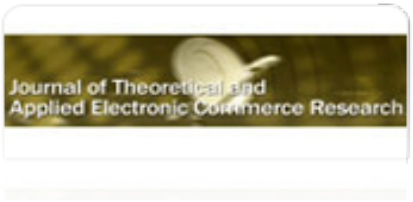

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Editorial: Impact of Information and Communication Technology to the Competitiveness of European Countries - Cluster Analysis Approach

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Introduction

Information and communication technology (ICT) has been recognized as a key factor in the economic development and growth of countries, especially in the last decades [3], [16], [19], [30]. Development of ICT contributes to higher productivity, efficiency, gross domestic product, and a higher level of innovation activity [17], [20], [29]. According to the European Commission, ICT drives 20% of productivity growth in the European Union countries [7].

The development of ICT impacts higher overall competitiveness in numerous ways. A positive impact of ICT usage can be found in many areas: the financial sector, health organizations, education and science, and public organizations [14]. The usage of ICT increases development of e-skills and the quality of education systems, changes the structure of business processes, encourages employment and collaboration among individuals and facilitates everyday activities [2], [27].

Usage and application of the information and communication technology (ICT) differs in particular countries, which lead to the digital divide among countries [22], [29], which has a negative impact on the overall development of the information society [13], [15], [28]. The digital divide does not present only the difference between using and not using ICT, but also the difference in the level of knowledge and skills which are necessary for using ICT [1].

According to numerous researches, digital divide is present in European countries. For example, Piatkowski [21] showed that ICT led to higher growth of productivity at macro and micro level in several post-transition countries which became EU members in 2004. He highlighted that the highest efforts were made by several countries such as: the Czech Republic, Poland, Hungary and Slovenia, followed by Romania. On the other hand, Slovakia and Bulgaria lag behind regarding economic development and ICT usage. This indicates that European leaders should invest more efforts in decreasing the digital divide [4], especially taking into account that EU countries are thriving to become the most dynamic and competitive knowledge-based economy and society [25]. In order to maintain a competitive position on the market in the next several years, European countries should enhance development of ICT and e-skills, since educated employees with such skills are a crucial factor for competitiveness, growth and employment [5], [10].

In this paper, we investigate how ICT influences competitiveness of European countries through four areas (e-learning, personal usage of the Internet, e-commerce, e-government). We attempt to determine if there are differences in the economic development of those countries and how ICT affects them. In order to attain this goal, we have conducted a two-stage analysis. In the first stage, the cluster analysis using K-means was used to organize European countries into sensible groupings for the year 2011, according to their usage of ICT. Defined clusters are compared using Anova analysis according to their competitiveness indices, using the Global Competitiveness Report.

The paper is organized as follows. The first section provides an introduction. In the second section data and the model specification are explained. Results of the cluster and the Anova analysis are described in the third section. At the end, a discussion and conclusion close the paper.

Methodology

In the following section, the methodological approach to the research will be presented: measuring ICT usage, measuring competitiveness, and statistical two-stage methodology.

Measuring ICT Usage

ICT usage was measured using four dimensions: e-learning, personal usage of the Internet, e-commerce, e-government.

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Indicators of the e-learning usage are: (i) purchase of e-learning courses/materials, (ii) search of information on education and training, (iii) usage of the Internet for education and training and (iv) usage of the Internet for decision-making on learning. Indicators of personal Internet usage are: (i) usage of online banking and (ii) usage of the Internet for finding an employment. Indicators of the e-government usage are: (i) usage of public administration sites to send forms and (ii) usage of public administration sites for the communication with public departments. Indicators of the e-commerce usage are: (i) CRM software usage, (ii) Internet purchase and (iii) selling over the Internet.

Data for the above indicators was collected from the statistical database of the European Commission - Eurostat, section on the Information society [8]. Data gathered for e-learning, Internet usage and e-government usage indicators include the percentage of individuals aged 16 to 74 in a country's population shown in percentage. The data gathered for the indicators of the e-commerce usage represent the percentage of firms with at least ten employees within individual countries and they are shown in percentage.

Data on ICT usage was collected for 32 European countries (EU countries, Iceland, Norway, Macedonia and Turkey). Other European countries were not used in the analysis because of missing data for 2011 for selected variables.

Measuring Competitiveness

The Global Competitiveness Report of the World Economic Forum (WEF) defines competitiveness as "the set of institutions, policies, and factors that determine the level of productivity of a country" [23]. WEF measures the competitiveness with overall competitiveness index (Global Competitiveness index), three subindices, and 12 pillars.

