Journal of Business Economics and Management
ISSN 1611-1699/eISSN 2029-4433
2017 Volume 18(5): 1042–1061
doi:10.3846/16111699.2017.1381146

DEVELOPING ECO-INNOVATION IN BUSINESS PRACTICE IN SLOVAKIA

Jana HRONCOVÁ VICIANOVÁ[1], Jana JAĎUĎOVÁ[2], Martin HRONEC[3], Silvia ROLÍKOVÁ[4]

Faculty of Economics, Matej Bel University, Tajovského 10, 974 01 Banská Bystrica, Slovakia
E-mails: [1]jana.hroncova@umb.sk (corresponding author); [2]jana.jadudova@umb.sk; [3]martin.hronec@umb.sk; [4]silvia.rolikova@gmail.com

Received 11 August 2017; accepted 14 September 2017

Abstract. The paper presents the analyses and evaluates the current state of implementation of eco-innovation in the most energy-intensive sectors in Slovakia and also compares the eco-innovation performance of EU countries. Furthermore, it identifies the economic and environmental benefits from which businesses can profit following the introduction of this type of eco-innovation; it confirms the relationship between investments in environmental technologies and increasing sales of ecological products and services and identifies opportunities for development of eco-innovations in Slovakia. The industrial sectors in Slovakia have the potential to utilise eco-innovation throughout the structure of their economic activities, to develop new technologies and knowledge as well as in creating and developing partnerships, networks and mutual cooperation for the development of eco-innovation on the proviso that appropriate supporting eco-innovation policies and stimulus measures are in place. An analysis of the current state of eco-innovations in the selected enterprises was carried out on the basis of original empirical research which is based on a questionnaire survey on enterprises in the Slovak Republic.

Keywords: eco-innovation, eco-innovation performance, economic benefits, enterprise, environmental responsibility, eco-innovation efficiency.

JEL Classification: M21, O31, O32.

Introduction

The economic growth of the world economy is encountering the limits of the natural environment (Jaffe *et al.* 2005), such as climate change, biodiversity loss, soil degeneration and erosion, waste, water and air pollution, and the gradual depletion of resources (Barbierri *et al.* 2016). The achievement of strong decoupling between economic growth and environmental degradation is crucial and depends on technological improvements that reduce environmental pressure from production and consumption (Popp *et al.* 2010). The long-term nature of many environmental problems, such as climate change, makes understanding the evolution of technology an important part of projecting future policy impacts (Jaffe *et al.* 2003). In addition, it assumes an evolutionary view of the innovations that arise through systemic processes characterized by the interconnectedness and dynamic interactivity of the actors (J. Carrillo-Hermosilla *et al.* 2010) and opens up possibilities for internalisation of environmental problems into the economic processes themselves (Jeck 2012). Understanding of the environmental impact of overall technological changes is also important in assessing the long-term sustainability of economic growth (Jaffe *et al.* 2005).

A determinant of long-term sustainable prosperity not only of Slovakia, but also the countries in CEE – Central and Eastern Europe, is the need to respond flexibly to global challenges whilst ensuring sustainable management of their natural capital. The opportunity for the countries is an economy that can secure green growth (Štreimikienė, Mikalauskienė 2016) and development while, at the same time, contributing to increased human wellbeing through the provision of dignified work, to balance differences, the fight against poverty, and the protection of natural capital on which we all depend (Ladomerský *et al.* 2016).

The transition to a sustainable economy requires the use of low-carbon and resource-efficient solutions, and intensified efforts to promote sustainable consumption and production patterns. All this requires a proper regulatory framework, providing strong incentives for markets and innovation, strengthening financial resources, support for entrepreneurship, and greater use of the private sector (EU, Report on eco-innovation 2013b).

One of the tools for implementation and also a primary factor of a sustainable economy is, according to the European Commission (EC), eco-innovation, whose role is captured in detail in the documents of the EC (Europe 2020; EP 2005; EC 2004; EC 2011).

Eco-innovation is a relatively young concept, the awareness of which occurred as late as the beginning of the 21st century. Due to environmental degradation, however, the environmental agenda became an important political issue as early as the 60s of the 20th century and part of corporate strategy through the concept of corporate social responsibility during the 90s. However, in applying corporate social responsibility in business practice, the environmental question is wrongly gaining in importance because for many businesses, applying the principles of responsible business is an obstacle in the environmental field causing increased costs to its implementation (Hroncová Vicianová, Hronec 2017). Eco-innovation, however, offers the opportunity to elevate the importance of environmental responsibility not only with a method that leads to minimizing negative environmental impacts and protection of the environment, but also by bringing economic effects in the form of increasing the effectiveness and efficiency of production, enhancing business competitiveness, employment, productivity and ultimately, the financial performance of the company.

The study aims to analyse and assess the current state of implementation of eco-innovation in selected companies in Slovakia and identify the factors that affect their development with regard to return on investment in environmental technologies.

1. Theoretical background

With regard to eco-innovation in literature, we encounter equivalent concepts such as green innovation, environmental innovation and green technology. For the purposes of the study, we will consider any innovation aimed at significant and visible progress towards sustainable development by means of reducing environmental impacts or achieving more efficient and responsible use of natural resources, including energy (EC 2011).This is related to the fact that eco-innovations are characterized by a so-called "double externality" (Rennings 2000), since, firstly, they reduce the production of negative environmental externalities and, secondly, they might produce positive knowledge externalities (Barbieri *et al.* 2016). Further, an eco-innovation must have a benefit linked to both the environmental impact of a product or service and to the economic performance. Eco-innovation can also be defined as the implementation of new or significantly improved products or services, processes, marketing methods, organizational structures or institutional arrangements that deliberately, or as a side effect, lead to environmental improvements (OECD 2010) and are an important tool towards sustainable development (Brunklaus *et al.* 2013).

