DATA ANALYSIS OF EUROPEAN UNION STATES: YOUTH BEHAVIOR IN DIGITAL WORLD

Miloslava Kašparová, Jan Barva

Abstract: *The paper deals with data analysis of young people behaviour (in age from 16 to 29 years) in digital world living in the European Union States. For this analysis, ten selected indicators from the area of digital world (focused for example on working with Internet, on social networks, on the Internet banking, on searching of information about travelling, about goods and services, e-mail communication and calls) and two economic indicators (gross domestic product per capita and unemployment rate) were chosen. Derived attributes were calculated in the data pre-processing phase. Selected algorithms of the agglomerative hierarchical clustering (as are the nearest neighbour method, the furthest neighbour method, the centroid clustering, the median clustering and the Ward method etc.) were used to find groups of similar objects (individual states of the European Union) based on the chosen indicators. Values of average coefficients of growth were used for clustering. The best results of clustering were achieved by the Ward's method; the data was divided into three clusters. Identified groups of European Union States were described by mentioned indicators.*

Keywords: Digital world, Youth, Model, Hierarchical Cluster Analysis.

JEL Classification: *C38, J19*

Introduction

Existing societies build more and more closer links between utilization of digital technologies and participation in society life and functioning. Promotion of use of information technologies by individual states is a condition for participation of these states in global information economy. Effective utilization of information technologies is more and more a condition of competitiveness for organizations. On the level of an individual digital inclusion becomes more and more one of social inclusion factors and that is true for all important areas such as education, work life, social life or communication with state institutions (Digital Literacy Strategy of the Czech Republic for the period 2015 to 2020, 2015).

The potential of digital technologies can be fully used only if people understand their benefits, if they are able to manage and operate them and to use them in practical life. One of the benefits of information society, knowledge society respectively, is also acquisition, rehabilitation and deepening of individual's digital competencies. (Digital Literacy Strategy of the Czech Republic for the period 2015 to 2020, 2015) Czechs are mostly behind in more demanding computer skills, in an international comparison across the European Union (EU).

Computer skills are also highly demanded by students in terms of their future involvement in the labour market. Those in these skills in the Czech Republic (CR) stand above the average and over the group of employees.

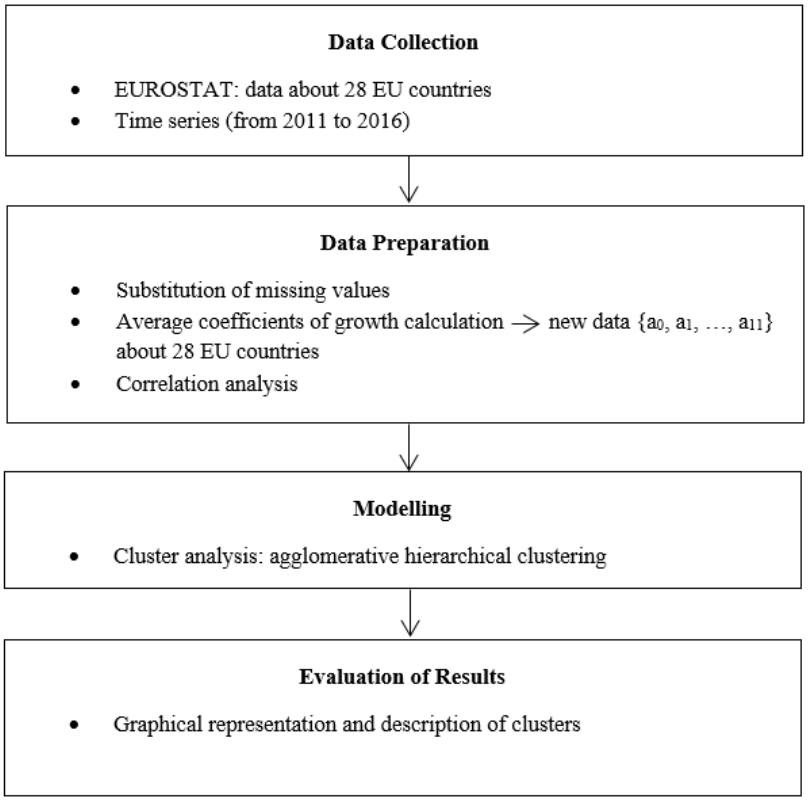
Currently the use of mobile phones also dominates next to Internet usage (in comparison with EU countries, the proportion of people in age from 16 to 74 years using Internet in the CR is the same as the European average (82% of individuals at that age

use the Internet on that territory). In the CR, 98% of individuals older than 16 years use mobile phones at present. (Czech Statistical Office, 2017a)