The overall competitiveness index (Global Competitiveness Index) is composed of three subindices (Basic requirements, Efficiency enhancers, and Innovation and sophistication factors) which are composed of pillars of competitiveness.

The Basic requirements index is composed of four pillars of competitiveness: Institutions, Infrastructure, Macroeconomic environment and Health and primary education. The Efficiency enhancers subindex is composed of six pillars of competitiveness: Higher education and training, Goods market efficiency, Labour market efficiency, and Financial market development, Technological readiness and Market size. The Innovation and sophistication factors subindex is composed of two pillars of competitiveness: Business sophistication and Business innovation.

In its Global Competitiveness Report 2011 report the WEF measured competitiveness of 142 countries. In our work we used the data for the competitiveness of 32 countries (EU countries, Iceland, Norway, Macedonia and Turkey) in 2011. We used the data on the overall competitiveness index, three subindices, and 12 pillars, which comprises in total the data of 32 countries with 16 competitiveness indicators. Appendix contains the list of abbreviations used for the competitiveness indices in our paper.

Two-Stage Methodology

In this paper we have conducted a two-stage analysis with the goal to investigate how ICT influences the competitiveness of European countries. In the first stage we used cluster analysis in order to organize European countries into sensible groupings for the year 2011, regarding their usage of ICT. In the second stage we used the Anova analysis in order to compare defined clusters according to their competitiveness indices, using the Global Competitiveness Report.

The first stage: Cluster analysis**.** One of the best ways to understand a large amount of data is to organize them into logical groups. The cluster analysis presents a statistical method used for grouping objects based on their similar characteristics [12]. Therefore, the main goal of the cluster analysis is to find structure in data and to group data into clusters based on their similarities. The three main purposes for using the cluster analysis are detecting: underlying structure, natural classification and compression [12]. Scientific fields in which cluster analysis can be used are numerous, and its common applications include the following: image segmentation, documents generation, customer differentiation [24]. There are several methods which can be used for defining the number of clusters, and one of the most popular is the K-means method [26].

In the first stage, data on the usage of ICT in 32 European countries were used for cluster determination. Using the non-hierarchical K-means cluster analysis, countries were grouped regarding indicators of development and usage of ICT: e-learning usage (individuals), Internet use (individuals), e-commerce (firms) and e-government usage (individuals). Using the K-means method, we chose to use four clusters as this is appropriate for our analysis according to the number of selected countries:

$$K \approx \sqrt{(n/2)} \approx \sqrt{(32/2)} = 4 \text{ clusters} \quad (1)$$

The second stage: Anova analysis. The Anova analysis is often used in order to test differences among defined clusters [9], [11]. In our paper, the analysis of variance was used in order to compare competitiveness of the countries of identified clusters. We compared countries in four clusters according to the average values of 16

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indicators of their competitiveness. In case statistically significant differences were found in terms of competitiveness indicators among compared clusters, we have concluded that there is a relation between ICT usage and country competitiveness.

Results

In the following section, clustering results will be presented that propose grouping European countries based on the ICT usage. Comparison of competitiveness of clusters is elaborated based on the Anova analysis.

Countries' Clusters

According to the K-means methodology conducted by means of indicators of ICT usage, 32 European countries are grouped into clusters. Table 1 presents the clusters of the selected European countries grouped based on different dimensions of ICT usage in 2011, using K-means. The results revealed that 32 countries grouped into four clusters differ according to the employed dimension of ICT usage. Four clusters were detected using K-means and the data on four dimensions on ICT usage in 32 European countries in 2011. We named clusters as A, B, C and D. Countries in Cluster A have the highest average value of ICT usage in four dimensions: e-learning, personal usage of the Internet, e-commerce, e-government. On the other side, countries in Cluster D have the lowest average value of ICT usage. Average values of ICT usage indicators for different clusters are provided in Appendix A.