More so than standard innovations, eco-innovations are characterized by the so-called "regulatory (policy) push/pull effect" (Rennings 2000), since they are mainly regulation-driven, and regulation acts bilaterally on both the supply side (push) and the demand side (pull). By changing the relative prices of production factors or by setting new (environmental) standards, existing as well as forthcoming policies induce (environmental) innovations in each of the phases of the Schumpeterian innovation process, from invention to adoption and diffusion (Popp *et al.* 2005). Besides this standard inducement mechanism, Ghisetti and Pontini (2015) detect the presence of corporate socially responsible behaviours by firms, consisting in innovation reactions to worse environmental performance when policy stimulus is weaker. The integration of sustainability-related aspects and innovation can be beneficial for business: they can reduce costs (e.g. through an energy management system), reduce risks (e.g. through enhanced safety features) (Klewitz *et al.* 2012), increase sales and profit margins (e.g. through the introduction of premium organic brands), increase reputation and brand value, become more attractive as an employer (e.g. through better alignment between personal and company values), and build up innovation capabilities (Schaltegger 2011; Rajnoha *et al.* 2017).

According to Kemp and Pearson (2008), eco-innovation is a production, assimilation or exploitation of innovations in products, production processes, services or management business methods. Their aim is, throughout the entire life cycle, to prevent or significantly reduce the risk to the environment, pollution and other negative impacts of use of resources (including energy consumption). This definition is based on the results of innovation activities. If innovations result in a positive impact on the environment, we can define them as eco-innovation. Innovations with a positive impact on the environment are divided by Kemp and Foxon (2007) into two basic groups. The first group consists of technologies that are directly designed for environmental purposes. The second group includes innovations whose positive environmental impact are their side effects, respectively, arose in the innovation process as a by-product aimed not primarily at environmental improvement or occurred by coincidence (which may take the form of, for example, growing market share and reduced costs) (Horbach 2010, 2014). Based on the above, a broader definition of eco-innovation as any innovation that has a positive impact on the environment than the existing alternatives or strictly defined definition which defines eco-innovation as an innovation whose primary purpose is to reduce the environmental damage can be discussed (Jeck 2012).

In examining eco-innovations, their typology is also of importance. For the purposes of the study, we categorized eco-innovation according to the basic division of innovation as they were defined in the fifties of the 20th century by Schumpeter (1943), and partly by Kemp and Foxon (2007):

- Innovation of products and services (innovation of products or services which provide environmental benefits, create new green products),
- Process innovation (environmental technology, pollution control technology, cleaning technology, clean production processes, internal recycling processes, measurement technology, logistics or distribution methods),
- Organizational innovation (e.g. pollution prevention schemes, environmental management and audit systems, and chain management),
- Marketing innovation (innovations in design – eco-design services, sales or distribution services, eco-packaging) (Rosenberg 2010; Hartley 2005).

Eco-innovations, according to the OECD study (2009), can be analysed and construed in accordance with its *objectives, mechanisms and impacts*. The aim of eco-innovations can be products (goods or services), processes, marketing methods and organizations or institutions. Products and processes are usually of a technological nature, on the other hand, the marketing methods of organizations and institutions are subject to non-technological changes. The mechanisms of eco-innovation present methods which apply themselves in eco-innovation objectives. The four basic methods include (i) modification, (ii) redesign, (iii) alternatives (or substitution) or (iv) the creation of an entirely new product, process, organization or institution. Impacts of eco-innovation are understood as the effects on the environment and are the result of mutual interaction of eco-innovation objectives and mechanisms in a certain socio-technological environment.

2. Research methodology

The study aims to analyse and assess the current state of implementation of ecoinnovation in selected companies in Slovakia and identify the factors that affect their development with regard to return on investment in environmental technologies.

An analysis of the current state of eco-innovations in the selected enterprises was carried out on the basis of original empirical research which is based on a questionnaire survey on small, medium and large enterprises from selected sectors in the Slovak Republic. An analysis of the eco-innovation performance of EU countries was made on the basis of secondary data obtained from EC statistics. We chose the research sample with respect to the industry and deliberately focused on energy-intensive industries that have a significant impact on the environment and which have the prerequisites for ecological production, adaption to sustainable production and working practices, and making resources more efficient. We have statistically and graphically processed the results obtained by the questionnaire survey using statistical methods of quantitative and qualitative character analysis using Microsoft Excel and IBM SPSS Statistics 23 software.

In order to rule out any distortion of the results, we used a random selection of companies within the selected industries.

For the needs of the research, the following sectors were selected: metallurgical industry (47.2% of businesses), engineering and automotive industries (39.72% of businesses), electrotechnical industry (6.54% of businesses), chemical and pharmaceutical industries (4,67% of businesses), and the extractive industry (1.87%).

The representativeness of the group of respondents is guaranteed by respecting the geographic location of the individual regions in Slovakia and the industry affiliation of the small, medium and large enterprises SK NACE Rev. 2. 2. In order to verify the representativeness of the sample, we used the nonparametric chi-squared *($\chi 2$ – test)*, whose principle consists in verifying the correspondence of the expected theoretical distribution with the (empirical) distribution (Hebák *et al.* 2013). According to the results of the test, we can say that the sample is representative by industry sector (p-value = 0.990) and by region (p-value = 0.550).

From the total 214 companies,42 were enterprises that have implemented some kind of eco-innovation; of which eco-innovation products or services 16 businesses, eco-innovation process 23 businesses, organization eco-innovation 1 business, and marketing eco-innovation 2 businesses. The survey was conducted in the period May–August 2016.

