10	48,96	40,98	61,19	85,66

Characteristics and parameters used in the table:

SS1 - the average value of the sample, calculated by formula (2) or (3).

SS2 - dispersion calculated by the formula:

$$D_B = \frac{\sum_{i=1}^{n} \left(x_i - \overline{x}\right)^2}{n} \quad (4)$$

where x_i – i-th element of the sample; $\overline{x}$ – the average value of the sample; n – sample size.

SS3 – standard deviation - sample values scattering factor calculated by the formula:

$$\sigma = \sqrt{D_B} = \sqrt{\frac{\sum_{i=1}^{n} \left(x_i - \overline{x}\right)^2}{n}} \quad (5)$$

where x_i – i-th element of the sample; $\overline{x}$ – the average value of the sample; n – sample size.

SS4 - the maximum value of the sample.

SS5 - minimum value of the sample.

SS6 - the range defined by the difference of maximum and minimum values.

SS7 - mode, the most frequent value in the sample.

SS8 - median - the value is the midpoint of a set.

EE1 - average wage value in the country in U.S. dollars.

EE2 - the industrial production index.

EE3 - percentage of the population that uses ICS.

HH1 - the percentage of households with a radio.

HH2 - the percentage of households with a television.

HH3f - the percentage of households with fix-line phone only.

HH3m - the percentage of households with a mobile cellular telephone.

HH4 - the percentage of households with a computer.

HH5 - the percentage of individuals who used a computer in the last 12 months.

HH6 - the percentage of households with Internet access at home.

HH10 - percentage of individuals using wireless technology.

The resulting correlation values calculated by formula (1) are shown in Table 2.

Table 2. Correlation coefficients

	EE1	**EE2**	**EE3**	**HH1**	**HH2**	**HH3f**	**HH3m**	**HH4**	**HH6**	**HH5**	**HH10**
EE1	1	0,398	0,771	0,257	0,059	0,281	0,103	0,652	0,753	0,499	0,411
EE2	0,398	1	0,374	0,247	0,008	0,174	0,053	0,352	0,365	0,344	0,262
EE3	0,771	0,374	1	0,264	0,016	0,209	0,052	0,769	0,839	0,650	0,488
HH1	0,257	0,247	0,264	1	0,188	0,420	0,385	0,260	0,278	0,139	0,096
HH2	0,059	0,008	0,016	0,188	1	0,491	0,477	0,107	0,055	0,093	0,092

HH3f	0,281	0,174	0,209	0,420	0,491	1	0,780	0,102	0,180	0,311	0,323
HH3m	0,103	0,053	0,052	0,385	0,477	0,780	1	0,016	0,076	0,257	0,299
HH4	0,652	0,352	0,769	0,260	0,107	0,102	0,016	1	0,931	0,826	0,746
HH6	0,753	0,365	0,839	0,278	0,055	0,180	0,076	0,931	1	0,779	0,706
HH5	0,499	0,344	0,650	0,139	0,093	0,311	0,257	0,826	0,779	1	0,907
HH10	0,411	0,262	0,488	0,096	0,092	0,323	0,299	0,746	0,706	0,907	1

The following relationships based on the values of the correlation coefficients are highlighted:

- A fairly high rate of correlation (0.771) between the growth of wages (EE1) and increasing number of ICS users (EE3);
- Average correlation (0.652) between the level of wages of the population (EE1) and percentage the use of computers (HH4);
- High value of the correlation coefficient (0.753) for wages (EE1) and access to the Internet for home users (HH6);
- Strong dependence (0.769) exists between the percentage of the population that uses the ICS (EE3) and users, which have a computer at home (HH4);
- Strong dependence (0.839) between the percentage of the population that uses the ICS (EE3) and users that have access to the Internet at home (HH6);
- The average dependence (0.650) between the percentage of the population that uses the ICs (EE3) and the use of computer technology in industry (HH5);
- High value of the correlation coefficient (0.780) between the access and use of stationary (HH3f) and mobile (HH3m) telephony that is caused due the needs of connection between users regardless of the location;
- Very high degree of correlation (0.931) between the indicators (HH4) and (HH6). Consequently, almost any user of computer technology in the household has access to the Internet;
- Highest correlation value (0.826) between the number of home computers (HH4) and computers at work (HH5) indicates uniform implementation of computer technology;
- A high correlation (0.746) between the indicators (HH4) and (HH10) shows that with computer technology home users prefer to use mobile technology;
- Highest correlation value (0.779) for samples (HH6) and (HH5) may be due to the fact that more information resources become available, improving the service sector, increasing information infrastructure in general;
- There is a high degree of dependence (0.706) between the access to the Internet (HH6) and the use of mobile technology (HH10);
- Very high correlation (0.907) between the indicators (HH5) and (HH10), showing that with computer technology mobile technology is introduced into the industry.

