# Preface

## Special issue of Acta Polytechnica Hungarica on Business Trends in the 21st Century

This issue of Acta Polytechnica Hungarica contains papers that were invited from academics and researchers of the V4 countries. Acta Polytechnica Hungarica as an interdisciplinary journal, although mainly accepting papers from the fields of engineering, applied informatics and mathematics, has decided to widen its scope and offer a variety of business related articles since there are no organisations, factories or research centres without effective business solutions. What is more, the broader economic and social environment even influences trends in research and development, along with the exploitation of the possibilities created through them.

The first article of the issue proves this statement by exploring renewable energy, economic development in the European Union and their interconnectedness. The research presented in the paper analyses data from 28 EU countries to determine to what extent economic development stimulates the production of energy from renewable sources and whether countries characterized by large greenhouse emissions are catching up with "green" nations.

The second paper focuses on socio-demographic factors and their effect on business processes. Risk avoidance is a characteristic of certain countries and national cultures, the same as the propensity to trust each other and invest in riskier businesses. The paper analyses the connection of risk perception and management with business behaviour. Although the starting point is psycho-social, the data presented in the paper emphasise, that risk taking has strong relation with the business performance of SME.

In the third paper the efficiency of the banking sectors in European Union countries is analysed, since financial issues have significant effect on every actor of the economic sphere, be them large multinationals or local SMEs. The financial crisis has proved the worth of this statement the hard way. For this reason, the paper analyses the efficiency of different nations' banking sectors and the efficacy of the national and international regulators pointing out significant differences between states within and outside the Monetary Union.

While the first three papers prove the importance of exploring the wider social, regulatory and financial environment, the fourth paper attempts to analyse business cycles as phenomena, based on various composite indicators. Factors, such as employment in manufacturing, export of goods and services, the number of hours worked in industry and industrial turnover are proved to be significant indicators for the past years. However, production index in the construction industry, insufficient demand, unemployment in the age group of 25-74 and short-

term interest rate - underlining the relevance of the topics discussed in the previous papers – create new composite coincident indicator for the future.

The first four papers of the special issue endeavoured to highlight the importance of macroeconomic factors, whereas the papers in the second half of the issue concentrate of microeconomic and business topics.

Money makes the world go 'round. Its importance is indisputable both on macro and on micro level. Hence the fifth paper focuses on the maturity of budgeting systems and their influence on corporate performance. Since traditional budgeting mechanisms have frequently been criticised for their inherent inflexibility and the substantial time frames they demand, the paper attempts to provide an alternative to the old and rigid systems and approach businesses and processes from a modern, performance-based budgeting perspective.

Although in the most part of the 20$^{th}$ Century people were regarded as replaceable elements of businesses, with the shortage of skilled labour and the negative demographic tendencies the value of human resources has increased enormously. Big companies realised it relatively faster than SMEs that employees should be regarded as key assets. The sixth paper explores and presents Human Resource Management practices in Small and Medium Enterprises in the Visegrad Group to estimate how long way SMEs have ahead of them in this regard.

The seventh paper of the issue also tackles the topic of Human Resource Management, but from the point of view of atypical forms of employment. Although most countries have significant unemployment, even in the EU, there is usually unmet demand for workers on the same labour market. The reason for this structural unemployment is either the mismatch in skills and competencies, or in working conditions. The research presented in the paper concentrated on the unemployment in the Slovak-Hungarian border region and attempted to discover whether and if yes how atypical forms of employment can reduce unemployment.

When considering the importance of various business functions, marketing is often underestimated. However, without a thorough market research that discovers the potential consumers' demand and preferences, a business venture can hardly be profitable on the long run. The eight paper of the special issue explores interestingness measures in online shoppers' data. The research presented in the paper underlines the significance of information provided online to potential consumers and the way products are marketed. The work provides general insights into how shopper-vendor transactional data can be explored.

In the last paper of the issue a circular evaluation tool for sustainable event management is presented, approaching the topic of green energy addressed in the first paper from the micro level. The paper introduces a pilot project which focuses on solar energy usage through the implementation of circular energy-sharing solutions for a possible Olympic village. The study, besides elaborating on innovative business and technological solutions for developing solar energy,

which can be applied to circular principles, and lead to further social-economic-environmental benefits, also introduces a newly developed methodology which has been created to measure the circular efficiency of events.

**Kornélia Lazányi**
Special Issue Guest Editor

# Renevable Energy and Economic Development in the European Union

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*Abstract: In recent years, the world has been facing issues concerning global warming and climate change. Therefore, one of the EU's priorities is limitation of gas emissions and promotion of energy production from renewable sources. On 23 April 2009, taking into account the level of economic development and the sources from which energy is obtained, the EU adopted Directive of the European Parliament and Council No 2009/29, which imposed limits on member states for the production of greenhouse gases. The aim of this research is to investigate whether and to what extent economic development stimulates the production of energy from renewable sources. For this purpose, we analyzed data from 28 EU countries from 2004 to 2014 to determine whether countries characterized by large greenhouse emissions are catching up "green" nations.*

*Keywords: renewable energy; global warming; climate change; hierarchical cluster analysis*

# 1 Introduction

In recent years, Europe and the rest of the world have faced a huge challenge: striking a balance between ecology and environmental protection, political and business interests, and meeting the energy needs of individual economies. In Europe, work on energy issues began during the period of the European Coal and Steel Community. In 1968, a document entitled "First orientation for a common energy policy[1]" was published, whose aim was to lay the groundwork for the creation of a common energy market based on cooperation and protection of the interests of individual countries. The document also emphasized the need for action towards the reduction of energy consumption. The turning point in energy

[1] First Orientation for a Common Energy Policy, Communication from the EC to the Council, 18 December 1968

policy for Europe was the 1970s energy crisis in the Middle east, which caused a dramatic spike in oil prices. This had a negative impact on individual economies, and highlighted their enormous dependence on external sources of energy, especially oil. The governments of European countries thus, began to create and adopt national energy programs intended to rationalize and optimize energy consumption, both by households and industry. It was during this period that the concept of an open internal energy market was developed[2], which fundamentally addressed the issue of energy production on competitive terms, while taking into account the requirements of environmental protection and energy policy [1]. This, therefore, constituted a breakthrough which, in a certain sense, laid the foundation for the further development of renewable energy. It became clear that the cost of obtaining energy would continue to rise, and would impede the development of individual countries in the long-term. This necessitated investment in technologies and solutions aimed at facilitating the obtainment, distribution, and conservation of energy. The Lisbon Treaty of 1992 significantly increased the importance of energy in the EU, which was considered a common value of all member states. The new Lisbon Treaty of 2007, in Art. 194 of the Treaty on the Functioning of the European Union (TFEU), identified four main energy policy objectives: to guarantee the functioning of the energy market; to guarantee the supply of energy to EU countries; to promote energy efficiency and development of new and renewable energy sources; and to promote international energy ties 3. The European Union subsequently published a number of documents and directives, such as a Green Paper and White Paper, Directive 96/92/EC on the common principles of the internal energy market, and Directive 98/30/EC on the common principles of internal gas market. All of these documents contributed to the ongoing effort to establish and enforce the principles of operation and liberalization of a common, European energy market that respects the interests of individual nations. The reformation and optimization of the EU energy market has been a tedious and complicated process, in which the short-term interests of individual countries often stand in conflict with the aims and objectives of the community. Moreover, the efficiency with which specific directives have been implemented on the domestic level has been far from satisfactory. The political turmoil in Europe as a result of the economic crisis and the conflict near the Ukrainian border with Russia have led to an intensification of efforts towards the energy security of the EU, a consequence of which was the 2007 adoption o the Energy and Climate Package. Then, in 2009, Directive 2009/29/EC of the European Parliament and of the Council was adopted, which imposed on member states the obligation to reduce production of greenhouse gases, depending on their level of economic development and the sources from which they obtain energy.

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2 Draft document on the internal energy market, Internal Energy Market 1988, COM (88) 238

3 http://www.europarl.europa.eu/meetdocs/2009_2014/documents/envi/dv/201/201006/20100602_envi_study_energy_policy_en.pdf

It is worth noting that since the 1970s, all studies on energy issues emphasize a strong correlation between increased efficiency and reduced costs of obtainment, distribution, and optimal use of energy, as well as economic development. In light of the above, they, therefore emphasize the need to diversify energy sources. Another key issue is currently the ecology of energy policy due to the negative impact of CO2 emissions on rapidly progressing climate change, as well as the threats related thereto. Hence, the increasing stress on replacing traditional energy sources with renewable energy sources. The aim of this article is therefore to determine if and to what extent economic development stimulates the production of energy from renewable sources. For this purpose, data from 28 EU countries from 2004 to 2014 was analyzed. Using taxonomic methods such as Ward's method, the countries analyzed were clustered according to their exploitation of renewable energy potential. Paper length must be between 12 and 20 pages.

# 2 Literature Review

There are conflicting views on the impact of renewable energy on economic growth. Formally, an increase in production and total demand is caused by an increase in energy consumption; however, some experts suggest that an increase in energy consumption is not a determinant of economic growth and total demand, but – on the contrary – a result thereof. The issue is thus not as straightforward as it may seem.

Limited energy resources and regulation by the European Commission over the years have led to increased efforts in the search for renewable energy sources, especially in European countries. Also, important here is the fact that renewable energy is significantly less harmful for the natural environment than non-renewable energy, which has triggered efforts to obtain energy from more environmentally friendly sources. Another determinant is that some countries provide additional tax incentives for investors in the sector, or grants to support projects related to energy production from renewable sources [2].

We must therefore explore the causal link between renewable energy production and the development of individual states on the basis on global research. Hypotheses concerning the issue are fairly diverse, which may be a consequence of the different data sets used in analyses, the profiles of the counties analyzed, and the application of various econometric methods.

We will consider two aspects of the above mentioned link: the relationship between the use of energy in general and economic growth; and the relationship between renewable energy and economic development. The latter aspect has been addressed by the research of R. Sarl, et al. [4]. They examined the issue in the American market on a monthly basis from 2001-2005 using the ARDL method.

P. Sadorsky [5] conducted a similar study in 18 developing countries from 1994-2003, using panels of contingency and detailed panels of the modified OLS method. Both the first group or researchers and P. Sadorsky demonstrated the validity of the hypothesis that an increase in energy usage is stimulated by economic growth. They claim that this relationship is nevertheless one-way, as manifestations of a potential energy-saving policy are not harmful for economic growth. This type of hypothesis is called a conservation hypothesis, and has also been confirmed in the studies of J. Kraft and A. Kraft [6] on the market in the USA, W. Lise and K. Van Montfort [7] on Turkey, C. C. Lee [8] on France, Italy and Japan, A.E. Akinlo [9] on Sudan and Zimbabwe, M. Shahbaz and others [10] on Portugal, and X. P. Zhang and X. M. Cheng [11] on China. Likewise, C. Caraiani and others [12] used the Granger causality test to analyze the causal link between energy usage and GDP in five emerging European countries from 1980-2013. They proved the validity of the hypothesis for Hungary, Poland, and Turkey, in turn D. Makarenko and D. Streimikiene [13] for Ukraine. D. Striemkine and others [14] reached the similar conclusions for the Baltic countries.

In contrast, Y. Fang [15] tested what is referred to as the growth hypothesis based on the analyses of the Chinese market from 1978-2008. This hypothesis expresses the idea that energy consumption is an important factor in economic growth, and that energy-saving policies can have a negative impact on the economy. N. Magnani and A. Vanona, who analyzed regions of Italy from 1997 to 2007, as well as R. Iglesi-Lotz [17], based on his observations of OECD countries, also confirm this hypothesis. Further support can be found in the work of A.N. Menegaki [18], who analyzed 27 European countries from 1997 to 2007, along with that of A. K. Tiwari, who used the VaR method to analyze the Indian market for nearly 50 years from 1960-2009. N. Apergis and J. E. Payne conducted a wide range of studies on the issue [20] in 80 countries, including in Central America. O. Ocal & A. Aslan [21] considered the relationship between renewable energy and economic growth on the basis of analyses of 18 countries from 1994-2003, and confirmed a correlation between the above mentioned factors. A. A. Azlina et al. [22] did the same on the basis of data from 1975-2011 using an error correction model. O. Ucan, E. Aricioglu, and F. [23] backed this position on the basis of studies conducted in 15 European countries between 1990-2011. Also worthy of mention in this case are the studies F. Kula [24] on 19 OECD countries from 1980-2008. C. Bozkurt & M. A. Destek [25], on the basis of case studies in OECD countries, hold that this hypothesis is true only for very developed countries. S. Kayhan, et al. [26] drew similar conclusions, but only with reference to Romania.

J. E. Payne has devoted much attention to this problem. On the basis of data from 1949-2006, he corroborated the so-called neutrality hypothesis, which posits that there is no causal relationship between energy consumption and economic growth [27]. In other words, any reduction in energy consumption will not affect economic development. A. Aslan and O. Ocal [28] reinforce the thesis based on

analyses of new EU member countries. The same can be said about other researchers, such as: C. C. Lee [8], who studied countries like Great Britain, Germany, and Sweden; as well as U. Soytas & R. Sari [29], and F. Haliciouglu [30], who studied Turkey, and G. Kharlamova, S. Nate, O. Chernyak [31] who analyzed Ukrainian market.

J. E. Payne and N. Apergis [32], in another work that analyzed 20 OECD countries, confirmed the feedback hypothesis, which posits a two-way causal relationship between energy consumption and economic development, underlining that a conservative energy policy may limit the economy. Apergis and Payne [33] further confirmed this hypothesis on the basis of research conducted in 13 Eurasian countries between 1992-2007; as did U. Al.-Mulali, et al. [34], who analyzed 18 Latin American countries between 1980-2010 using the co-integration method. The works of R. A. Salim, et al. [35], based on analyses of OECD countries from 1980-2011, are also consistent with this hypothesis. Lastly, the validity of the feedback hypothesis is bolstered by the research of M. Shahbaz, et al. [36] and T. Chang, et al. [37], which focuses on G7 countries.

# 3 Data

This article will attempt to answer the question of whether the EU directive from 2009 has affected the energy policies of individual countries and whether those countries themselves would have taken the same actions had the directive not been adopted. This will be done on the basis of an analysis of 28 European Union countries[4] (excluding countries belonging to the European Free Trade Association) from 2004-2014. The research will cover the five-year periods before and after the implementation of EU Directive 2009/29/EC, which obliged member states to reduce production of greenhouse gases. This amount of time appears sufficient to observe the first changes in the energy policies of individual member countries. Analyzed will be the amount of energy obtained from renewable sources and greenhouse gas emissions. In order to ensure the comparability of results, the study has also taken into account variables specific for each country, such as area, number of inhabitants, total energy production, and GDP per capita. The following is a list of individual variables together with their units of measurement:

[4] The primary sources of data were the websites of Eurostat http://ec.europa.eu/eurostat/data/database, and the International Monetary Fund (for data on Gross Domestic Product) [date of access: 28.11.2016]

**RE [toe] –** production of renewable energy in thousands of toe5

**CO2 [t]** – greenhouse gas emissions (CO2 equivalent) generated by production of energy

**EP [toe]** – production of energy in thousands of toe

**SA [km2]** - surface area (total area)

**P [-]** – population in thousands

**GDP** [current international dollar] - gross domestic product (at purchasing power parity) per capita

Furthermore, to facilitate analysis of three different years (2004, 2009, and 2014), an indication thereof has been added after each variable symbol, e.g. RE2004, RE2009, RE2014. The exception is surface area (SA), which is consant. These variables were used to create the indicators for characterizing countries, whereby the first two, i.e. production of renewable energy and greenhouse gas emissions, are related to the remaining four. Also, calculated was the ratio of greenhouse gas emissions to renewable energy production. All indicators together with their variable symbols for specific years are given in Table 1.

Table 1

Indicators and their averages for 2004, 2009 and 2014

| **Indicators 2004** | **Indicators 2009** | **Indicators 2014** |
|---|---|---|
| **RE2004/EP2004** | RE2009/EP2009 | RE2014/EP2014 |
| **RE2004/SA** | RE2009/SA | RE2014/SA |
| **RE2004/P2004** | RE2009/P2009 | RE2014/P2014 |
| **RE2004/GDP2004** | RE2009/GDP2009 | RE2014/GDP2014 |
| **CO2004/EP2004** | CO2009/EP2009 | CO2014/EP2014 |
| **CO2004/SA** | CO2009/SA | CO2014/SA |
| **CO2004/P2004** | CO2009/P2009 | CO2014/P2014 |
| **CO2004/GDP2004** | CO2009/GDP2009 | CO2014/GDP2014 |
| **CO2004/RE2004** | CO2009/RE2009 | CO2014/RE2014 |

Source: The authors' own research

5 http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Tonnes_of_oil_equivalent_(toe) [date of access: 28.11.2016]

# 4 Methodology

With numerous data sets characterized by many features, one of the best methods of comparison is clustering [38]. In order to determine groups of countries that were similar in terms of investment in renewable energy sources, we used a taxonomic analysis [39] with Ward's hierarchical clustering method [40]. This method is a type of agglomerative clustering method and is considered one of the most efficient in creating homogeneous clusters. The basis of analysis for agglomeration methods is an observation matrix composed of selected variables, from which a distance matrix is created. See below:

$$\begin{bmatrix} 0 & d_{12} & \Lambda & d_{1n} \\ d_{21} & 0 & \Lambda & d_{2n} \\ \mathrm{M} & \mathrm{M} & \mathrm{O} & \mathrm{M} \\ d_{n1} & d_{n2} & \Lambda & 0 \end{bmatrix} \tag{1}$$

$d_{ij}$ – the distance between i and j observations.

Culsters are created on the basis of the distance matrix in relation to the criterion of connection for the clusters in a group [41-42, 45-46]. Analysis of variance is used in Ward's method for estimating the distance between clusters. This technique aimed at minimizing the sum of squared deviations within clusters. The squared Euclidean distance is used as the criterion of connection for the clusters in a group:

$$d_{ij} = \sqrt{\sum_{i=1}^{p} (x_{il} - x_{jl})^2} \tag{2}$$

In Ward's method, it is desirable that the variables used have a coefficient of variation not less than 10%, and that they are not significantly correlated with each other. As can be seen from Table 2, the coefficient of variation greatly exceeds the limit in all cases. Analysis of the correlation (Table 3) showed a significant relationship between indicators CO2/RE, CO2/EP, and CO2/SA (coefficient of correlation greater than 0.75); therefore, the following indicators were omitted from further analysis: CO2/RE and CO2/SA.

Table 2

Coefficient of variation for the indicators for 2004, 2009, and 2014

| **Indicator 2004** | **Vz** | **Indicator 2009** | **Vz** | **Indicator 2014** | **Vz** |
|---|---|---|---|---|---|
| **RE2004/EP2004** | 99.9 | RE2009/EP2009 | 82.1 | RE2014/EP2014 | 70.6 |
| **RE2004/SA** | 69.7 | RE2009/SA | 67.5 | RE2014/SA | 64.2 |
| **RE2004/P2004** | 124.8 | RE2009/P2009 | 110.3 | RE2014/P2014 | 100.4 |
| **RE2004/GDP2004** | 121.4 | RE2009/GDP2009 | 99.9 | RE2014/GDP2014 | 87.3 |
| **CO2004/EP2004** | 495.5 | CO2009/EP2009 | 474.6 | CO2014/EP2014 | 245.6 |

| | | | | | |
|---|---|---|---|---|---|
| **CO2004/SA** | 125.4 | CO2009/SA | 133.3 | CO2014/SA | 137.8 |
| **CO2004/P2004** | 45.8 | CO2009/P2009 | 42.0 | CO2014/P2014 | 43.8 |
| **CO2004/GDP2004** | 78.3 | CO2009/GDP2009 | 60.7 | CO2014/GDP2014 | 66.7 |
| **CO2004/RE2004** | 420.5 | CO2009/RE2009 | 398.7 | CO2014/RE2014 | 132.4 |

Source: The authors' own research

Table 3
Correlation between indicators CO2/RE and CO2/EP

| **Indicator 1 - Indicator 2** | **Correlation [%]** |
|---|---|
| **CO2004/RE2004 - CO2004/EP2004** | 99.9 |
| **CO2009/RE2009 - CO2009/EP2009** | 99.9 |
| **CO2014/RE2014 - CO2014/EP2014** | 95.6 |
| **CO2004/RE2004 - CO2004/SA** | 77.6 |
| **CO2009/RE2009 - CO2009/SA** | 81.9 |
| **CO2014/RE2014 - CO2014/SA** | 88.8 |
| **CO2004/EP2004 - CO2004/SA** | 76.0 |
| **CO2009/EP2009 - CO2009/SA** | 80.7 |
| **CO2014/EP2014 - CO2014/SA** | 83.1 |

Source: The authors' own research

The seven most diverse indicators were chosen for analysis: RE/EP, RE/SA, RE/P, RE/GDP, CO2/EP, CO2/P, CO2/GDP. This was done separately for each year, e.g. RE2004/EP2004. The indicators had to be standardized in order to objectively assess similarities, regardless of the scales on which they were expressed. As a result of this standardization, we get a matrix of similarities that yields a statistical population. By using Ward's method on the matrix, we can determine groups with minimal differentiation of features, which in further steps will make up increasingly large clusters.

# 5 Empirical Results

## 5.1 Cluster Analysis for 2004

Clustering of countries was done for each year separately using the Statistica 12 program. A number of methods can be used to determine the optimal number of clusters, for example [43-44]. For 2004 (Figure 1), the dendrogram was cut off at 30, thanks to which the countries could be grouped into six clusters, similar to each other with respect to the chosen features, yet at the same time maximally different from the others.

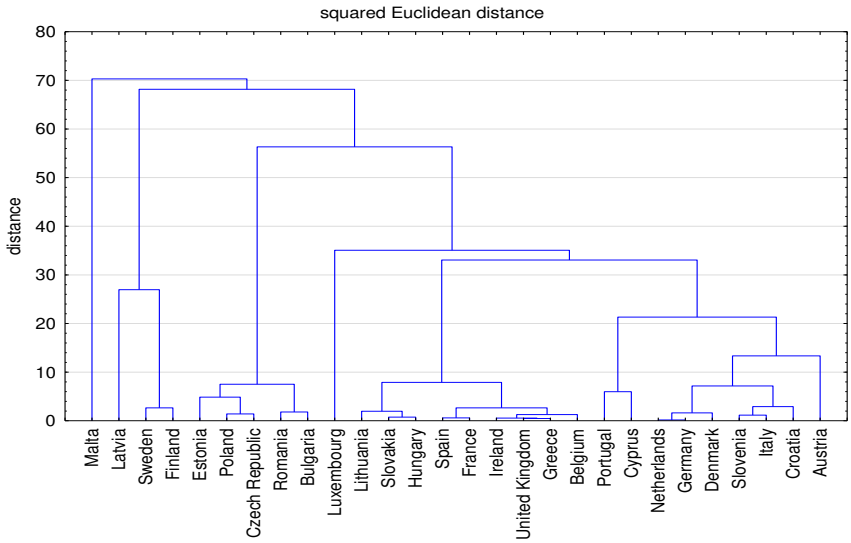


Figure 1
Dendrogram for 2004

Source: The authors' own research

The results of clustering with respect to renewable energy production and greenhouse gas emissions using Ward's method are presented in Table 4, and their group averages in Table 5.

Table 4
Clusters for 2004

| No\Group | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| **1** | Malta | Luxembourg | Finland | Bulgaria | Belgium | Austria |
| **2** | | | Latvia | Czech Republic | France | Croatia |
| **3** | | | Sweden | Estonia | Greece | Cyprus |
| **4** | | | | Poland | Hungary | Denmark |
| **5** | | | | Romania | Ireland | Germany |
| **6** | | | | | Lithuania | Italy |
| **7** | | | | | Slovakia | Netherlands |
| **8** | | | | | Spain | Portugal |
| **9** | | | | | United Kingdom | Slovenia |

Source: The authors' own research

Table 5

Group averages for 2004

| Gr | RE2004 /EP2004 | RE2004 /SA | RE2004 /P2004 | RE2004 /GDP2004 | CO2004 /EP2004 | CO2004 /P2004 | CO2004 /GDP2004 |
|---|---|---|---|---|---|---|---|
| **A** | 1.000000 | 1.26582 | 0.000993 | 0.000082 | 6.545125 | 0.006502 | 0.000538 |
| **B** | 0.587486 | 19.60557 | 0.109923 | 0.001833 | 0.131287 | 0.024565 | 0.000410 |
| **C** | 0.645873 | 28.07029 | 1.415474 | 0.085063 | 0.003315 | 0.007643 | 0.000418 |
| **D** | 0.110882 | 16.19952 | 0.228778 | 0.046727 | 0.004073 | 0.008673 | 0.001683 |
| **E** | 0.126601 | 14.81527 | 0.141524 | 0.012536 | 0.007854 | 0.007736 | 0.000496 |
| **F** | 0.429730 | 42.43694 | 0.336639 | 0.019017 | 0.021982 | 0.008492 | 0.000418 |
| **Total** | 0.324518 | 25.04821 | 0.350168 | 0.027668 | 0.249116 | 0.008693 | 0.000673 |

Source: The authors' own research

For comparison of the groups, the values of indicators for individual countries relative to the overall average have been determined on the basis of Table 5, and are presented in Figure 2.

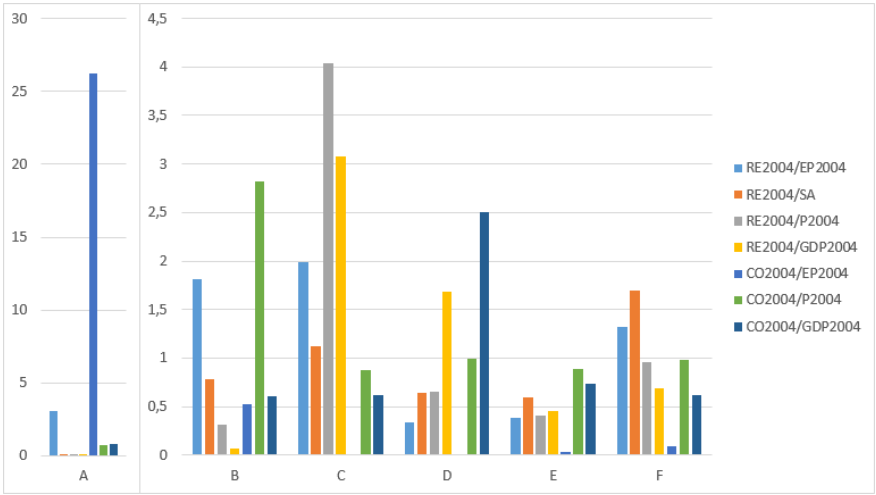


Figure 2

Comparison of group averages for 2004 - groups B - F

Source: The authors' own research

We can see that **group A**, which consists only of Malta, stands out in comparison with the other groups. This is due to the high value of the indicator for emission of greenhouse gases in relation to the total energy produced (CO2004/EP2004). Additionally, this group has the highest rate of energy production from renewable sources in relation to the total energy produced.

There is also only one country in **group B** (Luxembourg), which, as a small country, produces a large amount of greenhouse gases in relation to its number of inhabitants (CO2004/P2004). Similarly to group A, group B also has a large percentage of energy produced from renewable sources (RE2004/EP2004).

The most ecological group is **group C**, which consists of Finland, Latvia, and Sweden. In these countries, a large portion of the energy used is produced from renewable sources (RE2004/EP2004). This group is also positively distinguished by its high indicators for production of energy from renewable sources in relation to its population and GDP. This means that the economies of these countries are developing to the greatest extent on the basis of renewable energy.

In **group D** are mainly Central and Eastern European countries that joined the European Union in 2004 or later. In 2004, the economies of these countries were based mainly on energy produced from coal, and thus were polluting the environment with greenhouse gases to the greatest extent (CO2004/GDP2004). They can be considered the biggest polluters of the European Union.

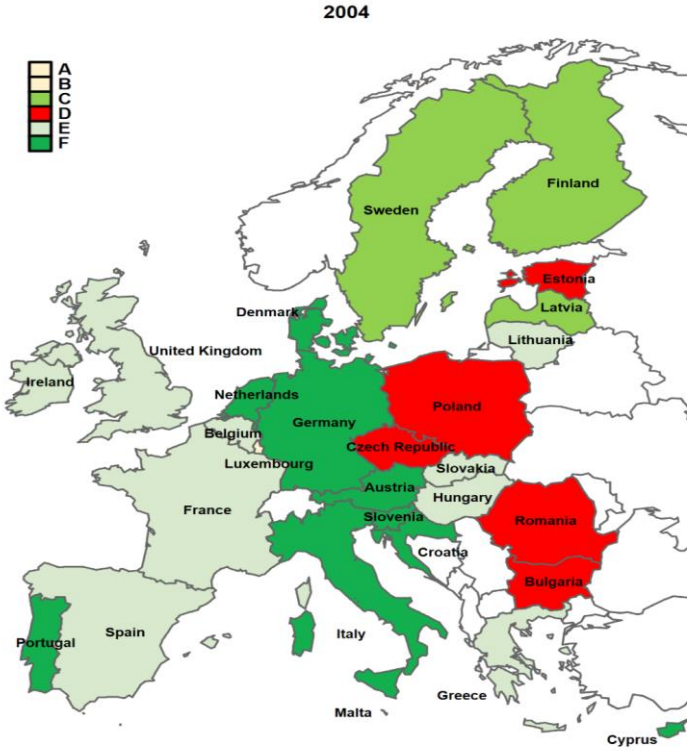


Figure 3
Visual presentation of the groups in 2004

Source: The authors' own research

**Group E** is a group of countries that do not stand out in terms of production of energy from renewable sources, or in terms of excessive emission of greenhouse gases. The group consists of countries from different regions of the European Union, which varies from one another with respect to sources of energy production, as well as when they joined the European Union.

In the last group, **group F**, are countries which, similarly to those in group C, are considered environmentally friendly. However, they are different from those in group C in that they produce a lot of renewable energy relative to their area, but their GDP is not strongly associated with this kind of energy. The areas of the countries in this group are insignificant, as it includes small countries like Cyprus and Slovenia, as well as large countries like Germany.

As a supplement to the data above, these groups have been plotted on a map of Europe according to a color scheme (see Figure 3). Red indicates the least ecological countries, while green indicates the most ecological countries.

## 5.2 Cluster Analysis for 2009

When making a cluster for 2009 (see Figure 4), the dendrogram was also cut off at 30, and six groups also appeared.

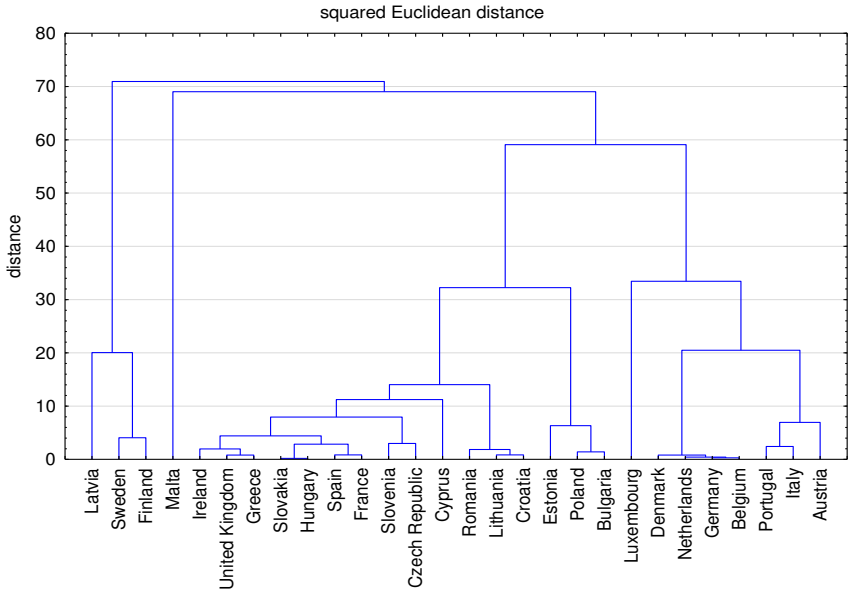


Figure 4
Dendrogram for 2009

Source: The authors' own research

The composition of groups is shown in Table 6. We can see that there are no changes to groups A, B, and C; though in groups D, E, and F, six countries changed places (see Figure 7). Belgium has moved to more ecological group F. Croatia, Cyprus and Slovenia moved from group F to "inferior" group E, where they are together with the Czech Republic and Romania. For these last two countries, however, belonging to group E is positive, as they have moved out of group D - the least ecological.

Table 6
Clusters for 2009

| **No\Group** | **A** | **B** | **C** | **D** | **E** | **F** |
|---|---|---|---|---|---|---|
| **1** | Malta | Luxembourg | Finland | Bulgaria | Croatia | Austria |
| **2** | | | Latvia | Estonia | Cyprus | Belgium |
| **3** | | | Sweden | Poland | Czech Republic | Denmark |
| **4** | | | | | France | Germany |
| **5** | | | | | Greece | Italy |
| **6** | | | | | Hungary | Netherlands |
| **7** | | | | | Ireland | Portugal |
| **8** | | | | | Lithuania | |
| **9** | | | | | Romania | |
| **10** | | | | | Slovakia | |
| **11** | | | | | Slovenia | |
| **12** | | | | | Spain | |
| **13** | | | | | United Kingdom | |

Source: The authors' own research

Table 7
Transitions of countries between groups from 2004 to 2009

| **Country** | **2004→2009** |
|---|---|
| **Belgium** | E→F |
| **Croatia** | F→E |
| **Cyprus** | F→E |
| **Czech Republic** | D→E |
| **Romania** | D→E |
| **Slovenia** | F→E |

Source: The authors' own research

When comparing group averages with the whole (Figure ), we get the impression that, aside from the transitions of a few countries between groups, there are no major changes to what we observed in 2004 (Figure 2). The profiles of the groups are also the same as in 2004.

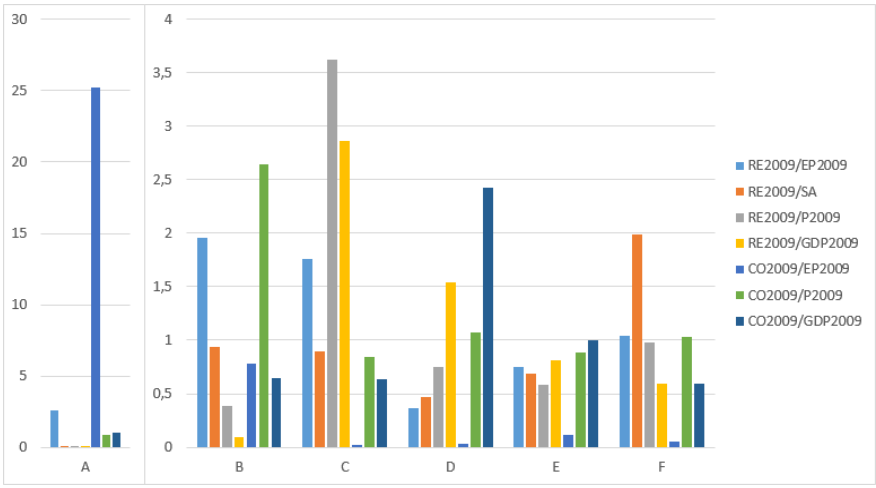


Figure 5
Comparison of group averages for 2009 - groups B -F

Source: The authors' own research

When comparing average indicator values in individual groups in 2004 and 2009, we can see that there is a change (Figure 5), but it is uniform enough to only cause small transitions between groups.

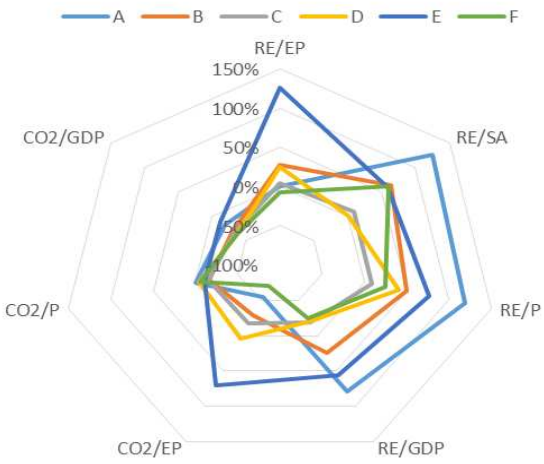


Figure 6
The change in average indicator values in individual groups from 2004 to 2009

Source: The authors' own research

Figure 6 reveals that, in most of the groups, the production of energy from renewable sources rose and the production of greenhouse gases fell. These changes indicate that the production of energy from renewable sources was developing in Europe before the EU directive on reduction of greenhouse gas emissions was introduced.

Figure 7 shows a visual representation of the changes within the groups in 2009 according to a color scheme. Red indicates the least ecological countries, while green indicates the most ecological countries.