The objective of this article is to analyse data about behaviour of young people living in the CR and in other EU member states in digital world based on selected attributes by means of selected cluster analysis algorithms. To analyse in found groups whether the interest in selected Internet activities is constantly increasing in the EU countries in selected age group.

This analysis focuses on ones of the most important activities that people can do by Internet (e.g. internet banking, using of social networks, searching of information about goods and services, about travelling and accommodation or sending e-mails etc.). In addition, it focuses on the resulting indicators in specific years including selected economic indicators that use to classify of economies and their distribution according to the stages of economic development and to inform about the labour market situation. After the data collection phase and data pre-processing phase a selected method of the cluster analysis is followed. Basic steps of this analysis are illustrated in Fig. 1.

Fig. 1 Design of the model creation



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1 Problem formulation

1.1 Target group definition

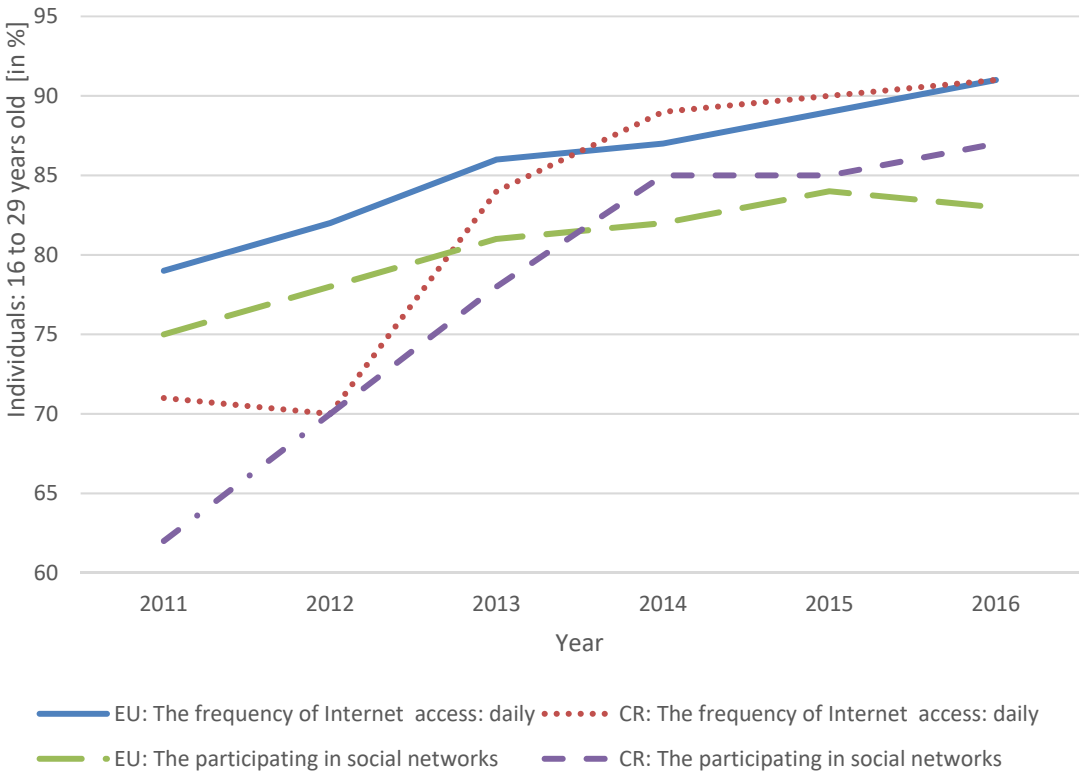
According to the Czech Statistical Office (Czech Statistical Office, 2017) the age group of youth (young people) is distributed into five-year categories in the following way: 15 – 19 years of age, 20 – 24 and 25 - 29 years of age.