In line with the objective of the study, the subject of the research is defined, namely eco-innovation. The object of investigation are companies in selected sectors in Slovakia.

The key methods of scientific research are the methods of classification analysis, comparison and abstraction; methods of quantitative analysis using statistical methods of processing and evaluation of information and methods of synthesis and partial induction in drawing research conclusions. In identifying dependencies in the interleaved study, we used the Friedman test, Wilcoxon signed-test, Mann-Whitney test, Kruskal-Wallis test and Spearman's ranking coefficient.

Using the Spearman coefficient method, we determined the degree of dependence between enterprise size, foreign capital, RD department and introduction of eco-innovation, as well as the amount of resources invested in resource efficiency and RD department and the share of ecological products and services in the company's annual turnover. The Spearman correlation coefficient is defined as the selective correlation coefficient calculated from the pairs $(R_1, Q_1)'$, …, $(R_n, Q_n)'$ and is determined by the factors that have the strongest effect on the introduction of eco-innovation.

Using the Fisher test, we determined whether dependence exists between the industry and the introduction of eco-innovation. It is based on the calculation of the direct probability *p,* with which a given set of frequencies *a, b, c, d,* occurs in the selection at the range $N = a + b + c + d$, or any other arrangement which is less favourable to the zero hypothesis. If the smallest observed frequency is *a,* then every smaller frequency, i.e. $a' < a$, with unchanged marginal frequency will result in closer dependencies between the examined characters. The limit case is $a' = 0$. We determined the level of significance α (for our needs $\alpha = 0.05$). If the sum of probabilities is less than the chosen significance level $(p \leq \alpha)$, the significance of the correlation between the examined characters has been proven, and therefore there is a certain dependence between these characters. The power of this dependence was calculated using the Cramer V contingency coefficient, which represents the most appropriate association (dependence) rate between the two nominal variables. It acquires values from 0 (no correlation) to 1 (perfect correlation).

Another test statistic was Pearson's chi-squared coefficient, which determined the dependence between the industry and the region and the introduction of eco-innovation. This coefficient takes values from the interval <0,1> or <1,1>. Value 0 means independence.

3. Eco-innovation performance in the EU

When evaluating the performance of eco-innovation of countries, it is necessary to be aware of the environmental challenges and the opportunities for tackling them not only in terms of short-term financial effects, but also in the longer term which envisages the sustainable development of each economy. The role of measurements of eco-innovation performance and the subsequent comparison between countries is not just a precautionary principle, but also of the development of technology and knowledge to be fully used in the eco-innovation processes in countries. One of the tools for measuring is the eco-innovation index (EC, Eco-Innovation index 2015).

The Eco-Innovation Scoreboard (Eco-IS) and the Eco-Innovation Index illustrate eco-innovation performance across the EU Member States. They aim at capturing the different aspects of eco-innovation by applying 16 indicators grouped into five dimensions: eco-innovation inputs, eco-innovation activities, eco-innovation outputs, resource efficiency and socio-economic outcomes. *Eco-innovation inputs* comprising investments (financial or human resources), which aim at triggering eco-innovation activities. *Eco-innovation activities* illustrating to what extent companies in a specific country are active in eco-innovation,

Eco-innovation outputs; quantifying the outputs of eco-innovation activities in terms of patents, academic literature and media contributions. *Resource efficiency outcomes*; putting eco-innovation performance in the context of a country's resource (material, energy, water) efficiency and GHG emission intensity. *Socio-economic outcomes*; illustrating to what extent eco-innovation performance generates positive outcomes for social aspects (employment) and economic aspects (turnover exports). The Eco-Innovation Index shows how well individual Member States perform in different dimensions of eco-innovation compared to the EU average and presents their strengths and weaknesses. The Eco-IS and the Eco-Innovation Index complement other measurement approaches of innovativeness of EU countries and aim to promote a holistic view on economic, environmental and social performance.

Since 2010, the European Union has published the eco-innovation performance of its member states. In the project The Eco-Innovation Observatory, the innovation capacity of the Slovak Republic is assessed as very low. In 2013, the performance of the Slovak economy in eco-innovation achieved only 47 percent of the EU average; only Cyprus, Poland and Bulgaria achieved a worse score in that year. However, eco-innovation performance in Slovakia has an upward trend; in 2014, it rose to 68% and in 2015 to 72%. Despite this growth in eco-innovation performance, Slovakia is still among those countries that are below the EU average. This means that it achieves less than 80% of the EU average (Table 1).

Table 1. Eco-Innovation index in EU

State/year	2010	2011	2012	2013	2014	2015
Denmark	155	138	136	129	185	167
Finland	156	149	150	138	135	140
Ireland	101	118	113	95	136	134
Germany	139	123	120	132	134	129
Luxembourg	94	130	108	109	188	124
Sweden	128	142	134	138	123	124
France	96	99	96	108	112	115
Austria	131	125	112	106	106	108
Italy	98	90	92	95	99	106
Spain	101	128	118	110	107	106
United Kingdom	103	105	101	122	100	106
Portugal	72	81	84	79	99	102
EU28				100	100	100
Czech Republic	73	91	90	71	92	99
Netherlands	110	109	111	91	96	98
Belgium	114	115	118	101	96	97
Slovenia	75	109	115	74	91	96
Romania	52	67	78	63	76	82
Hungary	70	83	73	61	79	81
Estonia	56	74	78	72	74	80
Latvia	60	77	71	52	72	75
Lithuania	45	52	53	66	71	73
Greece	55	59	67	66	72	72
Slovakia	48	52	54	47	68	72
Croatia	0	0	0	57	87	67
Malta	66	82	72	67	57	64
Cyprus	64	71	74	43	59	60
Poland	54	50	54	42	63	59
Bulgaria	58	67	80	38	49	49

Source: EC (2015).