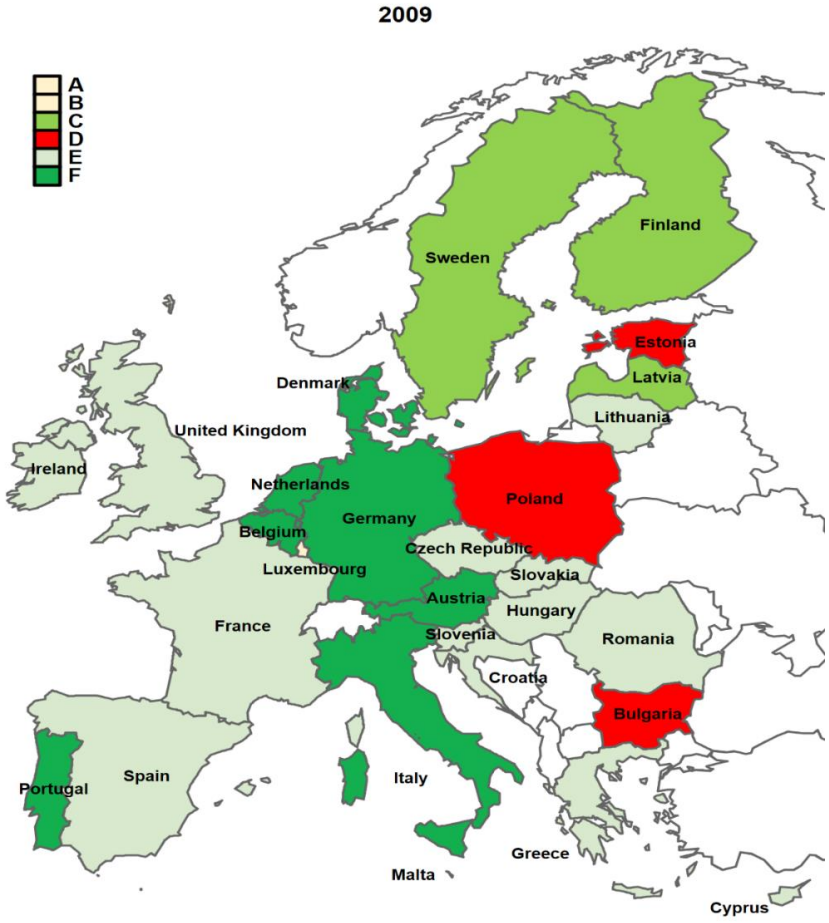


Figure 7
Visual presentation of the groups in 2009

Source: The authors' own research

## 5.3 Cluster Analysis for 2014

The last year for which the groups were clustered was 2014. Once again with the dendrogram (Figure 8) cut off at 30, this time only five groups appeared (Table 8). In order to preserve the nomenclature of groups from 2004 and 2009, group B has been omitted.

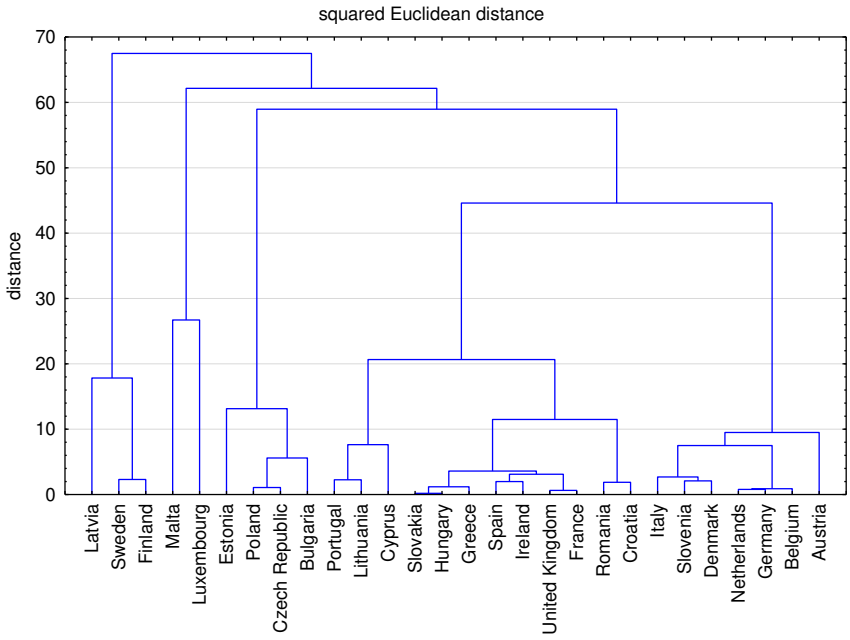


Figure 8
Dendrogram for 2014

Source: The authors' own research

Table 8
Clusters for 2014

| No\ Group | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| **1** | Luxembourg | | Finland | Bulgaria | Croatia | Austria |
| **2** | Malta | | Latvia | Czech Republic | Cyprus | Belgium |
| **3** | | | Sweden | Estonia | France | Denmark |
| **4** | | | | Poland | Greece | Germany |
| **5** | | | | | Hungary | Italy |
| **6** | | | | | Ireland | Netherlands |

| | | | | | | |
|---|---|---|---|---|---|---|
| **7** | | | | | Lithuania | Slovenia |
| **8** | | | | | Portugal | |
| **9** | | | | | Romania | |
| **10** | | | | | Slovakia | |
| **11** | | | | | Spain | |
| **12** | | | | | United Kingdom | |

Source: The authors' own research

There were only four transitions between groups during the five-year period from 2009 to 2014 (Table 9). The Czech Republic returned to group D (the least ecological), where it was in 2004. Slovenia also returned to its 2004 group, but in this case the change is positive, as group F is characterized by high production of energy from renewable sources in relation to its area. As aforementioned, group B has been omitted, and the country that previously belonged to it, Luxemburg, has moved to group A, characterized by high production of greenhouse gases in relation to total energy produced.

Table 9

Transitions of countries between groups from 2009 to 2014

| **Country** | **2009→2014** |
|---|---|
| **Czech Republic** | E→D |
| **Luxembourg** | B→A |
| **Portugal** | F→E |
| **Slovenia** | E→F |

Source: The authors' own research

When comparing the group averages for 2014 (Figure 9), we can see that there are no essential changes in the profiles of individual groups from 2004 and 2009. Only in group A is there a visible decline in indicator CO2004/EP2004. This is a consequence of Luxmbourg's transfer to the group, but it still does not affect the group's profile.

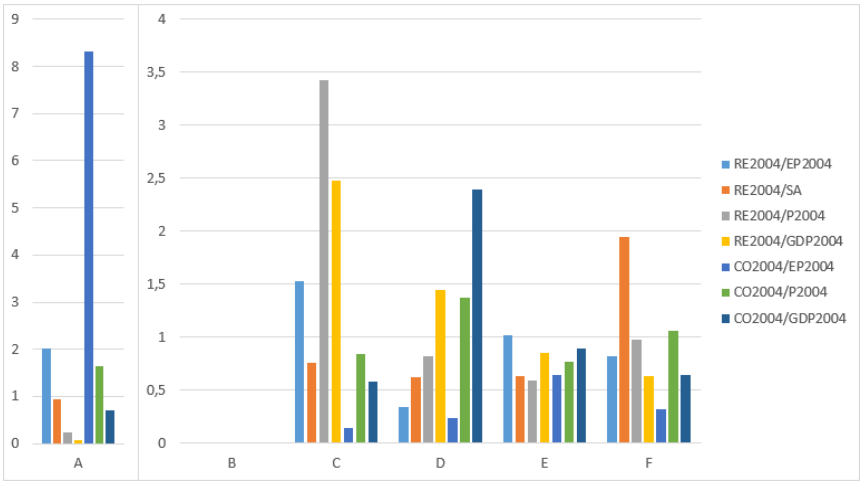


Figure 9

Comparison of group averages for 2014 - groups B -F

Source: The authors' own research

When analyzing the changes in indicators of groups from 2009 to 2014, we can see that only in group A is there a visible decline in indicator CO2004/EP2004 (Figure ). This is a consequence of Luxmbourg's transfer to the group, but it still does not affect the group's profile.

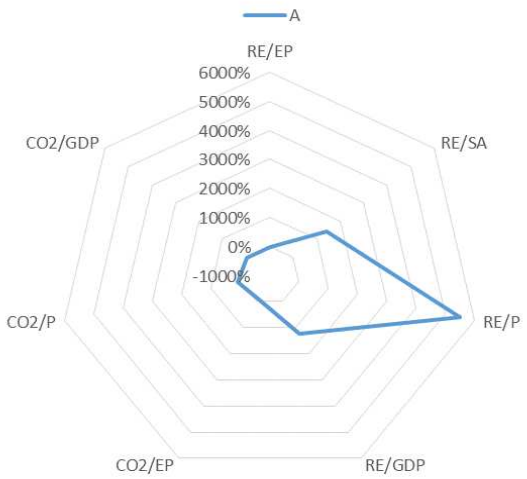


Figure 10

The change in average indicator values in group A from 2004 to 2009

Source: The authors' own research

When analyzing the changes in the indicators of groups C - F from 2009 to 2014 (Figure 11), we can see that the production of energy from renewable sources rose and the emission of greenhouse gases fell in all groups.

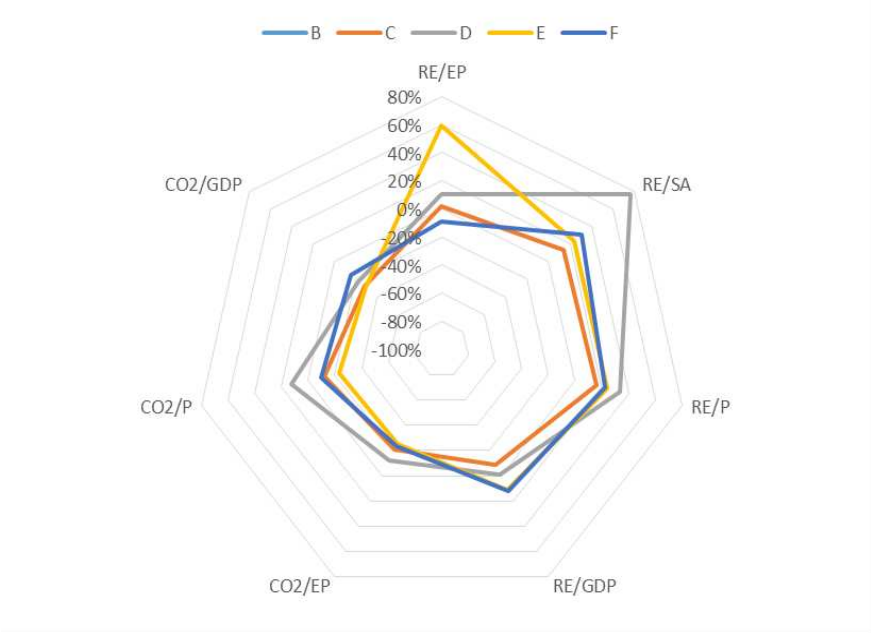


Figure 11
The change in average indicator values in groups C - F from 2004 to 2009

Source: The authors' own research

Figure 12 shows a visual representation of the changes within the groups in 2014 according to a color scheme (see Figure 3). Red indicates the least ecological countries, while green indicates the most ecological countries.

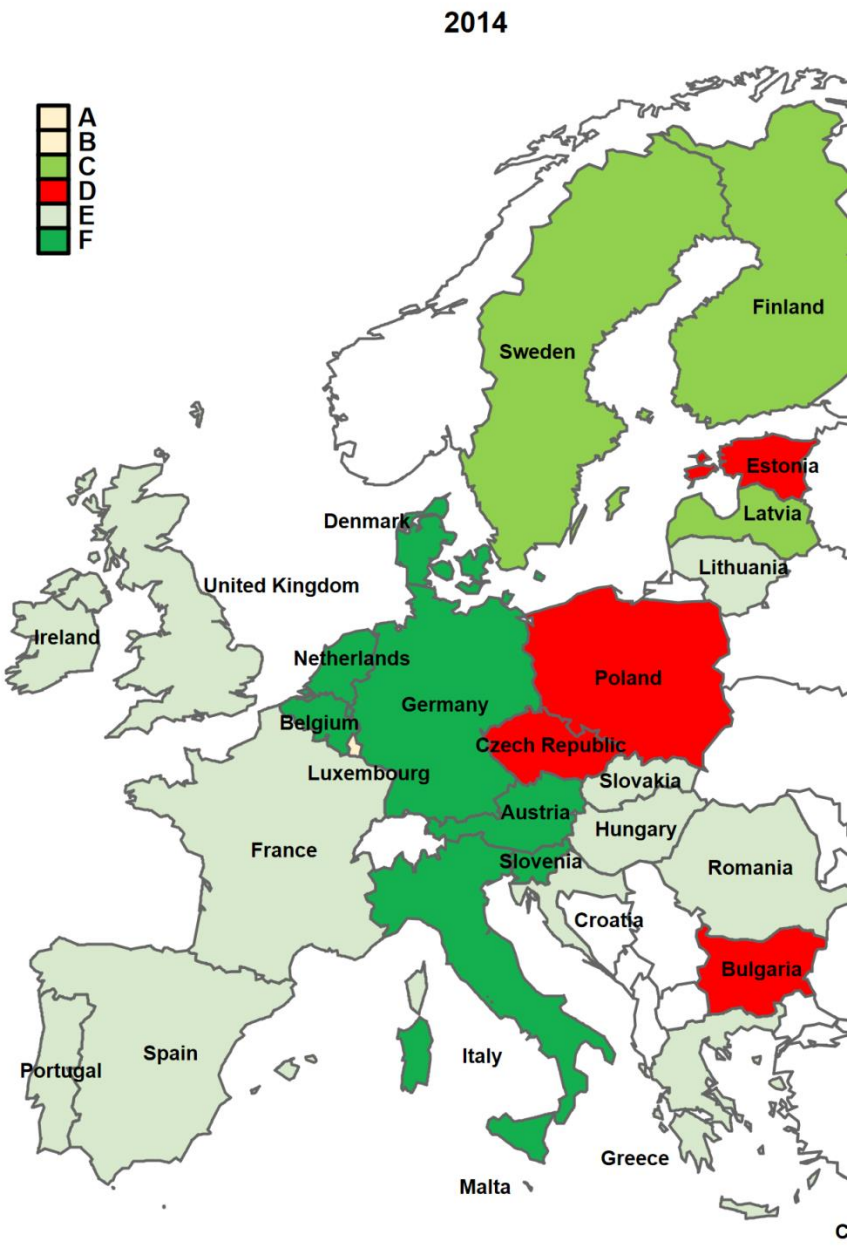


Figure 12
Visual presentation of the groups in 2014

Source: The authors' own research

## Conclusions

Using Ward's analysis, we created 5-6 groups of countries similar to each other with respect to the production of energy from renewable sources and emission of greenhouse gases. Two groups (C and F) are invariably groups of ecological countries. The countries of group D are exceptionally unecological. Groups A and B, despite being made up of countries that produce energy primarily (or only) from renewable sources, are simultaneously characterized by a high emission of greenhouse gases, which is difficult to comprehend. This anomaly found in the Eurostat data was not further explored by the authors of this article. Finally, group E is neutral.

The analyses showed that in each group, the production of energy from renewable sources rose and the production of greenhouse gases fell over the 10-year period. This was achievable in spite of the economic crisis. The EU directive from 2009 did not clearly impact investment in renewable energy in comparison with the 5 years preceding it. This should be interpreted positively, as it shows investor awareness in this area in different countries, regardless of top-down regulation.

Transitions between groups were only made by a few countries, the majority of which were from neutral group E. The lack of major transitions between groups is a negative phenomenon, especially in case of group D. This is because, despite investment, these countries (aside from Romania) were unable to move closer to neutral group E. Analysis of energy sources in individual countries in 2014, and the time needed for investments in this sector of the economy, shows that within the next decade, countries from group D will most likely not be able to make up for lost progress and "advance" to the level of groups C and F.

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# An Analysis of Factors Related to "Taking Risks", according to Selected Socio-Demographic Factors

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*Abstract: The aim of this paper is to analyze the approach to risks and risk management, as well as, the influence of selected factors to the risk management in small and medium-sized enterprises in the Czech Republic. This paper introduces the results of research conducted in 2015, at Tomas Bata University in Zlín. Data obtained through an on-line questionnaire incorporates information about SMEs (Small (Micro) and Medium-sized Enterprise) from all over the Czech Republic were surveyed by using an on-line. Although the sample of 1,141 respondents has not been collected through targeted sampling, and hence, cannot be regarded representative, owing to its size, it still provides trustworthy information about the business environment in the Czech Republic. The areas of risk perception, risk elimination and the courage to invest in risky projects were used for this paper. The influence of gender, age and age of the company on the courage to take business risks has been shown. Men are more likely to undergo the experience of risk taking than women, younger than older entrepreneurs, university-educated entrepreneurs rather than the less educated. The results of the research were then compared with previous surveys or publications.*

*Keywords: risks; approach; entrepreneurs; reserves; Czech Republic*

# 1 Introduction

SMEs are inevitable parts of the market economy [19]. Over 98% percent of all companies in the USA and the EU are SMEs [4]. What is more, Henderson and Weiler indicate that SMEs are the most important catalysts of economic growth. [17]

SMEs are a key factor in maintaining and creating the functioning market economy, particularly as a means of stimulating competition, creating jobs and promoting economic boost. [20] They contribute also to the solution of economic, political and social problems of the state. [1, 2, 21, 36]

Tamosiunas refers to the macroeconomic importance of SMEs. He states that SMEs are one of the most important factors of economic growth, which has an influence on basic trends and the entire development of economic policy, social stability and new job opportunities. Therefore, its development is one of the most important developments ever. [33] However, as Kramoliš's research indicates, SMEs struggle to survive; and while they are doing so they cut costs and focus efforts on profitability on the short run, while failing to engage in activities of development. Tasks (such as measuring the economic effects of design) are often neglected. [23]

The majority of business decisions are made under uncertain conditions. Accordingly, the business activities stemming from such decisions (and their results) can also be characterized with the same uncertainty and randomness. When the likelihood of deviation of processes and outcomes from their expected levels can be estimated, we talk about the risk of those processes; since risk is quantified uncertainty. [13] According to Kuzmišin permanent challenges for all players in the business environment are the improvement of business conditions, support of entrepreneurial spirit, flexible labor markets, company and worker adaptability, investments into education and science, research and innovations, market access and secure supply of energy. [24].

Previous research on the business environment within the Czech Republic has shown that the most significant business risk in the segment of small and medium enterprises, from the perspective of Czech and Slovak companies, is a market risk. The same research revealed a high degree of reliability of individual groups of entrepreneurs in their ability to manage financial risk in their businesses. [22]

The probability of becoming a businessman grows with an increasing risk of tolerance. [5] International studies conducted by The Economist Intelligence Unit and Dun & Bradstreet showed that companies not only manage the risks, but also regularly evaluate the success of their management to attain better results. Financial risk management and risks associated with insolvency are taken for granted in other countries. [6, 7, 8]

According to a survey conducted by the International Association for Financial Professionals European society perceive currency risk as the most serious risk, followed by liquidity and reputational risks. [6, 7, 8]

# 2 Problem Formulation

The European Commission declares the source of the European economic strength is 23 million European SMEs, thus representing 98% of the business sector. They cover two thirds of the employment contracts in the private sector and they have created approximately 80% of new jobs in the last 5 years. [11]

Among other sources, the definition of SMEs can be found in Commission Recommendation 2003/361. The European Commission divides businesses into three categories depending on two factors (the number of employees and annual turnover or annual balance sheet in total). The smallest businesses are micro enterprises with less than 10 employees and a turnover or balance sheet total is less than or equal to 2 M EUR. The second category consists of small businesses which employ less than 50 employees and whose turnover or total assets are equal to or less than 10 M EUR. The last category includes medium enterprises, where the number of employees does not exceed 250, and turnover is equal to or less than 50 M EUR and total assets equal to or less than 43 M EUR. [12]

SMEs' activities are threatened by a number of risks [18, 25]. For entrepreneurs, it is extremely important to continually evaluate all the risks that may affect them and take major decisions for their successful management. [9]. A large international study, which was conducted by The Economist Intelligence Unit and Dun & Bradstreed, showed that companies not only managing risk, but also regularly evaluating their management, achieve better results. Without a systematic approach, businesses are dependent on extinguishing emerging issues. [6, 7, 8]. It is essential for all companies to implement some type of risk management (RM) to identify, evaluate and handle risks. [35] What is more, SMEs need to exercise RM much more often than their larger competitors, since - owing to their scarce resources – they have to respond swiftly in case of internal or external hazards to cut their potential losses and save the organization from insolvency. [28, 31] All of the business risks have an impact in the financial area of the company and may even cause bankruptcy. According to the Eurobarometer survey that focused on business in the European Union and beyond, the risk of bankruptcy discourages almost half of all respondents from the start of their own business. [10]. According to Taraba et al., it is also possible to transfer financial risk to suppliers by way of establishing contractual prices and introducing a penalization system in case contract conditions are violated. If the risk occurs, it is possible (e.g. in terms of non-compliance) that the incurred costs will be refunded by the supplier. [34]

Entrepreneurs' approach to risk significantly affects their personality characteristics, in terms of a risk aversion or conversely searching for risks. Previous research has shown that situations in business are often unique to their unpredictability, complexity and changing requirements throughout the process, and entrepreneurs must simultaneously have some personality traits. The tendency to look for high-risk situations is also associated with a tendency to be optimistic and to focus more on opportunities than threats in any situation. Reasonable optimism is desirable in terms of development of the company. Excessive optimism may have adverse effects, because businessmen are lost in an ocean of numerous simultaneous tasks or make strategic mistakes. [14]

From the macroeconomic perspective, a healthy insecurity predicts an increase of future economic activity such as consumption, investment and output. While unhealthy uncertainty predicts a decline in economic growth and depresses asset prices. To achieve the set goals successful people are willing to take a degree of risk, but they expect a good result as feedback. [26, 30]

In line with the data of the Global Entrepreneurship Monitor, the proportion of women in business is different in various countries, however, it always fails to reach that of men. [15] The results are on the one hand due to the still lingering traditional gender concepts, where the role of a female is to nurse kids and care for the family and for the household, which make the female stay home or select steady employment. On the other hand, the existence, and even more so the success of women in business is heavily limited by the mistrust of external parties in female entrepreneurs resulting in lack of external financing, low respect from negotiating partners, more difficulties when starting a business. All this, despite research, have already indicated that females are better in role enhancement and as the ones managing the household duties and child-care. At the same time, they are better in balancing other tasks and still obtaining a work-life balance.

To explore the difference between male and female business leaders, some research has already focused on the risk perception and its effect on business decisions. [32] Interestingly, the various researches conducted on the topic of risk aversion and friendliness in business decisions arrived at different conclusions. Some authors state that if we are looking for a general distinction between male and female behavior; men are more inclined to risk than women, whereas others have seen opposite results. [16, 27, 29]

# 3 Methodology

The main objective of this paper is to analyze the approach to the risk according to the selected socio-demographic factors and further analyze the impact of access to the risk on the risk management and eliminate the negative impact of risks. The

results are the partial results of extensive research, which was conducted at Tomas Bata University in Zlin in 2015.

The statistical unit of research was one enterprise. The survey was carried out on a sample of 1,650 enterprises. We have managed to collect 1,141 responses from enterprises. Percentage of the completed questionnaire in form of positive feedback reactions was accounted for 70%. The method of obtaining data query and form filling in an on-line questionnaire was used for the research. To meet the objectives of this paper 5,705 statistical data were used out of the total of 60,476 data gathered from enterprises. The examined socio-demographic data were gender, education and age of the entrepreneur (two qualitative and one quantitative statistical code), the size of the enterprise and the length of operation on the market (two qualitative statistical codes). The structure of the sample according to the size of the entrepreneur was as follows: micro (65%), small (27%) and medium (8%) of the companies in the Czech Republic. Entrepreneurs were selected from the "Albertina" database by randomized numbers using mathematical functions "RANDBETWEEN". The extent required for the function has always been determined by the number of businesses in the region. Individual companies were directly addressed via email, phone, but also personal meetings.

The survey involved all regions of the Czech Republic. Their representation was as follows: Zlin Region (28.3%), Moravian-Silesian Region (24.2%), Olomouc Region (11.7%), South Moravian Region (10.2%), Liberec Region and equal representation in Prague (5.1%), Pardubice (4.8%), Pilsen Region (2.7%), Central Region (2.1%), Hradec Kralove (2.0%), Highlands (1.6%), South Region (1.0%), Usti Region (0.9%) and Karlovy Vary (0.3%).

The questionnaire was responded by 75% of men and 25% of women. The age structure of respondents was divided into three groups: under 35 years of age (25%), 35 to 45 years (28%), over 45 (47%). The age of the enterprise was also one of the factors. Most respondents have had their business for more than 10 years (62%), 17% of entrepreneurs 5-10 years and the rest (21%) of the entrepreneurs have operated their business for about 1-5 years.

Questionnaires were addressed to entrepreneurs from different areas of economy: 33% were from commercial companies, 23% from manufacturing companies, 14% from construction, 6% from transportation, 3% from agriculture and the rest belonged to other areas (industry was not mentioned in the questionnaire). Within this paper, partial results of research were processed, focusing on financial risk management, the impact analysis of selected socio-demographic factors, on perception and financial risk management.

In process of verifying the formulated hypotheses functions of SPSS Statistics 20 have been utilized. Tools of descriptive statistics were used (tables, descriptive characteristics - mean, variance, standard deviation) that were used subsequently in the Z-test. To be able to test the Hypothesis, basic statistical methods (absolute frequency, separation of statistical codes) were also utilized.

Table 1
Stated hypotheses. Source: [own]

| Mark of the hypothesis | Name of the hypothesis |
|---|---|
| **H1a** | At least 1/3 of respondents are not anxious to invest in high risk projects. |
| **H1b** | No statistically significant difference could be detected between the responses to the question about the willingness to invest in risky projects and willingness to minimize the negative impact of financial risk by creating reserves. |
| **H2a** | Men take risks in business more than women. |
| **H2b** | The difference is statistically significant between risk attitudes of entrepreneurs of the two genders. |
| **H3a** | Young entrepreneurs (under 35 years) have a higher tendency to take risks than their older colleagues. |
| **H3b** | There is a statistically significant difference in risk attitudes in terms of the age of the entrepreneur. |
| **H4a** | At least 30% of the entrepreneurs having a micro-enterprise are not afraid to invest in risky projects. |
| **H4b** | There is a statistically significant difference in risk attitudes in terms of the company´s size. |
| **H5a** | Entrepreneurs, who have had their businesses for over 10 years, have a higher tendency to take risks than entrepreneurs who have operated on the market for a shorter time. |
| **H5b** | There is a statistically significant difference in risk attitudes in terms of the age of enterprise. |
| **H6a** | Entrepreneurs with a university education are less inclined to take risks than entrepreneurs with lower education. |
| **H6b** | There is a statistically significant difference in risk attitudes in terms of education achieved by entrepreneur. |

We focused on the relative abundance of character using the method of simple separation. We also utilized sorting according to two statistical characters, dependence between plural qualitative statistical codes (PivotTable intensity contingency). Pearson coefficient (being based on square contingency) was used to quantify the intensity of contingency. Statistical hypotheses were tested with chi-square and Z-score tests at the level of statistical significance of 5%. Results with p-value lower than 0.05 led to the rejection of the null hypothesis of independence of variables. Various hypotheses were tested Z-score was used to determine statistically significant differences between the responses of selected socio-demographic groups. P-value of standardization (standardized) normal distribution was used for the evaluation of Z-score parameters. Conditions for performing the Z - test (normal distribution of statistical features and a large range of sample) have been met. Graphic tools for data analysis such as pie charts were created in order to visualize the relative abundance of selected statistical characters.

# 4 Results and Discussion

At the beginning we investigated the attitude to the business risk in general. Out of 1,141 respondents, 32% of entrepreneurs are not afraid to invest in risky projects. Almost 50% of them avoid risky investments and the rest (18%) did not respond positively or negatively. H1a was confirmed.

For the verification of hypothesis H1b were selected two sentences from the questionnaire to which entrepreneurs responded either approvingly or disapprovingly:

1. *I'm not afraid to invest money into risky projects.*
2. *Entrepreneurs minimize the negative impact of financial risk by creating reserves.*

It was found that no statistically significant difference was detected only in response to "completely agree", where the p-value appeared greater than 0.05. In other responses to these two questions were found statistically significant differences. With these results we cannot generally state that entrepreneurs, who are not afraid to invest in risky projects, eliminate the negative impact of financial risk in their business, and conversely, those who do not take risks, do not create reserves for potentially negative consequences of risk. H1b was rejected.

In the next stage, approaches to the statement "I am not afraid to invest money into risky projects" were determined and the hypothesis were tested.

Table 2
The analysis of risk attitudes based on the gender of entrepreneurs. Source: [own]

| Attitude of the entrepreneur | Gender of entrepreneur | | Z-score (p - value) |
|---|---|---|---|
| | Men | Women | |
| **I completely agree** | 19 | 7 | 0.7718 |
| **I agree** | 275 | 69 | 0.0209 |
| **I don't agree nor disagree** | 162 | 43 | 0.1902 |
| **I disagree** | 351 | 142 | 0.0035 |
| **I completely disagree** | 54 | 19 | 0.7566 |
| **chi square** | 10.143 | | |
| **p-value** | 0.0381 | | |

From graphic visualization (Fig. 1) of the entrepreneurs´ relative size which is sorted out by two statistical characters, gender and an entrepreneur's attitude to risk, which was processed by using double pie chart, it can be seen that the biggest inconsistency of opinion between men and women is expressed by 10% relative abundance in the response "I disagree".

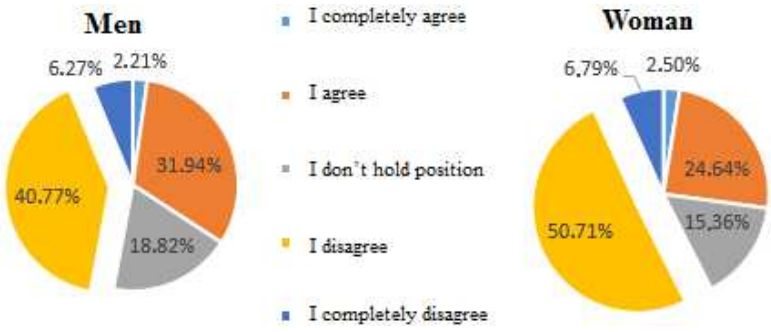


Figure 1

A comparison of the relative frequencies of approach to the risk by gender. Source: [own]

The table above shows the responses about the willingness to take risks of investing in venture projects in terms of the entrepreneur's gender. From a gender perspective 34% of men and 27% women agree with participating in risky investments. H2A was thus confirmed because 7% of men more than women answered approvingly. This factor revealed a statistically significant difference in the responses (chi square 10.143 and p-value 0.0381). This aspect also observed a statistically significant difference in terms of individual responses, since the majority of responses agree or disagree. H2B was partially confirmed.

Table 3

An analysis of the attitude to risk, based on the age of the entrepreneur Source: [own]

| Attitude of the entrepreneur | Age of the entrepreneur | | Z-score (p - value) |
|---|---|---|---|
| | -35 | 35+ | |
| **I completely agree** | 9 | 17 | 0.2225 |
| **I agree** | 113 | 231 | 0.0000 |
| **I don't agree nor disagree** | 39 | 166 | 0.0455 |
| **I disagree** | 107 | 386 | 0.0601 |
| **I completely disagree** | 11 | 62 | 0.7566 |
| **chi square** | 21.347 | | |
| **p-value** | 0.0001 | | |

From Fig. 2 a comparison of the relative frequencies of the attitude to business risk shows that entrepreneurs in age group up to 35 years take much more risks in their business than their older colleagues. 43% entrepreneurs under the age of 35 agreed with the statement that they are not afraid to invest in risky projects. 42% of entrepreneurs disagreed with this statement and others do not hold any position. In the age group over 35 years only 28% of respondents agreed and more than 50% responded disapprovingly. H3a hypothesis was confirmed.

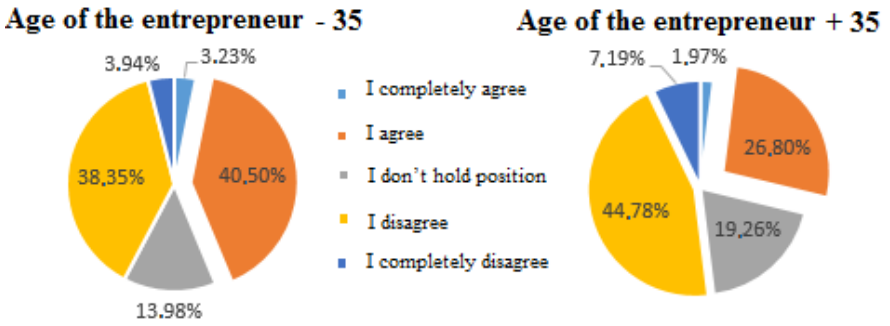


Figure 2
A comparison of the relative frequencies of the attitude to risk depending on the age of the entrepreneur Source: [own]

This group confirmed a statistically significant difference in responses between each groups (chi-square 23.347, p-value 0.0001) and the statistically significant difference between the answers I agree and I don't hold any position. H3b hypothesis was partially confirmed. The results show that the age of the entrepreneur has a significant effect on the attitude to risk taking.

Table 4
An analysis of the attitude to risk taking based on the enterprise´s size of the attitude to risk, based on the age of the entrepreneur. Source: [own]

| **Attitude of the entrepreneur** | **Size of the enterprise** | | **Z-score (p-value)** |
|---|---|---|---|
| | **Micro-sized** | **SME** | |
| **I completely agree** | 20 | 6 | 0.1936 |
| **I agree** | 210 | 134 | 0.0767 |
| **I don't hold position** | 138 | 67 | 0.4122 |
| **I disagree** | 328 | 165 | 0.3030 |
| **I completely disagree** | 44 | 29 | 0.3953 |
| **chi square** | 5.675 | | |
| **p-value** | 0.2247 | | |

The following figure (Fig. 3) expresses a relative abundance of the results in percentage. The label SME means small and medium-sized enterprises in the pie chart.

Based on the data displayed in Figure 3, while 31% of the managers of micro-size enterprises are risk tolerant, this ratio is slightly higher (35%) with business leaders of small and medium size enterprises. With this H4a hypothesis can be confirmed, since the ratio of affirmative responses for micro size businesses is higher than 30%.

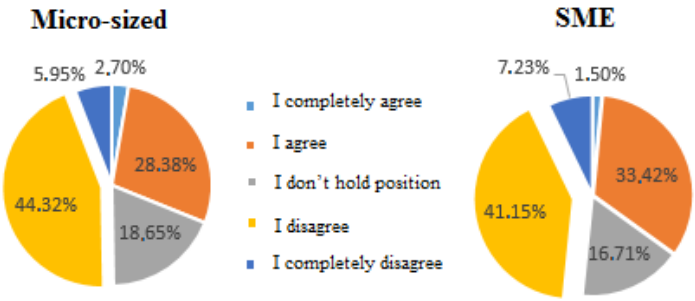


Figure 3
A comparison of the relative frequencies of the attitude toward risk taking, depending on the size of the enterprise. Source: [own]

Further analyzing the results did not indicate statistically significant differences neither between the groups by business size (chi-square 5.645, p-value 0.2247), nor between individual responses. Hence, H4b hypothesis can be rejected.

Table 5
The analysis of the approach to the risk based on the age of the enterprise. Source: [own]

| Attitude of the entrepreneur | Age of the enterprise | | Z-score (p-value) |
|---|---|---|---|
| | -10 | 10+ | |
| I completely agree | 12 | 14 | 0.4009 |
| I agree | 152 | 192 | 0.0063 |
| I don't agree nor disagree | 73 | 132 | 0.3953 |
| I disagree | 178 | 315 | 0.2005 |
| I completely disagree | 21 | 52 | 0.0854 |
| chi square | 10.167 | | |
| p-value | 0.0378 | | |

Enterprises were sorted into two groups (Age of the enterprises less than 10 years and Age of the enterprises more than 10 years) for the next comparison.

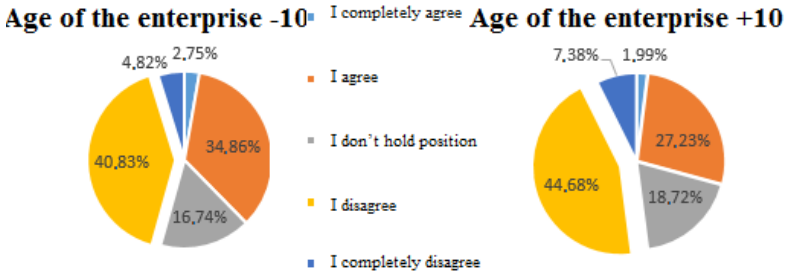


Figure 4
A comparison of the relative frequencies of approach to risk according to the age of the enterprise Source: [own]

In terms of the age of the enterprise it was found that the older the enterprise is, the less likely the entrepreneur takes risks. Entrepreneurs with an enterprise operating in the market for more than 10 years approvingly answered this question only in 30%, whereas entrepreneurs with younger companies agree with the risk projects in 37%. H5a hypothesis was thus rejected. This group confirmed a statistically significant difference in responses between the groups (chi-square 10.167, p-value 0.0378). In the structure of the responses was observed the difference only in the "I agree" responses. H5b hypothesis was thus only partially confirmed.