Eurostat (Eurostat, 2017) distributes the age groups according to the type of attribute into the following categories: 15 – 19 years of age, 16 – 19, 20 – 24 and 25 - 29 years of age and merged categories: 15 – 29 years of age and 16-29 years of age. This last mentioned category was chosen for the following evaluation.

From a comparison of the last ten years (to 2016) follows that some forms of internet use were already common at the end of the last century. A dynamics of their development was not so noticeable. A searching of information about goods and services or about travelling and accommodation are examples of these activities. However, an extension of the social networks is a major phenomenon on the Internet. For this reason, data are available from 2011, when 24.6% of people in the Czech Republic over 16 years old were active on the social networks. About these networks, it is speaking also as about matter of generations. Reading online news, newspapers and magazines are other similar phenomena. In this sector of the economy, there has been a fundamental change in the reader's relations in their transition to the Internet. In 2007, only 20% of the Czech population aged 16 and over were reading online news (newspapers and magazines), in 2016 it was already 62.2%. (Digital Literacy, 2017) The Fig. 2 and Fig. 3 show the using of the Internet, the Internet banking, the social networks and the seeking information about health in the age group from 16 to 29 years old in the period from 2011 to 2016 in the CR relative to the European average of the EU countries.

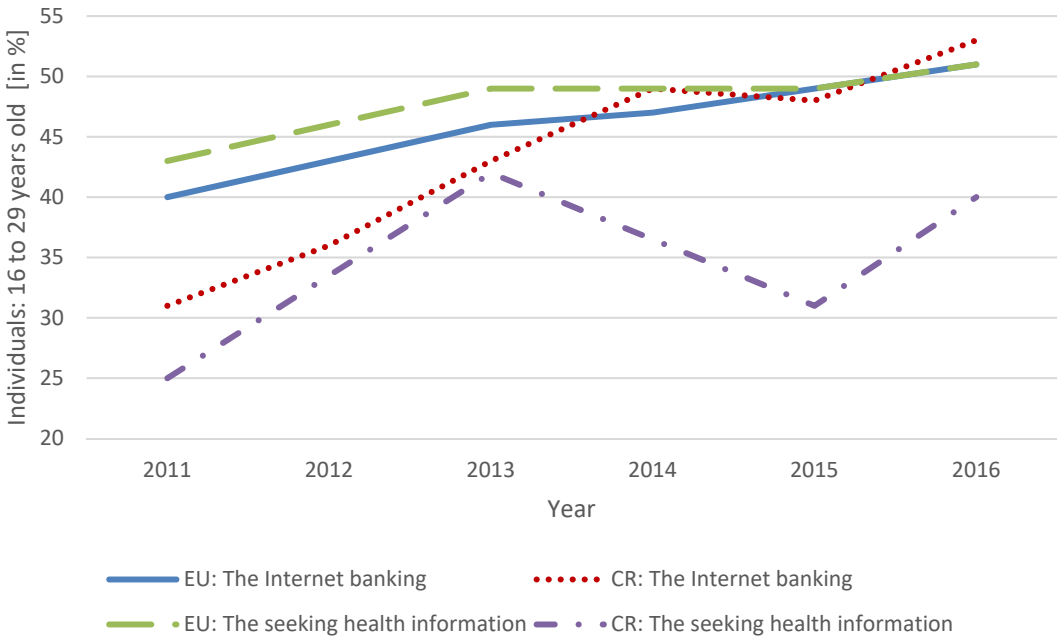
Fig 2 shows slight decrease in interest of participation in the social networks based on the European average (EU countries), while since 2011 in the CR, the interest about this activity is still increasing. Using of Internet in this age group in the CR achieved the same values as the European average (EU countries) in year 2016 and still increases. In Fig. 3, we can see that the interest in the Internet banking is mostly rising; and since 2011 in the CR, there has been a great increase in interest in this activity. It slightly has exceeded the European average (EU countries) in 2016. Large differences between percentage values in the CR and EU are visible in interest of people in seeking health information. The European average (EU countries) is rather slightly rising, but in the CR, values fluctuate significantly. There was a decline of 11% in 2015 relative to 2013. In 2016 this activity has increased by 9% compared to 2015 and is still increasing.