Table 1 shows the results from the aggregated Eco-IS in 2010–2015. In 2015, countries are ranked according to the level attained on the eco-innovation index. For illustrative purposes, countries have been clustered into three groups: 1. Eco-innovation leaders, scoring significantly higher than the EU average; 2. Average eco-innovation performers with scores around the EU average; and 3. Countries catching up in eco-innovation, with around 80% or less performance compared to the EU average (in 2015).

In the 2015 version of the Eco-IS, Denmark scored by far the highest of all EU countries, with an aggregate score of 167. Denmark was followed by Finland (140), Ireland (134) and Germany (129). Likewise, Sweden, Luxembourg and France have been grouped in the "eco-innovation leading" countries. Nine Member States obtained scores around the EU average of 100 and were therefore addressed as "average eco-innovation performers". The aggregated eco-innovation scores in this group range from 108 (Austria) to 96 (Slovenia). With the exception of Greece, all countries found in the group of "countries catching up in eco-innovation" were new Member States. Aggregated scores in this country group range from 82 in the case of Romania to 49 in the case of Bulgaria.

4. Current state of eco-innovation in Slovakia

In our survey, we examine whether the size of the company influences the introduction of eco-innovations in the surveyed companies (Table 2). Based on the p-value (0.466), we can confirm that moderate dependence exists between the size of the company and the introduction of eco-innovations, meaning that the larger the company, the more eco-innovations are introduced. In our survey, it is therefore not SMEs which are the bearers of eco-innovation in the relevant sector. These results are also related to the fact that for the needs of the survey we deliberately selected sectors that significantly affect the environment, namely heavy industry companies that require more investment, and are therefore more a matter of big business. We can also state that the introduction of eco-innovation in those companies surveyed depends on the sector (based on Cramer V, r = 0.416) and the presence of foreign capital (Spearman's ranking coefficient 0.553) and are independent of region (p-value = 0.096).

According to the OECD (2009: 16), the researched industries currently contribute significantly to the development of eco-innovation: the automotive industry which aims at streamlining vehicle energy efficiency while increasing their safety; the metallurgical industry in recent years introduced a number of austerity measures and technological eco-innovations; the electronics industry is focussed on reducing the energy consumption of the products themselves.

The strongest dependence (0.699) exists between the presence of a company's own research and development department (R&D) and the introduction of eco-innovations. 73.81% of companies that have introduced eco-innovations have their own R&D departments. Most companies with their own R&D departments operate in the engineering and automotive industries (35.71%) and in the chemical and pharmaceutical industries (23.81%). Companies with their own R&D departments, on average, rated the importance of information from them with a score of 3.73 points out of a total of 5 points.

The most rated sources of information from the studied companies stem from scientific research institutions and consultancy firms (3.95 points) and information from conferences, trade fairs and exhibitions (3.76 points). It follows that the studied companies in Slovakia are still increasingly reliant on resources from external sources. Our findings also agree with the research by Belil *et al.* (2011) confirming that information from external sources is more important in developing eco-innovations than in developing innovations in general.

Table 2. Correlation between eco-innovations and selected factors

Test statistic/Variable			Company size	Foreign capital	Research and development department	Eco-Innovation
Spearman‘s rho	Company size	Correlation Coefficient	x	0.478**	0.405**	0.466**
		Sig. (2-tailed)	x	0.000	0.000	0.000
		N	x	214	214	214
	Foreign capital	Correlation Coefficient	0.478**	x	0.594**	0.553**
		Sig. (2-tailed)	0.000	x	0.000	0.000
		N	214	x	214	214
	Research and development department	Correlation Coefficient	0.405**	0.594**	x	0.699**
		Sig. (2-tailed)	0.000	0.000	x	0.000
		N	214	214	x	214
Pearson Chi-Square	Sector	Cramer‘s V	x	x	x	0.416
		Asymp. Sig. (2-sided)	x	x	x	0.000
		N	x	x	x	214
	Region	Pearson Chi-Square	x	x	x	12.134
		Asymp. Sig. (2-sided)	x	x	x	0.096
		N	x	x	x	214

Note: **Correlation is significant at the 0.01 level (2-tailed).
Source: author's own research processed by SPSS.

Horbach (2014) also warns of the importance of R&D departments, and attributes the existence of an R&D department and the use of results from its own internal resources, especially in wealthy Western countries. Eastern European countries, according to authors, are more dependent on external measures for R&D, suggesting the transfer of technology from the West to the East. In these countries, the state in particular plays an important role in eco-innovation, and therefore, these countries are more dependent on subsidies. Regulatory activities of the state are therefore less important in western countries, which is also related to environmental awareness, which in western countries is higher than in the eastern ones.

The issues of development of eco-innovations in business practices need to be addressed and likewise, cooperation between the actors in the field. According to the SIEA (2013), up to 68% of companies cooperate with other companies or institutions during the innovation process, compared with 28% of non-cooperative enterprises, suggesting that the innovative process in Slovak companies is becoming an interactive affair. Even eco-innovative companies are not an exception, which is confirmed by the results of our survey which showed that only 4% of companies do not cooperate in the development of eco-innovation with any other actors (Fig. 1).