Table 6

An analysis of the attitude to taking risks based on the entrepreneur´s education. Source: [own]

| **Attitude of the entrepreneur** | **Entrepreneur education** | | **Z-score (p-value)** |
|---|---|---|---|
| | **University** | **Other education** | |
| **I completely agree** | 10 | 16 | 0.6527 |
| **I agree** | 131 | 213 | 0.0819 |
| **I don't hold position** | 66 | 139 | 0.4715 |
| **I disagree** | 156 | 337 | 0.0930 |
| **I completely disagree** | 29 | 44 | 0.3173 |
| **chi square** | 5.278 | | |
| **p-value** | 0.2599 | | |

As a final factor it was selected the entrepreneur´s education. It was found that university-educated entrepreneurs agree with the risky projects more than entrepreneurs with lower education (36%/31%), which is also evident in Fig. 5. The pie chart compares the positive attitude to the risk project of entrepreneurs without a university degree and entrepreneurs with university degrees (52%/45.5%).

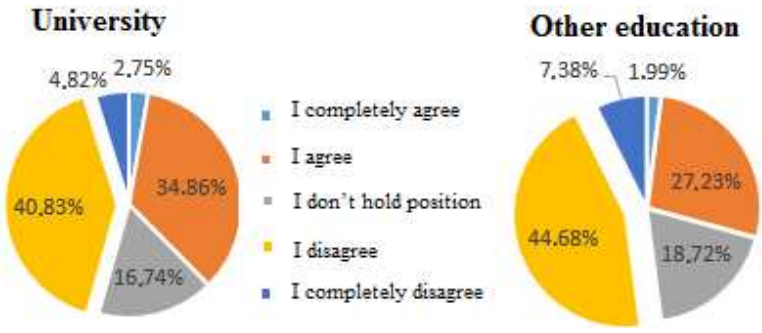


Figure 5

A comparison of the relative frequencies of approach to the risk according to the entrepreneur education Source: [own]

H6a hypothesis was rejected. We can conclude that entrepreneurs with higher education have a tendency to take higher risks, than entrepreneurs with lower education. There were no statistically significant differences in neither collective nor in partial responses in this group. H6b hypothesis was therefore also rejected.

**Conclusions**

The results of the research showed that almost half of the entrepreneurs who responded to our questionnaire from all regions of the Czech Republic are afraid to invest into risky projects. 18% of them do not possess the courage to take risks in their business at all. Investments into risky projects are more likely to be approved by men (34%) than women (27%). This confirms previously conducted research, for example, Göktan & Gupta or Langowitz & Minniti, who argue that men generally more inclined towards risk than women. [16, 27]

The research also showed that the dependency of attitude on the elimination of negative impacts on financial risk and the courage to take risks cannot be deduced. Entrepreneurs who take risks don't create reserves to eliminate the negative impact. Conversely, entrepreneurs whose attitude to taking risks is cautious, can over compensate for the possible negative effects.

In terms of entrepreneur age and the impact on business risk taking, it was found that younger entrepreneurs (under 35 years) invest more money in a risky way, than older entrepreneurs. This result may indicate the influence of previous entrepreneurs' experience and their reluctance to make higher risks decisions with an increasing age.

The age of the enterprise´s operation on the market also has an impact on the attitude towards risk. Enterprises that have been operating in the market for over 10 years do not take risky investments as often as younger enterprises. Once again it may be associated with the experience of entrepreneurs based on the age and the duration of operating on the market.

Micro-sized enterprises are less willing to invest in risky projects than small and medium size firms, most possibly because a risky investment – due to their size and vulnerability may destroy these businesses. This risk aversion, however, seems like a strategy for them, since they are optimistic about their general survival. In line with this, Belás et al.'s findings propose that despite the challenging business conditions, entrepreneurs are optimistic. Over 95% of entrepreneurs from the Czech Republic in their research stated to believe that their business ventures will endure the next 5 years. [3]

In terms of the entrepreneur´s education it was found out that university-educated entrepreneurs take more risks (36%) than their less educated colleagues (31%). This result is in contradiction with the response of university-educated entrepreneurs to the question if they think they can manage their financial risks in their businesses properly. Consistently, the question was responded by less than 10% university-educated respondents. This can be explained by the fact that

university-educated entrepreneurs are undergoing higher financial risks than they can properly manage.

Statistically significant differences in the responses were observed in both positive and negative responses, in terms of gender of entrepreneurs, in affirmative responses in terms of age of enterprise and also in affirmative responses and responses without holding any position in terms of the entrepreneurs' age.

The aim of present research was to offer information on the business environments and risk management of SMEs in the Czech Republic. However, authors are also aware of the limitations of the study. First of all, the lack of representation, for which the relative large size of the sample, cannot fully justify. Second, there is always a chance that respondents did not fully understand the research questions correctly or were not able to express their opinion. Hence, some answers may not be in line with the intentions of the respondents. We are also aware of the fact, that research conducted in the Czech Republic, has a national character and is only valid for the Czech Republic, hence, in the future, we plan to involve more countries and strive for an International comparison.

**Acknowledgement**

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# Non-Parametric Approach to Measuring the Efficiency of Banking Sectors in European Union Countries

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*Abstract: The European banking sector has been in the center of interest for the last ten years. There are several reasons for this: An impact of global financial crisis on banks stability; Fundamental influence of banking sector on the effectiveness of governments' anti-crisis actions, Vulnerability of banking institutions to the crisis of the Euro currency and last, but not least, the problems of the biggest banks in Italy and Germany, which for the last decades have been considered as the most efficient. The financial crisis and its negative influence, not only on the small national banks, but also on the strongest International Institutions, has shown that the problem of measurement of efficiency of the banking sector is still a current topic, important not only from the perspective of academic research, but also form the point of view of National and International Regulators. In this context, the objective of this study is to propose a methodology for a comprehensive evaluation of operational efficiency of the banking sectors in EU countries. The pointed problem is often discussed in a nonlinear fashion. Thus, the potential methodological proposal should be based on the interaction of multiple inputs with multiple outputs, without the knowledge of the functional relationships between them. In the research, Data Envelopment Analysis, is given as a suitable instrument for this purpose. Thanks to this methodology we measured the degree of (in)efficiency of banking sectors in the EU countries. Additionally, we proposed measures to increase their efficiency. We found that there are differences between the efficiency of banking sectors of "old" fifteen and "new" EU member countries. We also confirmed that there is a noticeable difference between the efficiency of banking sectors within the European Monetary Union members and Countries which do not belong to the Euro-zone.*

*Keywords: efficiency; banking sector; Data Envelopment Analysis; Malmquist Index*

# 1 Introduction

Banks are business entities, but they have a special meaning and role in national economies. Banking institutions can be classified as financial intermediaries, which are involved in allocation of excess liquidity among entities. They take deposits from entities with excess liquidity and they provide these resources to the deficient entities, in the form of loans, which is crucial, both from a micro and a macroeconomic perspective. During "normal" times, it significantly influences financial effectiveness and growth potential of enterprises, but what is more during the periods of market turbulence or crisis, the liquidity of the banking system determines an effectiveness measure of monetary authorities, governments' stabilization and anti-crisis actions [8, 21]. However, from the perspective of measuring efficiency of banking institutions, the range of banking services is currently much more diverse than simple financial intermediation. This is the reason why it is very difficult to define or to measure the bank "production" outcomes.

The logical consequence of the fact, that banks and banking sectors, have an extremely important role in National Economies, is the interest of the professional public in this issue, which is presented in many studies dedicated to the problem of measurement and evaluation of the efficiency of banks [6, 7, 15, 25, 34, 24]. The fundamental trends in recent years, such as deregulation; increased competition due to the globalization process; the global financial crisis of the years 2007-2008 and its long term consequences, have resulted in higher pressure in the sector and have forced banks to reduce costs and increase the efficiency of operational activities. In the past, ratio indicators such as liquidity, profitability, capital adequacy and so on, depending on the needs of the specific analysis, were treated as standard instruments for measuring of the banks performance. The results were usually a subject of comparison for a given bank in different time points or they were used as a benchmark tool with other banks.

These traditional indicators are attractive, as they have a quite easy interpretation and are simple from a methodological perspective. However, they have several limitations which should be considered. One is the assumption that all the rated banks are comparable, it means they should operate under conditions of similar returns of scale [39]. Another disadvantage is that each group of indicators is devoted to measurement of just a part of the banking activities. For this reason, these indicators often provide contradictory results, which can be confusing and provide inappropriate assessment of overall performance. Therefore, the simplistic analytical methods cannot offer an objective identification of ineffective banks, which could enable to separate them from the effective once. Simple financial indicators cannot capture the multiple natures of inputs and outputs, thus, the multivariate nature of efficiency phenomenon [2, 3]. These factors decrease the usefulness of standard financial ratios as tools for assessing the effectiveness of the group of banks.

The limitations which we mentioned above, led to the application of more sophisticated instruments for detecting single bank efficiency or the efficiency of whole banking sectors, which enable the measurement of the relative effectiveness of individual bank against to effectiveness of the best banks within examined group. For the case of all the methods, an objective problem relates to the determination of "the best" bank benchmark, which should be empirically pointed, as a theoretical "the best" bank model has not yet been developed. However, analysis of the production boundary enables to determine the comprehensive banks performance, and then divide them into the effective and ineffective groups. Subsequently, this analysis enables discovery of the causes of inefficiency. At the same time, the methods can provide specific recommendations which lead to the fact that an ineffective bank moves to the boundary of efficiency. We can divide the sophisticated methods for determining the efficiency into the following categories [14]: (i) parametric methods (Stochastic Frontier Analysis (SFA), Distribution-Free Approach (DFA)); (ii) nonparametric methods (Data Envelopment Analysis (DEA)), which will be applied in the article.

Therefore, the objective of the current research is to propose a methodology for a comprehensive evaluation of operational efficiency of the banking sectors in EU countries, which is based on the Data Envelopment Analysis and Malmquist index. From the strictly empirical perspective, the aim of the study is to measure the degree of (in)efficiency of European banking sectors and to verify potential differences between the efficiency of banking sectors of the “old” fifteen and the “new” EU member countries, the banking sectors in the European Monetary Union States and the “once outside” the Euro area.

The application of the DEA methodology to analysis of sectorial efficiency – also in the case of banking sector – is not a novel idea. However, in relation to the research on banking sector efficiency most of recent papers concentrate on single countries or even the micro-cases of single banks [1, 5, 14, 20, 23, 26, 31, 33, 37, 38, 41, 42]. The actuality and empirical contribution of this article to the current state of the art relates to the scope and scale of the research. To our best knowledge, in recent years, it is unique research that is devoted to the efficiency of the banking sector in the entire EU, with special consideration to the differences between the original countries of the EU and the new member states and member and non-member countries of the Euro zone.

# 2 Theoretical Framework

Efficiency is defined as a condition, where it is not possible to produce additional unit of a good with current resources, unless one reduces production of another good. It can be related to the microeconomic production frontier framework. Thus, under the mentioned condition an entity is on the edge of its production capabilities. Evaluation of efficiency is an integral part of rational behavior of the

production units that aims to survive in a challenging competitive environment in a long term. In practice it is possible to apply several methods to verify the level of efficiency [7, 22, 27, 28], namely: (i) financial ratios; (ii) indexes; (iii) multi-criteria evaluation of variants; (iv) statistical-econometric methods; (v) simulation.

The advantage of the first two instruments is their simple design and measurability. Other advantages are the clear explanatory power for a wide range of users and easy identification of deviations from targets or planned values. However, these instruments also have some important disadvantages, for example, they work with only two factors, or just with a few factors. It means that they are not useful for identifying simultaneous presence of several factors. From the quantitative perspective, a common problem is attributed to the fact that they are often not measurable together and they cannot be aggregated. The mentioned problems can be solved to some extent with application of many multi-criteria evaluation methods. But these methods are also far from perfect. Their important disadvantage is usually seen in the complicated interpretability of the obtained results [35].

However, econometric methods have also several drawbacks. One of them is defining inefficiency as the random variable that follows a certain probability distribution, which must be specified a priori, as well as the form of dependence transformation of input to the output. In the case of baking sector it is often stressed that the form of transformation of an input to an output is often nonlinear and difficult to specify [30]. Thus, the assumptions about the form of dependence and probability distribution of inefficiency are not usually known in practice. As a result, incorrect estimation of these parameters can lead to a situation, where the model has no relation to reality [6]. That problem was especially visible during the last global financial crisis.

Conversely, simulations can also have an important disadvantage – they are an application for one specific example. It means that simulation does not offer the rating for the set of several production units. This approach compares reading frame of one unit in the system and not the system of units as a whole [28].

## 2.1 Data Envelopment Analysis

Data Envelopment Analysis (DEA) enables to reduce the mentioned disadvantages of the traditional approaches. This is a group of methods which represents a special area of application of linear programming. DEA measures the efficiency of the various entities or organizational units. Investigation of efficiency is not only related to profitability of entity in a private sector. In general, one can examine the effectiveness of any entity that transforms an input to an output in some way. In a study [16] authors state that DEA analysis is most often applied in the following sectors: agriculture, banking, supply chain management, transportation, and public policy. The popularity of the method has

increased significantly in recent years. In the mentioned study the authors show that to 2016 there were 9881 scientific papers with DEA applications registered in Scopus and WoS databases. In the first phase, 1978-1994, only several dozen of papers per year were published. In the second phase, 1995-2003 the average number of published papers was about 134 per year. Interesting is the last phase 2004-present, where there is an exponential increase of published articles. Even within the three year period of 2014, 2015 and 2016, about 1,000 scientific applications of the method per year were published.

Although DEA method was originally created to evaluate the effectiveness of non-profit organizations, it began to be intensively used for an evaluation of business entities including banking institutions. As the first the possibility of measuring the efficiency of banks based on DEA investigated [39]. However, as a pioneering study in the area of measuring the efficiency of banks one can point [6], who analyzed the efficiency of 14,000 US banks. First, who carried the analysis of efficiency of bank branches were [9]. Detailed analysis of the historical development and application of DEA for analyzing banking sector was carried by [36], where 80 published studies from 24 countries were analyzed. Another study is [22] who verified 196 studies, which concentrated on the efficiency of banks and banking sectors of which 151 were based on DEA applications.

The aim of DEA method is to eliminate or exclude subjectivity of using output measurements in relation to input. The process of output and input selection, which are intended for comparison, changes the process of analysis to objectivity and eliminates subjectivity. Through the linear mathematical model weights to the input and output of individual production units (Decision Making Units DMU) – for example banks – are assigned, which reflect the efficiency of the bank. Models relating to the relevant banks have the same shape, but with the different efficiency they will have a different value of weights. According to these weights, banks will be compared and sorted. Given that, weights are the index numbers, it does not matter in which units they are expressed.

Basic ideas come from Farel [18] and later they were reformulated by Charnes, Cooper & Rhodes [10] (model DEA CCR) and Banker, Charnes & Cooper [4] (model DEA BCC). Because the method has few easily attainable assumptions, the proposals have opened new possibilities in the evaluation of DMU. Especially, when it is impossible to evaluate the DMU, mainly because of a complex and the unknown nature of the relationship between inputs and outputs. Cooper, Seiford & Ton [12] state that DEA models can be also applied in the cases, where other than DEA models are used for evaluation of efficiency.

All models can be oriented either to the input *(input oriented)* or to the output *(output oriented)*, or they can use a combination of the two previous options and an additive model *(slack-based models)* can be constructed.

In models which are input oriented, one detects efficiency of bank or banking systems based on the input variables (the number of banks, total assets, number of

employees, etc.). Banks whose optimal value of objective function is equal to one is considered as operating effectively within the observed group. Banks whose optimal value of objective function is less than one, are treated as inefficient. This value shows the need for a proportional reduction of inputs (improvement), so that ineffective bank became effective. It means that thanks to DEA models we are able to determine the degree of bank efficiency and also we obtain information how banks should "improve" their activities in order to become effective.

Output oriented models detect bank efficiency based on the output variables (the number of served customers, loans, interest income, and the volume of deposits). Banks whose optimal value of objective function is equal to one are considered as effective within the observed group, and banks whose optimal value of objective function is greater than one are inefficient. In output oriented models an increase of some or all of the output variables is considered as "improvement" of banks activities. Nowadays, there are a lot of modification of basic DEA models and Zhu [43] made their detailed description.

In the current research we propose to apply CCR DEA model. The model for DMU $U_q$ can be formulated as the task for linear refracted programming:

$$
\begin{aligned}
&\textit{maximize} \qquad z = \frac{\sum_{i=1}^{r} u_i y_{iq}}{\sum_{j=1}^{m} v_j x_{jq}}, \\
&\textit{subject to} \qquad \frac{\sum_{i=1}^{r} u_i y_{iq}}{\sum_{j=1}^{m} v_j x_{jq}} \le 1, \qquad k = 1,2,3,\ldots,n, \\
&\qquad\qquad u_i \ge \varepsilon, \qquad i = 1,2,3,\ldots,r, \\
&\qquad\qquad v_j \ge \varepsilon, \qquad j = 1,2,3,\ldots,m,
\end{aligned}
\tag{1}
$$

Where $z$ is a measure of efficiency of the unit Uq, $e$ is infinitesimal constant by which the model ensures that all weights of inputs and outputs will be positive and will be then involved in the model on at least a certain minimum level.

In the research we propose to apply output and input oriented CCR DEA model because we assume a constant returns to scale. A comparative study provided by [36] was a main argument for choosing that model. In this study authors state that from 80 DEA models which were applied in the area of measuring the efficiency of banks and banking sectors in more than 50 CCR was applied. Noulas [29] shows special advantages of applying CCR model in the context of the possibility of comparison of big and small banks or banking sectors, which is especially important form the perspective of current research. However, it should be noted

that there are also contradictory propositions. For example, in the summary [19], based on the 151 observed DEA models, the authors recommend to use the BCC DEA model (variable returns to scale). There are also some studies [11, 12, 40], where the simultaneous application of both CCR and BCC DEA is considered as a possible compromise.

## 2.2 Malmquist Index

An ineffective DMU can become effective, thanks to implementation of various rationalization measures. DMU which underrate the situation can be moved from effective category to the ineffective category, vice versa. However, we are not able to quantify this important fact with application of the basic DEA models. We can consider basic DEA models as static models which do not take into account the development or change in effectiveness of DMU in time. Fortunately, we are able to eliminate this problem by using Malmquist index [4]. Färe, Grosskopf, Lindgren and Roos [17] adjusted Malmquist index to measure changes in effectiveness of DMU in time. We can also formulate Malmquist index in various versions: oriented on inputs or outputs, with fixed, variables, not increasing or not decreasing returns of scale.

Malmquist input oriented index quantifies the change in effectiveness of production units q between successive periods t and t+1 and this model has following form:

$$M_q(x^{t+1}, y^{t+1}, x^t, y^t) = E_q P_q \tag{2}$$

Term Mq ($x^{t+1}$, $y^{t+1}$, $x^t$, $y^t$) is also called "Total Factor Productivity Index TFP". $E_q$ is given as the change in relative efficiency of unit $q$ in comparison with other DMU between period's t and t+1, $P_q$ quantifies the change in production possibilities boundary, which is caused by the technology development between periods t and t+1. These components are defined as follows:

$$E_q = \frac{D_q{}^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_q{}^{t}\left(x^{t}, y^{t}\right)} \tag{3}$$

$$P_q = \left[ \frac{D_q{}^{t}\left(x^{t+1}, y^{t+1}\right) D_q{}^{t}\left(x^{t}, y^{t}\right)}{D_q{}^{t+1}\left(x^{t+1}, y^{t+1}\right) D_q{}^{t+1}\left(x^{t}, y^{t}\right)} \right]^{1/2} \tag{4}$$

Then:

$$M_q(x^{t+1}, y^{t+1}, x^t, y^t) = \frac{D_q{}^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_q{}^{t}\left(x^{t}, y^{t}\right)} \cdot \left[ \frac{D_q{}^{t}\left(x^{t+1}, y^{t+1}\right) D_q{}^{t}\left(x^{t}, y^{t}\right)}{D_q{}^{t+1}\left(x^{t+1}, y^{t+1}\right) D_q{}^{t+1}\left(x^{t}, y^{t}\right)} \right]^{1/2} \tag{5}$$

The term in front of brackets is called the change of relative efficiency $E$ and measures the distance from boundary between period's t and t+1. The section in square brackets is the technical change $T$ or technological progress. It is the geometric average of change in production technologies between the two period's t and t+1. Färe in his paper showed how we can calculate the function of distance and Malmquist index by using DEA. This fact again lead to the task of linear programming, where for each of DMU we have to calculate four functions of distance in time periods t and t+1. This situation requires solving four tasks of mathematical programming. According to the value of $E_q$, $P_q$ and mainly according to the value of Malmquist index $M$ achieved results can be interpreted as follows: for the all indexes (technological progress, changes in economic efficiency and $M$ index) valid if they are less than one, it means that the position of DMU in the area is worse (wrong decision), if they are equal to one (decision were neutral), greater than one, DMU made good decisions that lead to improvement of status for this DMU.

# 3 Application of DEA for Measuring of Efficiency of European Banking Sectors

The objective of this study is to quantify the efficiency of banking sectors in European Union Countries by application of Data Envelopment Analysis for the years 2014 and 2015 and also quantify the interaction between them through the Malmquist index. The short time span of the analysis was restricted by the data availability for the whole panel of the EU countries.

In this study we determined three hypotheses:

H1: Banking sectors in the European Union countries are not enough consolidated after the strong impact of the financial crisis. As a result, banking sectors in most of the countries are ineffective.

H2: Banking sectors in "old" EU members countries are working more effectively than the banking sectors in "new" EU members.

H3: Banking sectors of European Monetary Union countries are working more efficient than the sectors of countries which do not apply the euro.

Providing proper definition of inputs and outputs is usually considered as the most difficult operation in the process of DEA model constricting. Defining of inputs and outputs of commercial banks is not an exception. Their definition is based on the three basic bank models [9, 39]: (i) intermediation model, (ii) production model), (iii) asset model. It should be noted that except of these basic models there are also other possibilities such as a model of cost per user (User cost model) or a model of value added (Value added model).

We took into account three models mentioned above and studies [15, 37] in the process of determining the input and output characteristics. In accordance with the extent of the group (28 countries) we chose six as an appropriate number of inputs and outputs, as the number of factors involved in the analysis significantly influences the results in the application of the DEA methodology. An excessive number of variables artificially increases the number of efficient DMU and then reduces the discriminatory power and explanatory power of the analysis. Thus, it is recommended that the number of variables should not be greater than one third of the range of the group [22]. In our study we used following input variables: assets, staff, Herfindahl-Hirschman index and number of banks. In addition, we used following output variables: deposits and loans. Tables 1 and 2 show the data for 2015 and 2014. The data was obtained from the annual report of the European Central Bank and the European Banking Federation.

Table 1
Input and output variables of bank sectors in 2015

| Country | INPUT | | | | OUTPUT | |
|---|---|---|---|---|---|---|
| | Assets [€ mil.] | Staff | HHI | Number of banks | Deposits [€ mil.] | Loans [€ mil.] |
| Belgium | 1102000 | 56611 | 998 | 103 | 619965 | 479513 |
| Germany | 7802346 | 647300 | 273 | 1808 | 4525100 | 4368244 |
| Estonia | 21455 | 4860 | 2409 | 37 | 14751 | 18582 |
| Ireland | 1079754 | 28871 | 679 | 446 | 349325 | 324808 |
| Greece | 397801 | 45654 | 2254 | 40 | 243789 | 236027 |
| Spain | 2973124 | 201643 | 896 | 226 | 2001535 | 1725788 |
| France | 8176956 | 411012 | 589 | 496 | 3985954 | 4375305 |
| Italy | 4022863 | 299684 | 435 | 670 | 2339704 | 2410291 |
| Cyprus | 91151 | 10956 | 1443 | 57 | 48866 | 65177 |
| Latvia | 30855 | 9374 | 1033 | 59 | 13945 | 19598 |
| Lithuania | 25487 | 8952 | 1939 | 89 | 16345 | 20938 |
| Luxembourg | 962871 | 25816 | 321 | 148 | 450633 | 387075 |
| Malta | 56872 | 4427 | 1621 | 27 | 26562 | 15341 |
| Netherlands | 2451308 | 94000 | 2104 | 218 | 1145010 | 1324449 |
| Austria | 879996 | 74110 | 397 | 707 | 503959 | 528696 |
| Portugal | 469053 | 53888 | 1159 | 150 | 284994 | 259468 |
| Slovenia | 43557 | 10682 | 1077 | 24 | 30095 | 28779 |
| Slovakia | 64238 | 18656 | 1250 | 28 | 46470 | 43118 |
| Finland | 579309 | 22019 | 2730 | 271 | 186249 | 273221 |
| Bulgaria | 47370 | 31715 | 2433 | 28 | 31573 | 31328 |
| Croatia | 57793 | 21190 | 1726 | 33 | 35788 | 43323 |
| Czech Republic | 195513 | 40334 | 1100 | 56 | 126154 | 114838 |
| Denmark | 1082400 | 37201 | 328 | 119 | 304283 | 639331 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Hungary | 113460 | 39456 | 982 | 189 | 63777 | 78105 |
| Poland | 379577 | 175972 | 411 | 679 | 241341 | 259129 |
| Romania | 90492 | 57732 | 1992 | 39 | 54825 | 61182 |
| Sweden | 1247067 | 54644 | 592 | 159 | 404193 | 697069 |
| United Kingdom | 8997563 | 402561 | 318 | 361 | 3819623 | 4080962 |

Source: European Banking Federation & European Central Bank

Table 2

Input and output variables of bank sectors in 2014

| **Country** | **INPUT** | | | | **OUTPUT** | |
|---|---|---|---|---|---|---|
| | **Assets [€ mil.]** | **Staff** | **HHI** | **Number of banks** | **Deposits [€ mil.]** | **Loans [€ mil.]** |
| Belgium | 1021568 | 58233 | 982 | 103 | 617928 | 469940 |
| Germany | 7528947 | 651250 | 301 | 1842 | 4482598 | 4429237 |
| Estonia | 19951 | 4861 | 2445 | 31 | 13449 | 16385 |
| Ireland | 1016950 | 31776 | 667 | 458 | 386260 | 360963 |
| Greece | 407407 | 51242 | 2195 | 40 | 266776 | 246206 |
| Spain | 3150735 | 215663 | 839 | 290 | 2046168 | 1828885 |
| France | 7881631 | 415953 | 584 | 623 | 3908181 | 4334755 |
| Italy | 4047885 | 306313 | 424 | 694 | 2301355 | 2382174 |
| Cyprus | 90198 | 11142 | 1303 | 101 | 52635 | 63581 |
| Latvia | 29258 | 10029 | 1001 | 63 | 13747 | 20434 |
| Lithuania | 24035 | 8392 | 1818 | 91 | 13873 | 18348 |
| Luxembourg | 914817 | 26237 | 329 | 147 | 430624 | 393022 |
| Malta | 50333 | 4197 | 1648 | 27 | 19636 | 14922 |
| Netherlands | 2250131 | 96423 | 2131 | 253 | 1041558 | 1268028 |
| Austria | 915105 | 75980 | 412 | 731 | 511214 | 553294 |
| Portugal | 515328 | 57556 | 1164 | 151 | 308545 | 284089 |
| Slovenia | 46354 | 11218 | 1026 | 23 | 32216 | 32313 |
| Slovakia | 61129 | 18540 | 1221 | 28 | 44873 | 41109 |
| Finland | 525312 | 22402 | 3310 | 303 | 183439 | 263833 |
| Bulgaria | 47410 | 32756 | 2305 | 30 | 31150 | 32987 |
| Croatia | 57944 | 21646 | 1596 | 35 | 35145 | 44864 |
| Czech Republic | 190868 | 39742 | 1059 | 56 | 128863 | 114914 |
| Denmark | 1048300 | 36367 | 335 | 161 | 285992 | 634588 |
| Hungary | 116064 | 40750 | 1006 | 189 | 62437 | 65896 |
| Poland | 361627 | 179385 | 395 | 691 | 230311 | 250302 |
| Romania | 91396 | 58612 | 1854 | 39 | 51459 | 64675 |
| Sweden | 1214496 | 53594 | 572 | 168 | 395313 | 693523 |
| United Kingdom | 8895348 | 421508 | 315 | 358 | 3977473 | 4315786 |

Source: European Banking Federation & European Central Bank

Capital represents the total average value of fixed assets of all banks in the country. The staff is expressed by the average number of employees in a given banking sector. Herfindahl-Hirschman index is used in the context of antitrust policy to measure the concentration of the sector in the national market. Low value of the index indicates low level of sector concentration, which can be interpreted as the sign of higher competition in the sector. Punt & Van Rooij [36] provide also other possibilities of measurement the concentration in banking sector such as Lerner index, Theil coefficient of entropy or concentration ratio. The last input variable is the total number of domestic banks and foreign banks or their branches. Deposits are measured as the total amount of current and term deposits, which banks obtained from individual clients and from other financial institutions. Loans are measured as the net value of loans to population, business sector and other financial institutions.

# 4 Results and Discussion

As it was pointed, the main aim in this paper was to measure the efficiency of banking sectors of the European Union member countries. The results of output oriented analysis are presented in Table 3 and the results of input oriented analysis are given in Table 4. We can conclude, that from the point of view of our analysis the banking sectors are effective in 15 countries in 2015 (the rate of efficiency is equal to one) and in 13 countries they are not effective (the rate of efficiency in output oriented models is higher than one and in input oriented models is lower than one, vice versa). In 2014, 18 banking sectors were effective and only 10 sectors were not effective. Compared to 2015 the rate of efficiency of banking sectors fell from 64.29% to 53.57%.

As it was mentioned, the advantage of DEA is the ability to measure the efficiency of DMU. In addition, DEA has another important advantage, which is the ability to detect the reserves. It means in the input oriented models DEA provide information on the necessary reduction of the inputs. In the output oriented models information on the possibilities to increase the outputs is given.

The degree of inefficiency in the banking sector will be illustrated with an example of Malta, which was rated as the least efficient banking sector in 2015. As the first step we will do the analysis of output oriented models. The rate of relative inefficiency of the sector was 0.6914 (1/1.44625). The banking sector in Malta would be considered as effective if the original value of deposits was increased from 26562 million € to 38415 million € (it must be increased by 11853 million €). Furthermore, the sector should increase the volume of lending from 15 341 million € to 33244 million € (the difference is 17903 million €). In the analysis for Malta, the Spanish banking sector is used as a benchmark.

Table 3
The efficiency of banking sectors in 2015 - output oriented model

| Country | Efficiency | Benchmarks | OUTPUT | |
|---|---|---|---|---|
| | | | Deposits [€ mil.] | Loans [€ mil.] |
| Belgium | 1.01704 | Spain | 10561 | 112288 |
| Germany | 1.00000 | --- | 0 | 0 |
| Estonia | 1.00000 | --- | 0 | 0 |
| Ireland | 1.35501 | Luxembourg | 124013 | 115309 |
| Greece | 1.00000 | --- | 0 | 0 |
| Spain | 1.00000 | --- | 0 | 0 |
| France | 1.00000 | --- | 0 | 0 |
| Italy | 1.00000 | --- | 0 | 0 |
| Cyprus | 1.00000 | --- | 0 | 0 |
| Latvia | 1.18413 | Cyprus | 4636 | 3609 |
| Lithuania | 1.00000 | --- | 0 | 0 |
| Luxembourg | 1.00000 | --- | 0 | 0 |
| Malta | 1.44625 | Spain | 11853 | 17903 |
| Netherlands | 1.00000 | --- | 0 | 0 |
| Austria | 1.00434 | Italy | 8108 | 2294 |
| Portugal | 1.09048 | Spain | 25786 | 23476 |
| Slovenia | 1.02310 | Estonia | 695 | 665 |
| Slovakia | 1.00000 | --- | 0 | 0 |
| Finland | 1.20294 | Spain | 37798 | 55448 |
| Bulgaria | 1.06088 | Estonia | 1922 | 1907 |
| Croatia | 1.00000 | --- | 0 | 0 |
| Czech Republic | 1.04639 | Spain | 5853 | 5328 |
| Denmark | 1.00000 | --- | 0 | 0 |
| Hungary | 1.01642 | Cyprus | 4685 | 1282 |
| Poland | 1.00000 | --- | 0 | 0 |
| Romania | 1.03857 | Greece | 2115 | 2360 |
| Sweden | 1.06255 | Italy | 25454 | 43605 |
| United Kingdom | 1.00000 | --- | 0 | 0 |

Table 4 shows the results of input oriented analysis. The number of efficient banking sectors must be the same as the benchmark for ineffective sectors. But the rate of inefficiency is expressed directly. When we use the example of Malta, it is 0.69144. It means that the banking sector has to reduce the following inputs: the assets must fall by 17 548 million €, from the amount of 56872 million € to 39324 million €. The number of employees must be reduced from the original amount of 4427 by 1366, which means that the employment level in the sector should be equal to 3 061. The degree of concentration of banking sector in Malta, which is

expressed by Herfindahl-Hirschman index, must fall by 1575, it means from the amount of 1621 to the final amount 46. Finally, the number of banks should fall by 13, it means from the original amount of 27 to 14.

Table 4
The efficiency of banking sectors in 2015 - input oriented model

| Country | Efficiency | INPUT | | | |
|---|---|---|---|---|---|
| | | Assets [€ mil.] | Staff | HHI | Number of Banks |
| Belgium | 0.98325 | 18458 | 948 | 473 | 2 |
| Germany | 1.00000 | 0 | 0 | 0 | 0 |
| Estonia | 1.00000 | 0 | 0 | 0 | 0 |
| Ireland | 0.73800 | 305042 | 7564 | 423 | 330 |
| Greece | 1.00000 | 0 | 0 | 0 | 0 |
| Spain | 1.00000 | 0 | 0 | 0 | 0 |
| France | 1.00000 | 0 | 0 | 0 | 0 |
| Italy | 1.00000 | 0 | 0 | 0 | 0 |
| Cyprus | 1.00000 | 0 | 0 | 0 | 0 |
| Latvia | 0.84450 | 4798 | 1458 | 161 | 32 |
| Lithuania | 1.00000 | 0 | 0 | 0 | 0 |
| Luxembourg | 1.00000 | 0 | 0 | 0 | 0 |
| Malta | 0.69144 | 17548 | 1366 | 1575 | 13 |
| Netherlands | 1.00000 | 0 | 0 | 0 | 0 |
| Austria | 0.99568 | 3802 | 320 | 2 | 521 |
| Portugal | 0.91703 | 38918 | 4471 | 96 | 32 |
| Slovenia | 0.97742 | 983 | 241 | 24 | 3 |
| Slovakia | 1.00000 | 0 | 0 | 0 | 0 |
| Finland | 0.83130 | 97732 | 3715 | 2463 | 224 |
| Bulgaria | 0.94261 | 2719 | 18649 | 1061 | 2 |
| Croatia | 1.00000 | 0 | 0 | 0 | 0 |
| Czech Republic | 0.95566 | 8668 | 13317 | 49 | 2 |
| Denmark | 1.00000 | 0 | 0 | 0 | 0 |
| Hungary | 0.98385 | 1833 | 637 | 16 | 44 |
| Poland | 1.00000 | 0 | 0 | 0 | 0 |
| Romania | 0.96286 | 3361 | 32894 | 87 | 1 |
| Sweden | 0.94113 | 73417 | 3217 | 35 | 9 |
| United Kingdom | 1.00000 | 0 | 0 | 0 | 0 |

In 2015, 15 banking sectors were effective, it means that there are no specific recommendations for changes in inputs and outputs in their case. This does not mean that it is not necessary to optimize their business continuously, as they can become ineffective in the future. Eventually, the results in 2014 were worse than

in 2015. We reviewed the change in efficiency between the two years by using Malmquist index. We investigated the development of the rate of efficiency in individual banking sectors in 2015 compared to 2014. In addition, we investigated whether the decisions of bank management, regulators or other uncontrollable exogenous factors had a positive, negative or neutral influence.