Fig. 2 The daily using of Internet and the participation in the social networks by the young people in the years from 2011 to 2016



Source: Authors

Fig. 3 The seeking health information and the Internet banking by the young people in the years from 2011 to 2016



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1.2 Data collection

Selected indicators (attributes, indicators, variables) from EUROSTAT database describe the monitored age group, from 16 to 29 years of age, in individual EU countries

in the digital world. Economic indicators describing the individual EU countries were added to these selected indicators. Values of all the above-mentioned indicators were reported for years 2011 to 2016 and were selected by (Digital Literacy, 2017) and on the basis of the availability of the data in the Eurostat database. The following list is a complete list of the selected indicators:

- Digital world (values of attributes in %): individuals who use Internet daily; individuals who use (receive/send) e-mails (data are available from 2012); individuals active on the social networks (missing values per year 2012); individuals who sell products or services on Internet; individuals who search for products or services on Internet; individuals who use Internet banking (missing value of the UK in 2011); individuals who search information about health on Internet (missing values per year 2012 and 2014); individuals who make calls and video calls on Internet; and individuals who search information about travelling and accommodation on Internet.
- Economic indicators: real gross domestic product (GDP) per capita; and long-term unemployment (in %).

2 Methods

This presented work deals with the application of clustering methods and its objective is to find groups of similar objects (EU member states) in the given area. Under the pre-processing phase the following steps were implemented: substitution of missing values in the time series, creation of derived indicators by using selected rate of time series dynamics and a correlation analysis.

2.1 Data pre-processing

The missing values occurred in the several indicators. Firstly, it was necessary to substitute them. According to the objective of the transformation, it can be proceeded by ways stated for instance in (Hančlová & Tvrdý, 2003), (Řezanková et al., 2009).

Missing values within the time series (except the beginning and the end of the time series) have replaced by the arithmetic average of the preceding and the following period (important for graphical representation of development – Fig. 2 and Fig. 3). Missing values at the beginning or at the end of the time series were predicted by using a trend curve of the given time series.

After filling the missing values, the development of the observed indicators has illustrated by means of the average growth coefficient $\bar{k}$ (Arlt et al., 2002). This coefficient determines what should be the rate of growth (decline) in order to change the value of the indicator from the original first value y_t to the last value y_n (Ramík & Čemerková, 1998, p. 86); it demonstrates the average change of time series values for one interval. Average growth coefficients (coefficient) were calculated according to this formula (1):

$$\bar{k} = \sqrt[n-1]{k_2\, k_3\, \ldots\, k_n} = \sqrt[n-1]{\frac{y_n}{y_1}}. \qquad (1)$$

In total nine attributes (from digital world) a_1, a_2, …, a_9 and two economic attributes a_{10} and a_{11} describing all 28 EU member states were derived on the basis of average growth coefficients from years 2011 to 2016 (Tab. 1).

Tab. 1: Data dictionary

Attribute	Range	Description of attribute
a_0		EU Member State
a_1	<0.99125; 1.09206>	Individuals using Internet daily
a_2	<0.97501; 1.0296>	Individuals using e-mail
a_3	<0.98876; 1.0702>	Individuals active on social networks
a_4	<0.83255; 1.2686>	Individuals selling products and services on Internet
a_5	<0.94294; 1.06608>	Individuals searching for products and services on Internet
a_6	<0.99041; 1.12888>	Individuals using Internet banking
a_7	<0.93053; 1.1487>	Individuals searching health information on Internet
a_8	<0.94409; 1.22176>	Individuals making calls and video-calls on Internet
a_9	<0.91967; 1.05436>	Individuals searching information about travelling and accommodation on Internet
a_{10}	<0.96901; 1.03112>	Real Gross Domestic Product per Capita (GDP)
a_{11}	<0,88903; 1,26484>	Rate of the long-term unemployment

Source: Authors

Prior to the start of the cluster analysis, itself correlation analysis was executed with regard to the value of the correlation coefficient. The Pearson‘s correlation coefficient (correlation coefficient) is the basic rate of similarity between two objects or two attributes expressed as quantitative data (Meloun & Militký 2002), (Ramík & Čemerková, 1998).