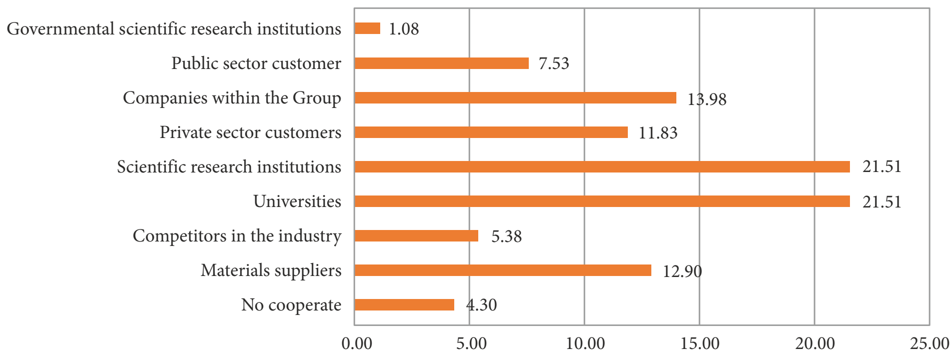

Fig. 1. Cooperation for eco-innovation development, in %
Source: author's own research.

Most eco-innovation arose between companies and scientific research institutions (21.51%) and between businesses and universities (21.51%). Despite being the most common cooperation, there are, however, reserves in the field of cooperation between companies and universities in Slovakia, which cause structural characteristics of the economy, seen as state-implemented measures and approaches and characteristics of the various actors (Brzica 2015) and a sustainability strategy in this area (Svidroňová 2013). According to Varga (2013 Country Brief), the biggest problems are: underfunding of Slovak schools, the preference of the quantity of course specialisation over quality, the amount of financial resources allocated for teachers, materials and equipment, and according to Černá *et al.* (2012), the fragmentation of the research sector, weak business involvement in research and the education process, and in particular, underfunding of the entire field of R&D.

Companies and universities are attempting to gain the effects from collaboration through: the successful careers of their staff (universities and companies); conditions for scientific work (universities); and commercial success in the field of eco-innovation (companies) (Brzica 2015). However, in some heavily science-based industries the most effective form of cooperation are patents and joint research (Belderbos, Carree 2004).

Eco-innovations originated in the surveyed enterprises also on the basis of cooperation between companies within the group of companies (13.98%), with material suppliers (12.90%), with clients from the private sector (11.83%), and customers in the public sector (7.53%). The least companies cooperated with government and scientific research institutions (1.08%). These results indicate that a relatively large number of eco-innovation in Slovakia is created through joint cooperation of businesses, as well as in cooperation with other relevant actors. These results partly agree with the research conducted by Kim and Wilemon (2002), where the highest collaboration is recorded with suppliers and customers, and also with Bocken *et al.* (2014) where up to 80% of suppliers and customers are involved in the innovation process, in 50% they are technology clusters. Based on the above survey results, we can say that enterprises rely heavily on external partners, which also concurs with comparative surveys (Kim, Wilemon 2002; Bocken *et al.* 2014; Horbach 2014).

5. Eco-innovation efficiency

The development of ecological technology in recent years has shown that investing in environmentally friendly technology is not an expensive obligation, but a huge economic opportunity (Dragomir 2013). In that almost every sector suffered heavy losses as a result of the recession, the ecological sector, despite a decline in growth, continues to gain strength (EP 2013a).

According to the SBA (2014), the performance of Slovak SMEs in the field of the environment is better than the EU average. This is evidenced by a survey carried out by the SBA in 2014. The percentage of SMEs in Slovakia, where the turnover in ecological products or services contributes more than 50%, is 18% (Survey in 2013), whereas the EU average is 22%. The percentage of SMEs which took measures in the field of resource efficiency is 95%, the EU average is 95%; the percentage of SMEs in Slovakia that offer ecological products or services is 32%, the EU average is 26%.

From a historical viewpoint, Schumpeter (1937) had already identified innovation as "new combinations of factors of production" through which new products and services that increase productivity and economic growth are placed on the market. Economic growth in a country is therefore directly dependent on innovation (Schumpeter 1939). From a microeconomic perspective, innovations, through the introduction of information and communication technologies, biotechnology, nanotechnology and new types of materials and energy, yield growth in effectiveness and efficiency of production and provision of services, an increase in productivity, and reduce transaction costs (Garnsey, Wright 1990). Eco-innovation also yields similar effects, even if on the one hand the investment is presumed to realize efficient use of resources. On the other hand, they represent an opportunity for new niche businesses, and small and medium-sized enterprises (SMEs); they offer the possibility to take advantage of new markets and business models by reviving existing traditional economic sectors through opportunities for ecologisation of existing jobs, and the adaptation of sustainable production and workflows that efficiently use resources. This offers businesses the opportunity to gain new customers who are not necessarily environmentally sensitive, and thereby increase their competitiveness.

According to Porter & Van der Linde (1995), they can have a positive impact on the long-term performance of a company, in the short-term they may affect the profitability indicators (e.g. stock-market gains) (Dechezlepretre, Sato 2014). Greve (2003) notes that companies begin to develop innovative activity as a result of poor performance. Mazzanti and Zoboli (2009) emphasize that environmental innovation plays a key role in the environmental and economic performance of the company. The positive impact on business performance was also confirmed by Lanoie *et al.* (2011), who explored the relationship between regulatory measures on the environment and their impact on economic performance on a sample of 4,200 companies from 7 countries of the OECD. It has a positive impact on business performance, despite the fact that the cost of environmental measures cannot completely be compensated for. Horbach and Rennings (2013) highlighted the existing potential for job creation due to the introduction of new environmentally considerate products and services rather than the effect of eco-innovation.

Barbieri *et al.* (2016), however, highlight the diversity in measuring the impact of eco-innovation on company performance, which can produce positive results.