Table 1: Countries' clusters based on different dimensions of ICT usage, 2011

Dimensions of ICT usage	Cluster			
	A	B	C	D
E-learning	Denmark, Finland, Iceland, Luxembourg, Norway	Austria, Estonia, Hungary, Spain the Netherlands, Germany, the United Kingdom	Belgium, France, Ireland, Italy, Latvia, Malta, Poland, Portugal, Slovenia, Sweden	Bulgaria, Cyprus, the Czech Republic, Greece, Croatia, Lithuania, Turkey Macedonia, Romania, Slovakia
Personal usage of the Internet	Denmark, Estonia, Finland, Italy, Sweden, the Netherlands, Norway	Austria, Belgium, France, Hungary, Malta, Lithuania, Luxembourg, Germany, the United Kingdom	Cyprus, the Czech Republic, Croatia, Ireland, Iceland, Latvia, Poland, Portugal, Slovakia, Slovenia, Spain	Bulgaria, Greece, Macedonia, Romania, Turkey
E-commerce	Belgium, Norway, the Czech Republic, Denmark, Ireland	Austria, Finland, Luxembourg, the Netherlands, Germany, Sweden, the United Kingdom	Estonia, France, Iceland, Latvia, Lithuania, Hungary, Malta, Portugal, Slovakia, Slovenia, Spain	Bulgaria, Cyprus, Greece, Croatia, Italy, Macedonia, Poland, Romania, Turkey
E-government	Denmark, Iceland	Estonia, Finland, Luxembourg, the Netherlands, Norway, Sweden	Austria, Belgium, France, Ireland, Latvia, Lithuania, Malta, Hungary, Germany, Portugal, Slovenia, Slovakia, Spain, the United Kingdom	Bulgaria, Cyprus, the Czech Republic, Greece, Croatia, Italy, Macedonia, Poland, Romania, Turkey

Source: Author's research based on Eurostat data (2012)

It can be concluded that countries are represented rather homogenously in the clusters.

Cluster A contains countries with the highest level of ICT usage. Denmark and Norway are present in Cluster A according to the e-learning, personal Internet usage and e-government usage. Some other countries are also represented in Cluster A according, such as Iceland. Countries with the highest level of e-commerce are: Belgium, the Czech Republic, Ireland, Denmark and Norway. Therefore, countries in Cluster A are situated mainly at the Northern Europe.

Countries which are grouped into Cluster B for the purpose of e-learning, personal Internet usage, and e-government are: Estonia, Hungary, the Netherlands and the United Kingdom. E-commerce is popular in the following countries in Cluster B: Austria, Finland, Luxembourg and Sweden. Therefore, countries in Cluster B are situated mainly in Central Europe.

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Countries which are grouped into Cluster C for the purpose of e-learning, personal Internet usage, and e-government are: Belgium, Ireland, Latvia, Malta, Portugal, Slovenia, Slovakia and Spain. E-commerce is especially developed in: Estonia, France, Iceland and Lithuania in Cluster C. Therefore, countries in Cluster C are mainly situated in Central Europe, with some countries from Southern Europe and Mediterranean countries.

Countries which lag behind developed countries regarding ICT usage are grouped into Cluster D (Bulgaria, Cyprus, the Czech Republic, Greece, Croatia, Romania, and Turkey). There is a lower rate of the ICT usage in the aforementioned countries for the purpose of e-learning, personal purposes, and e-government. E-commerce is developed the most in Poland, Macedonia, Bulgaria, Croatia and Greece in Cluster D. Therefore, countries in Cluster C are mainly situated in Southern Europe, with some Mediterranean countries.

Differences in Competitiveness among Clusters

In this section, results of the Anova analysis are presented. The analysis of variance is conducted in order to compare competitiveness of the countries of identified clusters (Tables 2-5). In order to estimate the relationship of e-learning usage and competitiveness of selected European countries in 2011, calculated average values of competitiveness indices of each cluster are presented in Table 2.

Table 2: Competitiveness of identified clusters using e-learning indicators, 2011