The high correlation value (0.753) was achieved between attributes a_1 (Individuals using Internet daily) and a_3 (Individuals active on the social networks) and higher value (0.473) between a_1 (Individuals using Internet daily) and a_6 Individuals using Internet banking). Based on the correlation coefficient values, the attribute a_1 has eliminated from data. The final data contained 28 EU countries described by 12 attributes a_0, a_2, a_3, …, a_{11}.

2.2 Cluster analysis

Clustering (Maimon & Rokach, 2005), (Han & Kamber, 2006), (Kasparova et al., 2013), (Kralik et al., 2016), (Petr et al., 2010) is the process of grouping a set of physical or abstract objects into classes of similar objects. (Han & Kamber, 2006) A data matrix is an input to such clustering. Identification of groups (clusters) is an output of such clustering. A cluster (Han & Kamber, 2006; p. 383) is a collection of data objects that are similar to one another within the same cluster and are dissimilar to the objects in other clusters. Objects are clustered according to the degree of similarity or dissimilarity.

Many clustering methods were developed, each of which uses a different induction principle. There are two main groups of the clustering: partitioning (these methods

relocate instances, by moving them from one cluster to another, starting from an initial partitioning (Maimon & Rokach, 2005; p. 75) and hierarchical methods. A hierarchical clustering method works by grouping data objects into a tree of clusters (dendrogram).

A dendrogram is commonly used for the representation of the process of hierarchical clustering (Han & Kamber, 2006; p. 410). It shows how the clusters are related to each other. It is a tree; the heights of the branches correspond to the distances between the clusters. (Chen et al., 2008; p. 566) A dendrogram cut at a given level defines a partition of the data cases into different k groups, where k increases by one at a time as the aggregation index (coefficient) decreases. Choosing the level of the cut, and by that the number of the resulting classes in the partition, can then be done by looking at the dendrogram (Chen et al., 2008; p. 363) and on the basis of an agglomeration schedule (the agglomerative schedule is a numerical summary of the cluster solution; a good cluster solution sees a sudden gap in the distance coefficient; the solution before the gap indicates the good solution (IBM Knowledge Center (2018)), too.

For acquisition of clusters the following agglomerative hierarchical clustering algorithms were used as described e.g. in (Řehák & Brom, 2015), (Chen et al., 2008), (Řezanková et al., 2009), (Maimon & Rokach, 2005): the nearest neighbour method, the furthest neighbour method (also called complete-link clustering), between-groups linkage, within-groups linkage, centroid clustering, median clustering, and Ward method (Řehák & Brom, 2015).

3 Problem solving and discussion

The agglomerative hierarchical clustering was used to examine similarities of multidimensional objects (EU countries) in IBM SPSS Statistics. Continuously the above-stated clustering methods were used (Barva, 2017). On the basis of the dendrograms comparison (in total seven dendrograms) and evaluation of the values of indexes in agglomerative schedule, the best results of clustering were achieved by the Ward‘s method (according to the achieved results of clustering in this area, as well as results of clustering in other areas (e.g. (Kralik et al., 2016), (Kasparova, 2016)), this method is the most appropriate for realisation of clusters. Data was divided into three clusters (Fig. 4).