Table 5
Malmquist index in time 2014-2015

| Country | Efficiency | | Malmquist INDEX |
|---|---|---|---|
| | 2014 | 2015 | |
| Belgium | 1.00000 | 1.01704 | **1.01319** |
| Germany | 1.00000 | 1.00000 | **1.03165** |
| Estonia | 1.00000 | 1.00000 | **1.05003** |
| Ireland | 1.25519 | 1.35501 | **0.93079** |
| Greece | 1.00000 | 1.00000 | **0.98142** |
| Spain | 1.00000 | 1.00000 | **1.07352** |
| France | 1.00000 | 1.00000 | **1.00630** |
| Italy | 1.00000 | 1.00000 | **1.01858** |
| Cyprus | 1.00000 | 1.00000 | **1.02416** |
| Latvia | 1.10606 | 1.18413 | **0.91714** |
| Lithuania | 1.04542 | 1.00000 | **1.07547** |
| Luxembourg | 1.00000 | 1.00000 | **1.02479** |
| Malta | 1.67847 | 1.44625 | **1.20013** |
| Netherlands | 1.00000 | 1.00000 | **1.06005** |
| Austria | 1.00000 | 1.00434 | **0.99585** |
| Portugal | 1.08703 | 1.09048 | **1.00622** |
| Slovenia | 1.00000 | 1.02310 | **0.96794** |
| Slovakia | 1.00000 | 1.00000 | **0.99288** |
| Finland | 1.16184 | 1.20294 | **0.96327** |
| Bulgaria | 1.04074 | 1.06088 | **0.97850** |
| Croatia | 1.00000 | 1.00000 | **0.97598** |
| Czech Republic | 1.00000 | 1.04639 | **0.96515** |
| Denmark | 1.00000 | 1.00000 | **1.05840** |
| Hungary | 1.20889 | 1.01642 | **1.18109** |
| Poland | 1.00000 | 1.00000 | **0.99206** |
| Romania | 1.00998 | 1.03857 | **0.95625** |
| Sweden | 1.04995 | 1.06255 | **0.98773** |
| United Kingdom | 1.00000 | 1.00000 | **0.96846** |

The first two columns of Table 5 express the efficiency of banking sectors in 2014 and 2015 separately. The third column presents the quantified change of effectiveness over time. Based on the Malmquist index we are able to downwardly classify the banking sectors of individual countries. The values of Malmquist

index, which are higher than one show the increasing rate of efficiency against other DMU. The values of Malmquist index lower than one show decreasing rate of efficiency. The value of index equal to one or around one expresses that the effects of endogenous and exogenous factors on the bank sector were neutral.

Starting again with the example of Malta, the banking system achieved the highest value of Malmquist index 1.20013. Despite of the fact that in 2014 (1.67847) and 2015 (1.44625) it was ineffective, this system achieved the most significant increase in efficiency. This situation can be considered as a positive phenomenon. The banking sector of Latvia was also ineffective in both years 2014 (1.10606) and 2015 (1.18413). However, unlike Malta, this sector had decreasing effectiveness, the value of Malmquist index was at the level of 0.91714. Banking sector of Poland was effective in both years and the value of Malmquist index equal to one informs us about this situation. Interesting is that Malmquist index of Czech Republic (0.96515) and Great Britain (0.96846) was almost the same. However, in the case of Czech Republic this situation expresses the inclusion of its banking sector into the category of ineffective bank sectors.

In regard to our findings, the rate of efficiency of banking sectors in the EU member countries was in 2015 at the level of 53.57%, whereas in 2014 it was at the level of 64.29%. According to papers [22, 36] we considered as effective these banking sectors which work with the rate of effectiveness higher than 70%.

Based on the obtained results we can state that the hypothesis H1 was confirmed, which means that the banking sectors of the EU member countries are still not sufficiently consolidated. Taking into consideration the pre-crisis research conducted by Pastor [32], when the banking sector of the EU members achieved an average rate of effectiveness equal to 86%, we can state that our results confirm the negative long term consequences of the financial crisis.

In regard to the H2 hypothesis, we divided our sample into two groups. The first group consists of "old" EU member states and in the second group the countries that joined the EU after 2004 are found. From the 15 original member countries the banking sectors in Germany, Greece, Spain, France, Italy, Luxembourg, Netherlands, Denmark and United Kingdom can be considered as efficient, and this situation reflects the rate of effectiveness at the level of 60%. From the countries that joined to the EU after 2004 the banking sectors were effective in Poland, Croatia, Slovakia, Lithuania, Cyprus and Estonia and this situation reflects the rate of effectiveness at the level of 46.15%. Based on these results it should be noted that the second hypothesis H2 was confirmed – the banking sectors of the old EU members were more effective from the operational point of view.

Finally, with regard to the H3 hypothesis we investigated whether the banking sectors of the Eurozone members are more efficient than banking sectors of countries, which have not applied the euro. For this reason we again divided our sample into two groups. From the 18 countries in the Eurozone the banking

sectors in Germany, Estonia, Greece, Spain, France, Italy, Cyprus, Lithuania, Luxembourg, Netherlands and Slovakia worked effective and this situation reflects the rate of effectiveness at the level of 57.89%. From the 9 countries outside the euro area the banking sectors of Croatia, Denmark, Poland and United Kingdom worked effective and this situation reflects the rate of effectiveness at the level of 44.44%. Therefore, it should be noted that the hypothesis H3 was confirmed – the banking sectors of the Eurozone members can be considered as more efficient than the once outside euro area.

In the end the obtained results especially pointing to the efficiency of such banking sectors as the once in Greece, Spain or Italy should be also commented form the perspective of banking sector stability. It should be stressed that in the present research the problem of undesirable output – for example, in the case of banking sector, the share of non-performing loans in the portfolio, which is important from the perspective of banking sector stability and capital adequacy requirements – was deliberately omitted, which is considered as a standard approach form the perspective of the objectives of the article [compare 40], and still present controversies of data interpretation in this regard. So the obtained results should be interpreted from the perspective of operational efficiency of the banking sectors not form the perspective of their stability.

## Conclusion

This paper was focused on the issue of measuring the efficiency of banking sectors, especially on the issue of measuring the operational effectiveness of banking sectors in the European Union member countries. The objective of this paper was to suggest a relevant methodology for measuring bank efficiency based on the Data Envelopment Analysis and Malmquist index.

The conducted empirical research confirms that the banking sectors in the EU countries are characterized with relatively low levels of efficiency in 2015. Empirical evidence suggests that the banking sectors are not enough consolidated. The research confirms still visible negative impact of the last global financial crisis, and probable negative implications of some other exogenous factors, where one can point relatively low effectiveness of monetary stabilization policy of the European Central Bank and the National Central Banks, and low effectiveness of regulation efforts at the European Union level.

With regard to the comparative analysis of efficiency of banking sectors in the Euro Area and outside the Monetary Union, we confirm that the banking sectors of the Eurozone members are more efficient than the banking sectors of countries which have not yet applied for the euro. In the case of comparison of banking sector efficiency of the old 15 EU members and the member states admitted to the EU after 2004, the first group can be considered as more efficient.

In the end, one should also point the restrictions of the research, the potential applications of the proposed methodology and areas of possible future studies.

When we tried to create a model for measuring the efficiency of banking sectors, we encountered several objective problems. This is the reason why we did not include all the variables for which we planned. For example, we were not able to obtain an average rate of profitability, the volume of non-performing loans, capital adequacy for the whole set of countries. In our opinion, the achievement of the assumption concerning homogeneity of DMU can be questionable, in the case of banking sectors. It should be also remembered that explanatory power of some variables, which we also used in the research, can also be questioned. For example, loans are commonly accepted and designated as outputs of banking activity, which is expressed in monetary units in the net value. However, this value itself does not provide information on the quality of loans, that is important from the perspective of sectors stability, which has been already stressed in a previous section.

Despite the barriers and the problems we can state that obtained results can be used for a variety of purposes, starting with continuous monitoring of the rate of efficiency of banking sectors, in the EU countries and comparative research between the countries. Interesting results, especially form a managerial perspective, could be obtained at the lower aggregation level – if we were able to assess for example the rate of effectiveness of individual banks within each country of the EU. Another important area of future research would involve addressing the problems with the development of technical, cost and overall efficiency. As it has been already stressed, the validity of the model could be also increased after expansion, including the undesirable output or the uncontrollable variables.

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# The Composite Coincident Indicator (CCI) for Business Cycles

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*Abstract: The aim of this paper is to introduce a composite coincident indicator for the Slovak economic cycle. The theoretical part of the work is concentrated on the analysis of current monitoring options of economic cycle using GDP, industrial production index and composite indicators. The analytical part of the work pays attention to authors' own composite coincident indicator and to testing its monitoring capabilities. Methodology used in this paper is a combination of the methodologies by the OECD, Conference Board and the authors of this paper. Such methods as seasonally adjusted time series, Hodrick-Prescott filter, standardization and cross-correlations are used as applied to 134 indicators of Slovak economy. Coincident cyclic indicators are selected from them, as they form the basis for Slovak composite coincident indicator. The resulting coincident composite indicator for Slovakia is made up of four indicators – employment in manufacturing, export of goods and services, the number of hours worked in industry and industrial turnover. The assembled indicator is then tested over time and a need for change in its composition as a result of significant economic changes is grounded. Significant changes in the composition of coincident cyclical indicator for 2010 are also proved. For the period of 2010-2015 a new composite coincident indicator is suggested of the composition of production index in the construction industry, a factor limiting production - insufficient demand, unemployment in the age group of 25-74 y.o. and short-term interest rate.*

*Keywords: business cycle; composite coincident indicator; gross domestic product, industrial production index*

# 1 Introduction

Business cycles can be presented as some sort of fluctuations within overall economic activity of countries that are basing their economies primarily on business enterprises. Such a cycle consists of expansions taking place during roughly same time in a range of economic activities, always followed by overall recession or some sort of other contractions, while revivals later merge into the expansion phase of a new, next cycle. This standard order of changes repeats itself in time, however, it is not periodic. In their duration, business cycles may vary from roughly a year to a decade or even more. Moreover, business cycles cannot be divided into shorter cycles of similar character and same volume of amplitude [1, 2]. From the time of Burns and Mitchell (1946), monitoring of the economic cycle is the subject of interest for many economists and international organizations such as the Eurostat, the OECD, the US Conference Board, and national statistical offices. The primary challenge in the pursuit of cyclical economic development is choosing the right economic indicator that by its nature would be able to replicate the economic cycle as accurately as possible. It is generally considered to be the best indicator of gross domestic product (GDP), which describes the development of economy and its cyclical behavior as a whole [3]. The growing influence of industry in most of the world´s economies convinced some economists that the Industrial Production Index is an equally appropriate indicator to monitor economic cycles. This observation is true in general, but in some countries the index of industrial production does not meet the basic assumptions that have oriented it to the representation of the economic cycle. For this reason, economists are designing new indicators, which by their nature seek to replace GDP due to the complexity and demands of their calculation. In this context, we encounter terms like composite, complete or complex indicators, which are composed of sub-economic indicators, corresponding with the development of GDP and can be used to monitor economic cycles [4]. There are many approaches in the world to the creation of composite indicators. Examples include works of Stock and Watson in 1991 and 1992 that describe the structure and advantages of the composite indicator, and are based on the work of Burns and Mitchell [5, 6]. Hamilton (1989) has shown that a set of coincident and upstream parameters for the production of composite indicators can be modeled [7]. On this basis, it is possible to identify and predict the turning points of an economic cycle [8].

The paper aims to form a coincident composite indicator (CCI), which can be used to monitor the cycle of the selected country. The theoretical part is devoted to review of the studies, which monitor the cyclical developments in the economy, by GDP, the industrial production index and CCI. By examining historical work, a methodology for indicator calculation is introduced applicable to any country. The analytical part demonstrates d its practical application on the example of Slovakia´s economic cycle. Then, it is examined for changes overtime, in the composition of the CCI.

# 2 Basic Monitoring Options of Economic Cycles

## 2.1 Gross Domestic Product (GDP)

The most commonly used indicator of monitoring the cyclical development of the economy is GDP (Gross Domestic Product) at constant prices, which is generally considered to be the broadest indicator of economic activity [9]. Real GDP provides the best representation that covers a broad range of economic activities and adequately reflects each of the real economic sectors in the country [10]. Eurostat defines GDP as a high quality economic indicator that best describes the cyclical behavior of the economy and can be set based on turning points that indicate economic growth, resp. economic downturn [11]. In the analysis it is not being used in the form of raw data, but the GDP time series is edited, only the cyclical component selected and analyzed [12]. There are many options for obtaining the cyclical component. The most commonly used methods to eliminate the trend and seasonal ingredients are Christiano-Fitzgerald (CF) filter, Hodrick-Prescott (HP) filter, or the Phase Average Trend method (PAT). The methods differ from each other, have their advantages and disadvantages [13]. GDP drawback is its temporal availability [14]. It is now featured in the form of quarterly data and is available with a delay of one or even two quarters, which is a problem in determining the current position of the economy as well as in predicting cyclical behavior of the selected economies [15]. Therefore, in practice, quarterly estimates of GDP are being used, that are of great value for policy makers and for assessment of its status in real time. In 2012, however, the OECD acceded to the making of methodology for decomposition of GDP and achieved a time series of GDP estimates on a monthly basis. Monthly estimates of GDP now represent a natural alternative for the composite coincident indicator. For the UK, Mitchell, Smith, Weale, Wright, and Salazar suggest a formal procedure to combine information about a range of monthly series into indications of short-term movements in output. Their assessment of the efficacy of the approach to evaluate the state of economic activity is rather satisfactory [16]. Significant problems of the GDP estimates are revisions, which are in macroeconomic indicators large and common [17-21]. Therefore, working with the last available data may provide starkly different results than those obtained using real-time data [22-24]. In particular, in forecasting applications, neglecting data revisions might substantially understate forecast errors [25].

## 2.2 Index of Industrial Production (IPI)

The Industrial Production Index (here and further - IPI, also known as the industrial output index or the industrial volume index) is one of the acknowledged globally business cycle indicator. It measures monthly change in the price-adjusted output of the national industrial production. IPI is one of the most

relevant and widely used short-term indicators in contemporary statistical analysis. It is usually used to identify the turning points in economic development at some early stage and it also assesses future development of GDP. For this matter, data in it is available on the monthly basis and in a rather detailed breakdown by activities. Noteworthy, this data is provided with a relatively short delay (1 month and 10 days). The industrial production index also belongs to the so-called Principal European economic indicators (PEEI)'which are used to monitor and reconsider economic and monetary policies within the EU and inside the Eurozone specifically [26]. The advantages of the industrial production index for monitoring the cyclical behavior of the economy in the long term used the OECD. This institution used IPI by March 2012 for major cyclical indicator precisely because of faster and more frequent time access compared to GDP [27]. Bascos-Deveza argues that Real Gross Domestic Product is the most comprehensive measure of overall economic activity. The second most complex indicator is currently the IPI, which should be used for verification of consistency of the business cycle [28].

In monitoring the global economic cycle the monthly IPI has ranked among the most important coincident indicators with the quarterly GDP [29]. IPI is not suitable as a main indicator tracking the cyclical development of the economy in all countries [10]. The disadvantage of the use of industrial production index for Slovakia is that it does not follow the trend of transition economies [30]. Another reason is that the index of industrial production, in some countries, may act as a leading indicator, that does not develop in coincident but with some time before the development of GDP, which precludes its use as a concurrent indicator. Tkáčová, Siničáková and Králik explored in their study the cyclical properties of selected indicators of cyclical industries in the V4 countries in the years 1995-2011. IPI was among the leading indicators in Poland, the Czech Republic and Slovakia. In Hungary it showed signs of concurrent indicator of Hungary's GDP [31]. Other problems associated with the industrial production index, also means that it indicates more turning points than GDP and can be a source of false signals even when converted to quarterly data [32].

## 2.3 Composite Indicator

The third option of monitoring the cyclical behavior of the economy is to create a unique composite indicator, which includes a number of selected cyclical indicators. We are talking about composite indicator of cyclical economic developments, which reflects the development of the economy and its cyclical behavior better than individual indicators alone. GDP or industrial production index are created in the case of reference range of composite indicators, which is the basis for its calculation. Choice of cyclical indicators into a composite indicator is not accidental, but is conditioned by their economic significance, explanatory value and statistical quality [33, 34].

Currently, there are several views on the composition of the composite indicator of cyclical economic developments. OECD believes that economies differ, and therefore the composition of the composite indicator varies depending on the country. On the contrary, Eurostat noted that economic cycles can be tracked through the composite indicator of the same composition [35]. In the case of composite indicators, the leading composite indicator is the most important that represents the aggregated time series showing ahead of the reference array representing the economic cycle of the selected country [27]. A composite indicator that can reproduce the cyclical development of the economy represents a coincident composite indicator (Composite Coincident Indicator - CCI). Coincident indicators were viewed as useful tools for assessing the current condition of the business cycle and now casting [36, 37].

Cyclical indicators have been used for many years as tools to understand the aggregate U.S. economy. The National Bureau of Economic Research (NBER) published the first formal list of cyclical indicators in 1938. NBER then produced revised lists in 1950, 1961, and 1967. In 1975, in cooperation with NBER staff, BEA completed a comprehensive review of existing statistical indicators and began publishing cyclical indicators, including composite (leading, coincident and lagging) indices. In early 1996, the preparation and publication of cyclical indicators was transferred to The Conference Board. Today, The Conference Board maintains and publishes over 250 analytical indicators as part of its responsibility for producing and publishing the three composite cyclical indicators for the United States (leading, lagging, coincident) [38]. The composite coincident indicator designed by Conference Board includes employees on nonagricultural payrolls, personal income less transfer payments, index of industrial production and manufacturing and trade sales [39]. The Index of Coincident Indicators is issued monthly in a press release along with the other Business Cycle Indicator data [40]. Conference Board methodology used, for example, also by Marcellino but during the construction of leading composite indicator for the UK business cycle [41].

McGunckin, Ozyildirim and Yarnowitz noted that over time, it needs access to the translation of the composite indicator. The main reason is the availability of indicators, which in the past may not have been available (mainly on a monthly basis), and use more modern methods to produce composite indicator [42]. Carriero and Marcellino claim that there is an overall over time change in components forming the CCI [43]. The reason for this can be significant economic changes as the financial and economic crisis, accession to the integration groupings and other [44, 45].

In case of the Slovak and Czech economies, a coincident composite indicator has not been the preferred tracking option in the past [30]. The length of time series of economic indicators was too short and it was not possible to determine which variables define the economic cycle, and which ones are only random fluctuations [46]. Length of each cyclical indicator already enables the creation of a coincident

composite indicator of sufficient quality even when using quarterly data. Tkáčová lists the groups of coincident cyclical indicators that have been selected from a set of 425 indicators monitored for the V4 countries. Table 1 shows the coincident indicators that in time period Q1 1993 – Q4 2011 were appropriate for compiling the composite concurrent indicators in these countries [31].

Table 1

Coincident cyclic indicators for the creation of CCI (1993-2011)

| Country | Coincident cyclic indicators |
|---|---|
| **Slovakia** | Unemployment rate by age group and gender in %<br>Imports of goods and services, mill. EUR<br>Official foreign reserves, special drawing rights (SDR), EUR<br>Industrial Production Index, 2005 = 100 |
| **Poland** | GDP creation, PLN<br>Current account balance of payments, bill. USD<br>Construction works (new construction) 2005 = 100<br>Foreign currency reserves (securities), mill. PLN |
| **Czech Republic** | Import of goods, bill. USD<br>Confidence in retail trade<br>Total foreign reserves (including gold), mill. CZK<br>Input prices of materials used in construction (2005 = 100) |
| **Hungary** | Industrial Production Index, 2005 = 100<br>Total retail sales, 2005 = 100<br>Imports of goods and services, bill. HUF<br>Turnover in industry (intermediate and capital goods), total market, 2005 = 100 |

Bakarić et al. reported on the example of Croatia's approach to generating CCI for this post transitive economy, while analyzing 278 monthly time series, of which only four are entering into the final CCI. Their article applies a combination of Markov switching modeling, logit and dynamic factor modeling in order to measure the business cycle condition for a European post-transition country [47]. Business cycle analysis in Croatia focused either on constructing a non-model based CCI, as in case of Cerovac or on constructing a quarterly composite index [48, 49]. Cerovac identified CCI components using correlation coefficients, while the CCI itself was calculated using deterministic formula [48]. Wozniak and Lohmus and Demekas do construct a CCI for Poland and Estonia but they do so by applying unobserved component method and ordinary least squares (OLS) regression respectively [50, 51]. In recent years, dynamic factor models were used more intensively, in order to build short-term a CCI, used for the purpose of now casting. These applications include Arnoštová et al. and Rusnák who develop cyclical indicators for the Czech Republic, and Porshakov et al. who build CCI for Russia [15, 52, 53]. Dynamic factor model is also being more widely used for examining business cycle properties in developed countries (see for example [54-58]).

# 3 Objective and Methods of Creation of Coincident Composite Indicator and Data

The aim of this paper is to propose a suitable coincident composite indicator for tracking Slovak economic cycle. These hypotheses are being tested:

**Hypothesis 1:** As the reference range/series for the calculation of the composite coincident indicator for Slovakia the cyclical component of GDP at constant prices should be used.

**Hypothesis 2:** The created coincident composite index for Slovakia reaches higher value of cross-correlation than coincident cyclical indicators included in it.

**Hypothesis 3:** There are changes in the composition of coincident composite indicator for Slovakia over time.

The methodology used in the creation of CCI used in this paper is a combination of OECD and Conference Board methodologies. Formulation of a CCI is based on growing cycle that is more appropriate in the case of transition economies with higher rate of growth [59]. For proper design of CCI these steps need to be followed:

1. **Choice of the reference series –** it is a basic indicator that represents the economic cycle (cyclical component of GDP or IPI).
2. **Creation of economic indicators database** – The paper studied 134 indicators from various economic sectors such as industry, construction, trade, services, labor market, state budget, balance of payments, foreign trade, prices retailers and consumers, monetary aggregates, and stock indices. In addition to quantitative data, cyclical behavior, in the case of qualitative data, such as the consumer confidence indicator, or an indicator of consumer confidence in the retail, services, construction and industry was also observed. Preference is given to the quarterly data. If monthly data would be used, only 76 indicators would be valid, which would not represent the whole country. Data were obtained from OECD, Eurostat, Slovak Statistical Office and National Bank of Slovakia. Time period Q1 1997 – Q4 2015 was the subject of interest.
3. **Seasonal adjustment of time series (seasonal indices)** – seasonal indices enable us to adjust time series and gain a cyclical component from original data.
4. **Trend elimination (Hodrick-Prescott filter)** – Beneš and N´Diaye considered the HP filter to be the simplest variant of advanced filtering techniques [60]. It can be quite easily applied to any time series [61]. In addition, it is only necessary to specify the input parameter $\lambda$, which optimizes the smoothing trend [62]. Smoothing parameter cannot be accurately determined or calculated, it can be only estimated on the basis of

empirical observations; $\lambda = 14400$ for monthly data, $\lambda = 1600$ for quarterly data, $\lambda = 100$ if time series consists of annual data [63]. One of the reasons for the choice of the HP filter is that is eliminates trend component in one operation and it smoothes the whole time series in the same step [64, 65].

5. **Cross-correlation** – allows us to express relationship between a referential series and time series of cyclical indicators that we observe. Cross-correlations are carried out with five-period forward and backward looking shift. Linear relationship between variables is expressed via Pearson correlation coefficient [66]. If a time series is not linear, its linearization can be realized through variable transformation (e.g. logarithmical operations) [67]. Consequently, new correlation can be calculated.
6. **Creation of coincident cyclical indicators group** – according to the value of correlation coefficient we can create group of cyclical indicators. For ***coincident indicators*** the highest absolute value of correlation coefficient is in time *t* and the second highest absolute value of correlation coefficient has to be at least 0.55.
7. **Selection and scoring methodology –** data selection and scoring methodology are important for choice of convenient leading indicators involved in the CLI. We evaluate their economic and statistical significance, as well as statistical quality [32].
8. **Data normalization (standardization)** – normalization of data enables us to use data in different units. In our case, we will apply standardization of a time series.
9. **Weight determination** – to create a CCI we will application of the same weights.
10. **The CCI formulation –** the CCI will be based on the sum of indicators multiplied by their weights. The procedure is explained more precisely in the section on the CCI formulation.

# 4 Construction of the Coincident Composite Indicator for Slovakia

## 4.1 Choosing the Reference Series as a Representation of the Slovak Economic Cycle

To determine the relationship between GDP and industrial production index cyclical component of these indicators were extracted and cross-correlation for monthly and quarterly data was implemented. If data were monthly estimates of GDP according to OECD were used. Results can be seen in Table 2.

Table 2
The results of the cross-correlation between the cyclical component of GDP and the IPI for the period 1993-2015

| | t-5 | t-4 | t-3 | t-2 | t-1 | T | t+1 | t+2 | t+3 | t+4 | t+5 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **M** | 0.07 | 0.31 | 0.54 | **0.69** | 0.60 | 0.58 | 0.5 | 0.42 | 0.12 | -0.2 | -0.15 |
| **Q** | -0.06 | 0.09 | 0.34 | 0.52 | **0.68** | 0.61 | 0.43 | 0.16 | -0.05 | -0.29 | -0.43 |

Note: M – monthly time series; Q – quarterly time series.

As Table 1 shows, there is a correlation between GDP and IPI as for the monthly and quarterly data. IPI, however, does not overlapping but advance of developments in the cyclical component of GDP demonstrating the highest cross-correlation value at time *t-2* (advance two months) for monthly data and *t-1* (advance 1Q) at a cross-correlation value of 0.68. IPI can be used as a reference range for the creation of coincident composite indicator for Slovakia. IPI would cause that the calculated CCI would have a character of a leading, not coincident composite indicator, which is not the aim of this article. Based on Table 2, we can accept Hypothesis 1, which says that as a reference range for calculation of composite concurrent indicator for Slovakia the cyclical component of GDP at constant prices should be used. A look on Figure 1 can be taken for an illustration, which shows the evolution of cyclical components of GDP and IPI in tracking quarterly time series from 1997 to 2015.

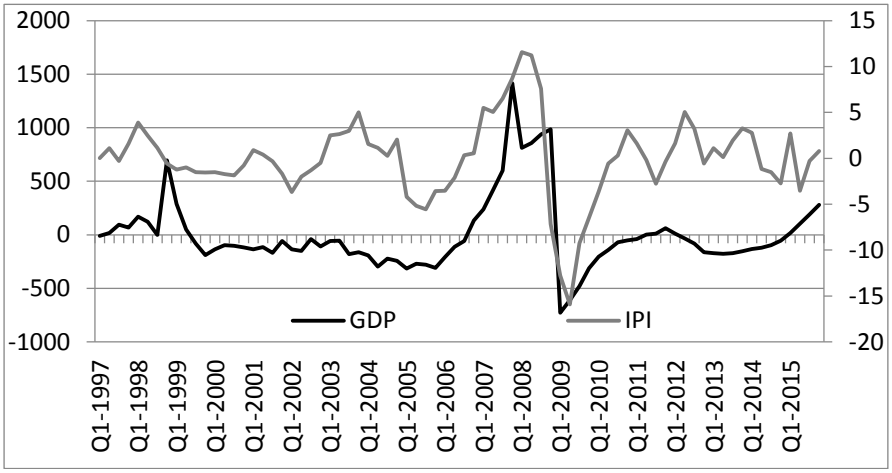


Figure 1
Development of cyclical component of GDP and IPI for Slovakia in 1997-2015

Figure 1 highlights the leading capabilities of IPI in comparison to GDP especially in the period before the crisis in 2008. A large number of signals are also apparent indicating a change in economic development, which is considered to be one of the drawbacks of the IPI for the monitoring of the economic cycle. For this reason

there will be the cyclical component of GDP at constant prices chosen as a reference range for the calculation of CCI.

## 4.2 Composition of the Coincident Composite Indicator for Slovakia for the Period 1997-2015

Based on the chosen methodology 10 coincident cyclic indicators were selected. They are listed in Table 3.

Table 3

Results of the cross-correlation in time "t" for coincident cyclical indicators calculated for the period Q1 1993 – Q4 2015

| **Coincident composite indicator** | **The value of cross-correlation at time "t"** |
|---|---|
| Exports of goods and services (bill. EUR) | 0.6904 |
| Export of services (bill. EUR) | 0.6101 |
| Employment in manufacturing | 0.6812 |
| The actual productivity of the employee | 0.6805 |
| Labor productivity (per hour) | 0.5820 |
| The number of hours worked in industry | 0.6710 |
| Turnover in industry, capital goods, domestic market | 0.6210 |
| Turnover in manufacturing, domestic market | 0.6903 |
| Turnover in industry, intermediates + capital products, domestic market | 0.6925 |
| Indicator of confidence in retail trade | 0.5507 |

Indicators like turnover in industry or exports are found in Table 3 several times and would create duplication in the composition of the CCI. For selection of coincident indicators scoring method was used. 5 of 10 coincident indicators were selected by the use of this method. Due to the different units for the indicators, the method of normalization was applied. 5 of the selected indicators does not necessarily mean an optimal composition of CCI. Therefore, a CCI composed from 5, a CCI composed from 4 and a CCI composed from 3 indicators are created. The indicator with the lowest value of cross-correlation is still taken out. Table 4 shows the different composition of the CCI for the period Q1 1997 – Q4 2015.

Table 4

Alternatives to composition of the CCI for the period Q1 1997 – Q4 2015

| **CCI** | **CCI composition** |
|---|---|
| **CCI 1** | Employment in manufacturing<br>Exports of goods and services<br>The number of hours worked in industry<br>Turnover in industry, intermediates + capital goods, domestic market<br>Indicator of confidence in retail trade |
| **CCI 2** | CCI 1 – Indicator of confidence in retail trade |
| **CCI 3** | CCI 2 – The number of hours worked in industry |

In the case of CCI 1, all the 5 indicators are included. For CCI 2, the Indicator of confidence in retail trade is taken out, which had cross-correlation value of 0.5507 at time t. For CCI 3, The number of hours worked in industry is taken out, which had cross-correlation value of 0.6710. To build relationships to calculate the CCI the system of same weights was used. Subsequently, the created CCIs were correlated with cyclical component of GDP. The results of the cross-correlation can be seen in Table 5.

Table 5
Results of the cross-correlation between the CCI 1, CCI 2, CCI 3 and the cyclical component of GDP for the period Q1 1997 – Q4 2015

| | t-5 | t-4 | t-3 | t-2 | t-1 | T | t+1 | t+2 | t+3 | t+4 | t+5 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CCI 1** | 0.07 | 0.20 | 0.35 | 0.53 | 0.72 | **0.82** | 0.66 | 0.42 | 0.20 | -0.05 | -0.36 |
| **CCI 2** | -0.01 | 0.18 | 0.32 | 0.52 | 0.74 | **0.87** | 0.66 | 0.46 | 0.27 | 0.05 | -0.27 |
| **CCI 3** | 0.03 | 0.18 | 0.32 | 0.53 | 0.73 | **0.85** | 0.67 | 0.47 | 0.26 | 0.02 | -0.29 |

Source: own processing by authors

The highest value of cross-correlation (0.87) was demonstrated in the CCI 2, which confirmed one of the basic properties of the composite indicator. The resulting CCI has a significantly higher cross-correlation value. This is higher than the cross-correlation values of indicators, which are involved in it.

The resulting relation for the calculation of the CCI 2 has this form:

*CCI (1997–2015) = ¼ * employment in manufacturing + ¼ * export of goods and services + ¼ * number of hours worked in industry + ¼ * turnover in industry (1)*

A look on Figure 2 can be taken for illustration. It depicts the development of the CCI 2 and the cyclical component of GDP in Q1 1997 – Q4 2015. From Figure 2 it is apparent that CCI 2 and GDP are coincident especially in period 1997-2009. It can be seen that since 2010 there is a number of false signals about the state of Slovak economy in CCI 2. For this reason, it is necessary to verify the ability of CCI to monitor the Slovak economic cycle even in shorter periods of time.

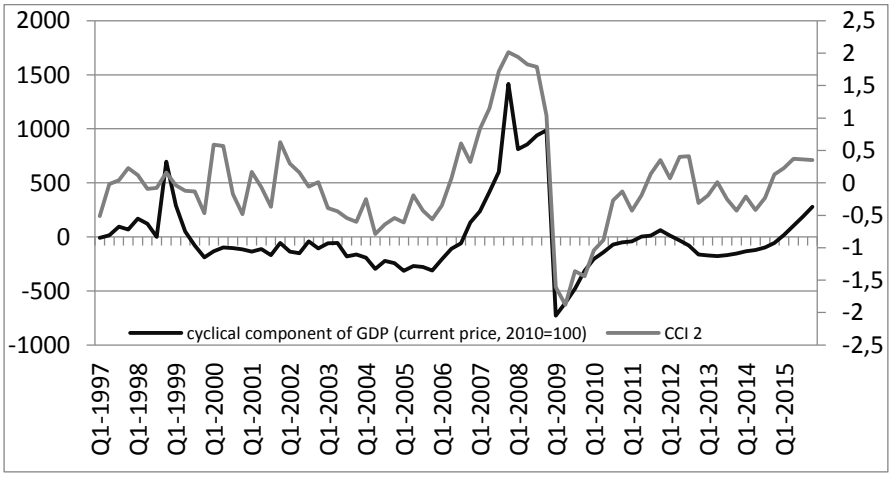


Figure 2
Development of CCI 2 and the cyclical component of GDP in Q1 1997 – Q4 2015

## 4.3 Verification of Concurrence Capabilities of CCI and GDP for Slovakia over Time

Periods after 2009 when the CCI 2 is not sufficiently coinciding with the cyclical component of GDP are visible based on Figure 2. Therefore, the quality of concurrence of CCI 2 even in shorter time periods, such as, 2000-2015, 2005-2015 and 2010-2015 was verified. The results of cross-correlation of CCI 2 calculated for the period 1997-2015 and the cyclical component of GDP for the given periods are visible in Table 6.

Table 6
Results of the cross-correlation of CCI 2 in shorter time periods

| | t-5 | t-4 | t-3 | t-2 | t-1 | t | t+1 | t+2 | t+3 | t+4 | t+5 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **2000-2015** | -0.01 | 0.18 | 0.32 | 0.52 | 0.74 | **0.87** | 0.66 | 0.46 | 0.27 | 0.05 | -0.27 |
| **2005-2015** | -0.0 | 0.16 | 0.30 | 0.52 | 0.76 | **0.89** | 0.66 | 0.45 | 0.25 | 0.02 | -0.32 |
| **2010-2015** | -0.37 | -0.11 | -0.01 | 0.10 | 0.33 | 0.54 | 0.62 | **0.63** | 0.50 | 0.31 | -0.06 |

Source: Research by authors

Based on Table 6 it can be seen that in the period from 2000 to 2015 and from 2005 to 2015 the ability of concurrence with GDP has been maintained or improved. In the period 2010-2015, the highest cross-correlation value was obtained at time *t+2* and accounted as a delay. This means that in the period 2010-2015 the composition of CCI 2 does not suit and there cannot be confirmation or

denial of the cyclical development of the Slovak economy on that basis. One can even say that the predictive abilities of CCI 2 until the year 2010 should be better, than shown by the cross-correlation for the period 1997-2015. This assumption was further examined and increase of cross-correlation CCI 2 up to 0.8910 in time to the year 2010 was found, which is also visible on the Figure 2. It can be presumed that the significant economic changes after 2008, as the financial crisis and subsequent economic crisis have resulted into the fact, that the composition of CCI 2 calculated from the period 1997 to 2015 was not suitable. Table 6 also highlights another important methodological fact. When using long time series (1997-2015) for the calculation of CCI a significant skewing of results can happen. Cross-correlation value of 0.87 speaks about a relatively good ability of CCI to copy the economic cycle in Slovakia in the period 1997-2015. Graphical analysis, however, revealed a time period for which the composition of the CCI 2 was not suitable at all. This means that the length of the used time series of all the economic indicators required for the calculation of CCI has a significant impact on the actual composition and therefore on the properties of the CCI. It is therefore necessary to carry out the conversion of CCI after at least every five years or after significant economic changes such as the transformation of the economy, entrance to integration groupings, whether financial, economic or debt crisis, which could affect the cyclical development of the economy.

## 4.4 Composition of the Coincident Composite Indicator for Slovakia for the Period 2010-2015

CCI calculated from the period 1997-2015 is not suitable to the present needs of monitoring the cyclical development of the economy and especially after 2010. For this reason, the new CCI was made for the period Q1 2010 – Q4 2015. The most suitable is the variant of CCI with four coincident indicators – the volume index of output in the construction industry, factors limiting production - insufficient demand, unemployment 25-74 and short-term interest rate. Again, the same system of weights was used. Cross-correlation value at time t for the period 2010-2015 was 0.859. This is a significant improvement in the properties of the coincident indicator over time. Different coincident cyclical indicators were extracted the same way that were consistent with the cyclical development of the economy in 2010-2015. CCI with this composition can more accurately confirm or refute the current position of the economy. The resulting relation for CCI 2010-2015 has the following form:

*CCI (2010–2015) = ¼ * volume index of production in construction industry + ¼ * factors limiting production – insufficient demand + ¼ * number of hours worked in industry + ¼ * unemployment of the age group 25-74 + short-term interest rate (2)*

Improved ability of CCI to copy Slovak economic cycle is shown also in Figure 3.