Competitiveness Indices	E-learning Clusters				Total	F
	A	B	C	D		
	Avg (Std)	Avg (Std)	Avg (Std)	Avg (Std)	Avg (Std)	
Global Competitiveness Index	5.17 (0.29)	4.98 (0.46)	4.69 (0.47)	4.21 (0.19)	4.68 (0.51)	9.69***
Basic requirements	5.79 (0.28)	5.47 (0.41)	5.18 (0.45)	4.67 (0.29)	5.18 (0.54)	12.28***
Efficiency enhancers	5.01 (0.29)	4.90 (0.41)	4.64 (0.41)	4.20 (0.23)	4.62 (0.46)	8.85***
Innovation and sophistication	5.01 (0.40)	4.70 (0.74)	4.35 (0.7)	3.51 (0.31)	4.27 (0.79)	9.52***
Institutions	5.70 (0.33)	4.93 (0.66)	4.59 (0.74)	3.71 (0.40)	4.56 (0.88)	14.64***
Infrastructure	5.55 (0.36)	5.59 (0.71)	5.06 (0.76)	4.31 (0.57)	5.02 (0.81)	7.11***
Macroeconomic environment	5.47 (1.03)	5.11 (0.46)	4.78 (0.60)	4.74 (0.57)	4.95 (0.67)	1.83
Health and primary education	6.43 (0.24)	6.24 (0.24)	6.28 (0.23)	5.91 (0.26)	6.18 (0.30)	6.45***
Higher education and training	5.53 (0.52)	5.28 (0.40)	5.12 (0.39)	4.49 (0.37)	5.02 (0.55)	9.53***
Goods market efficiency	4.91 (0.36)	4.73 (0.34)	4.61 (0.37)	4.23 (0.31)	4.57 (0.41)	5.37***
Labour market efficiency	5.00 (0.29)	4.64 (0.49)	4.33 (0.42)	4.20 (0.40)	4.47 (0.49)	5.06***
Financial market development	4.95 (0.78)	4.54 (0.31)	4.36 (0.66)	4.09 (0.37)	4.41 (0.59)	2.94*
Technological readiness	6.05 (0.19)	5.38 (0.60)	5.10 (0.71)	4.26 (0.39)	5.05 (0.81)	13.61***
Market size	3.60 (0.88)	4.86 (1.07)	4.31 (1.10)	3.89 (0.76)	4.19 (1.02)	2.10
Business sophistication	5.13 (0.34)	4.95 (0.75)	4.66 (0.64)	3.88 (0.33)	4.55 (0.72)	8.14***
Business innovation	4.90 (0.51)	4.45 (0.76)	4.03 (0.85)	3.15 (0.31)	3.98 (0.89)	9.97***

Source: Author's research based on Eurostat data (2012) and Schwab (2012)
Note: *** statistically significant at 1%, * statistically significant at 10%

Table 2 reveals that average values of competitiveness indices indicators are the highest in Cluster A, in which countries whose citizens use e-learning the most can be found. The only exception is the average value of the competitiveness pillar Market size which has the lowest value compared to other values for countries from Cluster A. Countries which can be found in Cluster A are: Denmark, Finland, Iceland, Luxembourg and Norway (Table 1). Average values of competitiveness indices from other clusters are related to e-learning usage. After Cluster A where countries with the highest average values are grouped, there are Cluster B, Cluster C and Cluster D where countries with the lower average values of competitiveness indices are, as well as the lower value of e-learning usage. Anova analysis revealed that calculated average values of competitiveness indices of the clusters for e-learning indicators are statistically significant for all competitiveness indices, except for the competitiveness pillars Macroeconomic environment and Market size.

In order to estimate the relationship of the Internet usage by individuals (e-banking and finding an employment) and competitiveness of selected European countries in 2011, calculated average values of competitiveness indices of each cluster are presented in Table 3.

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Table 3: Competitiveness of identified clusters using personal internet usage, 2011

Competitiveness Indices	Personal Internet Usage Clusters				Total	F
	A	B	C	D		
	Avg (Std)	Avg (Std)	Avg (Std)	Avg (Std)	Avg (Std)	
Global Competitiveness Index	5.21 (0.38)	4.92 (0.46)	4.40 (0.18)	4.10 (0.13)	4.68 (0.51)	15.64***
Basic requirements	5.77 (0.29)	5.41 (0.46)	4.94 (0.22)	4.45 (0.14)	5.18 (0.54)	21.14***
Efficiency enhancers	5.05 (0.35)	4.83 (0.44)	4.42 (0.20)	4.06 (0.14)	4.62 (0.46)	12.32***
Innovation and sophistication	5.06 (0.62)	4.63 (0.73)	3.90 (0.36)	3.32 (0.19)	4.27 (0.79)	13.65***
Institutions	5.64 (0.42)	4.89 (0.62)	4.07 (0.53)	3.54 (0.15)	4.56 (0.88)	22.54***
Infrastructure	5.52 (0.49)	5.44 (0.82)	4.86 (0.54)	3.92 (0.52)	5.02 (0.81)	8.35***
Macroeconomic environment	5.49 (0.85)	5.01 (0.52)	4.71 (0.38)	4.61 (0.80)	4.95 (0.67)	2.96**
Health and primary education	6.43 (0.20)	6.28 (0.24)	6.13 (0.22)	5.75 (0.22)	6.18 (0.30)	10.23***
Higher education and training	5.66 (0.29)	5.22 (0.39)	4.81 (0.24)	4.25 (0.29)	5.02 (0.55)	23.36***
Goods market efficiency	4.89 (0.27)	4.76 (0.38)	4.41 (0.33)	4.11 (0.21)	4.57 (0.41)	7.85***
Labour market efficiency	5.00 (0.21)	4.58 (0.37)	4.24 (0.39)	4.01 (0.43)	4.47 (0.49)	9.73***
Financial market development	4.86 (0.65)	4.71 (0.47)	4.10 (0.43)	3.92 (0.27)	4.41 (0.59)	6.49***
Technological readiness	5.94 (0.47)	5.39 (0.61)	4.70 (0.38)	3.94 (0.23)	5.05 (0.81)	22.091***
Market size	3.94 (0.98)	4.31 (1.38)	4.29 (0.85)	4.12 (0.89)	4.19 (1.02)	0.21
Business sophistication	5.18 (0.59)	4.91 (0.66)	4.26 (0.39)	3.68 (0.27)	4.55 (0.72)	11.02***
Business innovation	4.94 (0.69)	4.36 (0.80)	3.53 (0.39)	2.96 (0.12)	3.98 (0.89)	14.91***