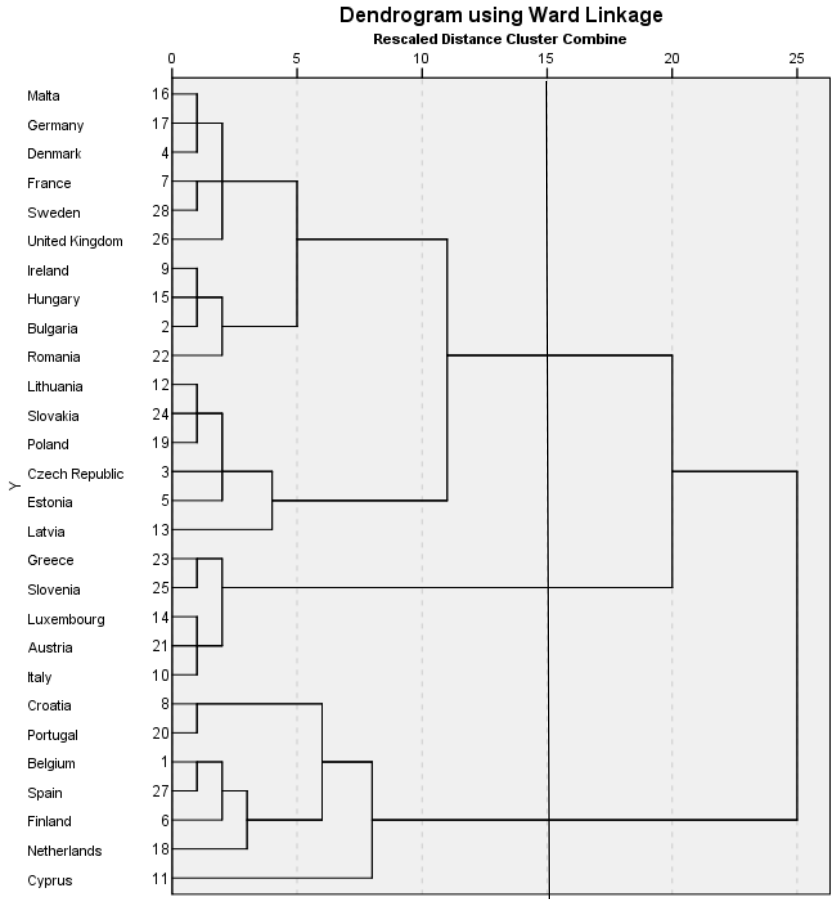
3.1 Interpretation of achieved results

Cluster characteristics according to the model are the following:

Cluster 1 contents these 16 EU countries: Bulgaria, the CR, Denmark, Estonia, France, Ireland, Malta, Lithuania, Latvia, Hungary, Germany, Poland, Romania, Slovakia, the UK and Sweden. It was created primarily based on similarity of economic attributes. In this cluster mainly the states with lower value of GDP per capita, lower than is the EU average, in the observed time period from year 2011 to 2016, are presented. The EU average is 26 900 EUR per capita (with the exception of Denmark, France, Ireland, Germany, the UK and Sweden). Contrary to that the average GDP growth coefficient for these states (with the exception of Denmark) is of growing character. In these countries, long-term unemployment rates decline the fastest in the observed period, which indicates their overall economic growth and increase of production capabilities in these states‘economies. Regarding the geographic attributes these states are not concentrated in some specific territory, but they are scattered along the entire EU territory.

The following similarities were found between countries in this first cluster in the area of digital literacy. There is an interest in calls and video calls by Internet with exception three countries: the CR, Estonia and Latvia in the given period – we can see the similarity these countries in the dendrogram in the Fig 4; and the e-mail communication is rather declining or does not expose the change. There are significant values of the average growth coefficient in the activity of the Internet banking in all countries in this cluster in exception of Sweden. In this country, there is the decrease of this activity compared to 2011. In the participation in the social networks (in exception of Sweden and Latvia), the countries are typical with value of this coefficient up to 1.05; the higher values was only achieved Romania (1.07). It means, the interest in this activity has annually grown in average by 5% in these countries.

Fig. 4: Dendrogram: the model by Ward's method



Source: Authors

Cluster 2 is the smallest group with five countries: Greece, Slovenia and Luxembourg, Austria and Italy. This cluster is typical for its growing long-term unemployment caused primarily by increased limit of retirement age on one hand (Svoboda, 2014), (Czech Social Security Administration, 2017) and at the same time by influx of labour force from abroad on the other hand. Values of the average GDP per capita growth are slightly declining (with the exception of Austria, value of the average growth coefficient is 1.001).

The most represented Internet activities are the following: the increasing value of the attribute concerning Internet banking, social networks (countries have values of the average growth coefficients up to 1.05) communication by means of e-mail mailbox (with the exception of Italy, 0.994) and the declining value of sales of products and

services on Internet in the observed period. On the other hand there is growing interest in searching information about goods and services with exception of Italy (this activity has annually decreased in average by 5.7%). Since 2012 it has seen a decline in interest of young people in this activity in this country. The interest in seeking information about health is rather declining (with exception Luxembourg, the average growth coefficient is 1.051; this activity has annually increased in average about 5.1%). In this cluster, it is a typical interest in calls and video calls by Internet. The significant values we can see in Slovenia (the value of average growth coefficient is 1.145), Greece and Luxembourg (more than 1.090).