Despite Barbier's criticism, it is clear that eco-innovation can enhance business competitiveness, employment, productivity, and promote the growth of the financial performance of the company.

Based on the above facts, we investigated whether there is a correlation between the sum of funds invested for improving resource efficiency and the share of ecological products and services on the annual turnover of the company (Table 3). In determining the premise, we started from the fact that a company has to invest a percentage of its turnover in the development of eco-innovation, and from the expectation that the company has a return on invested funds in the form of profits, respectively, an increase of other economic indicators, namely an increase in turnover from the sale of ecological products and services resulting from the eco-innovation. Furthermore, we relied on a broad idea of the concept of eco-innovation that defines eco-innovation as any form of innovation aimed at progress towards achieving sustainable development by reducing the impact on the environment and ensuring the efficient and responsible use of resources.

To determine the dependence, we used Spearman's ranking coefficient. We can confirm a moderately strong linear relationship (0.546) between the sum of funds invested for improving resource efficiency and the share of ecological products and services on the annual turnover of the company. This means that the more money companies invest on efficient use of resources, the higher is the proportion of ecological products and services on the annual turnover of the company.

The following graph (Fig. 2) illustrates the average annual investment required for more efficient use of resources as a percentage of turnover and the proportion of ecological products and services on the annual turnover of the company. The graph clearly shows that the greatest number of businesses is at 21% or more in annual sales, whether in the annual average funds invested on the efficient use of resources or a share of ecological products and services on the annual turnover of the company. Most funds (21% or more of turnover) were invested in more efficient use of resources by 12 companies, 11 to 20% of annual turnover was invested in eight businesses, likewise, 8 companies invested 6–10% of their annual turnover and nine companies invested up to 5%.

Table 3. Efficiency investments in environmental technologies

	Test statistic/Variable		The sum of funds invested for improving resource efficiency	Share of ecological products and services on the annual turnover of the company	Research and development department
Spearman's rho	The sum of funds invested for improving resource efficiency	Correlation Coefficient	x	0.546**	0.332*
		Sig. (2-tailed)	x	0.001	0.041
		N	x	36	38
	Share of ecological products and services on the annual turnover of the company	Correlation Coefficient	0.546**	x	0.160
		Sig. (2-tailed)	0.001	x	0.351
		N	36	x	36
	Research and development department	Correlation Coefficient	0.332*	0.160	x
		Sig. (2-tailed)	0.041	0.351	x
		N	38	36	x

Notes: **Correlationis significant at the 0.01 level (2-tailed); *Correlation is significant at the 0.05 level (2-tailed).
Source: author's own research processed by SPSS.

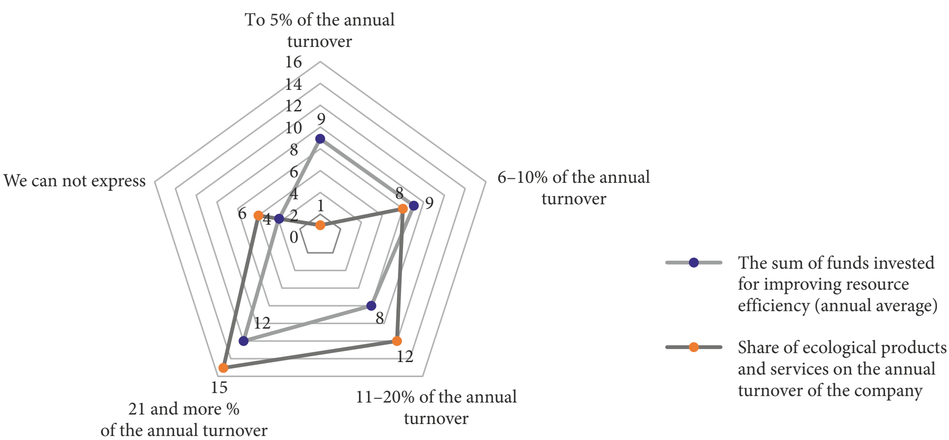

Fig. 2. Efficiency investments in environmental technologies
Source: author's own research.

The highest possible proportion of ecological products and services on the annual turnover of the company (21% or more) was attributed to as many as 15 companies, 12 companies had an 11 to 20% share of the annual turnover. These results of the survey confirm the growing interest in ecological products.

Further attention was focused on the economic and environmental benefits that accrue from the introduction of eco-innovation by companies. Eco-innovation reduces material requirements, utilises closed material flows or generates, respectively, uses new materials. At the same time, it also focusses on reducing energy demand or creating, respectively, using alternative energy sources, reducing its overall emissions to the environment or existing environmental burdens and health risks (Loučanová, Trebuňa 2014). At present, there is growing interest in eco-innovation among young people. This increasing market demand for ecological products is related to the fact that young people have a greater awareness of the environment (Musová 2013; Maráková *et al.* 2015), climate change, use of alternative materials, environmentally friendly production processes, distribution, packaging and eco-design (Žabkar *et al.* 2013).

According to our research, following the introduction of eco-innovation, companies achieved the following effects (Fig. 3), whereby the points are evaluated on a scale from 1 to 5, where 5 has the greatest impact on the indicator.