Source: Author's research based on Eurostat data (2012) and Schwab (2012)
Note: *** statistically significant at 1%, ** statistically significant at 5%

It can be seen that average values of competitiveness indices indicators are the highest in Cluster A, in which countries whose citizens use the Internet for banking and finding an employment the most can be found. Similar research findings are available from Dumičić et al. (2013) [6]. The only exception is the average value of the competitiveness pillar Market size which has the lowest value compared to other values for countries from Cluster A. Countries which can be found in Cluster A are: Denmark, Estonia, Finland, Italy, Sweden, the Netherlands and Norway. Average values of competitiveness indices from other clusters are proportional to personal Internet use. After Cluster A including countries with the highest average values, there are Cluster B, Cluster C and Cluster D where countries with the lowest average values of competitiveness indices are. Anova analysis revealed that calculated average values of competitiveness indices of the clusters regarding the indicator of the Internet usage by individuals are statistically significant for all competitiveness indices, except for the competitiveness pillar Market size.

In order to estimate the relationship of e-commerce usage and competitiveness of selected European countries in 2011, calculated average values of competitiveness indices of each cluster are presented in Table 4.

Table 4: Competitiveness of identified clusters using e-commerce indicators, 2011

Competitiveness Indices	E-commerce Clusters				Total	F
	A	B	C	D		
	Avg (Std)	Avg (Std)	Avg (Std)	Avg (Std)	Avg (Std)	
Global Competitiveness Index	5.01 (0.36)	5.35 (0.20)	4.48 (0.28)	4.20 (0.19)	4.68 (0.51)	32.37***
Basic requirements	5.48 (0.42)	5.85(0.17)	5.05 (0.32)	4.65 (0.29)	5.18 (0.54)	22.81***
Efficiency enhancers	4.97 (0.30)	5.17 (0.21)	4.46 (0.25)	4.18 (0.23)	4.627 (0.46)	26.99***
Innovation and sophistication	4.78 (0.46)	5.32 (0.34)	3.98 (0.45)	3.51 (0.34)	4.27 (0.79)	31.45***
Institutions	5.11 (0.90)	5.60 (0.33)	4.31 (0.57)	3.76 (0.43)	4.56 (0.88)	16.86***
Infrastructure	5.30 (0.45)	5.87 (0.29)	4.99 (0.72)	4.24 (0.63)	5.02 (0.81)	10.49***
Macroeconomic environment	5.18 (0.88)	5.50 (0.52)	4.74 (0.52)	4.64 (0.58)	4.95 (0.67)	3.46**
Health and primary education	6.33 (0.31)	6.42 (0.18)	6.15 (0.22)	5.95 (0.31)	6.18 (0.30)	5.23***
Higher education and training	5.42 (0.36)	5.55 (0.44)	4.98 (0.32)	4.44 (0.34)	5.02 (0.55)	14.89***
Goods market efficiency	4.90 (0.24)	5.05 (0.23)	4.41 (0.17)	4.20 (0.30)	4.57 (0.41)	21.80***
Labour market efficiency	4.88 (0.32)	4.82 (0.29)	4.37 (0.44)	4.07 (0.38)	4.47 (0.49)	7.51***
Financial market development	4.60 (0.77)	4.99 (0.33)	4.23 (0.50)	4.07 (0.42)	4.41 (0.59)	5.22***
Technological readiness	5.65 (0.57)	5.89 (0.32)	4.99 (0.55)	4.12 (0.28)	5.05 (0.81)	24.35***
Market size	4.38 (0.26)	4.75 (1.01)	3.75 (1.14)	4.19 (1.02)	4.19 (0.02)	1.52
Business sophistication	5.04 (0.42)	5.47 (0.27)	4.27 (0.38)	3.90 (0.45)	4.55 (0.72)	26.34***
Business innovation	4.52 (0.50)	5.16 (0.47)	3.69 (0.55)	3.12 (0.25)	3.98 (0.89)	29.81***