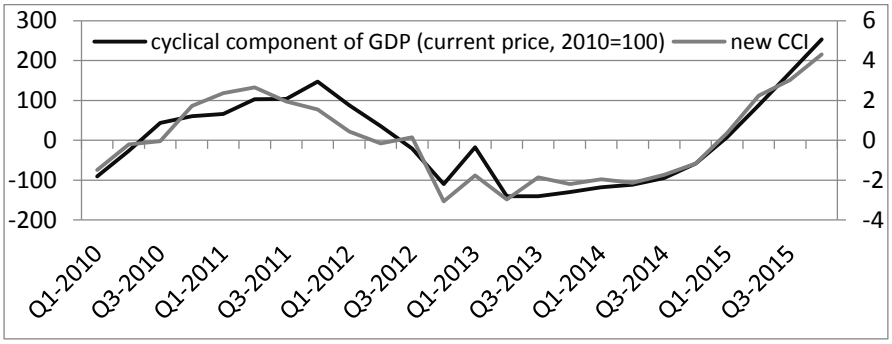


Figure 3

Development of cyclical component of GDP and new CCI in the period 2010-2015

After the establishment of the new CCI we can also confirm Hypothesis 3, stating that there is an overtime change in the composition of coincident composite indicator for Slovakia.

## Conclusions

This paper represents a platform for the creation of a Coincident Composite Indicator (CCI) for monitoring the cyclical development of the economy with the application for Slovakia. The methodology for creating the CCI is universally valid for application in any country using methods, such as, seasonally adjusted time series, HP filter, cross correlation and normalization of data. In this study, three main hypotheses were validated. By testing Hypothesis 1 it was shown that as the reference range for the formation of CCI for Slovakia the cyclical components of GDP at constant prices should be used. The Industrial Production Index (IPI) has been ranked among the leading cyclical indicators for Slovakia, which precludes its use as a reference range, to calculate the CCI. The resulting CCI for the period 1997-2015 consists of four indicators from various economic sectors and the resulting CCI performs better than partial coincident cyclical indicators, which were included. That confirmed Hypotheses 2. The newly created CCI was analyzed for its capability to monitor the Slovak economic cycle over time. It has been found that the CCI created after 2010 did not copy at all the cyclical development of the economy. New CLI 2010-2015 contained a completely different composition. That confirmed Hypotheses 3, concerning the composition change of CCI over time. In practice, it is necessary to test the ability of CCI to monitor the economic cycle in real time, resp. accede to the conversion of CCI after significant economic changes.

In this paper we have managed to construct a quality indicator, for the concurrent need, of the constant monitoring of the cyclical behavior of an Economy. On that basis, it is possible to confirm the current position of Slovak economic cycle. A new area of research for the monitoring of economic cycles should also provide a CCI consisting of monthly data. The condition, however, is to ensure a sufficient

set of economic indicators, which cover the entire economy. An interesting area for further investigation is the creation of CCIs for the different economies of the EU. On this basis, it is possible to create a group of countries with a similar structure of business cycles.

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# The Maturity of a Budgeting System and its Influence on Corporate Performance

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*Abstract: In recent decades, the features making up corporate budgeting systems have been profoundly deliberated over by academics and professionals. Indeed, so-called traditional methods of budgeting have borne the brunt of severe criticism due to their inflexibility and the sheer amount of time they demand of employees. Nonetheless, several examples exist of budgeting systems that have somehow been transformed, and of organizations which have adopted advanced, flexible budgeting procedures based on evaluation of performance. In the study presented, the authors look into any relationships that may exist between the primary elements of corporate budgeting systems and their performance in the enterprise. The aim is to contribute towards existing knowledge by: 1) summarizing the latest advances that relate to budgeting and corporate performance; 2) reporting on current budgeting practices applied by companies in the Czech Republic, with analysis of how budgeting systems affect managerial behaviour; 3) evaluating any statistical dependence between selected features of corporate budgeting systems; i.e. utilizing a budget as a managerial tool, how enterprises express the added value of budgeting systems, endeavour on the part of management in implementing an effective budgeting system, the workload pertaining to individual components of a budgeting system, and the significance of a budgeting system in comparison with other tools designed for adapting to change in market conditions. In general, the study describes interconnections between the profit-based performance of firms and the majority of the factors and features of the budgeting systems examined.*

*Keywords: Budgeting; Corporate Performance; Beyond Budgeting*

## 1 Introduction

Budgeting, one of the essential tools of management accounting, is frequently used for control of organizations by management [16]. Malmi et al. [22] states that budgeting is one of the main tasks of a firm´s accountants. Traditional budgets are usually based on annual periods and present the transformation of a plan into currency units [10].

Over the last three decades, it has been possible to observe increasing dissatisfaction with traditional budgeting systems: they began to be frequently

criticised in literature and by practitioners. Bunce et al. [7] presented a number of shortcomings of budgeting, including such claims as the following: that annual budgeting is soon outdated; is time-consuming, expensive and causes gaming; does not add value; and is based on a supply-oriented idea of production, which means that it lacks a customer orientation. These statements are supported by other authors: Libby and Lindsay [19] state that budgets are criticized for being time-consuming. Prendergast [27] claims that a lot of guesswork is required in the budgeting process, which takes up a lot of managerial time. Similarly, Neely et al. [25], state that the budgeting process actually consumes up to 20% of all managerial time. Nazli Nik Ahmad et al. [24] argue that budgets do not take into account the aspects of customers and quality, and thus prove ineffective in a changing environment.

In literature we can observe the broad discussion related to the elimination of the above-stated limitations of traditional budgets. Henttu-Aho and Järvinen [16] describe this discussion as the *Beyond Budgeting* debate. Scientific studies presented in recent decades reflect this normative criticism of the changing budgeting practice: they conclude that some shift exists from annual budgeting practices towards methods of simplified budgeting and rolling forecasts with a more forward-looking emphasis [19, 20, 26, 31]. However, only limited evidence exists of radical developments, or of companies that have applied Beyond Budgeting. A simple explanation of this is the fact that most transformations of budgeting practices or systems are both continuous and incremental, and they take place over relatively long periods of time [16]. In a study published in 2015, we have observed a very low number of firms which plan to abandon the traditional use of budgets for control but a modest number of firms which plan some changes in the budegting process [28].

In general, budgeting practices are changing very slowly [11]. In a few field studies, traditional budgeting still seems to be in a relatively strong position, but some evidence exists of emerging developments such as rolling forecasts and the balanced scorecard [19, 34].

Hansen et al. [14] state that dissatisfaction with budgeting systems is leading to two different approaches: some firms wish remove budgeting altogether and others wish to improve it. Hope and Fraser [17] present several studies of European companies which abandoned traditional budgeting systems and replaced it with performance measurement systems based on performance indicators.

Classical management accounting textbooks [10] point at the conflicts in utilization of budgets; this is caused by utilizing the self-same budgeting system for different purposes such as motivation and planning. This conflict causes unfavourable manager behaviour which may in turn affect a decrease in company performance. Henttu-Aho and Järvinen [16] state that interaction between the multiple purposes and goals of budgeting could be regarded as the central theme in budgeting studies. Arnolda and Gillenkirch [2] presented a deep study focusing

on analysis of the conflict between different roles of the budget. The authors also state that conflict between different budgetary purposes has been analysed from an economic perspective, but little is known about their effects on corporate behaviour beyond monetary incentives.

A frequently criticised attribute of traditional short-term budgeting is its strict orientation on annual accounting periods [1]. One of the trends present in contemporary budgeting practices is the use of rolling budgets or rolling forecasts. These are produced by firms on a monthly or quarterly basis, and illustrate more dynamic and flexible processes in contrast to static traditional budgeting [16]. In rolling forecasts, the forecast is usually prepared for a specified future period (usually between 12 and 18 months) and adds a new month or quarter as the old month or quarter ends. The rolling forecast includes several benefits such as continuous planning throughout the year, less detailed content, easier updating, better focus on the future and timely reaction to planning [15].

In the literature, we also observe indications of gradual fragmentation of budgeting into various budget-related management accounting methods. These include fixed cost budgeting, activity-based budgeting, rolling budgets, rolling forecasts, the economic value added, target setting, balanced scorecard and benchmarking [16, 29, 34].

One of the most crucial features of modern budgeting practices is its linkage to company performance. Performance-based indicators are a key building block of the Beyond Budgeting approach [17]. The relation between budgeting systems and performance is usually explained through budgetary participation [33]. The relationship between budgetary participation and corporate performance has been investigated by many studies [3, 4, 5, 12, 21, 32]. Yang Qi [33] defines two major conceptual models in current management accounting literature which link budgetary participation with performance. The first are psychological theories [23] which state that participation (the upward information sharing) in the budgeting process – when given to subordinates – can stimulate motivation and commitment in budget-setting; this in turn positively affects job satisfaction and performance [6, 8, 18]. The second model explains the above-stated relationship from a cognitive point of view. It is explained that through budget participation (the downward information sharing), subordinates gain information from superiors that helps clarify their organizational roles, including their duties, responsibilities and expected performance; all of this leads to a performance increase [9, 18, 30].

In our study, we have focused on the relationship between the budgeting system maturity, which is measured by quality perception of managers and perceived company performance. We expected that firms with more advanced budgeting systems demonstrate higher performance when compared with their competitors. The maturity of the budgeting system has been measured by four factors based on the Libby and Lindsay [19] study, in which these factors were analysed as the important indicators of the budgeting system. We have analysed the following

factors: UB, the use of budgets for control where we have analysed on which level firms are using them in that capacity; PAV, the perception of the budgeting system's added value, where we have measured how firms perceive the overall value-added quality of the budgeting system; EMNA, an effort dedicated to the budget's preparation; and ERP, the effectiveness of the budgeting process in the field of adaptation to changes in the business environment.

This paper tries to contribute to the recent discussion in investigating the relationship between company performance and selected factors of the organizational budgeting process. Despite the several limitations of the study (the subjectivness of the data collected from respondents and statistical processing of that data), we hope it brings new findings related to budgeting and its use in Czech firms.

# 2 Methods

The main objective of this paper is to identify and quantify significant factors determining profit-based performance of enterprises in the Czech Republic. The secondary objective is to compare profit-based performances of enterprises among selected groups of enterprises. The statistical characteristics of enterprises are investigated both by the number of employees and by the volume of sales received over the two preceding years. Scientific hypotheses have been formulated to fulfil the main and secondary objective of this paper.

H1: Enterprise performance in terms of profit (EP) is determined by the following factors: a) use of budget (UB) as a tool for enterprise management, b) perception of added value of the budgeting system for an enterprise (PAV), c) effort on the part of managers and workload volume expended to compose a budget (EMNA), d) significance of the budgeting process compared with other tools to adapt to changing market conditions (BP).

H2A: None of the selected groups of enterprises – neither by the number of employees nor by the volume of sales – report any statistically significant differences in the overall structure of evaluation of enterprise performance with regard to their direct competitors.

H2B: Enterprises under and above 500 employees and enterprises with sales under and above 8 million EUR will report statistically significant differences in their enterprise's evaluation of performance (in terms of profit) with regard to their direct competitors.

The research was undertaken in 2015 by the authors, these being academics at the Faculty of Management and Economics of the Tomas Bata University in Zlin (UTB). Data was collected via a questionnaire accessible on-line. Initially, the

ALBERTINA database was utilized to discern which enterprises would make suitable subjects for investigation, as well as to access contact details for the responsible persons at the same. The authors narrowed their search to companies of medium and large size operating in the industrial sector, thereby excluding service and trade establishments. The authors expected that such enterprises would represent those wherein budgeting played a critical role. For inclusion in the sample, the individuals contacted had to be employed at a senior level of financial management, with corresponding job titles such as Financial Director, Chief Financial Officer, Economic Director or Head of the Controlling Department. Such criteria were important in order to ensure that the contacts would possess sufficient experience in activities related to budgeting and gauging performance.

Afterwards, the people detailed in the database were contacted by telephone and asked about their willingness to take part in the study. Those who agreed to be surveyed were sent an email containing a link to the questionnaire, the latter taking approximately 30 minutes to complete.

In all, the authors contacted 1,375 companies, out of which 618 agreed to participate in the survey. In the end, the authors received 177 fully complete questionnaires, i.e. a return rate of 12.9%.

We applied regressive analysis in order to fulfil the main objective. The significance of the linear regressive model was to provide explanation of the course of dependency (relation) between enterprise performance (dependent variable) and its determinants (independent variables – UB, PAV, EMNA, BP). We verified the assumption of linearity through a graphic analysis of data with the application of dot graphs (Scatter Plots), of which significance consists of finding non-linear patterns between a dependent variable and independent variable. We performed the assumption of normal distribution of data with comparison of graphic analysis with the application of a histogram with a normal distribution curve (curve of normal profitability plot for every independent variable) and with testing of descriptive characteristics of independent variables (z-test of skewness and acuteness). The critical value of inclusion of independent variables into the regressive model is 1.973 (173 degrees of freedom, significance level at 0.05). The assumption of constant scattering of random errors and thereby also residues (homoscedasticity) was tested through Bartlett's test. The assumption of homoscedasticity was satisfied if the p-value of the test was greater than 0.05. We used the comparison matrix to determine the intensity of dependency of a dependent variable on independent variables. Values of parameters of the linear regressive model with more independent variables can be affected negatively with multicollinearity. We accept these multicollinearities in the results of the regressive modelling if the value of Variance Inflation Factor is more than 5 [13].

We applied z-score to determine differences between individual permutations of a statistical attribute. In order to verify dependency between two statistical attributes, we used the Chi-square test of independence in the contingency table,

based on calculation of square contingency. The execution of the independence test is conditional on that none of the theoretical frequencies is less than 1 and that a maximum of 20% of theoretical frequencies are less than 5 [13]. We utilized Pearson´s contingency coefficient to determine the value of dependence. We selected the significance level at 5% (0.05) for all performed tests. Graphic verifying of assumptions as well as testing were performed in the statistics software of data analysing IBM SPSS statistics.

The basic regressive model with linear function is defined with the following relation between the dependent variable (EP) and independent variables (UB, PAV, EMNA, BP):

$$EP = \beta_0 + \beta_{UB}\, x\, UB + \beta_{PAV}\, x\, PAV + \beta_{EMNA}\, x\, \text{EMNA} + \beta_{BP}\, x\, BP, \quad (1)$$

where $UB$ – independent variable; $\beta_0$ – constant, $\beta_{UB;}\ \beta_{PAV}\ \beta_{EMNA;}\ \beta_{BP}$ – parameters of independent variables (UB, PAV, EMNA, BP*)*; UB, PAV, EMNA, BP – independent variables.

For purposes of evaluation of the regressive model proposed in this manner, it was necessary to unify scale of determinants evaluation into a uniform structure. After consulting with experts, we have assigned word equivalents to the initial numeric evaluation of determinants PAV (perceived value on the scale 0-100): 0-20 significantly lower, 20-40 slightly lower, 40-60 on the same level, 60-80 slightly greater and 80-100 significantly greater. Further, for the factor affecting EMNA (rating 1 – 5), we have the scale: 1 - significantly lower, 2 - slightly lower, 3 - on the same level, 4 - slightly greater and 5 - significantly greater.

Basic results of the descriptive statistics of enterprises by selected statistical attributes (Table 1):

Table1

Detailed statistics for respondents of the survey

| | **Frequencies** | **%** |
|---|---|---|
| **Number of employees** | | |
| 100-500 | 145 | 81.9% |
| More than 500 | 32 | 18.1% |
| **Sector** | | |
| Manufacturing | 81 | 45.7% |
| Automotive | 12 | 6.8% |
| Construction | 16 | 9% |
| Engineering | 15 | 8.5% |
| Agriculture | 15 | 8.5% |
| Other | 38 | 21.5% |
| **Annual Revenue** | | |
| Less than 8 million EUR | 82 | 46.3% |
| Greater than 8 million EUR | 95 | 53.7% |

# 3 Results and Discussion

The selective data file consisted of 177 filled-in questionnaires from enterprises. With regard to fulfilment of the paper's objective and the verification of hypotheses, we identified the most significant determinants affecting enterprise performance. Variables derived from results of descriptive statistics (dependent, independent) with expression of absolute and relative frequency of enterprises on the rating scale are given in Table 2.

Table 2
Evaluation of enterprise performance and their determinants in terms of absolute and relative frequencies

| Dependent and independent variables | Rating scale | | | | |
|---|---|---|---|---|---|
| | **Significantly lower** | **Slightly lower** | **On the same level** | **Slightly greater** | **Significantly greater** |
| **EP** | 10 | 24 | 68 | 57 | 18 |
| | 5.6% | 13.6% | 38.4% | 32.2% | 10.2% |
| **UB** | 6 | 29 | 70 | 49 | 23 |
| | 3.4% | 16.4% | 39.5% | 27.7% | 13.0% |
| **PAV** | 4 | 1 | 25 | 63 | 84 |
| | 2.3% | 0.6% | 14.1% | 35.6% | 47.5% |
| **EMNA** | 32 | 53 | 49 | 25 | 18 |
| | 18.1 | 29.9 | 27.7 | 14.1 | 10.2 |
| **BP** | 26 | 33 | 89 | 29 | 0 |
| | 14.7% | 18.6% | 50.3% | 16.4% | 0.0% |

Results of relative and absolute frequencies show that more than 80% of respondents hold the opinion that performance of their enterprise (EP) is the same or greater compared with their direct competitors. Results also show that 47.5% of enterprises hold the opinion that their budgeting system has a significantly high added value (PAV) for their enterprise.

In order to verify assumptions of the regressive analysis, which are specified in greater detail in Methods, we used graphical data analysis. Linear courses between the enterprise performance (in terms of profit) and independent variables (UB, PAV, EMNA, BP) result from the graphic data visualization performed in the IBM SPSS statistics. The linearity assumption is satisfied. We can observe deviations in frequency of individual groups of enterprises from the normal distribution curve during visualization of the histogram of independent variable BP with the normal distribution curve. Subsequently we will proceed to calculations and testing of descriptive characteristics (skewness, kurtosis) from which we can decide whether data satisfy the condition of normal distribution. Results are illustrated in Table 3.

Table 3
Skewness, kurtosis and z-value of independent variables of company performance model

| Independent variable | Skewness | Z – value (skewness) | Kurtosis | Z – value (kurtosis) | Bartlett´s test |
|---|---|---|---|---|---|
| UB | 0.987 | 0.425 | 1.081 | 0.556 | 0.706 |
| PAV | 0.647 | 1.899 | 0.568 | 0.754 | 0.447 |
| EMNA | 1.983 | 2.687 | 1.716 | 1.188 | 0.059 |
| BP | 2.612 | 2.872 | -1.633 | -3.175 | <0.010 |

Results confirmed that independent variables UB and PAV satisfied the assumption of rating frequency normal distribution (z- score skewness and z-score kurtosis ≤ 2.000) as well as assumption of homoscedasticity (Bartlett's test for UB and Istrie ≥ 1.899). Independent variables EMNA and BP do not comply conditions of normal data distribution (EMNA: skewness z-score = 2.687; BP: skewness and kurtosis z–score > 2.000). The independent variable BP does not comply the condition of homoscedasticity (Bartlett's test < 0.01). Thus, the efficiency of the "budgeting process at adapting to the changing market" (BP) cannot be considered as a significant factor which would affect company performance. We did not admit the independent variable EMNA as a significant determinant into the regressive model in the first step. However, error of the data normality assumption is shown as decreasing with sufficiently large file extent (177 enterprises) [13]. Results of t-value confirm the statistical significance of the EMNA (t-value = 3.174) determinant, because it is greater than the critical area of its refusal. Intensity of dependency between a dependent variable and significant independent variables is displayed in Table 4.

Table 4
Correlation matrix of variables in company performance model

| | EP | UB | PAV | EMNA |
|---|---|---|---|---|
| **EP** | 1 | | | |
| **UB** | 0.6722 | 1 | | |
| **PAV** | 0.58334 | 0.6461 | 1 | |
| **EMNA** | 0.54125 | 0.4679 | 0.5674 | 1 |

Medium-strong to strong dependency results from the correlation matrix results with the application of the correlation coefficient [13]. We admit independent variables UB, PAV and EMNA as **statistically significant parameters** of the linear regressive models from z-test results (see Table 3) and further EMNA results of t-test and correlation matrix (see Table 4). We have performed testing of the significance of the regression model proposed in this manner with three independent variables and recorded them into the following Table 5.

Analysis of the regression model by means of graphic and analytical tools has confirmed conditions of linearity, homoscedasticity and independence of variances as well as a condition of normality.

Table 5
Characteristics of regression model of company performance

| **Least squares multiple regression** | | | | | |
|---|---|---|---|---|---|
| $R^2$ | | | | 0.52147 | |
| Adjusted $R^2$ | | | | 0.51317 | |
| Multiple correlation coefficient | | | | 0.72212 | |
| Residual standard deviation | | | | 0.1328 | |
| **Regression equation** | | | | | |
| **Independent variables** | **Coefficient** | **Std. Error** | **t- Stat** | **p-value** | **VIF** |
| Constant | 0.2156 | | | | |
| **UB** | 0.4857 | 0.2074 | 2.3412 | 0.020 | 1.8241 |
| **PAV** | 0.2821 | 0.0844 | 3.3424 | 0.001 | 1.5157 |
| **EMNA** | 0.2981 | 0.1229 | 2.4255 | 0.016 | 2.8488 |
| **Analysis of variance** | | | | | |
| F-ratio | | | | 18.014 | |
| Significant level | | | | < 0.001 | |

Variance Inflation Factor results have not proved multicollinearity in the regression model (VIF – test of independent variables is less than critical value 5: UB = 1.8241; PAV = 1.5157; DPP = 2.8488). Differences between the determination factor and adjusted coefficient of determination are minimal ($R^2$-0.52147 and Adjusted $R^2$-0.51317). P-value of F-ratio of the entire regression model is less than 0.001. Following the aforementioned conclusions (see Table 5), we proceed to the formulation of a regression equation with linear function; this acquires the form:

$$EP = 0.4857\,x\,UB + 0.2821\,x\,PAV + 0.2981\,x\,EMNA, \quad (2)$$

where EP - enterprise performance (profit), UB - use of budget as a tool of enterprise management, PAV - perception of added value of the budgeting system for a company, EMNA - effort on the part of managers and quantity of their activities expended to compose a budget.

The proposed regression model is statistically significant with three factors on the level of significance 0.05. The variability of the selected independent variables (UB, PAV, EMNA) explains up to 52.14% variability of enterprise performance, which can be considered as satisfactory. The other 47.86% of enterprise performance variability is explained by determinants not included in our search. Results show that UB determinant has the greatest influence on EP, or specifically that enterprises use a budget as a tool for enterprise management. Perception of added value of the budgeting system for an enterprise has the smallest influence out of the statistically significant determinants. Efficiency of the budgeting process at adapting to the changing market (BP) does not have any statistically significant influence and does not determine enterprise performance in terms of profit. H1 hypothesis can be admitted, however with the exclusion of BP determinant.

We have investigated enterprise performance on a sample of 177 enterprises in terms of profit. The authors have identified four determinants which come not only from theoretical-professional knowledge but also from practical knowledge. These selected determinants were subjected to statistical evaluation. The achieved results can be seen as a tool to explain significance and importance of the selected determinants and their effect on enterprise performance.

Table 6 includes responses of respondents by selected groups who evaluated enterprise performance during the past two years, with respect to their direct competitors.

Table 6

Comparison of enterprise performance evaluation in relation to direct competitors

| **Profit** | **Number of employees** | | **Volume of sales** | | **Z - score** |
|---|---|---|---|---|---|
| | **<500** | **>500** | **< 8 million EUR** | **> 8 million EUR** | **Number of employees Volume of sales** |
| Significantly greater than competitors: 10.2% enterprises | 16 | 2 | 12 | 6 | 0.417 |
| | 11% | 6% | 14.3% | 6.3% | 0.054 |
| Slightly greater than competitors: 32.2% enterprises | 50 | 7 | 24 | 33 | 0.167 |
| | 34% | 22% | 29.3% | 34.7% | 0.435 |
| On the same level: 38.4% enterprises | 54 | 14 | 29 | 39 | 0.490 |
| | 37% | 44% | 35.4% | 41.1% | 0.435 |
| Slightly lower than competitors: 12.6% enterprises | 19 | 5 | 12 | 12 | 0.703 |
| | 13% | 16% | 14.6% | 12.6% | 0.696 |
| Significantly lower than competitors: 5.3% enterprises | 6 | 4 | 5 | 5 | 0.064 |
| | 4% | 13% | 6.1% | 5.3% | 0.810 |
| Chi - square | 7.200 | | 4.000 | | |
| P - value | 0.124 | | 0.412 | | |

Results (see table 6) show that up to 42.4% of respondents evaluate the performance level of their enterprise (by profit) better (significantly and slightly greater) than their direct competitor for the past two years. Structure of enterprise evaluation by number of employees or by volume of sales **is not statistically significant** (p-value is greater than 0.05). And thus we accept the H2A hypothesis. Z-score results show that differences in the number of employees up to 500 and above 500 and also with the volume of sales under 8 million EUR and above 8 million EUR do not represent statistically significant differences in the frequency of responses (p-value > 0.05). And thus we refuse the H2B hypothesis.

## Discussion and conclusions

Despite criticism of the traditional budgeting systems which has appeared plentifully in recent literature, we can state that budgeting represents an irreplaceable tool in enterprises and plays a significant role also in terms of enterprise performance. This fact was confirmed by the survey performed. As the statistical linear regression model results show, we are able to identify determinants which are perceived in companies as significant with respect to increase in the enterprise performance.

We perceive in our case the following factors as determinants with **significant** influence in companies:

- use of budget (UB) as a tool for enterprise management,
- perception of added value of the budgeting system for an enterprise (PAV),
- effort on the part of managers and quantity of activities to compose a budget (EMNA).

On the contrary, the factor of significance of the "**budgeting process** compared to other tools for adapting to changing market conditions" (BP) appeared to be statistically insignificant this means that managers do not perceive for it any significant influence on enterprise performance in terms of profit. We can derive from it that managers perceive the significance of the budgeting process itself (with regard to influence on enterprise performance) on the same level as application of other relevant tools.

We can formulate a number of conclusions on the basis of the evaluation of these factors. The use of a budget as a tool of management has a statistical dependence on perceived enterprise performance in terms of profit. This conclusion is in partial conflict with opinion of some authors [19]. They perceive enterprises which stopped using a budget for management purposes as those using more developed systems for performance control. This conclusion can be also interpreted in the manner that there is a significant group of enterprises in our sample which do not use budgeting at all (or possibly only for simplified purposes, as for example for resource allocation).

Another factor for which statistical dependency appeared is the perception of added value of the budgeting system for an enterprise (PAV) to increase its performance. Results show that if a company perceives highly added value of its budgeting system, it is reflected into higher perceived value of enterprise performance. This dependency would confirm the assumption that more developed budgeting systems manifest themselves in higher perceived company performance.

Other factors which were investigated in relation to enterprise performance (EP) include "effort on the part of managers and number of activities expended to

compose a budget" (EMNA). Results have confirmed that the greater effort expended to compose a budget can be demonstrated in a higher perceived value of performance. This fact would indicate that higher effort expended to budgeting is an attribute of a greater advanced level and quality of budget, which is then demonstrated in greater perceived enterprise performance, which according to searches of the literature is not a generally accepted fact.

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# Development Trends in Human Resource Management in Small and Medium Enterprises in the Visegrad Group

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*Abstract: The processes of transformation and the changes in company structures that have been carried out in market economies have impact also on human resources management in all businesses. The objective of the paper is to highlight the current trends in human resources management and development in small and medium-sized enterprises in the countries of Visegrad Group. The research has been focused on a set of factors having impact on human resource management in enterprises operating in selected countries. The methodology is selected in line with the goals of the research. We have proved what macro-factors and to what extent have impact on human resources management. Our research has been focused on identifying current trends in the above mentioned field. Our concern has also been to present micro factors that have impact on making decisions by personnel managers. The key factors, corporate strategies and corporate policy in human resource management in small and medium enterprises are presented in the paper.*

*Keywords: human resource management; small and medium enterprises; development and trends in human resource management; Visegrad Group*

# 1 Introduction

The current business environment is determined by a receding economic crisis that had interfered in all-sized businesses in a negative way. The environment can be identified also by a very strong competitiveness among businesses. The above

mentioned facts have had impact on running business in all sectors of the national economy [1] and they have become key factors designing further development and prospects in business activities. Last decade some new tendencies in companies that follow the global current trends including challenges and business and financial risks are observed. They are all determinants that form the business environment [7], in which businesses and enterprises operate and determine the quality of the environment according to the size of the company and the type of its activities. Entrepreneurs start up their companies in accordance with the conditions created for running a business. Transformations in the external business environment have direct impact on the internal environment in companies and on the human resources, marketing, finance, information technologies, etc. The internal environment in companies can be adjusted and modified by company management to a certain extent, the external environment of companies must be accepted by them and companies need to be modified to it if they want to be successful in the market.

Slovakia as a member of the European Union shares the specifics of the EU business environment furthermore it has its national specifics [3] based on the size of the market, geography and development of regions. Other Visegrad countries have similar or identical conditions for business development. In lines with the statements by [12] competitiveness of national economies depends on competitiveness of enterprises, companies, competitiveness of regions [13] and socio-economic conditions [5]. Regional development [20] and development of countries can be conditioned by the results that companies achieve and then they result in economic growth [32]. Economic growth in each country is based on the relation between supply and demand. The relation enters company structures and defines further development and future prospects. Companies and enterprises can become competitive when they respond to customers' needs and market changes in a flexible way [23, 42]. Small and medium enterprises play a key-role in national economies and according to [19, 38] they are the most important element in economic development. The above mentioned statements underline the need to deal with the issue of entrepreneurship, of running a business and its conditions. Entrepreneurs take the risk and responsibility for their decisions and in small and medium enterprises making bad decisions may result in fatal consequences [34]. The determinants having impact on entrepreneurship are of different types, such as external and internal. Our paper focuses on one of the key determinants and it is human resources as a functioning area in company management. Intellectual capital born by human resources is considered by many authors [18] to be the most important. Human resources need to be led in such a way that they can become an effective capital for companies [29], producing new ideas, showing hard working effort and loyalty. The effectiveness is based on the attitude and qualities of managers and their ability to motivate and initiate human resources to achieve the company objectives.

# 2 Theoretical Background

Nowadays human resources management in an entrepreneurial and business environment needs to be understood as a strategic attitude towards recruiting, selecting, hiring, and developing and training employees, labour force. Also, the authors [33] state that human resources play a strategic role and have a firm position in company strategic management.

It is a system of influencing people so that their activities can contribute to achieving partial goals of groups of workers, departments and achieving corporate goals that a company has set and are to be achieved. It is also an ability to persuade co-workers to attempt to achieve goals. Thus, leadership has become an inseparable part of management. Leadership relates to leading workers, being a leader and having charisma.

Table 1
Benchmarking: manager´s and leader´s tasks

| **Managers** | **Leaders** |
|---|---|
| plan | Innovate current knowledge |
| Maintain standard operations | Develop approaches, relations with markets |
| Organize | Inspire and motivate co-workers |
| Manage company´s operation | Find opportunities at new markets, modifies products, carry out conceptual activities |
| Control | Creates values, resources |
| Manage goals in a right way | Set up the right objectives (modify them) |
| Ask a question: How? When? | Ask a question: What? And why? |

Table No. 1 shows that managers fulfill challenging tasks so that by means of workers long-term, short-term, and operational and tactic plans can be fulfilled. Leaders have a task to be innovators [37], they are expected to develop standard attitudes to work in a creative way through motivating approaches. The activity must be connected to motivating people. According to the authors [44] motivation of employees and incentives are very necessary especially in a time of crisis and post-crisis period. The authors [25] focus their attention on analysing factors of motivation utilised by managers in company management. Their paper [16] deals with motivation factors applied especially by managers in small and medium enterprises.

Human resources are employed also in knowledge management [8] not only in human resources management. Companies can profit on knowledge of their employees only when they create good conditions for transferring the knowledge into day-to-day practice [11].

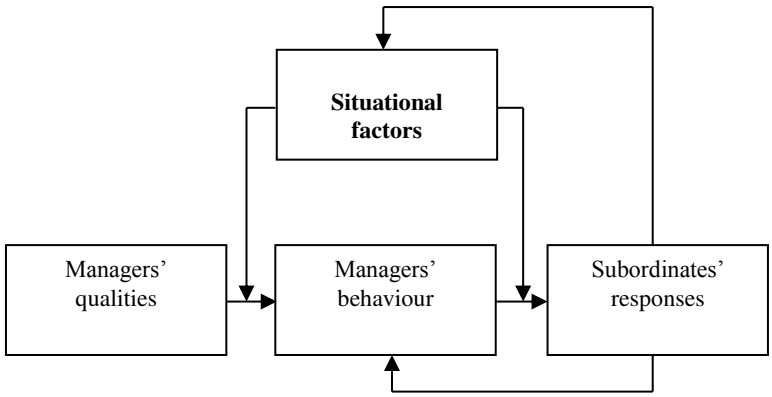


Figure 1
Integrated model of leading employees

Diversity in human resources management becomes more complicated as in practice managing employees needs to apply also psychological approaches emphasising interpersonal factors, as it is emphasised by [24]. Only in this way an effective system of managing employees [27] and a motivating working environment can be created by means of developing corporate culture and transparency [41, 26]. Symbiosis of managerial and psychological factors can initiate effective management. Many authors have devoted their specialised work to this field – leading employees. An integrated model of leading people is based on situational factors referring to managers´ qualities and behaviour. They are shown in picture no. 1.

The current labour market enables free active migration, movement of labour force, of employees in European countries [36]. The European human resources management can be characterised by outsourcing employed by small-sized companies, as it is described by the authors [9]. From the economic point of view outsourcing is economical and cutting cost in small-sized companies as some of specific operations may be carried out by external companies [40]. At the same time, full-time workers are needed to increase their productivity [28]. The authors [17] in their study highlight the current trends in human resources and are stating that human resources management cannot be done by chance, it must be target-oriented and conditioned by the market situation and by the company needs. Companies modify their conditions to the market changes that are reflected also in personnel management [15]. Since needs of companies that are affiliated with the company goals are diverse and relating to the production programme, seasonal factor and other factors, flexible forms of employment can be observed in the labour market

[39]. The valid labour law enables such an option for companies [22]. Entrepreneurs as employers have been appealing on creating more flexible and liberalized labour law relations that may result in higher employment rate [43].

Current entrepreneurial activities can be evaluated as starting business in the national market and to some extent in the international market as well. Most European countries have accessed the European Union and are integrated so except for national legislation the EU countries have to observe and follow international regulations valid for the EU [4]. The impact of international environment on SMEs is inevitable. Regional development [14] is conditioned by regional economic growth and the quality of life in regions [10] and in the country.

Enterprises and businesses play a key role in each developed economy specified by competitiveness principles, diverse forms of ownership and competitiveness between companies of different size. The Private sector represented by small and medium enterprises produce more than ninety per cent of the GDP, its contribution in added value amounts to more than a half of the value created by companies and offers two thirds of the positions and ensures two thirds of the employment rate. Their existence cannot be replaced and is in line with the process of globalization. Many enterprises and businesses view the option for business internationalization as an opportunity to add a value to the company resources and to gain some achievements and success. Operations in a company in the international environment mean also to respond to changes in the company environment [2]. Managers have to focus attention on every company operation as the risk carried by companies in a tough international competition is much higher. Human resources management in an international environment means to perform managerial activity outside a country furthermore managers need to be prepared for their international operation. If they underestimate the preparation stage, they are usually unsuccessful.

The performance of companies in the international markets means to get to know the markets, their specifics and conditions. Referring to the diversity in cultures, jobs and economic conditions it is necessary to prepare each stage of human resources management [30] carefully, including recruitment [21], selection and modification and then establishing the right style of managing employees [31], ensuring a systemic development and training employees [35] and adapting to the conditions of a country or a market.

Many specialists have been paying close attention to the tendencies in development and management of human resources. Some of the specialists in their studies analyse human resources management in national companies and some of them analyse the issue in large international, global companies and corporations. A certain group of specialists carry out research in human resources management in small and medium – sized companies. This paper reflects the need for monitoring trends in the field of development of human resources management. We have paid attention to and searched HR management in Slovak companies and neighbouring countries forming the Visegrad Group.

# 3 Data and Research Methodology

The methodology applied in the paper is based on the objectives we have set up for our research in HR management in Visegrad Group countries.

Our paper is aimed at current trends in human resources management and development in the sector of small and medium enterprises operating in the Visegrad Group. We have searched a group of factors having impact on human resources management in companies, in selected countries. The methods are selected in order to achieve the research goal. We have searched impact and its extent of a group of macro factors on HR management, so that current trends in management can be identified. Our interest covers also micro factors having impact on making decisions by HR managers. The paper presents the most challenging factors that have impact on HR management. It also presents strategies and policy applied in HR management in SMEs.

We have opted for the SME sector on purpose. According to current data small and medium enterprises have opened the largest number of positions; they absorb free labour force, bring a large number of innovations and form the backbone of the economy in the countries of the Visegrad Group and in the EU. The enterprises represent ninety-nine per cent of all companies operating and they are a driving force for economic growth.