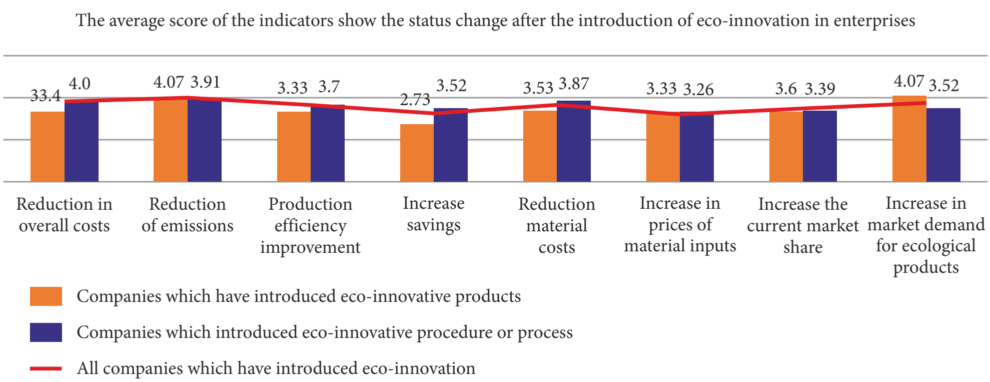

Fig. 3. Eco-innovation indicators
Source: author's own research.

For companies which have introduced eco-innovative products, the most rated indicators are those which are significantly environmental in nature; reduction of emissions and increase in market demand for ecological products; for those companies which introduced eco-innovative procedure or process it is a reduction in overall costs, and a reduction in emissions and material costs. Our results are consistent with the results of Klewitz *et al.* (2012), where enterprises have been motivated to the greatest extent by cost-effectiveness, i.e. cost reduction, and in the research of Bocken *et al.* (2014) which was 83% in reduction in emissions and waste.

Discussion, limitations and conclusions

In our survey, eco-innovation was mainly the concern of large companies with foreign capital and their own R&D department. This is despite the view that the bearers of innovation, in general, are primarily small and medium-sized ones. For the creation and commercialization of knowledge in favour of eco-innovation it is essential to shape the conditions for improving the parameters of the functioning of innovation actors and stimulate cooperation between them. Despite the fact that cooperation between the actors in the development of eco-innovation suggests that the eco-innovation process in the studied sectors is an interactive affair, there are still reserves in this area.

Cooperation in the development of eco-innovation in the surveyed enterprises in our survey is mainly carried out with scientific institutions (21.51%), universities (21.51%), clusters (13.98%), suppliers (12.90%) and through customers, whether from the private (11.83%) or public sector (7.53%). Based on the above survey results, we can say that enterprises rely heavily on external partners. This fact is confirmed by the weighting of 3.95 points from a possible 5 points allocated by the enterprises in our survey for information from scientific institutions and consulting agencies and 3.46 points for information from conferences and trade fairs.

Despite the importance of external information and business cooperation with external entities, the results of our survey also confirmed the importance of an enterprise's own R&D department because the highest dependence ($r = 0.699$) was confirmed exactly between the existence of an R&D department and the introduction of eco-innovation. The enterprises surveyed rated information from internal sources (R&D) at an average 3.73 points out of 5 possible points.

An opportunity for companies is the establishment of a separate department, a so-called environmental division aimed at monitoring and improving the environmental performance and cooperation of the researched networks in the industry.

Development in the field of environmental technologies in recent years has shown that investing in ecological technologies brings growth to business competitiveness, employment, productivity and promotes the growth of the financial and environmental performance of the enterprise and may have a positive impact on the long-term performance of the enterprise.

This argument is supported by the results of our survey, to the extent that in the studied sectors the return on investment in environmental technologies was confirmed by a moderately strong dependence (0.546) between the amount of funds invested for improving resource efficiency and the share of green products and services on the annual turnover of the company. Testing the presented dependence is unique because the dependence between the amount of funds invested in more efficient use of resources and the share of organic products and services in the annual turnaround of the enterprise, according to our knowledge, has not yet been tested. Economic and environmental benefits which yield eco-innovations have an unquestionable value. Following the introduction of eco-innovations, the surveyed companies reported, in particular, a reduction of emissions, an increase in market demand for environmentally friendly products and a reduction in overall costs.

Support of the development of eco-innovation can therefore be seen as a rational step that is not directed only to the protection of the environment but also the economical use of resources such as energy savings, raw materials, renewable resources, substitution of materials or products, recycling and so on. Prospects for the development of eco-innovation could be the transformation of established industries into the environmental industry with a high added value which will create jobs while still protecting the environment. Ecological solutions will attract a new generation of producers and services in the high-tech field, increase competitiveness and create new highly specialized jobs whilst on the other hand, attracting environmentally sentient customers.

This research has a few limitations. Firstly, the sample of respondents is limited to 214 small, medium and large enterprises. This research has the potential for further expansion of the research sample and for more detailed results.

A further limitation is the selected industries. For our research purposes, we deliberately chose the most energy-intensive sectors that have the potential to greatly influence the environment. For the needs of further expansion of the research and comparison of the factors examined, findings may be interesting in other sectors which may not only be of a manufacturing character but, for example, services and trade, as these sectors also have the potential to develop eco-innovations. These results could bring interesting, statistically significant analysis of the differences between these different sectors.

The final limitation is an intensive review of the co-operation itself in creating eco-innovations, because the combination of innovation system thinking and proper knowledge sharing leads to a higher level of adoption of new or improved technologies or practices. An innovation system in this context is the combination of different factors – economic, social, political, organizational, institutional - that influence the development, diffusion, and adoption of innovations.

In spite of these limitations, we can provide useful results for future research, both for professionals and for corporate practice. Despite the size of the research sample and the limited number of industries, we can confirm that the industries in Slovakia have the potential to use eco-innovation across the whole range of economic activities, to develop new technologies and knowledge, and to create and develop partnerships, networks and mutual cooperation for eco-innovation.

Funding

This work was supported by the <VEGA> under Grant [VEGA 1/0651/17 Drafting the innovative synergetic Corporate Social Responsibility model as a perspective the implementation of responsible entrepreneurship in small and medium enterprises].