Source: Author's research based on Eurostat data (2012) and Schwab (2012)
Note: *** statistically significant at 1%, ** statistically significant at 5%

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It can be seen that average values of competitiveness indices indicators are the highest in Cluster B, in which countries whose firms use the Internet for doing business the most can be found. The only exception is the average value of the competitiveness pillar Market size which has the lowest value compared to other values for countries from Cluster B. Countries which can be found in Cluster B are: Austria, Finland, Luxembourg, the Netherlands, Germany, Sweden and the United Kingdom. After Cluster B where countries with the highest average values of e-commerce are, there are Cluster A, Cluster C and Cluster D where countries with the lowest average values of competitiveness indices are. Anova analysis revealed that calculated average values of competitiveness indices of the countries of identified clusters for e-commerce indicators are statistically significant for all competitiveness indices, except for the competitiveness pillar Market size.

In order to estimate the relationship of e-government usage and competitiveness of selected European countries in 2011, calculated average values of competitiveness indices of each cluster are presented in Table 5.

It can be seen that average values of competitiveness indices indicators are the highest in Cluster B, in which countries whose individuals use public services via Internet the most can be found. The only exception is the average value of the competitiveness pillar Market size which has the lowest value compared to other values for countries from Cluster B. Countries which can be found in Cluster B are: Estonia, Finland, Luxembourg, the Netherlands, Norway and Sweden. Estonia has one of the most developed e-government systems in Europe and it was one of the first countries which started election voting via Internet. Finland has a large number of IT firms and constantly works on improvements and development of ICT. After Cluster B where countries with the highest average values of e-government usage are, there are Cluster A, Cluster C and Cluster D where countries with the lowest average values of competitiveness indices are. Anova analysis revealed that calculated average values of competitiveness indices of the clusters for e-government indicators are statistically significant for all competitiveness indices, except for the competitiveness pillar Market size.

Table 5: Competitiveness of identified clusters using e-government indicators

Competitiveness Indices	E-government Clusters				Total	F
	A	B	C	D		
	Avg (Std)	Avg (Std)	Avg (Std)	Avg (Std)	Avg (Std)	
Global competitiveness index	5.08 (0.46)	5.22 (0.36)	4.70 (0.46)	4.23 (0.20)	4.68 (0.51)	9.61***
Basic requirements	5.59 (0.39)	5.85 (0.23)	5.19 (0.40)	4.67 (0.29)	5.18 (0.54)	152.98***
Efficiency enhancers	4.92 (0.50)	5.06 (0.31)	4.66 (0.41)	4.23 (0.26)	4.62 (0.46)	7.60***
Innovation and sophistication	4.99 (0.45)	5.03 (0.66)	4.33 (0.71)	3.57 (0.37)	4.27 (0.79)	8.74***
Institutions	5.55 (0.55)	5.69 (0.38)	4.53 (0.65)	3.75 (0.41)	4.56 (0.88)	18.70***
Infrastructure	5.80 (0.13)	5.44 (0.50)	5.24 (0.77)	4.31 (0.62)	5.02 (0.81)	5.99***
Macroeconomic environment	4.59 (1.14)	5.89 (0.39)	4.78 (0.43)	4.70 (0.57)	4.95 (0.67)	8.44***
Health and primary education	6.42 (0.25)	6.41 (0.20)	6.22 (0.25)	5.94 (0.29)	6.18 (0.30)	5.17***
Higher education and training	5.70 (0.07)	5.48 (0.50)	5.11 (0.38)	4.49 (0.36)	5.02 (0.55)	11.09***
Goods market efficiency	4.78 (0.40)	5.02 (0.30)	4.58 (0.33)	4.24 (0.31)	4.57 (0.41)	7.94***
Labour market efficiency	5.29 (0.14)	4.84 (0.11)	4.43 (0.43)	4.13 (0.40)	4.47 (0.49)	7.99***
Financial market development	4.30 (1.01)	5.13 (0.37)	4.34 (0.52)	4.10 (0.40)	4.41 (0.59)	5.83***
Technological readiness	6.21 (0.01)	5.87 (0.48)	5.14 (0.54)	4.19 (0.34)	5.05 (0.81)	22.02***
Market size	3.27 (1.34)	4.01 (0.87)	4.38 (1.10)	4.22 (0.96)	4.19 (1.02)	0.76
Business sophistication	5.11 (0.59)	5.17 (0.59)	4.64 (0.65)	3.96 (0.45)	4.55 (0.72)	6.46***
Business innovation	4.88 (0.32)	4.90 (0.76)	4.03 (0.78)	3.19 (0.31)	3.98 (0.89)	10.28***

Source: Author's research based on Eurostat data (2012) and Schwab (2012)
Note: *** statistically significant at 1%

Discussion

After the cluster analysis and the analysis of variance were conducted, the conclusions are drawn regarding the relation between ICT usage of countries and their level of competitiveness.