We have gathered facts offered by primary and secondary resources on the above mentioned issue. Primary facts represent results gained in a research carried out at the Pan-European University, the Faculty of Economics and Business in Bratislava collaborating with institutions operating abroad. Primary data are gained during the research through a questionnaire processed during the years 2013 until 2016. The questionnaire was distributed to SMEs in Slovakia, the Czech Republic, Hungary and Poland. The research started with a pilot research carried out with a small number of companies. All small and medium-sized enterprises represent the basic statistics files. We have selected a file via stratified selection ad hog and it is based on selected indicators at a macro-level. Companies selected and appointed for our research sample needed to meet following criteria:

- They operate in Visegrad Group countries: in Slovakia, the Czech Republic, Hungary and Poland;
- They meet the condition for being a SME according to the categorization described in the EU Regulation No.2003/361 ES dated on May 6, 2013;
- They have revealed their interest and a will to participate in the research.

The selected statistics file is created by the data on 1248 businesses categorised as SME operating in Visegrad countries. For our research also, secondary resources were needed and they are represented by literature written by national and international authors – specialists in management, HR management and business

activities. The information offered by other authors has been uploaded from an international scientific database and mirrors the current trends in the researched area

Adequate scientific methods have been applied to cover all the parts of the research and to analyse and interpret the results. Hypothesis have been defined and statistically tested. The chi-squared Test of Independence has been employed in dependence verification. Pearson´s Correlation Coefficient C has been applied while testing the strength of dependencies. In addition to those, methods of descriptive statistics and logics learning methods have been employed

Chi-squared test of independence is mathematically reported:

$$\chi^2 = \sum_{i=1}^{k}\sum_{j=1}^{l}\frac{n\,(n_{ij})^2}{n_i n_j} - n \tag{1}$$

$H_o$: line and column variables are not dependable

$H_1$: line and column variables are dependable

Calculated test criterion $\chi^2$ (Chi-squared) to verify the null hypothesis is compared to the table value or P-value is compared to the selected significance level. Selecting a significance level for testing criterion is 5%. Testing criterion to verify the null hypothesis $H_0$ assuming independence between given qualitative signs is calculated according to the relation:

$$\chi^2 = \sum_{i=1}^{r}\sum_{j=1}^{c}\frac{\left(E_{ij} - T_{ij}\right)^2}{T_{ij}} \tag{2}$$

$H_o$ is accepted, if the calculated value of the testing criterion$\chi 2 < \chi 2tab$. If $\chi 2 > \chi 2tab$ the Hypothesis $H_o$ is rejected, it means the signs at the selected significance level are dependent. Based on P-value the Null Hypothesis $H_o$ is expressed in the following way:

- P- value< $\alpha = 0.05$ statistically proven dependence
- P- value< $\alpha = 0.01$ statistically highly dependent proven
- P- value< $\alpha = 0.001$statistically highly dependent proven

Pearson correlation coefficient C is applied while testing the strength of dependence between qualitative signs and is defined by the relationship:

$$C = \sqrt{\frac{\chi^2}{n+\chi^2}} \tag{3}$$

# 4 Results and Discussion

Businesses and enterprises being oppressed by hard competitiveness have been trying to find new markets where they could be able to sell the company´s resources and make a better profit. Therefore, many of them do not operate in the national domestic environment, but they make their business international and enter into foreign markets based not far off. At present, not only SMEs enter international markets but also companies running micro business and small enterprises make their business international. It can be said that the European Union businesses have become international; they do not run their business operations only in the country.

Companie's management needs to realise that being active in an international environment means to adopt the process of managing into the international business environment and to the culture having an impact on operation of businesses. Macro factors concerning legislation, politics, culture, geography, demography, ecology and others must be taken into account by company management. There are also other micro factors affiliated with real businesses and they are owners, managers and employees. In addition to them, there is also life cycle of the business, quality of technology, knowledge, and the financial situation of the company, etc.

Monitoring current trends in the business development belongs to the basic tasks of company management and must be involved in operational and strategic management. Based on the data it is possible to accept effective measures so that the development in a certain area can be corrected and modified. There are a large number of diverse factors that have impact on management. We have decided to opt especially for human resources management as human resources are considered to be the basic resource in a company; without them, companies would not be able to perform a single activity.

Next part of our paper analysis primary data gained from companies in a time of research projects. It is a general fact, that most often companies enter the markets in neighbouring countries and this is the reason to analyse the data offered by companies operating in Central Europe, in the Visegrad Group Countries (Slovakia, Czechs, Poland, and Hungary).

The basic data were gained via surveys designed for the purpose to get and specify current trends in development of human resources management in small and medium enterprises in the Visegrad Group. The survey was tested during a pilot study of our research, then some corrections were implemented and when we received the feedback from companies the scientific research started on a larger scale. The data were gained through partnership research institutions.

Following table (Table 2) shows the number of companies taking part in a primary research in the countries during the research.

Table 2
Companies and countries participating in the research

| Country | Absolute number - frequency (companies) | Relative number in % |
|---|---|---|
| Slovakia | 320 | 25,64 |
| Czech Republic | 356 | 28,53 |
| Poland | 298 | 23,88 |
| Hungary | 274 | 21,95 |
| **Total** | **1248** | **100** |

A total of 1,248 companies - SMEs were selected out of the basic statistics data sets. Table 1 shows countries participating in the research: 320 Slovak companies represent more than one fourth of respondents. The Czech Republic is represented by 356 companies, that is more than 28%, 298 Polish companies formed almost 24% of respondents, the least number of companies represented Hungary – 274 companies, almost 22% of respondents.

Figure 2 illustrates the size of companies divided into categories per countries. The largest number of micro-companies was of Polish origin and from the Czech Republic. The smallest number of companies in this category operated in Slovakia. The largest group of small enterprises operated in Slovakia, followed by the Czechs. Quite large number of small enterprises participating in the research was from Hungary. Middle sized companies are represented by the largest number of Czech and Slovak companies. The smallest number of companies in this category was Polish enterprises.

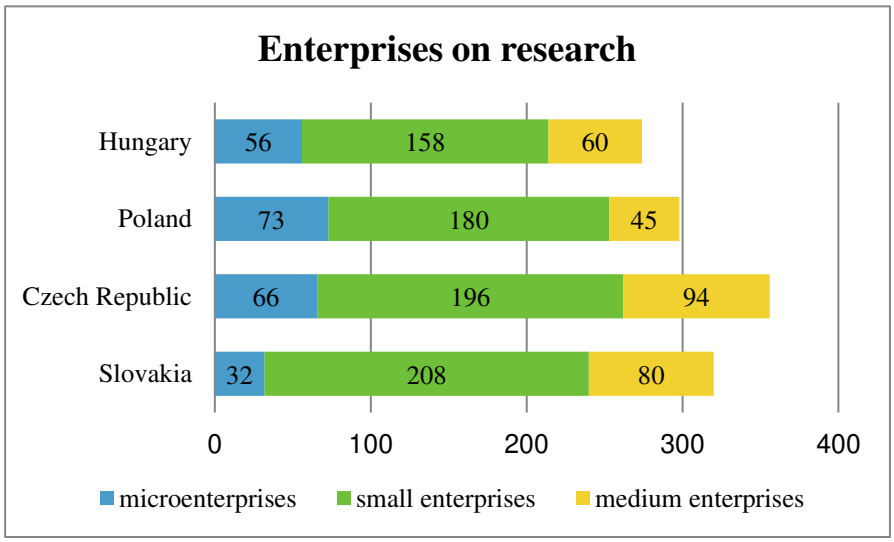


Figure 2
Enterprises on research

The research carried out in companies operating in the Visegrad Group countries covers a total of 1,248 companies employing 22,747 workers totally. This data is important from the point of view of HR management. The HR management and the attitudes of managers towards it are different in companies and depend on the number of employees. Figure 3 shows the number of employees categorized according to the size of the company. The least number of employees are employed by micro-companies defined by the number 0 to 9 employees. Our sample of companies contains companies employing above 160 workers (Slovakia) up to 362 employees (Czechs). From the point of view of employment an interesting fact is found in the category of small enterprises; the number of employees in the enterprises amounts to more than 4,000; in Slovakia it was 4,190 and in the Czech Republic it amounted to 4,704. The least number of employees: 3,002 in the category of small enterprises was employed by the Hungarian companies that participated in our research. It is a surprising finding as the largest category of middle-sized companies had the number of employees within the limits from 3,690 in Poland up to 7,208 in the Czech Republic. The Polish category of small enterprises employed more workers than the category of middle-sized companies. In Hungarian middle-sized enterprises the number of employees varied and reached the number of employees in small enterprises in other countries.

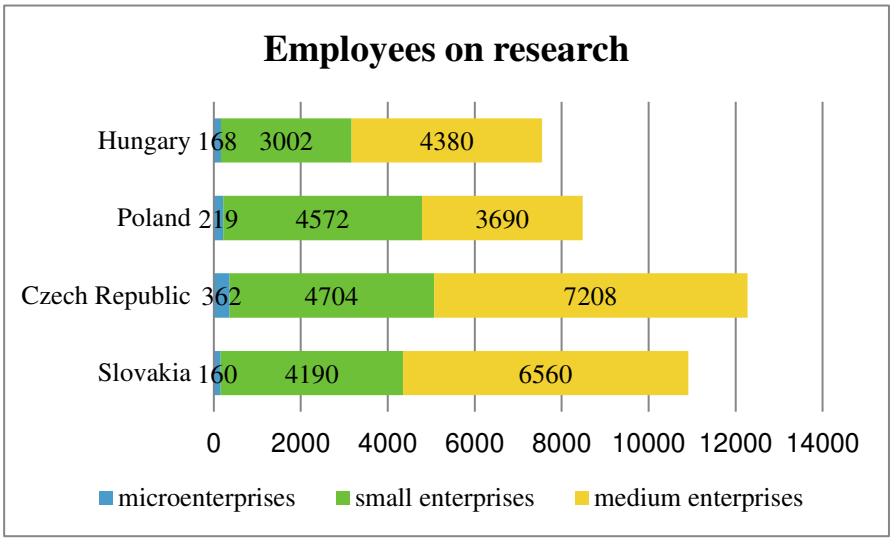


Figure 3
Employees on research

Following part of our paper analyses the attitude towards HR management in small and middle-sized enterprises in the Visegrad Group. We were interested also in factors having the largest impact on decision making in the field of human resources. The set of factors having impact on management can be divided into groups according to the type of factors from a macro level or into a group of factors

belonging to the internal environment of a company (micro factors). At this point it is necessary to point out that the type of tools and measurements employed in human resources management depend on the fact of whether companies operate only at a national or international market or make the company activities international. When companies enter the global market they and their managers are confronted by specific conditions in the international business environment. It is a concern for the conditions of a hosting country in the field of legislation valid for businesses (in our analyses the focus is on labour law valid in a country concerned), furthermore a concern of the culture is also important (the issues of gender, working time, observing customs), demography, language competence of managers and employees involved in that working environment.

According to the above mentioned facts human resources managers modify their performance. Current trends in HR management approaches are based on the so-called Perlmutter's typology. The Perlmutter´s international business model includes three dimensions with four managers´ approaches towards HR management:

- Ethnocentric approach,
- Polycentric approach,
- Geocentric approach,
- Regiocentric approach (region-based approach).

The countries lying in Central Europe have applied regiocentric approach towards human resources management. Company managers while applying the regiocentric approach recruit and hire qualified candidates who know well the regional conditions and know well also the factors influencing the regional market. Employees work in a neighbouring market and get know the culture typical for the regional market. It means that the Visegrad Group countries and companies operating in them share identical markets and almost identical cultures.

We were inquiring which approach towards human resources management is applied by company managers most often. The findings are offered in figure 4. We have verified the fact for size categories separately; results are for the complete set of companies. In the category of micro enterprises the prevailing approach towards HR management is an ethnocentric approach, 67% of companies apply the style of management in which managers and other employees are recruited and selected and appointed by the central company management. Owners and top managers trust "their people" and they are identified by a mutual trust. Regiocentric approach is applied in almost one fourth of management approaches (23%). Micro enterprises out of all enterprises and businesses are the most sensitive to changes and are most vulnerable. Due to this reason managers in micro enterprises apply the regiocentric approach, as employees get know well the conditions in regional markets. This is a way how companies can avoid the risk they bear when they do not know the conditions in the business environment. Geocentric approach is applied only by 8%

of micro enterprises. This category of enterprises is very small to recruit best qualified employees from other regions and to motivate them. Almost 2% of micro enterprises apply the polycentric approach towards human resources management. The HR managers inquired in our survey report the lack of active communication and loss of the employees´ performance control as the most outstanding drawback.

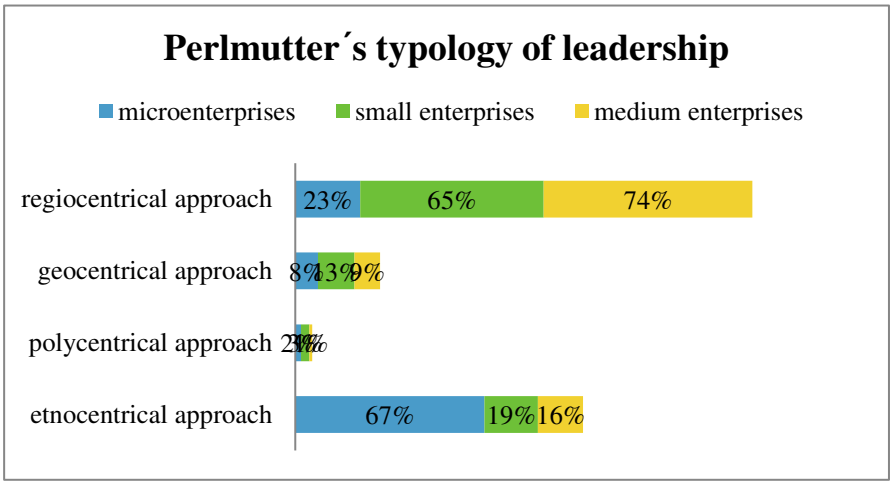


Figure 4
Employees on research

The situation in the category of small enterprises is different. The region-centric approach is prevailing due to its advantage of knowing the region where the company runs its businesses. This approach is employed by 65% of respondents. The second position is taken by the ethnocentric approach that is preferred due to a complete confidence in teams. In small enterprises the geocentric approach is the third one applied by 13% of businesses. These businesses are a bit larger than micro enterprises so they can afford to employ qualified and trained candidates, human resources coming out of the region where the company is based. The businesses can offer better incentives and know-how than micro enterprises can. The polycentric approach is applied by small businesses the least. The reasons are identical to the ones in microenterprises.

The situation in the category of middle-sized enterprises is more outstanding for the approach preferred. Three fourths of inquired businesses - respondents have stated that they apply the regio-centric approach so that the risk can be minimized and the regional business environment is well known. The businesses belonging to this category slowly releases the ethnocentric approach. The confidence to other members of a team except to the company top management becomes stronger. The geocentric approach is applied by 9% of businesses inquired by our questionnaire. The indicator is smaller than the one in the category of small businesses. Relating to the size of companies and the time of running a business, middle-sized companies

have already built a stable team of highly qualified workers. Polycentric approach has been applied the least, the percentage of inquired respondents amounts to almost 1%.

A hypothesis has been tested whether the experience gained by managers in the field of human resources management may be reflected in the business success of companies.

$H_{0:}$ Business success and the managers experience gained in managing human resources are independent variables.

$H_1$: Business success and the managers experience gained in managing human resources are dependent variable.

The hypothesis has been tested at the significance level $\alpha = 0.05$.

Based on the results of the test the hypothesis $H_0$ is rejected, according to it there is no dependence between business success and experience of managers gained while managing employees. Businesses involved in the research sample have reported better results in business success while appointing HR managers who have already gained experience with managing human resources. Table 3 shows the results gained in the test statistics.

Table 3
Hypothesis Verification - results

| | **Value** | **Df** | **p-value** | **Exact Sig. (2-sized)** | **Exact Sign. (1-sized)** |
|---|---|---|---|---|---|
| $\chi^2$ | 4.887 | 1 | 0.042 | | |
| Fisher´s Test | | | | 0.428 | 0.428 |

Verifying results of Chi-squared test also Fisher´s test was employed. The interpretation by means of p-value is identical to Chi-squared test.

Factors that have impact on human resources management are evaluated and the results are shown in Table 4. Six factors are selected and they are as it follows: planning, recruiting, hiring, mentoring, corporate culture and relations in a workplace.

Human resources planning as a part of HR management amounts the variable 5.64, while the median varies around the level 3.00. While testing the dependence strength the result is 0.38 and indicates the medium dependence. Recruitment amounts average value 7.32, median varies around the level 5.00 and while testing dependence strength a strong factor (0.88) is concerned and has impact on effective human resources management. Thus, it can be said that businesses are motivated to hire qualified employees. The process of acquisition of employees amounts to an average value of 4.10, median - level 2 and Pearson´s coefficient reaches the value of 0.26. In running a business, a company means that there is a weak dependence and acquisition and recruiting employees does not represent a domain in personnel

management in micro, small and medium-sized enterprises. Mentoring as a part of personnel management amounts an average value of 4.82, median reaches level 2 and middle dependence strength reaches the level 0.64. Corporate culture amounts to the average of 5.46, median – 3.00. Based on the result of Pearson´s coefficient it can be concluded that personnel management reaches a middle dependence strength in the corporate culture. It is mirrored in practices of businesses that more and more companies are aware of the fact that corporate culture plays a key role in effective management. Relations in a workplace as one of the challenging factors reaches an average value of 5.14, median – 2.00 and there is a middle dependence strength in relation to human resources. Prosperous relations at a workplace are a desired condition for the corporate culture and more and more companies are aware of this fact.

Table 4
Evaluation of Human Resource Management Factor´s

| | **Average** | **Median** | **Pearson´s C** |
|---|---|---|---|
| Planning of Human Resources | 5.64 | 3.00 | 0.38 |
| Recruitment | 7.32 | 5.00 | 0.88 |
| Acquisition | 4.10 | 2.00 | 0.26 |
| Mentoring | 4.82 | 2.00 | 0.64 |
| Firm´s culture | 5.46 | 3.00 | 0.52 |
| Labor relations | 5.14 | 2.00 | 0.44 |

## Conclusions

Developed market economy is based on operations of small and middle-sized companies. They are flexible and able to adapt to changes at markets, although they are vulnerable at the same time. Due to this reason close attention is paid to them by national governments and by the EU as well.

The paper has searched current trends in HR management especially in the Visegrad Group countries. A primary research has been carried out in small and middle-sized enterprises including also micro, small and middle businesses. 1,248 businesses form the research sample.

It can be concluded:

- Micro businesses employ the least number of employees; employment in small enterprises in some countries can be compared to the employment in middle-sized enterprises.

- Validity of Perlmutter´s business model has been verified. The Visegrad Group countries apply the region centric approach towards human resources management. Its advantage is knowing the regional conditions and hiring employees who are fully aware of the regional facts and are qualified. The exception is micro businesses with prevailing ethnocentric approach.

- A hypothesis has been tested: experience gained by managers in personnel management may be reflected in business success. The hypothesis is proved; it means that the experience in personnel management is mirrored in business success.

- The factors playing a key role in human resources management are: recruitment, planning, corporate culture and prosperous relations at a workplace.

From the point of view of development of human resources management in small and middle-sized enterprises it can be recommended that businesses need to concentrate on a specialised selection of employees, recruiting qualified and experienced workers who will become a competitive advantage. One more recommendation: more attention should be paid to mentoring employees who can become highly qualified and trained and loyal.

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# Atypical Forms of Employment on Hungarian-Slovakian Border Areas in Light of Empirical Researches

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*Abstract: A survey was conducted to gain information about typical and atypical patterns of employment among unemployed, students of higher education and companies. The research was geographically restricted to the Slovak-Hungarian border region, to Komárom – Esztergom (Hungary), and Révkomárom (Komarno) – Párkány (Štúrovo) (Slovakia) areas. A questionnaire survey was applied, which could be submitted in printed form or electronically. The research was actually a continuation of a previous study with a focus to find out how atypical forms of employment were able to reduce and influence unemployment.*

*Keywords: employment; atypical employment; youth employment; re-employment of the unemployed; corporate attitudes*

# 1 Introduction

The workforce is more valuable and complex item than any other goods or services available on the market. It is not enough to hire employees, they have to be encouraged to work effectively and remain loyal to their employer. The employee does not only work for a living, but also appreciates the work, prestige,

and pays attention to other factors, e.g. company image, corporate culture and many other internal and external factors. The form of employment itself can be an important factor. Nowadays, there is an increase of non-traditional forms of employment; however, they are still regarded as atypical forms of employment. On the basis of foreign and partly domestic experience atypical patterns of employment can provide more comfortable and personalised working conditions for the employee, but they may bring some benefits to the employer as well.

The reason why non-standard forms of employment have not spread in the Central and Eastern European region is, that these forms of employment are still regarded as alternative opportunities to reduce unemployment. Our research focused on the Slovak-Hungarian border area, Komárom and Esztergom, resp. Révkomárom (Komarno) and Párkány (Štúrovo), more precisely Komárom-Esztergom county and district of Komárom and Érsekújvár (Nové Zamky). Four universities of two countries, a number of local labour offices and other institutions joined the research.

Our objective was to examine the attitude of companies, employees, generation Y and the future employees of generation Z towards atypical forms of employment (atypical, non-standard and cross-border employment). The surveyed issue was approached from two different perspectives. Our first assumption was that the age and qualification of employees determine their attitude towards atypical forms of employment. We can assume that respondents of generation Y and Z show more willingness to accept atypical employment patterns. We can say that young job seekers are less likely to weaken the perspectives of atypical employment patterns than the older generation. At the same time, public employment has the lowest preference among young (future) employees.

# 2 Typical and Atypical Employment

The issue of atypical employment has already been in the focus of economists for three decades. Since the last quarter of the 20$^{th}$ Century, we can find several contributions in scientific literature. Efren Córdova (1986) from ILO is one of the pioneers, who studied the emergence of atypical employment patterns at a global level. According to him, the non-standard patterns of employment were widespread, when he published her article. The attitude towards atypical employment patterns was different. Some observe regarded them as a threat to the survival of the principles that have shaped the labour law; others were worrying about the disappearance of classical system of workforce protection, which would lead to reorganization of employment relationships and increasing anomalies that may undermine the effectiveness of traditional system of the employment relationship. According to Córdova, it would be unwise to declare that all forms of atypical employment are said to be insecure but it does not mean that there are no problems. Atypical employment is characterised by a total or partial absence of regulations that could increase the vulnerability and instability of workers.

The increasing tendency of atypical employment patterns in the United States was analysed by Moberly (1987). Firms, offering temporary employment existed in the USA in the 1920s, but the boom in the industry started immediately after World War II and continues up to now. Moberly describes the legal background quite differently. Most of the workers, who have atypical work arrangement, are protected by collective bargaining agreements.

The atypical forms of employment in the European Union became so general in the last decade of the 20th Century that would be enough to analyse only two types of them. De Grip, Hoevenberg and Willems in 1997 dealt with the most widespread forms; the part-time and temporary employment relations. Their article provides a summary based on a survey of Eurostat about the member states of the EU. Interesting and comprehensive data about the situation in EU member countries between years 1996-2011 was published by the Research Centre for Social Sciences - Sozialforschung (Allmendinger, Hipp and Stuth, 2013). A review about the atypical employment patterns in Central and Eastern European region was completed by Lipták (2011). The research of Oliveira, Carvalho and Veloso (2011) focuses on young people (aged 15-24).

The European Union regulates only one form of atypical employment, namely part-time work. Directive 1997/81/EC (supplemented by Council Directive 98/23/ EC) aims to provide a legal framework for combating discrimination against part-time workers to improve the quality of work, while facilitating the development of part-time work on a voluntary basis. Part-time work has also been used as a tool against unemployment, with the current focus placed on youth unemployment. Directives were adopted with a specific goal of integrating atypical workers into the labour market and preventing them from facing insecurity by trying to force them into the same position as workers with standard contracts.

Magnani (2003) provides an interesting review how industrial shift in manufacturing, trade and services introduced the use of alternative labour arrangements; how long-term employment contracts and domestic labour markets shifted towards contracting out labour. It should be also interesting to mention the contributions of Ogura (2005), who provides a historic overview of the concept of atypical employment and compares the Anglo-Saxon, European and Japanese models.

Hevenstone (2010) analysed the problem at national level. The complexity of the issue is based on the large variety of definitions. She is writing about part-time work, self-employment, fixed-term contracts, temporary work and freelancing. Lipták (2011) adds to the list mentioned above teleworking, outsourcing and fixed-term labour contracts. Guerrero, Burguillo and Domínguez (2008) ranked part-time job, fixed-term job and temporary work among atypical forms of employment. Havenstone (2011) pointed out that countries with high level of self-employment have high levels of part-time and fixed-term employment. She also said that a country becomes more prosperous and has higher social protection, if

there is less self-employment. On the other hand, as the society becomes more prosperous and social security is expands, the level of fixed-term and part-time employment rises, because workers have more willingness to work less and risk periods of unemploy¬ment between fixed-term contracts. On the other hand, those social benefits provided by employers seem to discourage atypical employment. Finally, the barriers, like strong trade unions and the EPL [employment protection legislation], increase self-employment and fixed-term employment, but discourage part-time work.

In Hungary and in Slovakia the presence of part-time employment is lower compared to the average of 28 EU countries (Figure 1).

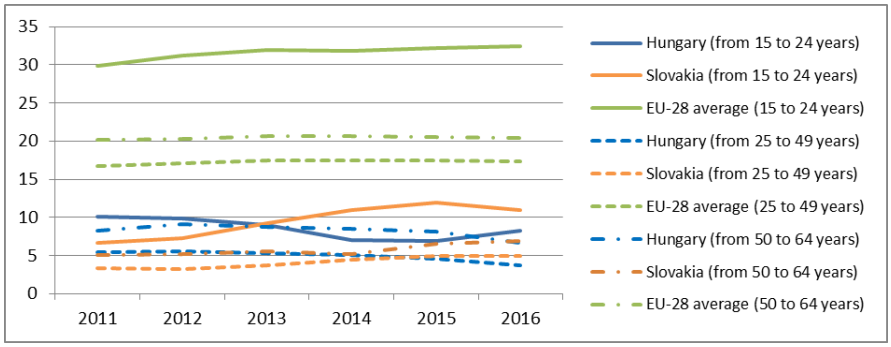


Figure 1

Part-time employment as a percentage of the total employment, by age in Hungary and in Slovakia in 2011-2016 (%)

Publications focusing on specific problems of different states were published with a focus on employment in Australia, Germany and Great Britain with an emphasis on the social security system (Bieback, 1993). The same perspective in the USA was studied by Stone (2007), in Canada by Robinson (1991), in Spain by Ojea (2009). The emphasis was put on flexibility and security system in the Malaysian private sector by Saad (2001) and labour standards in Ghana (Akorsu and Cooke, 2011). We can mention the contribution of Jana Španková and Tatiana Masárová (2008), who shared their research results about the attitude of employees towards atypical patterns of employment in car industry. Finally, we should mention the study of Poór at al., (2014) about the practices of atypical employment among Slovak and Hungarian employees on the Hungarian-Slovak border.

The researchers are also examining the atypical forms of employment in connection with companies or they consider the issue from different perspectives, e.g. social, political and legal. Some theorists are analysing different forms of atypical employment to make the job market more flexible. The authors are frequently writing about the diversity of atypical employment.

In our research we focused on unemployed, young people and companies. We are trying to present their attitude towards atypical forms of employment. Fleetwood (2001) discusses the issue from the perspectives of philosophy. He is trying to demonstrate that deductive method encourages the development of theoretical concepts in such a way that it reduces the multidimensional, qualitative reality of employment and unemployment to the quantitative, single dimension of variables. Addison and Surfield published an article (2009) about the jobless. Those jobless, who choose an atypical form of employment are not only more likely to be employed 1 month and 1 year later than those who continue to search for employment, but also enjoy employment continuity.

The correlation between the atypical forms of employment and companies was researched by most of the scientists. The relation of wage and atypical employment was analysed by Flaschel and Greiner (2011). They pointed out that minimum wage is an important component of flexicurity.

The problem of social security was the issue discussed by Bieback (1993). As we saw at Cordóva (1986), in the late 80's and the early 90's atypical employment was combined with a lower wage and lower living standard as well. As Bieback (1993) said, the most atypical workers were women, so the problem of atypical employment many times is a social problem.

The social approach to atypical employment remains important. In the UK, as one of the most developed countries, Bardasi and Francesconi (2004) conducted a research, how atypical employment influences the wellbeing of the individual. The well being of individual meant to be the mental health, general health condition, life satisfaction and job satisfaction. According to the results of the British Household Panel Survey (1991–2000), the atypical employment does not appear to be associated with adverse health consequences for either men or women, when both health and employment are measured at the same time. Buschoff and Protsch (2008) in a 6-country comparison (Germany, the United Kingdom, the Netherlands, Italy, Denmark, Poland) analysed, how the national social protection policy of individual countries deals with the various forms of non-standard employment patterns, and the specific risks of this policy. They have found significant differences between the policies of the observed countries.

The importance of atypical employment during economic crisis was analysed by Lang, Schömann and Clauwaert (2013). The authors summarized their findings as the following: A two-phase process has been observed during the crisis considering the atypical forms of employment. Employees, who chose atypical pattern of employment, were the first to lose their jobs, as it is easier to get rid of workers not enjoying as much employment protection as standard workers.

In their contribution Ellison and van Berkel (2014) also deal with non-standard forms of employment during an economic crisis. The economic crisis brought increase in unemployment and reduction of social security. Under "atypical" Ellison and Berkel mean "atypical" population groups. The most vulnerable ones

are the young, migrants and disabled workers. The authors advises to introduce an employee-oriented policy, welfare reforms and austerity measures.

According to Kiss (1997), standard employment is a form of full employment, which means a fixed-time work, social security, defines a social status and equally characteristic for the members of the society, i.e. the busy, hard-working life becomes a unitary pattern (Kiss, 1997).

Frey (2000: 1008) seeks to formulate a definition based on standard features of work. According to her, the traditional standard employment means full-time employment, with an employment contract for an indefinite period, fixed working schedules and working days from Monday to Friday. Atypical employment pattern is considered to be different from this.

Kiss (1997) is disputable when she declares that standard work is characteristic for everyone. It is not even characteristic in the USA, which is still considered to be the most developed country and the homeland of free enterprise. In the 1970s about 85-90% (Heck, 1995) of the employed worked for wages as employees. Standard work was the norm to be achieved. It is an activity of an adult, who is prepared to get a job after receiving the appropriate qualification.

# 3 The Research Objectives and Hypotheses

The main objective of this research was to explore how atypical forms of employment can help to reduce the unemployment. Flexitime, as a new phenomenon of atypical employment pattern shows a positive impact. It sounds attractive for candidates. The importance and practical part of many theories, which are based on mathematical calculation concerning the labour market, are limited to apply in the reality.

The spread of different forms of employment patterns is influenced by the perception of the public. Our survey is aimed to reveal attitudes towards typical and atypical forms of employment.

- We focused on two areas of interest:

On both sides of the border, and with the help of the (Hungarian and Slovak) Labour Offices, we examined the attitudes and opinion of unemployed towards taking typical or atypical forms of employment. In our research we examined the attitude and opinion of young university and college students studying Economics on adopting typical and atypical forms of employment. In the survey, we also focused on businesses, both sides of the border, following what kind of impact the economic and financial crisis had on their activities, and how did the recovery from the crisis influence their future employment practices.

As similar research was conducted in different countries in the region, we can assume that Central and Eastern European countries reacted similarly on the economic and financial crisis. Based on different criteria (size, form of ownership,

sector, etc.) the companies provided different HR responses (Fodor, Kiss and Poór, 2010 and 2011). Publications before the crisis clearly highlighted the fact that the employment and HR areas of foreign-owned companies significantly differed from those of domestic companies. The rate of increase in salaries and wages in foreign-owned companies (mainly at management level) exceeded the salary level in locally owned companies.

The research completed in 2014 can be regarded as a second phase of a longer research, as the problem has been analysed from the point of view how non-traditional forms of employment can contribute to the growth of employment. The significant increase in unemployment in 2009 made the issue relevant again, as well as finding new employment opportunities have become an important issue. The results of the previous phase of the research have already been published.

## 3.1 Hypotheses of the Research

The following hypotheses were set up regarding the group of unemployed.

*H1.1*: The age of the respondents determines their attitude towards the atypical employment patterns.

*H1.2*: We assume that the respondents of the older generation, as well as the general public will accept the atypical forms of employment involuntarily as a temporary solution.

*H1.3*: The job seekers believe the adoption of non-standard jobs (or some of them) will reduce the chance for standard jobs.

*H1.4*: A group of respondents, especially women on maternity leave prefers some atypical forms of work, (part-time and teleworking) and graduates prefer fixed-term contracts).

*H1.5*: We assume that atypical forms of employment have the lowest preference among the public sector employees.

Younger respondents agreed on the following hypotheses, we aimed to investigate:

*H2.1*: Age determines the attitude respondents have towards atypical forms of employment.

*H2.2*: Higher education makes young people more open to atypical forms of employment.

*H2.3*: Significant differences can be observed between Hungarian and Slovak youth in the evaluation of the acceptance and importance of the atypical forms of employment.

In case of companies we analysed the following hypotheses:

*H3.1*: Different sectors are affected in different measure; significant relationship can be assumed between the sectors and the areas affected.

*H3.2*: The Hungarian and Slovak firms differ significantly in the planned measures related to employment. The outsourcing and the increase of atypical employment patterns are much more characteristic in Slovakia than Hungary.

*H3.3*: Although atypical forms of employment are known by the majority of companies in Hungary and Slovakia, these are not popular with them, and the companies do not intend to change their standard system of employment.

*H3.4*: Part-time employment and telecommuting opportunities are used only by a smaller number of companies in both countries, and are more characteristic for foreign companies and joint ventures than the domestic enterprises.

## 3.2 Description of the Samples

The final sample size in the survey was 689 respondents. 294 questionnaires from Slovak respondents and 395 from Hungarians were filled in any significant way. With regard to the location of the respondents the sample had the following territorial distribution: 220 respondents from Esztergom, 175 from Komárom, 91 respondents from Štúrovo and 203 from Komarno. According to the residence of the respondents 65% lived in cities, while 35% lived in villages. 51.4% of the Slovak participants in the study were urban inhabitants, while in Hungary this proportion was much higher, namely 75% of the respondents indicated city as their place of residence. Analysing the gender composition of the sample, women are almost double incidence. The research included 243 male and 423 female respondents.

Regarding the age structure the under 30s were about 37% of the sample, while 25.8% of respondents were in the age group 30, and 37.2% 40 years of age or older were represented in the survey. Analysing the age structure by country it can be observed that the proportion of responses from the age group under 30 in Slovakia (38.2%) and Hungary (36%) was quite similar. In the case of the 30s age group the proportions differed as follows: in Slovakia it was 22.9%, while in Hungary 28%, followed by people over 40 where there was a similar distribution by country (in the Slovakian sample 38.9%, while in the Hungarian sample 36%).

Looking at the marital status of the respondents, 34.3% of respondents were single and 31.5% married, 21.2% lived in a stable relationship, 10.5% were divorced, while 2.4% were widowed. The highest proportion, i. e. 34.9% of the Hungarians in the sample were single. However, among the Slovak respondents the proportion of married and the single people was almost the same (33.6% and 34.6%).

57.5% of respondents did not have any children, 23.2%, had one child, 13.8% grew two children, while 5.5% had 3 or more children. 89.3% of the participants said that they had no children under three years of age, and nearly 10% of them

(9.7%) grew 1 or 2 foster children under three years old, and 1% had 3 or more children of this age in the family. In the case of Hungarian respondents without children were represented in the highest proportion (60.6%), while the lowest proportion of respondents had 3 or more children (7.6%). Among the Slovak respondents the still childless were represented in an extremely high proportion (53.4% of the sample), while the proportion of respondents with 3 or more children was in total 2.7% of the sample. In both countries, most of the respondents had no children under 3 years (this proportion was in the case of Hungarian respondents 87.7%, while 91.3% of the Slovaks).

The questionnaire asked about the educational level as a significant factor influencing the chances of obtaining a job. Percentage of subjects with highest level of education was as follows: 25.1% of them had basic qualifications, in 24.7% of them had secondary education without maturity, 35.6% had a high school diploma, while 14.6% had tertiary qualification. The respondents gave the following answers regarding their most recent jobs or positions.

Table 1

Frequency distribution of unemployed respondents by occupational status

| Occupational status | Hungary | | Slovakia | |
|---|---|---|---|---|
| | number of respondents | percentage of respondents | number of respondents | percentage of respondents |
| entrepreneur | 14 | 3,54 | 22 | 7,48 |
| lower-level manager | 4 | 1,01 | 12 | 4,08 |
| middle manager | 14 | 3,54 | 5 | 1,70 |
| top manager | 2 | 0,51 | 6 | 2,04 |
| subordinate employee | 159 | 40,25 | 108 | 36,73 |
| skilled worker | 52 | 13,16 | 48 | 16,33 |
| unskilled worker | 53 | 13,42 | 40 | 13,61 |
| casual worker and daily wage | 26 | 6,58 | 30 | 10,20 |
| public employee | 39 | 9,87 | 8 | 2,72 |
| Valid value | 363 | 91,90 | 279 | 94,90 |
| Missing value | 32 | 8,10 | 15 | 5,10 |
| Total | 395 | 100,00 | 294 | 100,00 |

*Source:* Authors' own research

During the research, a total number of 495 questionnaires were handed out. From these were 476 pieces filled in and returned. We were able to evaluate 380-420, questionnaires depending on the answered questions. Respondents who filled in the questionnaires are 74 men and 128 women from Hungary, 73 men and 128 women from Slovakia. The age structure of respondents is shown in the Table 2.