Conclusion

The obtained results concretize proverbial dependence of ICT development on the economic condition of the country, and allow us to estimate how the increases of resources allocated to information technology are increasing their qualitative and quantitative characteristics. Analysis of the results shows that most of the ICT

takes just computer technology, both in the household and in industry. The close relationship between the fixed and mobile telephone connection points on their mutual influence, so a person who has a fixed-line phone probably has a mobile phone for access to the telephone network, regardless of location. Together with the need for the entire spectrum of the ICS regardless of location through the development of wireless technologies we have a big impact of computer technology.

Bibliography

[Astafurova, 2014] Astafurova I.S., Linear pair correlation. Access mode: http://abc.vvsu.ru/Books/um_statistikazo/page0004.asp

[Bendat & Piersol, 1993] Bendat J.S., Piersol A.G., Engineering application of correlation and spectral analysis. Wiley-Interscience, New York, NY, 1993.

[Eliseeva, 2001] Eliseeva I.I, Econometrics: A Textbook. Ed. II - Moscow: Finance and Statistics, 2001.

[Hartigan, 1975] J.A. Hartigan, Clustering Algorithms, Wiley and Sons, 1975.

[ITU, 2009] Manual for measuring and use households and individuals to ICS. Access mode: http://www.itu.int/dms_pub/itu-d/opb/ind/D-IND-ITCMEAS-2009-PDF-R.pdf

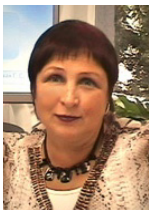
[ITU, 2014] ITU Statistics. Access mode: http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx

[Jain & Dubes, 1988] A.K. Jain and R.C. Dubes, Algorithms for Clustering Data, Prentice Hall, 1988.

[Johnsonbaugh & Schaefer, 2004] R. Johnsonbaugh, M. Schaefer, Algorithms, Pearson Prentice Hall, 2004, ISBN 0-13-122853-6.

[UNECE, 2014] UNECE Statistics. Access mode: http://w3.unece.org/pxweb/

Authors' Information



Galina Gayvoronska *– School of information technologies and cybersecurity of V.S. Martinovsky Institute of Refrigeration Cryotechnologies and Ecoenergetics ONAFT, technical science's doctor, professor, chief of the information-communication technologies' department; Dvoryanskaya str., 1/3, Odessa-26, 65026, Ukraine; tel. (048)-720-91-81, e-mail: GSGayvoronska@gmail.com*

Major fields of scientific research: optimization of transient periods at telecommunication networks' evolution. Calls' streams, load and intermodal inclination in nets. Problems of perspective access networks' and fully optical switching systems' development.

Illia Gannytskyi *– School of information technologies and cybersecurity of V.S. Martinovsky Institute of Refrigeration Cryotechnologies and Ecoenergetics ONAFT, PhD Telecommunication technologies, lecturer in the information-communication technologies department, Dvoryanskaya str., 1/3, Odessa–26, 65026, Ukraine; tel. (048)-720-91-48;*

e-mail: igannytskyi@ikt-osar.od.ua

Major fields of scientific research: streams of calls on telecommunication network.

Petro Yatsuk *– National Commission for the State Regulation of Communications and Informatization, Chairman, Khreshchatyk Str., 22, Kyiv – 01001, Ukraine.*

e-mail: yatsuk@ikt-osar.od.ua

Major fields of scientific research: telecommunication networks.