Table 6 summarizes the results of the analysis of variance for the year 2011. The statistical significance for the differences of calculated average index values of competitiveness for countries from identified clusters (using indicators of e-learning, the personal usage of the Internet, e-commerce and e-government) is shown.

The analysis showed that the calculated average index values of competitiveness for countries from identified clusters of e-learning, personal Internet usage, e-commerce an e-government usage indicators are statistically significant for all indices of competitiveness, mostly with the 1% probability. The exception is the Market size, which are not statistically significant different among none of countries' clusters, as well as the pillar of Macroeconomic environment that is not statistically significant different among e-learning clusters.

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Table 6: Statistical significance for differences in competitiveness of clusters, 2011

Competitiveness Indices	Statistical significance of the differences among clusters based on Anova analysis			
	E-learning	Internet usage	E-commerce	E-government
Global Competitiveness Index	1%	1%	1%	1%
Basic requirements	1%	1%	1%	1%
Efficiency enhancers	1%	1%	1%	1%
Innovation and sophistication	1%	1%	1%	1%
Institutions	1%	1%	1%	1%
Infrastructure	1%	1%	1%	1%
Macroeconomic environment	-	5%	5%	1%
Health and primary education	1%	1%	1%	1%
Higher education and training	1%	1%	1%	1%
Goods market efficiency	1%	1%	1%	1%
Labour market efficiency	1%	1%	1%	1%
Financial market development	10%	1%	1%	1%
Technological readiness	1%	1%	1%	1%
Market size	-	-	-	-
Business sophistication	1%	1%	1%	1%
Business innovation	1%	1%	1%	1%

Source: Author's research based on Eurostat data (2012) and Schwab (2012)

In most of the cases, the average competitiveness indices in Cluster A were the highest, and Cluster D were the lowest according to the e-learning usage and Internet personal usage (Table 7). The research revealed that Cluster A includes some of the most developed countries of Europe, given the different characteristics and uses of ICT (Table 1).

Table 7: Cluster with the highest and lowest average value of competitiveness indices, 2011

Competitiveness Indices	Cluster with the highest / lowest average value of competitiveness indices			
	E-learning	Personal Internet usage	E-commerce	E-government
Global Competitiveness Index	A / D	A / D	B / D	B / D
Basic requirements	A / D	A / D	B / D	B / D
Efficiency enhancers	A / D	A / D	B / D	B / D
Innovation and sophistication	A / D	A / D	B / D	B / D
Institutions	A / D	A / D	B / D	B / D
Infrastructure	B / D	A / D	B / D	A / D
Macroeconomic environment	A / D	A / D	B / D	B / D
Health and primary education	A / D	A / D	B / D	A / D
Higher education and training	A / D	A / D	B / D	A / D
Goods market efficiency	A / D	A / D	B / D	B / D
Labour market efficiency	A / D	A / D	A / D	A / D
Financial market development	A / D	A / D	B / D	B / D
Technological readiness	A / D	A / D	B / D	A / D
Market size	B / D	B / D	B / D	B / D
Business sophistication	A / D	A / D	B / D	B / D
Business innovation	A / D	A / D	B / D	B / D

Source: Author's research based on Eurostat data (2012) and Schwab (2012)

Most of these are countries of Northern Europe (Denmark, Finland, Iceland, Luxembourg and Norway). The second group of countries belongs to Cluster B. These are the countries of Western Europe (Austria, the Netherlands, Germany, Sweden and the United Kingdom) and Estonia, which leads over the other Eastern European countries. In the third cluster, there are predominantly countries whose citizens and firms use ICT on a smaller scale in relation to the countries of the first two clusters (the Czech Republic, France, Ireland, Lithuania, Hungary, Malta, Portugal, Slovakia, Slovenia, Spain). Cluster C mainly groups countries of Southern and Eastern Europe. In the last Cluster D, there are mostly countries that lag behind in comparison to other countries according to their characteristics and usage of ICT (Bulgaria, Cyprus, Greece, Croatia, Italy, Macedonia, Poland, Romania and Turkey). The above group consists of developing countries, or countries that have lately entered the European Union as well as candidate countries. Because of lower socio-economic development, these countries lag behind in development, but also in the use of ICT.