Table 2
Frequency distribution of respondents by age

| Age-groups | Hungary | | Slovakia | |
|---|---|---|---|---|
| | Frequency | Percentages | Frequency | Percentages |
| below 19 | 10 | 4,98 | 1 | 0,49 |
| 19 – 21 | 56 | 27,86 | 68 | 33,01 |
| 22 – 24 | 57 | 28,36 | 85 | 41,26 |
| above 24 | 78 | 38,81 | 52 | 25,24 |
| Total | 201 | 100,00 | 206 | 100,00 |

*Source*: Authors' own research

As for marital status, Hungary, 35.14% of the respondents were single, 13.96% were married or 59.90% lived in a stable relationship. In Slovakia, the corresponding proportions were as follows: 56.19; 13.40 and 30.41%. 88.08% of the Hungarian respondents had no children, the number in the case of Slovaks was 90.78%, and 5.70 and 4.85% of them had one child. While in Hungary 66.27% of the respondents were full-time tertiary students, the corresponding percentage from the Slovaks was 87.58%. 66.19% of Hungarian young people participating in the survey work, while for Slovak young people this rate is 69.10%. 19.52% of Hungarian young people and 14.04% of Slovaks do not work according to their qualifications. With regard to employment patterns, Hungarian young people make the most (9.9%) of the normal work (8 hours), 18.62% in flexible working time, and 13.30% part-time. Slovak young people tend to undertake 8-hour work in a much smaller proportion than their Hungarian counterparts (11.52%), 17.28% in flexible working hours, and 16.23% in part-time work. The shortened working week is not typical of Hungarian youth, 7.85% of Slovak young people have chosen this atypical employment form.

Some of 232 companies participated in the survey, 161 from Hungary (69% of all respondents), while 71 companies from Slovakia (31%). In terms of the distribution of the sample by ownership, the Hungarian and Slovak companies show a similar picture, 75-75% of them are in the hands of domestic owners, while 20% of Hungarians, 14% of Slovaks (18% of the total sample) have foreign owners. The proportion of mixed ownership companies among Hungarian companies is 5%, 11% of Slovaks and 7% of the total sample.

79% of the surveyed organizations and companies are private companies, 15% of them are state- or public owned. In both countries the proportions are very similar in this regard, 81% of Hungarians, 76% of Slovaks are private companies in both countries and 15-15% of organizations / companies are public- or state-owned. Overall, in terms of staff number of companies, 57% are under 50, 16% between 51-100 people, 13% between 100-500 employees, 7% between 500-1000 people and 8% of the companies employ over 1,000 people. In this area, there is some difference between the two countries. Slovakia represents a higher percentage of companies working with fewer than 100 employees (85% vs. 67%), among them

there is a significant proportion of companies between 50-100 men, which makes 39% of all Slovak companies. Among the Hungarian companies those firms which employ less than 100 people mostly have less than 50 employees (62% of all Hungarian companies). The largest companies employing more than 1000 men are mostly Hungarians, 11% of Hungarian companies (18 companies), while among the Slovak companies there is just one of these companies (1%).

The sectorial distribution of firms is very similar in both countries. The maximum rate, a quarter of the total sample, is represented by industrial companies, 26% among Hungarians, in the Slovaks this ratio is 23%. They are followed by 16% of trade (14% of the Hungarians, Slovaks 20%). There are no companies which are active in the field of FMCG and telecom companies among the Slovaks, the companies in these two areas is only 2-2% (that means 4-5 companies), additional 2-2% is represented by the areas of energy and education.

# 4 Analysis of the Results

Processing and statistical analysis of the data was carried out by IBM SPSS 22.0 for Windows statistical software package. Verification or rejection of the hypothesis is summarized in the Tables 3-5.

Table 3
Summary of Results and Conclusion on the unemployed research

| Hypothesis | Method | Results | Conclusion |
|---|---|---|---|
| *H1.1: Age determines the attitudes of the unemployed towards atypical forms* | Chi-square test, adjusted standardized residuals | Familiarity of atypical forms of employment by age: Chi-square: 17,197 sign p <0,05. Accepting employment in atypical forms of employment by age: Chi-square: 23,076 signal p <0,001). There was a significant disagreement by age in the assessment of atypical forms of employment such as part-time employment, seasonal work, labour leasing, and agent work as future employment opportunities. | justified (true) |

Table 3
Summary of Results and Conclusion on the unemployed research (continued)

| Hypothesis | Method | Results | Conclusion |
|---|---|---|---|
| *H1.2: We assume that the respondents - especially older ones - believe for themselves and also for others – that they themselves and* | Chi-square test, adjusted standardized residuals | In the age-based study, the majority of respondents evaluate atypical forms of employment as a temporary solution, but only in the case of contract with a labour leasing company (Chi-square 22,355 sign p <0,05) and in the case of employment as a leased worker ( Chi-square : 24.381 | partially justified |

| | | | |
|---|---|---|---|
| *people in general accept the atypical forms involuntarily as a temporary solution.* | | signal p <0.05), statistical difference can be detected.<br>Considering the reasons for acceptance of atypical forms of employment, only in the case of casual work (Chi-square: 32,455 sign p <0,001) and agent work (Chi-square: 21,862 sign.: <0.05), statistical difference can be detected between the age groups.<br>Considering the reasons for acceptance of atypical forms of employment, there is a significant difference only in the case of casual work (Chi-square: 32,455 sign p <0,001) and agent work (Chi-square: 21,862 sign p <0,05) The choice of casual work is evaluated as a necessity by all ages, in the case of agent work the benefits dominate. | |
| *H1.3: Job seekers consider the adoption of non-standard jobs (or some of them) will reduce the chances for a "normal" position.* | Chi-square test, adjusted standardized residuals | There was a significant difference between the respondents of the two countries regarding the possibility of later employment. Hungarian respondents were more likely to expect increasing future chances, while the Slovaks expected to decrease future chances from the surveyed atypical opportunities. | partially justified |
| *H1.4: We assume that among the respondents, especially women, mothers with young children prefer some atypical forms of work, (part-time and teleworking) and school leavers (mainly concrete tasks and fixed-term contracts).* | Independent Samples T test | The impact of atypical employment on the reconciliation of work and private life. The opinions of women with and without children are significantly different. (T: -3.974 signal p <0.001).<br>There is no justifiable difference between the two groups in the assessment of the atypical forms of employment. | partially justified |
| *H1.5: We assume that from the atypical forms of employment the public employment has the lowest level of preference among employees.* | Chi-square test, adjusted standardized residuals | There was no significant difference in public employment between the groups compared. Nearly half of the respondents would not accept this form of employment as a solution. | partially justified |

*Source:* Authors' own research

Table 4

Summary of Results and Conclusion on the youth research

| Hypothesis | Method | Results | Conclusion |
|---|---|---|---|
| *H2.1: Age determines the attitudes of the young people towards atypical forms* | Kruskal Wallis Test, Chi-square test, adjusted standardized residuals | Hungary: younger than 21 years are more open to casual, part-time, and one season work.<br>Slovakia: younger than 21 years refuse public employment and training organized by the Labor Centre significantly in higher proportion. | partially justified |
| *H2.2: Higher education makes young people more open to atypical forms of employment* | Mann-Whitney U test | Hungary: young people with GCSE are more open to casual, part-time and one season jobs compared to their counterparts with tertiary education.<br>Slovakia: those with a tertiary education are more open to public employment compared to their peers with secondary education. | refused (false) |
| *H2.3: There are significant differences between Hungarian and Slovak youth in the evaluation of admissibility and importance of the atypical forms of employment* | Mann-Whitney U test | Willingness to committing connected with acceptance of atypical forms of employment: Slovak students are more mobile compared to their Hungarian counterparts.<br>Atypical foreign employment: Slovak young people would have been more likely to have atypical work abroad than their Hungarian counterparts. | justified |

*Source:* Authors' own research

Table 5

Summary of Results and Conclusion on the corporate research

| Hypothesis | Method | Results | Conclusion |
|---|---|---|---|
| *H3.1: The single types of atypical forms of employment vary by sector.* | Chi-square test, adjusted standardized residuals | Hungary, Slovakia: statistically significant ($p<0.01$) differences were identified between the various sectors in the application of different atypical forms of employment. | justified (true) |
| *H3.2. The Hungarian and Slovak firms differ significantly from each other in the planned measures related to employment, of the Slovaks outsourcing and the increase of* | Mann-Whitney U test | Statistically significant ($p<0.01$) differences were identified between the Hungarian and Slovakian companies in the increase in atypical employment. | justified (true) |

| | | | |
|---|---|---|---|
| *atypical employment are much more typical than of the Hungarians.* | | | |

| Hypothesis | Method | Results | Conclusion |
|---|---|---|---|
| *H3.3: Although atypical forms of employment are known for the majority of companies in Hungary or Slovakia, these are not popular with them, and the companies do not intend to change the usual system of employment.* | Mann-Whitney U test | There is no significant difference between the Hungarian and Slovak companies in the attitudes towards atypical forms of employment | partially justified |
| *H3.4: Part-time employment and telecommuting opportunities are used only a smaller part of companies in both countries, and are more characteristic of foreign companies and joint ventures, than of the national ones.* | Mann-Whitney U test | There is no significant difference between the Hungarian and Slovak companies (p=0.345) in the share of part-time employees. | partially justified |

*Source:* Authors' own research

## Conclusions

We had assumed that respondents – particularly the older ones – would believe that "atypical forms of employment were accepted by them (and by others in general) only under compulsion and as a temporary solution". This hypothesis could, in fact, be accepted only in part since the respondents' opinions on opting for atypical ways were inconsistent. Most of the participants in the study basically considered these forms as a possible temporary or transitional form of employment. However, they did not always evaluate these solutions negatively; they even acknowledged the benefits of some. From this perspective, most responses were not age-dependent.

The hypothesis according to which "job-seekers consider at least some atypical ways of employment as diminishing their chances of obtaining a 'normal' job" could be regarded as partly justified. Respondents expressed greater aversion to certain forms of atypical employment, such as casual work, public work and telecommuting, in that a relatively high proportion believed that these forms could have a negative effect on their normal opportunities for obtaining work. In addition, it was clear that the responses from the two countries differed significantly on certain atypical types of employment (apart from 'occasional work'). It was also assumed that some respondents (especially women and mothers with small children) prefer some atypical form of work (part-time or tele-commuting). Again, this hypothesis could be accepted in part. Among women with a family, atypical forms are believed to be a possible solution for

coordinating work and private life. They did, however, accept the majority of these forms only as a temporary solution, although having a contract with a labour rental company and telecommuting were thought (by a relatively high proportion) to be an opportunity for longer-term employment.

Finally, it was assumed that of the atypical forms, public-work or public employment has the lowest level of preference among employees. 'Public work' provided a very low preference level according to the respondents, whilst 'utility' was considered above-average in all respects.

Based on the 407 responses to the questionnaire that we received, the main findings can be summarized as follows: On the basis of the results of our research, we can say that age alone does not determine the attitudes of respondents towards atypical forms of employment. There are significant differences between age brackets in respect of some forms of atypical employment, but they often do not match in the two countries. The same age group may have a totally contrary attitude in respect of certain forms of employment in our two countries.

Examining attitudes towards atypical employment among young people, it is clear that only in the case of certain atypical forms of employment can significant disagreement be detected among young people with Secondary or Tertiary Education. Interestingly, the differences shown in the attitudes of Hungarian and Slovak young people do not support each other since the circumstances are quite different. Summarizing the results of the statistical tests, significant differences are visible between Hungarian and Slovak young people in many instances of evaluating and accepting atypical forms of employment. Based on the commuting tendency associated with atypical forms of employment, the occupational mobility of Slovak students is higher than that of their Hungarian counterparts. Highly significant differences can be observed between Hungarian and Slovak young people in atypical employment regarding working abroad: a higher proportion of Slovak youth would agree to atypical forms of work abroad.

We hypothesize that the impact of the recovery from the crisis and of the subsequent growth as this affects corporate employment action, is primarily visible in terms of headcount and increased remuneration in both countries. Both tend to grow most in private enterprises and foreign-owned firms; also, in respect of size, larger companies are more likely to display this than smaller ones. Each area of impact differs by sector and by industry, and in these areas significant relationships can be discerned. Hungarian and Slovak companies differ significantly in the action which they plan in relation to employment: in Slovak companies outsourcing and increasing atypical employment feature much more strongly than in Hungarian. In both countries the measures planned by enterprises concerning employment tend to be more long-term by nature than merely personnel-related solutions. We also see that, although atypical forms of employment are known by the majority of companies, these forms are (neither in Hungary nor in Slovakia) well-liked by business, and the majority of companies

does not intend to change their customary employment systems. In both countries the option of part-time employment and telecommuting is offered by only a small number of companies and it is more characteristic of foreign companies and joint ventures than of the domestic sector. Two years after the closing of the research, there is a completely new situation in Hungary and Slovakia. Apart from unemployment, there is an increasing problem with labour shortages. Therefore, we are pursuing our research in this direction.

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# Mining Interest In Online Shoppers' Data: An Association Rule Mining Approach

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*Abstract: Online shopping, as a form of e-commerce, is not nearing extinction anytime soon. As the interplay between shoppers and vendors continues to grow in the midst of complex transactional data, extracting knowledge from the data has become imperative. In view of this, this paper explores the use of the association rule mining technique to glean relevant information from such shopper-vendor interactions. In particular, this paper looks at some of the unusual, frequent relationships existing between online shoppers on one hand, and vendors on the other hand in the Czech Republic. The results revealed with higher confidence values the following: (1) there is a strong association between criteria for buying items on the Internet and information gathered before initiating an online transaction; (2) a sizable number of online customers engage in online shopping because of the price attached to the product in question; and (3) a greater proportion of online customers engage in online transactions through specialized e-shops. The work provides general insights into how shopper-vendor transactional data can be explored.*

*Keywords: E-commerce; online shopping; consumer buying behavior; association rule mining*

# 1 Introduction

Online shopping contributes to the massive volumes of data in e-commerce. The emergence of the Internet and other technologies have ensured that these large transactional data are stored, processed, and analyzed with speed. In fact, the exponential increase in online shopping is clear evidence of the growth in electronic buying and selling. The usages of several digital modes by many companies worldwide have contributed by and large to the resilient electronic platform. For example, marketers are now able to reach many prospective and existing consumers at a minimal cost, hence aiding them to achieve their set targets [1, 2]. Similarly, most companies that operate via the electronic medium are able to take hold of a large share of clients at a minimal cost. This stems from the introduction of marketing tools such as viral or email marketing in addition to

special digital offers and periodic promotions firmly supported by other multimedia resources [3]. According to Min and Wolfinbarger [4] and Brown [5] resulting in huge sales and profits annually. Ahluwalia, Hughes, and Midha [6] and Lennon, Johnson, and Lee [7] cited a classic example indicative of huge profits that emanate from large annual sales with specifics on the infamous "Black Friday" sales. Indeed, they observed the fast pace that companies take advantage of the Internet business and online shopping, with less cost of an input to rake in so much profit during annual festive occasions around the globe.

Various studies have sought to confirm the conception that online shopping is gaining roots as a new positive feature for sales increase and retention of customers [8, 9, 10, 11]. In line with this trend, many authors [12, 13, 14] also offered various opinions on some of the ways online shopping can become important to most companies. They contended that this requires analyzing the value proposition for customers of these companies in order to acquire the needed data from digital-savvy consumers for research purposes. In these circumstances, well-known multinational companies like Coca Cola, Amazon, eBay, and Proctor and Gamble (P&G), among others, have been regarded as perfect examples of companies that have—by virtue of Internet technologies—fruitfully shifted from brick and mortar strategies to brick and click techniques [15, 16].

Eurostat [17] further reported on the scale or extent that consumers have redirected their concentration from the brick and mortar style of shopping to the brick and click style. The study indicated that consumers (a) appreciate the convenience of being able to shop anytime and anywhere; (b) applauds the ease in acquiring information from a broader range of products; and (c) are satisfied with the ability to compare prices and share their opinion of goods with other consumers. In respect of this, [18] posited that online shopper-vendor retail sales have shot up to an estimated USD$840 billion in 2014. This exceeded the USD$695 billion in sales recorded in the preceding year of 2013, and sales were projected to rise to USD$1.506 trillion in the year 2018. Earlier, EMarketer [19] revealed that global online sales were expected to garner a whopping sum of USD$1.915 trillion; this would be accompanied with a sales growth of 23.7% in 2016. The study further revealed a projected increase of USD$4.058 trillion with such a corresponding increase, making up 14.6% of its total retail spending in the year 2020.

In spite of all these benefits attained by e-vendors as a result of the introduction of online shopping, online providers need to keep track of their regular e-shoppers. In a broader context, this brings to the fore how online companies and their respective customers interact by extending new resolutions in terms of customer relationships and customer loyalty [20]. To analyze both geographic and demographic patterns of online buying behavior, this paper uses a data mining algorithm—association rule mining—to mine relevant patterns of online shopper-vendor interactions from a large data set in the Czech Republic. The paper fills the gap in the literature about online shopper-vendor interactions, and primarily aims

at widening the general concept of online buying behavior. The findings of this study are of great significance to e-vendors in achieving value proposition for their customers. In addition to e-commerce or e-vendors, industry relevance, the study will thus add to the scant research output on association rules purposed for online buying behavior, and subsequently shed light on online customers' preferences in e-stores associated with the Czech Republic. As a result, the goals of this study are to (a) analyze the reasons and rationales that influence customers to buy via the Internet; (b) determine the criteria embarked upon by customers in initiating online transactions; (c) access the requisite information needed to make online transactions; and (d) identify the particular type of online shops consumers prefer to use, coupled with the specific products most commonly purchased online.

The rest of the paper is structured as follows. Section 2 provides a review of the literature and the theoretical background on this topic. Section 3 briefly explains the concept of association rule analysis and its related applications, accompanied by research questions used in this paper. Section 4 explains research questions and the methodology, including the samples and procedures used. A case study of the association rule analysis approach is conducted using a large data set acquired from respondents in the Czech Republic. The main results are presented and discussed in Section 5, followed by a summary and conclusions.

# 2 Synopsis of Online Buying Behavior in the Czech Republic

Online shopping in the Czech Republic dates back to the second half of the 1990s, and was initiated by a group of IT specialist who turned American-styled ideologies into a reality [21]. According to Redakce [21], the turn of events in the Czech Republic regarding sales, retailers, and marketing in general became "saturated" in the millennium year, with customers churning away from their usual brick and mortar stores because of the conditions meted out to them. As a matter of fact, the startling revelation of Internet retail took turns from this era, since wholesale and retail had been entrenched. It was easier for retailers to use their existing stores coupled with their vast array of experience in computers to penetrate Internet retail as earlier envisaged. The initial establishment of Internet retail saw Alza, Czech computers, and Mironet entering the game of Internet retail in the Czech Republic [21].

In mid-2012, the Czech Statistical Service reported that almost 2.6 million persons, representing 31% of the entire population in the Czech Republic and 44% of the total number of Internet users in the country, claimed they had shopped online in 2012 [22]. According to Czech News Agency [23], the number of online

shops in the Czech Republic increased from 16% to 37% over the last two years. As part of the rapid penetration of Czech customers in online transactions, a study on e-commerce is carried out regularly to monitor the inflow and outflow of customers in collaboration with notable companies from the Czech Republic, such as Gemius, Centrum Holdings, and Seznam.cz. The rationale of the annual study is to probe into the distinction between Czech Internet users and the tendency of these users to shop online. Some of the valuable facts retrieved from this study are not limited to the fact that Czech Internet users are driven to shopping each and every time they are online. Women were also seen as the most inclined online shoppers in terms of gender distribution; approximately 60% or more take advantage of Internet shopping in the Czech Republic [22]. Again, the report indicated that Czech Internet users who have already transacted business online continue to grow unprecedentedly. Moreover, a sizable proportion of Internet users start shopping for something new online. Yet, the report further opines that almost three-quarters of Czech Internet users have not finished a transaction or purchase through the Internet at least once. It is within this context that we use association rule analysis to explore online shopper-vendor interactions in the Czech Republic.

The setting of this exploratory study, the Czech Republic, appears to stand tall among other Central European sister countries in terms of infrastructure and market size as well as in the total global position of the online retail market (stores). This gives credence to the study conducted by Hutchings, Best and Mahmuti [24] that ranked the Czech Republic as 33$^{rd}$ in the world for online buying and 20$^{th}$ among the list of Internet retail sales per capita of USD$217 million in 2012. Again, a report by eCommerce news [25] indicated that in the Czech Republic there has been an increase in online transactions to more than 20% with an amount of CZK$25 billion, which is equivalent to €$925 million. The report further stated that Czech customers spent €$3 billion in their local online stores in 2016; this was estimated to double by 15% in the subsequent year.

# 3 Association Rules

The association rule mining (AR) approach is one aspect of a data mining algorithm that is used for market basket analysis; it is specifically useful and viable in retrieving and discovering interesting relationships concealed in a large data set [26]. The impact of AR methodology, helps retailers analyze a large data set, among other things, with the intention of learning more about the purchasing pattern of customers [27, 28]. Over the years, this algorithm has been widely used by astute researchers in academia and the industry in general, specifically in the area of marketing. However, the full-fledged application of AR methodology could be attributed to Agrawal, Imielinski and Swami [29]; later works by

Agrawal and Srikant [30] assisted in shaping the algorithm into a well known concept for utilization in academia. Other renowned scholars [31, 32] cannot be left out as championing the cause of AR methodology into the mainstream research seen today.

The method has been curbed to fit into diverse data forms feasible in different and multiple scenarios. As part of its standard usage and application, association rule analysis has been used in many academic disciplines in a variety of areas within academia and industry as earlier indicated. For example, Becquet, Blachon, Jeudy, Boulicaut, and Gandrillon [33] used association rule mining in the application of gene-expression data analysis to detect sets of genes whose expressions were interrelated, while Borgelt and Berthold [34] also made use of association rules to analyze fragments embedded in molecules that assist to discriminate between diverse classes of molecules. AR has in many ways resulted in other modifications apart from the Apriori algorithm. These include the Frequent-Pattern Growth algorithm and the Eclat algorithm [35, 36, 37]. However, these algorithms are categorized into two stages before their application. The reliability, accuracy, and strength of AR mining produced in many research areas and academic disciplines gives credence to its relevance and accurate usage in any research endeavor [38].

Conventionally, AR mining is denoted by $A \geq B$, showing when the two products (A and B) were purchased. A then becomes the antecedent, while B is denoted as the consequent, indicating that A influenced the purchase of B.

# 4 Research Questions and Methodology

Though in extant studies the authors have positioned online shopper-vendor interactions [39, 40, 41, 42], the pattern of online shopping behavior has been silent. In other words, using a data mining algorithm (association rule mining) to mine the relevant patterns of online shopper data as earlier stated is a concern. To this end, these research questions are formulated to guide the study:

1. What are the reasons that cause the customer to start buying on the Internet?
2. What are the criteria for buying items on the Internet?
3. What information is needed or gathered before initiating online transactions?
4. Which online shops do customers prefer, based on their previous online purchases?

This study was conducted on a notion of a probability sampling method - pseudo simple random sampling technique. Data collection was centered on self-administered questionnaires. In particular, we collected data from different

geographic regions in the Czech Republic, and focused on people who have shopped online before or have yet to shop online. The demographics and geographic location of respondents were also pertinent to the research; this necessitated the inclusion of respondents from the biggest cities across the Czech Republic—notably Prague, Brno, and Ostrava. The research was carried out during 2015 and 2016. To execute the agenda of our study, both RapidMiner data mining software (an open source data mining software) and Adindoft Xlstart (2014) software were used for the whole analysis. We disbursed 1,803 questionnaires to respondents for the study, of which 1,602 (88%) were accurately filled out and returned to us for evaluation. The rules generated from our data were coined from the questions presented to online shoppers (the respondents) from the Czech Republic, and generally focused on determining the reasons that propel e-shoppers to start buying on the Internet, conditions for buying items on the Internet, and the information gathered from customers before initiation of online transactions. It can be seen from Table 1 that most of our antecedents were mainly generated and extracted toward "specialized online shops" and "price" as the main consequents for our discussion. Table 1 provides a vivid analysis of the associations retrieved from e-shoppers in the Czech Republic and shows the frequencies and percentages for some demographic factors.

Table 1

Sample demographics

| Demographic considerations of the respondents | | Frequencies (N) | Percentages (%) |
|---|---|---|---|
| Gender | Male | 665 | 41.5 |
| | Female | 937 | 58.5 |
| Age | 16–24 | 418 | 26.1 |
| | 25–34 | 392 | 24.5 |
| | 35–44 | 270 | 16.9 |
| | 45–54 | 203 | 12.7 |
| | 55–64 | 170 | 10.6 |
| | 64+ | 149 | 9.3 |
| Study level | Primary education | 112 | 7.0 |
| | A Secondary school without graduating | 151 | 9.4 |
| | Secondary school with graduation | 572 | 35.7 |
| | University degree | 767 | 48.9 |
| Level of Internet literacy | Beginner | 243 | 15.1 |
| | Common user | 806 | 50.3 |
| | Advanced user | 391 | 24.4 |
| | Professional | 162 | 10.1 |

Next, we applied the association rule analysis technique to analyze and learn the patterns inherent in the large data set. This helped discover the associations connected with respondents' choices of embarking on online transactions. Association rule analysis follows the systematic procedures or steps below. The adopted methodology is generally focused on the terminologies listed below and based on the Apriori algorithm which was used in this study. The algorithm works by expounding on the following mathematical theory of Agrawal, Imielinski and Swami [23]:

Let $I = \{i_1, i_2, ..., i_n\}$ be a set of $n$ binary attributes called items. (1)

Let $D = \{t_1, t_2, .. t_m\}$ be a set of transactions referred to as the database. (2)

Each *transaction* in $D$ has a unique transaction ID and contains a subset of the items in $I$.

AR mining assumes the form A ≥ B, where A and B are item sets and are satisfying $(A, B \subseteq I)$; (e.g., {Milk, Diaper} → {Beer}). The right-hand side of the rule (A) is termed the antecedent or the premise and the left-hand side the consequent or the conclusion.

In extracting or generating rules for analysis, we selected the variables of interest to mine the relevant relationship patterns. Variables of interest were converted into a transactional data format to aid association rule mining. Three important metrics underpin the foundation and deployment of association rules. These are measures of "support", "confidence", and "lift":

1. Support: The support of an association rule A ≥ B is the percentage (%) of transactions in the database that contain both $A$ and $B$. Mathematically, Support = $frq\,A, B/N$, where $N$ is the number of transactions.
2. Confidence: The confidence (Φ) for an association rule A ≥ B is the proportion attributed to the number of transactions that is made up of A U B assigned to the number of transactions that comprises A. This is shown mathematically as: Confidence ( $\Phi$ ) = $\left(frq[A, B]\right)/\left(frq[A]\right)$.
3. Lift: The lift of an association rule is the fraction of the support of (A, B) to the support of (A) and the support of (B). In practice, the lift looks at the left-hand side rule and finds the percentage of chance of (B) appearing would increase: Lift = $\left(support[A, B]\right)/\left(\left[support\{A\}\right] * \left[support\{B\}\right]\right)$

# 5 Empirical Findings and Results

As earlier indicated, association rules are presented in antecedent A ≥ B format. The two main metrics used for rule evaluation are confidence and support. Support is the fraction of transactions that contain both the antecedent and the consequent, whereas confidence measures how often items in the consequent appear in transactions that contain the antecedent. It must be noted that when associations between three or more attributes are found (e.g., {Milk, Diaper} → {Beer}), the confidence percentages are computed based on the two attributes being found in the third. Other metrics such as lift, Laplace, gain, and so on, are additional indicators that demonstrate the strength of the rules' relationships [43]. Table 2 and Table 3 present some preliminary findings of association rules for our large data set from the Czech Republic.

Table 2
Binary attributes of the data set toward specialized shops

| Rules | Antecedent (A) | Consequent (B) |
|---|---|---|
| #1 | Price, clothes, shoes | Specialized online shops |
| #2 | Clarity and menu navigation | Specialized online shops |
| #3 | Convenience (home delivery), clothes, shoes | Specialized online shops |
| #4 | Information from friends, colleagues (word of mouth), clarity, and menu navigation | Specialized online shops |
| #5 | Price, Internet discussions | Specialized online shops |
| #6 | Price, convenience (home delivery), electronics | Specialized online shops |
| #7 | Electronics, clarity, and menu navigation | Specialized online shops |
| #8 | Information from friends, colleagues (word of mouth), electronics | Specialized online shops |

Table 3
Binary attributes of the data set toward price

| Rules | Antecedent (A) | Consequent (B) |
|---|---|---|
| #1 | Electronics, clarity, and menu navigation | Price |
| #2 | Specialized online shops (e.g., Alza), official reviews | Price |
| #3 | Specialized online shops (e.g., Alza), information from friends, colleagues (word of mouth), electronics | Price |
| #4 | Information from friends, colleagues (word of mouth), clarity, and menu navigation | Price |

| | | |
|---|---|---|
| #5 | Convenience (home delivery), terms of delivery | Price |
| #6 | Electronics, terms of delivery | Price |

Tables 2 and 3 provide both antecedents (premises) and the consequents (conclusions) of some of the online shopper-vendor interactions in the Czech Republic as our case study for the evaluation.

This section elaborates some of the main findings retrieved from respondents. The association rules extracted from online shopper-vendor interactions in the Czech Republic were centered on specialized online shops (e.g., Alza, Heureka, etc.) and the price of purchasing a particular product via the web or online. Specialized online shops recorded the highest rules extracted from our data followed by price as the consequent. The implication is that Czech online customers are keen on specialized online shops anytime they pause to embark on online transactions, while the price in question becomes the second option of initiating online transactions. Detailed analyses are discussed in the next chapter, given the confidence and support of the extracted rules.

## 5.1 Association Rule Analysis Generated and Extracted (Price)

Table 4

Association rules extracted from online shopper-vendor interactions

| Rules | Association rule | Confidence |
|---|---|---|
| #1 | {Electronics, clarity, and menu navigation} ⟶ {Price} | 81% |
| #2 | {Specialized online shops (e.g., Alza), official reviews} ⟶ {Price} | 81% |
| #3 | {Specialized online shops (e.g., Alza), information from friends, colleagues (word of mouth), electronics} ⟶ {Price} | 81% |
| #4 | {Specialized online shops (e.g., Alza), quick goods comparison} ⟶ {Price} | 81% |
| #5 | {Specialized online shops (e.g., Alza), Internet discussions} ⟶ {Price} | 83% |
| #6 | {Convenience (home delivery), terms of delivery} ⟶ {Price} | 85% |

| | | |
|---|---|---|
| #7 | {Specialized online shops (e.g., Alza), terms of delivery} ⟶ {Price} | 85% |
| #8 | {Information from friends, colleagues (word of mouth), terms of delivery} ⟶ {Price} | 85% |
| #9 | {Electronics, terms of delivery} ⟶ {Price} | 86% |

Table 4 presents rules generated with a confidence of more than 80%. The findings shed more light on price as the consequent of our analysis. Rule #8 indicated that when online Czech customers pause during their transactions to ask for more information from friends, colleagues or about the terms of delivery, the overriding factor of consideration they looked out for was price, which is accompanied by a confidence of 85%, indicating a higher association between the antecedent and the consequent. Likewise, Rule #9 implied that when customers are buying electronics and thinking of the terms of delivery, the most important factor of influence is price, representing a higher confidence of 86% of influence of price as a deciding factor. In the same vein, when online customers decide to make a decision to purchase electronic gadgets or equipment, and tend to seek clarity and probe into the menu on the website, the prevailing factor is attributed to the price of the said electronic appliance or gadget with 81% confidence.

Additionally, when customers, channel their attention to specialized online shops (e.g., Alza, Heureka, etc.) in the Czech Republic with a higher emphasis on official review of the said product (as Rule #2 stipulated), then it is as a result of the product in question. This scenario, however, recorded 81% confidence similarly to Rule #4 which indicated that online Czech customers hold the view of rationalization through the web by comparing the various prices for a similar product before purchases are made. This means that Czech customers are more particular about the price of the products on the web when the product is basically situated in a specialized online shop. Hence, they tend to seek more information from previous users and subsequently check other online shops to confirm the price range.

Alternatively, in both Rule #3 and Rule #5 involving the bid for online shoppers to consider purchasing through specialized online shopping, while shoppers seek information from Internet discussions, friends, or word of mouth when attempting to purchase electronic appliances, the leading factor was price, with 81% and 83% confidence, respectively, for both rules. This means that online Czech customers tend to consider the price of an electronic appliance through a specialized shop in an attempt to initiate a purchase. Again, Rule #6 presented quite different scenarios from all the associations generated from our data set. Rule #5 indicated 85% confidence from Czech online customers who intend to make purchases on the web with the notion of convenience (home delivery) as well as terms of

delivery being the guiding principle of the price that needs to be paid for the product in question. This rule was supported by 85% confidence indicating that customers are concerned about how the goods will get to them, and the way and manner these goods will be delivered is embedded in the price of the goods.

## 5.2 Association Rule Analysis Generated and Extracted (Specialized Online)

This section presents the results calculated for specialized online shops as a consequence and the antecedents or premise. The extracted variables generated in tandem with the consequent (specialized online shops) were price, information from friends, and convenience (home delivery, electronic appliances) as a background. These are discussed within the subsequent chapter with figures provided for clarification.

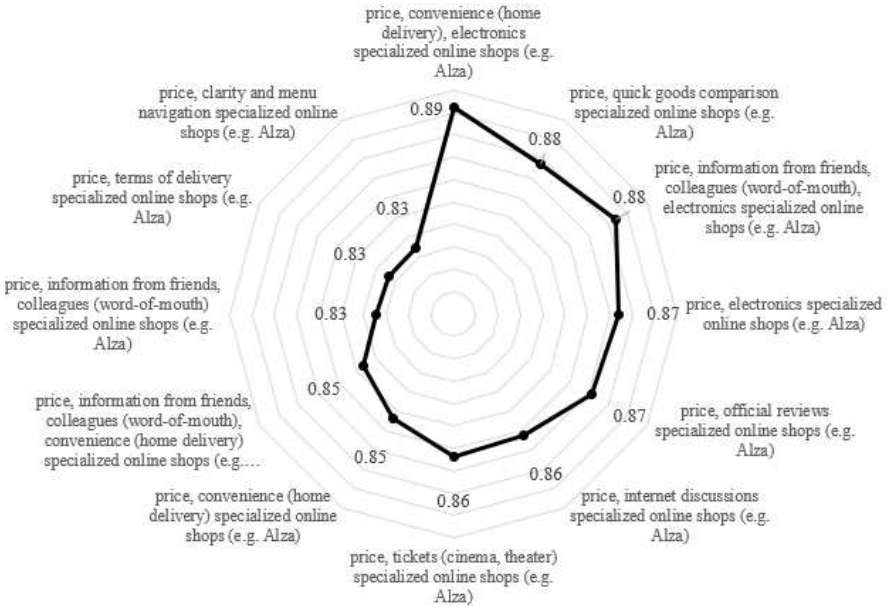


Figure 1

Association rules of price and specialized online shops

The association rule extracted from Figure 1 provides confidence and support of rules embedded in price and specialized online shops in the Czech Republic. As shown in Figure 1; price, convenience (home delivery), electronics, specialized online shops with the highest confidence of 89%. This means that when online customers are focused on purchasing an electronic appliance via a specialized online shop in the Czech Republic, they look out for the price and how the said

electronic appliance will get to them. Second to the highest rule (recorded with 88% confidence), online customers in the Czech Republic tend to seek clarification from friends and to subsequently do a quick price comparison anytime they decide to purchase a product from specialized shops across the Czech Republic. Price was extracted with a higher confidence as a deciding factor of online customers to embark upon specialized online shops; see Figure 1. However, the lowest confidence extracted from the figure stood at 83%, which was centered on information from friends, clarity and navigation, terms of delivery associated with specialized online shops, and price as a deciding factor for online customers. This means that online customers seek clarity and first-hand information from colleagues and also on how the products yet to be purchased (price) will get to them from the specialized online shops.