Cluster 3 contents these seven EU countries: Belgium, Finland, Croatia, Cyprus, the Netherlands, Portugal and Spain. It is represented by those states where generally speaking it is possible to say that their youth more and more discover benefits of Internet technologies. That means email and electronic communication, utilization of the social networks and sales of products and service on Internet. The significant values were achieved for this last activity "selling goods and services" (countries as Croatia (the value of the average growth coefficient is 1.27) and Portugal (1.25), Cyprus (1.18) and Spain (1.15)); and as well as in the activity of searching for information about health and about healthy life style (Belgium (1.084), Croatia (1.07) and Portugal (1.063). It means this activity has annually increased by more than 6% in these countries. Growing penetration of Internet services is evidenced by the fact that growing percentage of youth makes calls or video-calls via Internet (the significant values of the average growth coefficient were achieved for Finland (1.222), Belgium (1.130), Portugal (1.157) and Croatia (1.129). Compared with 2011 there was a significant increase in interest of young people in the given activity with the exception of Netherlands where the average coefficient of growth for the observed period declines (0.993).

Regarding the economic indicators this cluster is characterized by increasing average coefficient for long-term unemployment, however for the indicator GDP per capita the value of the average coefficient of growth is constant or it slightly declines.

In the framework of this model the CR is put into cluster 1. The typical characteristics of this cluster are GDP growth and long-term unemployment (rate) decline. In comparison with the EU average values the CR however reaches in GDP only 60% of the EU average. On the contrary, regarding the long-term unemployment it does not reach even half the value of the EU average. In the CR GDP slowly but steadily grows each year.

In the Fig. 4 we can see that the CR is very similar with Estonia. The same behaviour of youth is in activities "using e-mails" (a_2) and "searching information about travelling and accommodation on Internet" (a_9). In addition, other Internet activities are popular too (e.g. for the CR is typical the participation in social networks (1.111; this activity has annually increased in average by 11.1%), the seeking information about health (1.099) or finding information about goods and services (1.04)) in exception of calls and video calls (0.979). It means that this activity of young people has annually decreased in average by 2.1%. Latvia, Poland, Slovakia and Lithuania (see Fig. 4) have also the more significant similarity with the CR based on given economic attributes and the behaviour of the young people using Internet. The young people in the CR are more active than young people living in Slovakia in given Internet activities (in exception of calls and video calls). The same values of the average growth coefficient were achieved for sales of

products and service on Internet (1.020). In means that this activity has annually increased in average about 2% in these two countries.

Conclusion

The analysis of data about behaviour of young people living in the CR and in other EU member states in digital world based on selected attributes by means of selected cluster analysis algorithms was the objective of this article.

Model, that compared youth in digital world living in EU countries, was created on the basis of the Ward‘s method. The values of the input attributes described situation in time series year 2011 to year 2016. The acquired data was pre-processed. Missing values were substituted and average coefficients of growth for the observed indicators were calculated. Groups (clusters) of EU states with characteristics were identified by means of selected algorithm of the agglomerative hierarchical clustering. The achieved results of modeling were described.

According to the modelling outputs the CR is not anyhow specific regarding the average values identified for the EU as an entity. On the contrary it is possible to state that youth in the age from 16 to 29 years of age living in our country is, based on their behaviour in digital world, ranked among more advanced countries. *(note: the results of modeling were described in the previous parts of this article including behavior of czech young people in the digital world)* This is possibly a reflection of prior financial funds invested into elementary schools. These financial funds, mostly originating from various subsidies programs financed by the EU, supported the development of technical and information infrastructure of elementary and secondary schools. This is demonstrated currently exactly on the group defined as youth with higher level of digital literacy and ability to perceive the ever developing up-to-date information technologies.

This positive finding should not however be the only criterion. On the other hand in some EU countries (Finland, France, Germany, Italy, the Netherlands and Sweden) we can already see slight decline in the amount of time and in the frequency of time spent by youth on the Internet. This is without any doubt also the outcome of the fact that youth want to lead their lives in a different way.

The overall perception of the digital world leads not only youth to the need of continuous education, of working on oneself and of being adaptable and creative. Such is the world of information technologies, permanently new, youthful, developing and fast changing. These days young people have permanently available „at hand“ all information and a mobile Internet connection becomes to be almost a natural thing for the observed group of people.

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