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On the other hand, Cluster B has the highest level of the competitiveness according to e-commerce for most of the indices. This result could indicate that the countries that are most developed are still oriented towards their strong national markets and traditional marketing and sales channels. These are the countries in the e-commerce Cluster B: Austria, Finland, Luxembourg, the Netherlands, Germany, Sweden, and the United Kingdom. On the other hand, the countries those are more oriented towards the online marketing and sales channels are still lagging behind according to the competitiveness indices. These countries are in the e-commerce Cluster A: Belgium, Norway, the Czech Republic, Denmark, and Ireland. However, it can be concluded that the result indicate the existence of the positive relation between the level of ICT usage and country competitiveness.

Conclusion

Our research revealed that the aforementioned European countries, which are also the most competitive, lead in the usage and implementation of ICT when it comes to firms which invest significant funds in the development of ICT, as well as when it comes to residents who use ICT extensively. The research and the results confirmed that the impact of the use of ICT on the competitiveness of a country is different for particular groups of countries with regard to the level of economic and social progress. The research showed the existence of the digital divide among European countries. The most developed countries of Western, Northern and Central Europe are also among the most competitive countries in the world and they lead in investments and also in the development and the usage of ICT.

The contribution of this study is the identification of four clusters that could help less developed countries in achieving a higher level of ICT usage which will lead to their social and economic growth. The following countries stand out as the most developed with the highest level of ICT usage: Denmark, Finland, France, Iceland, Luxembourg, Norway, Sweden, the Netherlands, Belgium, Ireland and Austria, which are also classified in the first two clusters, Cluster A and Cluster B. Developing European countries whose residents and firms use ICT on a smaller scale in relation to the countries of the first two clusters (the Czech Republic, Lithuania, Hungary, Malta, Portugal, Slovakia, Slovenia, Spain, Bulgaria, Cyprus, Greece, Croatia, Italy, Macedonia, Poland, Romania and Turkey) form the Cluster C and Cluster D group. It is also important to point out that the Cluster D mainly contains countries that are among the last that entered the EU, as well as candidate EU countries. These countries economically and socially lag behind the developed European countries, taking into consideration the use of ICT, and the scale of the global competitiveness index on which they are ranked is much lower compared to the countries of the first two clusters.

We consider the findings of this paper a valuable indicator for those who are preparing European strategies for the next years. The results showed the existence of the digital divide, which means that new strategies and policies should be directed toward development and implementation of ICT in less developed countries. Although the number of users who use the Internet increases every year in the world, both in developed countries and developing countries, not everyone has the necessary knowledge, skills and abilities to use it in the right way to achieve the significant benefits from its usage. It is therefore important, in addition to the use of ICT, to also encourage young people to obtain education on the use and possibilities of ICT. In this way it is possible to encourage the development of the information society thus reducing the digital divide between countries.

Limitations of this research refer to data collection and the analysis, which is made for only one year, i.e. 2011, and only for European countries. Also, it could be possible to expand the number of indicators of ICT usage. Future research should therefore focus on the analysis of time series data and compare the results obtained for the several years in order to determine whether developing countries have made some progress over the past four years. Also, countries outside Europe should be included in the analysis, since these countries lag behind to the largest extent.

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Appendix A: Average Values of ICT Usage Indicators for Countries' Clusters, 2011

ICT usage indicators	Cluster			
	A	B	C	C
E-learning usage indicators				
Purchase of e-learning courses/materials (% of individuals 16-74 yrs)	30%	19%	12%	4%
Search of information on education and training (% of individuals 16-74 yrs)	44%	35%	29%	20%
Usage of the Internet for education and training (% of individuals 16-74 yrs)	69%	37%	43%	22%
Usage of the Internet for decision-making on learning (% of individuals 16-74 yrs)	63%	27%	38%	18%
Personal Internet usage indicators				
Usage of online banking (% of individuals 16-74 yrs)	78%	48%	26%	5%
Usage of the Internet for finding an employment (% of individuals 16-74 yrs)	26%	19%	14%	10%
E-commerce usage indicators				
CRM software usage (% of firms 10+ employees)	22%	23%	16%	16%
Internet purchase (% of firms 10+ employees)	48%	37%	19%	7%
Selling over the Internet (% of firms 10+ employees)	25%	17%	13%	7%
E-government usage indicators				
Usage of public administration sites to send forms (% of individuals 16-74 yrs)	50%	30%	14%	5%
Usage of public administration sites for the communication with public bodies (% of individuals 16-74 yrs)	75%	58%	32%	15%

Source: Author's research based on Eurostat data (2012)