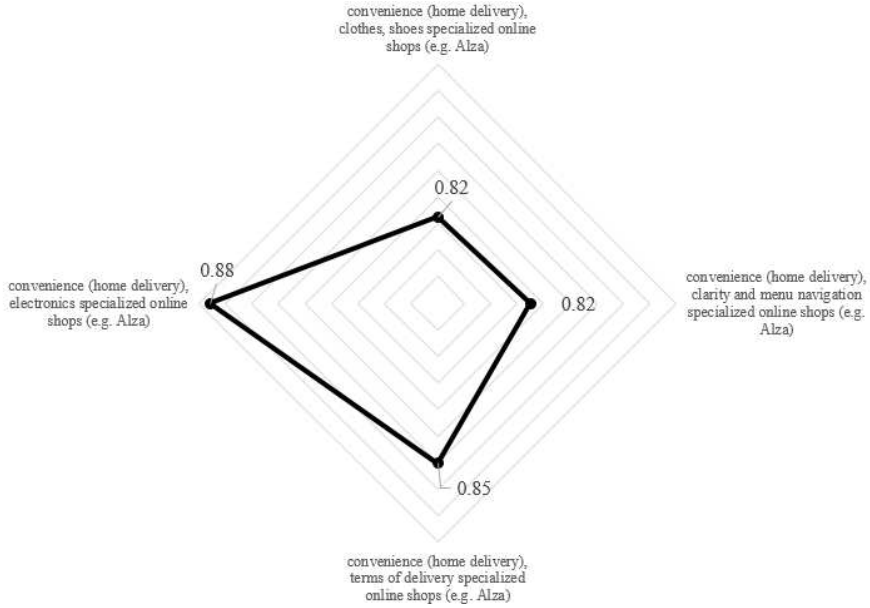


Figure 2

Association rules convenience and specialized online shops

Figure 2 presents an extracted rule from convenience (home delivery) with respect to specialized online shops in the Czech Republic. The highest rule from Figure 2 recorded 88% confidence, convenience (home delivery), electronic specialized online shops. In the event that a customer is targeting an electronic appliance from a specialized online shop, the tendency for the particular electronic appliance to be purchased stems from the fact that the product will be delivered accurately without any hindrance. The second rule generated stood at a confidence level of 85% showing that convenience, terms of delivery are a domain of specialized online shops. This is attributed to the fact that online customers, channel their

attention toward specialized shops when the product they wish to purchase will be delivered without obstruction, and the terms of delivery are well negotiated. Alternatively, the last two rules regarding specialized shop engagement in the Czech Republic present an interesting rule that indicates online customers tend to adopt convenience, and clarity and navigation when they intend to purchase goods like clothes, shoes, and so on, with 82% confidence in those two rules extracted. It is an obvious fact that online customers will seek more clarity when they intend to purchase goods of such caliber because of the size, color, and so on. Since these qualities cannot be experienced online like brick and mortar stores, it becomes vital for the online customer to get to the specialty online shops that deal with a specific kind of item.

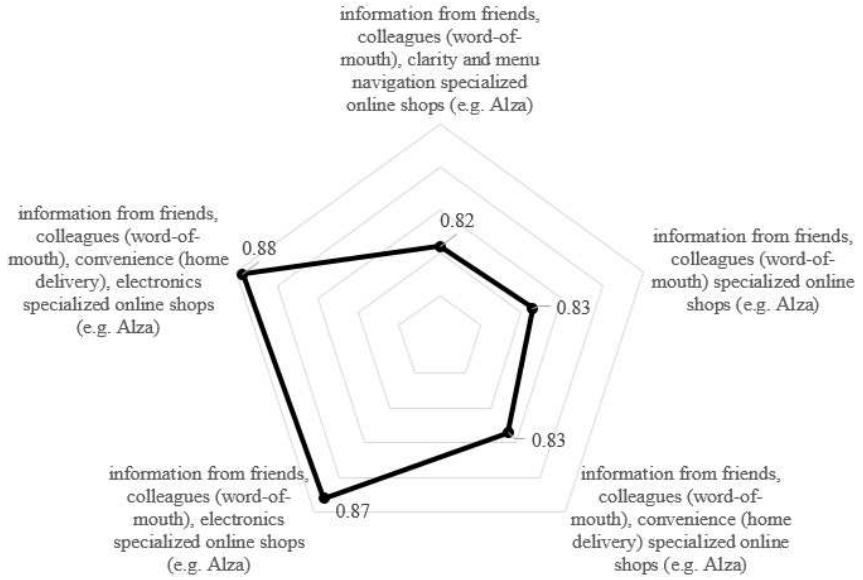


Figure 3
Association information from friends and specialized online shops

The association rules extracted from information from friends against the inclination to shop at specialized online shops in the Czech Republic are presented in this section. The highest confidence retrieved from our data stood at 88%. The extracted association centered on information from friends, colleagues (word of mouth), and clarity and navigation, with the specialized online shop as the consequent. This implies that in the quest of online customers engaging in specialized online shops, the dominant factor is seeking information both from friends and at the site before initiating an online purchase. Again, in the event of online customers planning to purchase any electronic appliances via specialized online shops, the deciding factor is feedback from friends who have already purchased the said product, with 87% confidence. Interestingly, there were two

extracted rules that recorded the same confidence of 83%, with convenience as the only distinguishing factor. As previously indicated, this implies that online customers inquire more with their friends or colleagues before embarking upon specialized online shops, and also look out for the convenience of the product they intend to purchase. In contrast to the previous claims made by respondents as to the association between information from friends and the need to adopt specialized online shops, it can be seen from Figure 3 that the clarity of the site as well as colleagues (word of mouth) plays a pivotal role for the online customer in initiating specialized online shopping; this stood at 82%, indicating the lowest confidence from the respondents.

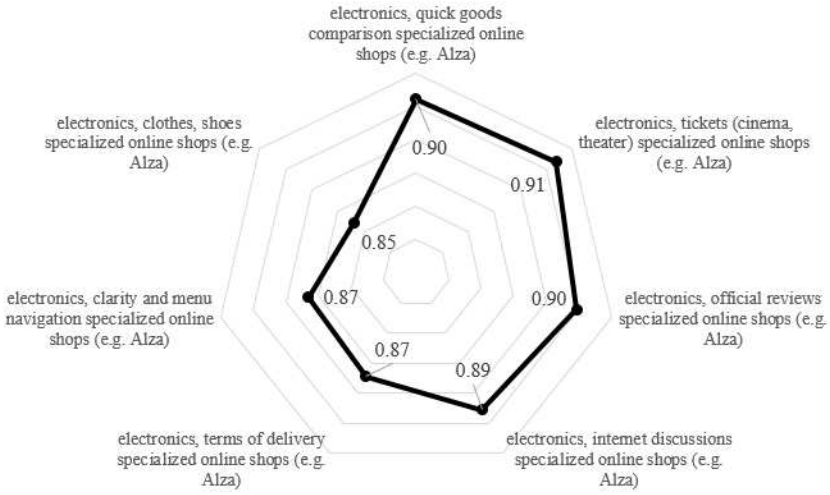


Figure 4

Association rules electronics and specialized online shops

Figure 4 represents the associations extracted from our data. It can be noted that the tendency for online customers to pause to buy electronic gadgets as well as tickets to cinemas or theatres in a specialized online shop cannot be overemphasized. This assertion recorded a confidence of 91% as the highest of all confidence retrieved from the association between electronic appliances and specialized online shops. This means that online Czech customers tend to locate specialized online shops anytime they think of buying tickets for cinema or theatre and also any electronic gadget. The second rule extracted from the above scenarios centered on convenience, official reviews, and Internet discussions by online customers when they embark on specialized online shops to purchase any electronic appliances. These rules recorded both 90% and 89% confidence; that is to say, online Czech customers are more particular about how their electronic appliances will get to them and also want to delve into what others are saying about the said electronic appliances or gadgets.

## Conclusions

This study is aimed at applying a data mining technique, to evaluate and analyze online shopper-vendor interactions, with the Czech Republic as our case study. Online transactions are evolving, and are both a blessing and a challenge for both the e-vendor and the e-shopper. To ensure smooth operations, research must generate and extract relevant information and transactional data from online customers in the Czech Republic. The association rule mining approach was used to help maintain a robust understanding of online customer preferences and to enlighten the general purview of online customers' (e-shoppers') value proposition in online transactions. This will intend aid online providers to increase in online sales and customer retention as the core mandate of every company, and for that matter online providers in and beyond the Czech Republic.

Association rule mining was chosen for this study because of its tremendous and unique influence on research, helping studies retrieve the hidden and untapped knowledge embedded in a pool of data sets, particularly due to its segmenting and targeting approach in a large data set. The data mining algorithm used in this study demonstrates the way and manner that— despite the complex nature of online transactions—online providers can keep track of their regular customers and also lure more customers into their folds. The approach used, however, provides a clear picture and a gateway for online providers to succeed in their business endeavors and subsequently maximize their profit margin. However, the authors are lamenting on some limitations of the present study. The entire rule set that was generated and extracted was centered on some small aspect of online shopper-vendor interactions, notably price and specialized online shops. These form only a small part of the base of online interactions, and hence does not represent entire interactions that go on between the e-vendor and the e-shopper. Therefore, we cannot generalize our findings as a true reflection of what pertains to the online shopping environment. Different algorithms could be used or applied in the future to analyze and/or enhance the understanding of online shopper-vendor interactions, especially by blending them with other algorithms in different Countries and presenting multiple questions to the respondents.

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# A Circular Evaluation Tool for Sustainable Event Management – An Olympic Case Study

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*Abstract: This paper introduces a pilot project, which focuses on solar energy usage through the implementation of circular energy-sharing solutions, by event management. The conducted research examines the possibility of constructing a solar power park for a possible Olympic village. The study demonstrates a newly developed methodology which has been created to measure the circular efficiency of similar events. The analysis also elaborates on innovative business and technological solutions for developing solar energy schemes, which can be applied to circular principles and lead to further social-economic-environmental benefits. According to the findings, the current energy infrastructure is not always suitable for improvement to higher development levels. The structure itself requires fundamental changes in order to enhance the sustainable and circular performance. Thus, pilot projects are required, as a first step, to implement similar technological and business salutations. In the case of earlier Olympics sustainable or carbon strategies, instead of long term planning, was important to focus for the short term thinking and management actions (carbon and ecological footprinting). The implementation of such novelties (circular principles), at highly anticipated events, could contribute to spreading closed structured, circular thinking in the future.*

*Keywords: circular economy; sustainable event management; circular economic value; solar energy park; energy cooperative; Olympic games; event management; renewable energy*

# 1 Introduction

In the case of previous Olympics' Carbon Strategy, not only the calculation of the carbon footprint was important, but also, its reduction [1, 2]. The carbon neutralization of the events can happen in two ways. During earlier Olympics, optimizing the material flow had an important role, by which their systems could manage a lower emission level [3, 4]. Furthermore, there are opportunities for offsetting the internal hazardous emissions. This method aims to compensate for inevitable GHG (Green House Gas) emission levels by financing mitigation projects in other geographical regions. After that, global climate policy mechanisms make it possible for the promoters to use 'carbon credits' to account them in the GHG balance of their event [5]. Finally, the third method, is to decrease GHG emissions, is to use clean renewable energy resources, which has already been applied during previous Olympics to make the games more sustainable [1, 2].

This paper introduces a pilot project which focuses on solar energy usage, through the implementation of circular energy-sharing solutions. The energy from the sun is one of the most popular renewable energy resources and its application becomes cheaper and more efficient annually. The price of solar systems decreases each year, which makes the financial indicators of related projects consistently better. The solar energy usage, of the European Union, for production of electricity, is currently low, at a mere 4% level. Only Italy, Greece and Germany are substantially different, where the amount of usage is around 7-8%. However, in renewable markets, stakeholders are getting more interested, so current studies expect significant Solar energy development projects in the coming years [6].

This research is aimed at examining the possibility of constructing a solar power park for the possible Budapest 2024 Olympics, based on the principles of Circular Economy. By realizing that initiative, in Budapest, the Olympic village would be supplied, almost completely, by green energy, during the games. Even though the event was cancelled by the Hungarian government, the present study introduces an evaluation tool, which has been developed for the measurement of its sustainability. The Budapest 2024 Olympics was the first ever major event planned, in respect of Circular disciplines and the further elaborated methodology may easily be interpreted, to other event organization processes. Through the application of that novel circular tool and a cost-benefit analysis, the results show the improvements, in the project’s material and energy flow that can be reached through the use of solar energy. Eventually, the analysis will introduce innovative business and technological solutions for developing solar energy, which can be applied to circular principles, and lead to further social-economic-environmental benefits.

# 2 Materials and Methodology

According to previous experiences, the complete energy supply of the Olympics and the Paralympics cannot be realized entirely by renewable resources. The capacities constructed exactly for this purpose could only satisfy one part of the energy requirements from studies on prior Olympics [2]. This case study introduces a scenario, where at least 80% of the Olympic village's electricity supply is generated by a solar power park. The analysis is for the timeframe of the Olympics and the Paralympics, but the solar power park could obviously remain in the legacy period, and used as well.

The energy requirements of the Olympic village planned in Budapest were estimated based on data from the London Olympics. In London, the electricity demand of the Olympic village reached 4300 MWh [2]. The planned Olympic solar power park could sustain 20 MW capacity on its own, which will probably require 40 hectares. However, due to efficiency increases for solar panels, it should need only half that space by 2020. According to recent calculations, this equipment can sustain 80% of the estimated energy requirement (close to 3600 MWh). This naturally means that the remaining 20% would be supplied from the Hungarian energy production network.

## 2.1 Calculating the Circular Economic Value (CEV)

The circular efficiency of the system was measured by the circular economic value (CEV) which was established for this very case study. The main aim of the methodology is to illustrate the effects of the renewable energy resource usage on the Olympics' energy- and material flow improvement. During the calculations, two scenarios have been distinguished. One is where the energy supply of the Olympic village comes from the domestic energy production networks which is usually employed (Business-As-Usual – $BAU_{CEV}$). The other is when the introduced solar power plant is realized, and the energy requirement is partially supplied by renewable energy resources ($Scenario_{CEV}$). The calculation method of the CEV is illustrated on Equation 1.

$$CEV\% = 100 - \left( \frac{\left(\frac{M_p}{M_p + M_s} + \frac{M_d}{M_r + M_d}\right) + \left(\frac{E_f}{E_s + E_f} + \frac{E_l}{E_c + E_l}\right)}{4} \right) \times 100 \quad (1)$$

*where:*

***CEV*** *= Circular economic value*
$\boldsymbol{M_{lin}}$ *= Material volume on the input side (linear)*
$\boldsymbol{M_{lout}}$ *= Material volume on the output side (linear)*
$\boldsymbol{M_p}$ *= The amount of primary raw materials used for the manufacturing of the product*
$\boldsymbol{M_s}$ *= The amount of secondary raw materials used for the manufacturing of the product*
$\boldsymbol{M_d}$ *= Amount of non-recyclable materials remaining after the product is used (linear)*
$\boldsymbol{M_r}$ *= Amount of recyclable materials remaining after the product is used (circular)*
$\boldsymbol{E_{lin}}$ *= Energy value on the input side (linear)*
$\boldsymbol{E_{lout}}$ *= Energy value on the output side (linear)*
$\boldsymbol{E_f}$ *= Amount of non-renewable energy used during the manufacturing of the product*
$\boldsymbol{E_s}$ *= Amount of renewable energy used during the manufacturing of the product*
$\boldsymbol{E_l}$ *= Amount of energy produced during disposal, after the product was used (linear)*
$\boldsymbol{E_c}$ *= Amount of energy used for the product's recyclability, after the product was used (circular)*

The description of the equation's parts contains a universal sample, which can be translated for any case. The main point is that it handles the input and output material and energy flows for systems, separately. The most important point is to describe the ratio between the linear and circular processes on the input and output sides.

### 2.1.1 Analysis of the Material Side Indicators

The analysis of the material flows required a thorough consideration of measures, since the whole study is basically about energy production networks. This means that the 'material' and 'energy' definitions cannot be subjects of confusion concerning the various sides. The material description elaborates on the nature of the material flow, regarding the produced energy in the BAU and Scenario versions. This indicator indicates the ratio of resource materials which aid the non-renewable (linear) energy production on the input side. The output side focuses on the amount of the resource materials – that flow into the system – used during the energy production. This logic can easily be demonstrated through the efficiency problem of vehicles. As the vehicle only uses 18-25% of the fuel loaded into the tank for moving itself, the other part is lost for other operational mechanisms [7]. This is similar for the fossilized energy production networks of today, where a significant material loss occurs during the operation of power plants (Figure 1).

The Figure illustrates that the current energy production networks are far from operating efficiently. By the time the produced energy is consumed, the energy content of the system’s material input is reduced to a fragment of the original. Therefore, the output side of the CEV takes the rate of energy losses – of used materials – in power plants into consideration. In the various energy production

processes, waste (heat) energy has a huge role, which is produced in a higher amount then electric energy during electricity production. Table 1 introduces the energy conversion efficiency usually observed in the networks of the Hungarian energy mix.


Figure 1
Energy loss observable during the lifetime of a light bulb[1]

Table 1
Energy conversion efficiency values of various technological solutions [8]

| Year of construction | Gas- and oil combustion plants | Coal- and biomass combustion plants | Nuclear power plants | CCGT (combined gas) |
|---|---|---|---|---|
| 1960 | 37.00% | 35.00% | 25.00% | - |
| 1970 | 39.00% | 37.00% | 27.00% | - |
| 1980 | 41.00% | 39.00% | 29.00% | - |
| 1990 | 43.00% | 41.00% | 31.00% | 50.00% |
| 2000 | 45.00% | 43.00% | 33.00% | 55.00% |
| 2010 | 47.00% | 45.00% | 35.00% | 58.00% |

### 2.1.2 Interpreting the Energy Side Indicators

As for the energy flow, the calculation is based on what ratio of the produced energy gets used during the phase after the material flow. In accordance with circular principles, the produced energy which does not fulfill its function of final consumption, contributes to linear processes. An important characteristic of current energy production networks is that their own operations require part of the energy they produce. Expert energetics literature calls this amount, self-consumption [9]. Table 2 introduces the rate of self-consumption the energy production networks in the Hungarian energy mix have. The values in the table were included in the energy input calculation of the CEV.

[1] MPower UK – Energy Efficiency
http://www.mpoweruk.com/energy_efficiency.htm

Table 2
Service and self-consumption of plants of different technological solutions [8]

| Plant types | Service percentage | Self-consumption |
|---|---|---|
| Gas- and oil combustion plants | 90.00% | 5.00% |
| Coal plants | 85.00% | 13.00% |
| Nuclear power plants | 95.00% | 6.00% |
| CCGT plants | 90.00% | 5.00% |
| Wind power plants | 20.00% | 0.00% |
| Biomass, biogas | 85.00% | 13.00% |

The output side of the energy flow refers back to Figure 1. The figure clearly shows that apart from plant energy losses, there are further losses in the network. Therefore, there is merit in asking if this phenomenon will prevail for the solar power park planned for the pilot project as well. However, the solar power park planned for the Olympics will not only fulfill the role of a power source, but its geographical location will also have a significant role in circular planning. Unlike current centralized networks, its decentralized placement near the place of usage (0-5 km) will induce a minimal network loss [10, 11]. For the energy output calculation, the 'Network loss' factor – signified by 'D' on Figure 2 – is required.

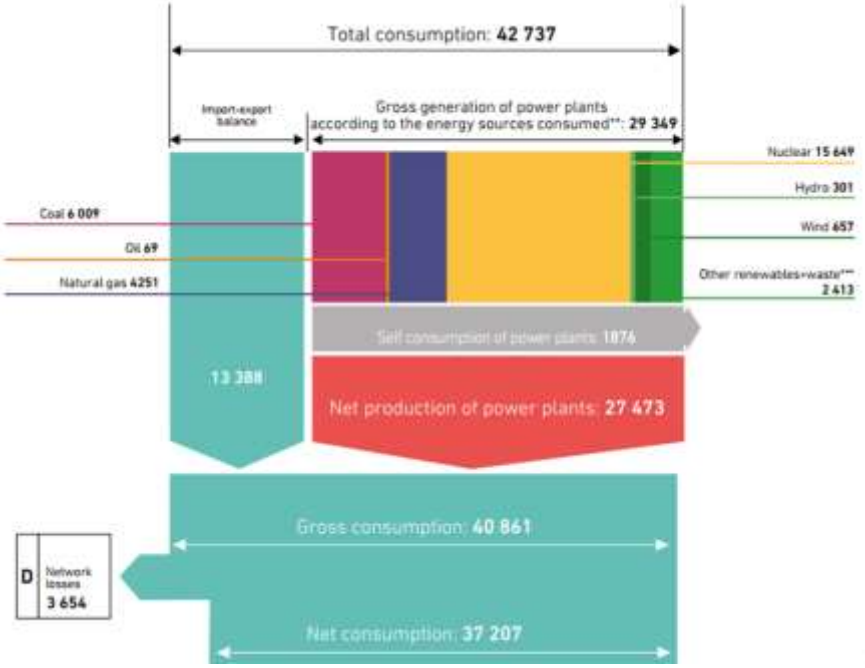


Figure 2
Electricity production and usage of Hungary (in GWh) in 2014 (incomplete) [12]

# 3 Results and Recommendations

## 3.1 CEV Values of the Olympic Village's Energy Supply Scenarios

The circular economic values have been calculated for both the BAU and Scenario variants using the introduced criteria system. An important clause is that the Scenario version's solar power park can be used to supply only 80% of the Olympic village's energy requirements. Therefore, the Hungarian energy mix represented by the BAU variant (49% fossilized, 43% nuclear, 8% renewable) also appears in the Scenario version, up to 20%. It must be stressed that of all the processes (linear and circular) on the input-output sides regarding the material- and energy flow, CEV considers the share of linear processes. Therefore, components do not only contain the simple ratio of their indicator (e. g. self-consumption, or network losses). These values were weighed with the intensity of their persistence, based on the technological solutions used in the variants. The indicators assigned to CEV components are the following:

- $M_{lin}$: Out of the total amount of material usage, this represents the material volume used for linear processes.
- $M_{lout}$: Out of the total material losses, this represents the material losses during linear processes.
- $E_{lin}$: Out of the total plant self-consumption, this represents the plant self-consumption during linear processes.
- $E_{lout}$: Out of the total energy losses, this represents the energy loses in the network during linear processes.

Detailed and aggregated CEV values based on the factors can be seen on Figure 3.

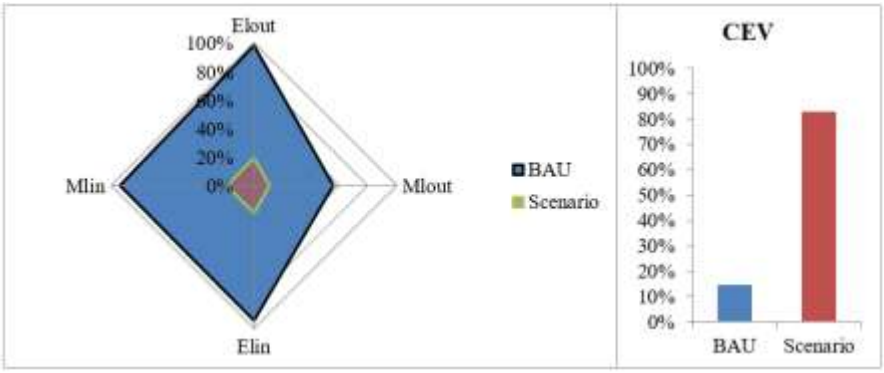


Figure 3
CEVs of BAU and Scenario variants, and illustrating their components

The Figure clearly illustrates that the energy mix of the BAU variant only contains a scarce amount of circular tools ($CEV_{BAU}$=17.3%). This is obvious, since merely 8% of the electricity production comes from renewable energy sources, which could improve these values. Contrary to this, the Scenario variant based on the Olympic solar power park is on a high level of circularity ($CEV_{Scen}$=85.5%). The lost amount can be accredited to the fact that the solar power park cannot supply the entire energy requirement, thus the scenario must employ the BAU energy mix for the remaining 20%.

Perhaps the more important part of the analysis is not even the CEV of the Scenario variant. Renewable energy resources are already known to be on a high level of sustainability [13]. Seeing the values, it is no surprise that solar panels are the most efficient. For these technological solutions, linear processes are completely outclassed. The moral of this analysis is the BAU version, which – apart from the Olympics – highlights an extremely important aspect. Nuclear energy is a supported process – even in some low-carbon concepts. Its energy is cheap and reasonably clean concerning GHG emission [14, 15]. However, in case of circularity, it does not stand so firm, as the analysis also proves. It employs linear processes, and the production of nuclear waste creates a massive amount of externalities (and their effects are not taken into consideration in many analyses) [16].

In order to see the entire picture for both the investment and operation costs – in case of both BAU and the solar battery-equipped Scenario – a cost-benefit analysis (CBA) demonstrates the related costs and profits to ΔCEV, which is the difference of the two CEVs ($CEV_{BAU}$, $CEV_{Scen}$).

## 3.2 ΔCEV Cost-Benefit Analysis

The first step of the CBA was to determine the average capital costs of 1kW regarding Hungarian plant capacity. This makes up the BAU value. Then, it was compared to two different variants. On its own, it can be compared to only the capital values of the solar plant, and its corrected value. This latter follows the same logic as previous CEV calculations, which means, that these costs were compared to the quotient of the internal production and the network usage. The same principles were used for the repair and maintenance costs during operations. The other costs needed for the produced electricity were not accredited for, since the value of that would only improve the balance. The results can be seen on Figures 4 and 5.

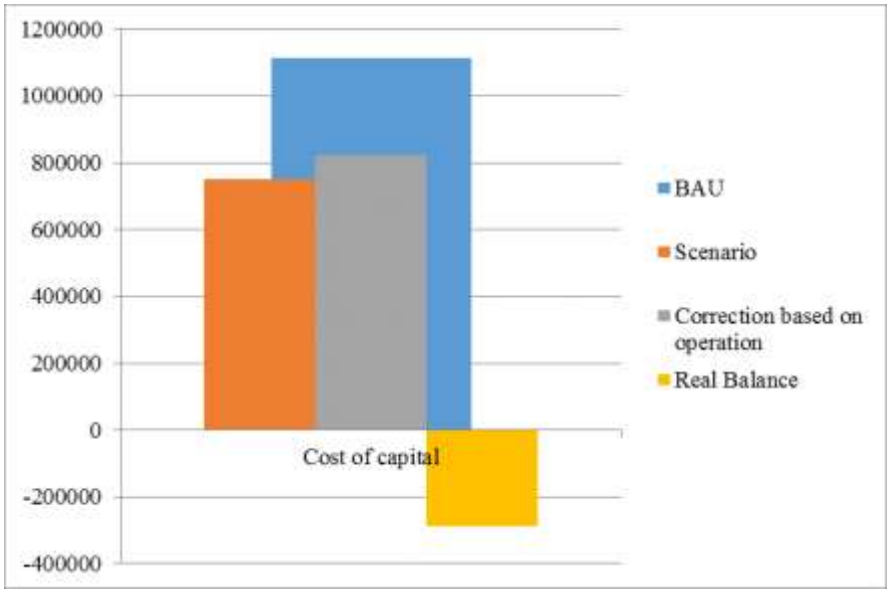


Figure 4
Capital costs of establishing 1 kW capacity

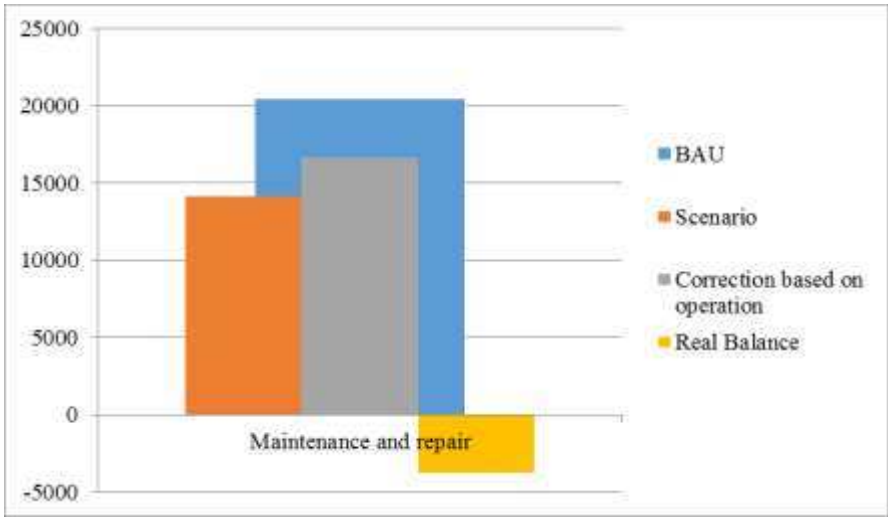


Figure 5
Comparison of annual maintenance and repair costs of BAU and Scenario for 1 kW capacity

As the results of the primary calculations show, the Scenario variant also comes with cost-efficiency compared to the domestic BAU economic values. In case of the capital costs, this means 288.392 HUF for each kW of capacity, considering

the 20 MW solar plant, whereas it causes 3.761 HUF of cost sparing in the case of the annual maintenance and repair factor, also for each kW of capacity established. Concerning the financial part of the calculation, the amount of savings are estimated to be 25.9% (from the cost of capital). In case of the operation, the capacity's maintenance costs would be 18.4% lower than in the original BAU value.

## 3.3 Business and Technological Solutions Aiding the Circularity of Renewable Energy Networks

So far, the analysis has mainly focused on highlighting attributes which could make the Olympic solar power park more circular. This, however, is still insufficient for a circular system innovation. The sustainable benefits of renewable energy resources were already well-known, the CEV analysis mainly translated these advantages to the language of circular economy. However, the circular concept means more than a simple 'exchange' in technological solutions. The question of *'how?'* is much more important than that of *'what?'*. While renewable energy resources had an important role in 'low-carbon' principles, the design of long-term, sustainable usage methods comes into perspective in case of circularity.

The usage of renewable energy resources is still shrouded in misconception, as far as society's knowledge goes. Though the studies published in the topic continuously stress the improving financial criteria [6] – apart from environmentally friendly effects – there are still barriers standing in the way of mass usage. In countries of lower incomes – even if the return indicators are improving steadily – people do not have the initial capital for such investments. Loan options or financing models for renewable energy developments are either non-existent, or they do not reach a wide range of society [17]. Concerning the western society, where people possess an advanced entrepreneurial mentality, there are other types of problems. In such countries, real estate is usually not owned by the tenant. In these life areas, tenement houses and flats are more widespread, meaning the tenants cannot install solar panels on the real estate, in contrast to their strong positive attitude towards them – since it is not their own property [18].

Gunter Pauli, the creator of the Blue Economy concept (one of the pillars of circular economy), described such uncomfortable situations as follows: *"What we need in the first place is not technology, we need new business models that operate like ecosystems. If we can't design business models that offer what's good for you & Nature cheaper than junk: forget sustainability!"* His words clearly describe the position of green technologies. The solution is given, but the problem is that not many can afford it [19]. The newest western business trends do not reach exclusively towards new technological innovations, they rather prefer

business model innovation [20]. This stands true for business models striving for not only economic but social and environmental sustainability as well [21]. The difference between the two is that while the former only aims at economic profit, the latter extends its value proposition to social and environmental horizons [22]. This study also tends to reach this goal for the Olympic solar power park. By using an innovative business model, the profits of this pilot project could reach a wider range of society.

### 3.3.1 A Business Solution Aiming at the Social Aspect of Solar Energy Usage

The story begins on a small Greek island named Sifnos. The inhabitants were fed up with problems persisting in the existing centralized energy supply. Such as, energy costs always surfacing and the perception that they are not the ones deciding the source of their energy. The local population could not afford the local, individual usage, of the renewable energy resources. This is when the idea of community energy production was born. Its essence is that the local community pools its resources to invest in projects, using renewable energy resources. In these cases, the volume of the investment is naturally greater which results in the establishment of a small-scale power plant. The legal description of the method, is called the cooperative form. This is where the name of the initiative comes from: Renewable Energy Source Cooperative (RESCOOP). The RESCOOP model began its march in Northern European countries, like Belgium or Denmark. An interesting point is that later, the Greeks themselves went to these nations to seek best practices. The key of success in these countries was the positive and supportive social attitude towards environment-friendliness. The communities were basically open to renewable energy, but they did not have the business model for realization [23].

Meanwhile, the example of RESCOOPs created 'spinoff ideas' which were never thought of by its creators. In time, the ideas of 'energy independence' and 'energy democracy' were spread, which were later integrated into the fundamental principles of the European Union. Their essence is that local communities create community renewable energy programs in a decentralized manner. This way, they gain the opportunity to choose the energy resource they want to make use of. Furthermore, as a cooperative, and as the owner of the resource, they can also determine the price of the produces energy [24]. In case they produce more than they consume, they can even sell it on the energy market – obviously, below the market price. The members of the cooperative can be natural persons, enterprises, municipalities and NGOs. During actual usage, the model can be formed at will. There's even an opportunity for the local community – in case of insufficient resources – to be in an investor role, instead of the owner of the project. The main point is the democratic principles of operation, during which all partial owners can state their opinions [25].

One such initiative has numerous economic-social-environmental advantages [26]. It creates new workplaces, boosts local economy [27], while decreases overhead costs – which are the greatest amount of costs the society has to bear – and increases the income people can spend at their convenience [28]. The environmental awareness of the populace improves [29], and due to the cooperative organizational form, they feel the pattern of energy closer to themselves, compared to when they are just customers of an external company (at higher costs). Concerning the Olympic solar power plant, it is also an important factor that the decentralized manner of the system can decrease network losses. Furthermore, renewable energy itself further decreases the self-consumption and the plant loss. This is how the material- and energy losses become much lower. The decentralized energy production offered by the RESCOOP business model is extremely compatible with circular principles which aim to avoid waste right at the first step of the life cycle.

### 3.3.2 Smart Technology Applications for a More Efficient Energy Flow

The application of smart technological solutions has been known in the field of energy production and consumption for quite a while. Italy was the pioneer of using smart measurement systems at the end of the 1990's [30]. By now, multiple European countries began to use them. Even more so, their widespread installation is among the short- and mid-term goals of the EU [31]. The essence of such systems is that they show the amount of energy usage in real time – unlike the traditional flat rate system. This way, the consumption trends can be followed more accurately which makes it easier to plan the energy production process. Furthermore, the splurging tendency of society also changes, if they can understand the costs of their behavior in real time [32]. Later, these served as the basis of the smart grid systems. On a unit level, they connect all energy-consuming applications of a household – which can even be controlled on the owner's remote controller tool. On a macro level, one obtains the opportunity to optimize the energy production systems. This process works best if the decentralized energy production spreads [33].

The description of the elaborated technological innovations clearly indicates that they all serve the efficiency improvement of energy production- and consumption systems. The traditional, centralized, flat rate mechanism caused a high amount of energy losses on the production side. On the consumption side, further negative effects surfaced. To supply over-consumption, additional energy production capacities' activity was required. Operating these systems offers electricity more expensive than the market price. Therefore, in the case of consumption peaks, some consumers pay much more for their consumed energy unknowingly. This phenomenon birthed the innovative initiative which may completely raise the world of efficient energy production. People of the United Kingdom came up with the *'Dynamic demand response*' model based on the elasticity of the demand side of the energy market [34].

The concept is based on a future state, where smart tools and smart systems are installed. With their help, energy-consuming applications will be subjected to regulation, in order to continuously balance the supply-demand sides. In case of consumption peaks, the system tracks applications which may neglect energy for a short while. By turning them off, the demand stressing the energy production systems may be decreased. In other cases, like over-production, the intelligent system turns on applications, which serve as a sink for excess energy. The supply-demand balance of energy supply is an undying question for the energy market. The general practice is that at the time of peak demand, there is a need for extra energy production capacities. In case of supply peaks, the excess energy has to be rerouted, or stored. The extra capacities kept for either storing or rerouting are fossil-based, which impacts environmental indicators (even in the case of production systems basically using renewable energy) [35]. By balancing the production and consumption, a perfect energy circulation is created, which can be the future of energy systems.

## Conclusions

The positive feedback of technology comparisons and circularity solutions introduced – based on the calculations – may serve as a sufficient basis for designing pilot programs for Olympic Games infrastructures. It can serve as an example for the modernization/optimization of the energy supply. An important aspect of sport event planning is to keep the built structures, in use, after the games, by analyzing the social dimensions of sustainability. Based on the introduced example, the solar power plant electricity supply may offer significant cost-efficiency improvements regarding the energy bills of the Olympic village. It can be purchased as an outside service, thereby gaining a place on the National Olympic Committees' subsidy sources. In case of the RESCOOP model, not only the GHG decrease or carbon-elimination obligations can be completed, but by converting the Olympic program into a social venture (meaning including small consumers into the realization of the investment), the economic sink-in of the sustainability problem could be solved as well. The owners of the Olympic establishments (Olympic solar power plant) would use the sports establishments powered by the solar power system for their own interests.

Therefore, the conclusion of the research is that climate and environmentally friendly technological solutions are highly compatible with the Olympics for the starting of pilot programs, if those are assigned to circular planning elements. The elaborated case study highlighted an important innovation possibility regarding energy systems. According to the findings, the current infrastructure is not always suitable to be improved to higher development levels. The structure itself requires fundamental changes in order to enhance circular performance. Thus, pilot projects are required, as a first step, to implement similar technological and business salutations. The implementation of such novel aspects, at highly anticipated/attended events, could contribute to growth in the future.

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