References

Barbieri, N.; Ghisetti, C.; Gilli, M.; Marin, G.; Nicolli, F. 2016. A survey of the literature on environmental innovation based on main path analysis, *Journal of Economic Surveys* 30(3): 596–623. https://doi.org/10.1111/joes.12149

Belderbos, R.; Carree, M. B. 2004. Cooperative R&D and firm performance, *Research Policy* 33(10): 1477–1492. https://doi.org/10.1016/j.respol.2004.07.003

Belil, J.; Horbach, J.; Oltra, V. 2011. *Determinants and specifities of eco-innovation. An econometric analysis for the French and Germany industry based on the community innovation survey* [online], [cited 11 July 2017]. Working Paper of Gretha. Available from Internet: http://cahiersdugretha.u-bordeaux4.fr/2011/2011-17.pdf

Bocken, N. M. P.; Farracho, M.; Bosworth, R.; Kemp, R. 2014. Corrigendum to "The frond-end of eco-innovation for eco-innovative small and medium sized companies", *Journal of Engineering and Technology Management* 31: 43–57. https://doi.org/10.1016/j.jengtecman.2013.10.004

Brunklaus, B. *et al.* 2013. *Eco-innovative measures in large Swedish companies – An inventory based on company reports* [online], [cited 15 October 2015]. Vinno Va – Swedish Governmental Agency for Innovation Systems/Verket för Innovationssystem. Available from Internet: http://www.vinnova.se/upload/EPiStorePDF/va_13_03.pdf

Brzica, D. 2015. Development of innovation, cooperation and motivation of workers in the context of the knowledge society: some challenges faced by the Slovak Republic, *Prognostic Work* 7(1): 33–52 [online], [cited 02 October 2016]. Available from Internet: http://www.prog.sav.sk/fileadmin/pusav/download_files/prognosticke_prace/2015/PP7_1_2015_Brzica_cl2.pdf

Carrillo-Hermosilla, J.; del Río, P.; Könnölä, T. 2010. Diversity of eco-innovations: reflections from selected case studies, *Journal of Cleaner Production* 18: 1073–1083. https://doi.org/10.1016/j.jclepro.2010.02.014

Černá, J.; Vicenová, E.; Čambál, M. 2012. Increase the innovative capacity of enterprises through cooperation with universities, in *Barriers of distribution routes and knowledge from Universities to the business environment*. Trnava: Univerzita sv. Cyrila a Metoda v Trnave, 23–28.

Dechezlepretre, A.; Sato, M. 2014.*The impacts of environmental regulations on competitiveness.* Policy brief. Grantham Research Institute on Climate Change and the Environment, Global Green Growth Institute.

Dragomir, V. D. 2013. Environmental performance and responsible corporate governance: an empirical note, *E&M Ekonomie a Management* 16(1): 52–68.

EC. 2004. *Stimulating technologies for sustainable development: an environmental technologies action plan for the European Union* [online], [cited 2 October 2016]. European Commission. Available from Internet: http://www.sazp.sk/public/index/go.php?id=1914

EC. 2011. *Attitudes of European entrepreneurs towards eco-innovation*. Analytical report [online], [cited 2 October 2016]. European Commission. Available from Internet: http://ec.europa.eu/public_opinion/flash/ fl_315_en.pdf

EC. 2015. *Eco-innovation for a sustainable future (EcoAP)* [online], [cited 2 October 2016]. European Commission. Available from Internet: http://ec.europa.eu/environment/ecoap/

EC. 2015. *The eco-innovation scoreboard and the eco-innovation index* [online], [cited 2 October 2016]. European Commission. Available from Internet: http://ec.europa.eu/environment/ecoap/scoreboard_en

EP. 2005. *Stimulating technologies for sustainable development framework program for competitiveness and innovation (2007–2013)* [online], [cited 2 October 2016]. European Commission. Available from Internet: http://eur-lex.europa.eu/legal-content/SK/TXT/PDF/?uri=CELEX:32006D1639&from=SK

EP. 2013a. *Draft resolution on eco-innovation*, 2012/2294 (INI) [online], [cited 2 October 2016]. European Commission. Available from Internet: http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+REPORT+A7-2013-0333+0+DOC+PDF+V0//SK

EP. 2013b. *Report on green innovations – employment and growth through environmental policy* (2012/2294 (INI)) [online], [cited 2 October 2016]. European Commission. Available from Internet: http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+REPORT+A7-2013-0333+0+DOC+XML+V0//SK

Europe 2020. 2010. *A strategy for smart, sustainable and inclusive growth* [online], [cited 02 October 2016]. European Commission. Available from Internet: http://ec.europa.eu/eu2020/pdf/COMPLET%20EN%20BARROSO%20%20%20007%20-%20Europe%202020%20-%20EN%20version.pdf

Garnsey, E.; Wright, S. M. 1990. Technical innovation and organizational opportunity, *International Journal of Technology Management* 5(3): 267–291.

Ghisetti, C.; Pontoni, F. 2015. Investigating policy and R&D effects on environmental innovation: a meta-analysis, *Ecological Economics* 118: 57–66. https://doi.org/10.1016/j.ecolecon.2015.07.009

Greve, H. R. 2003. A Behavioral Theory of R&D expenditures and innovations: evidence from shipbuilding, *Academy of Management Journal* 46(6): 685–702. https://doi.org/10.2307/30040661

Hartley, J. 2005. Innovation in governance and public services: past and present, *Public Money & Management* 25(1): 27–34.

Hebák, P., *et al.* 2013. *Statistical thinking and data analysis tools.* Praha: Informatorium.

Horbach, J. 2010. The impact of innovation activities on employment in the environmental sector-empirical results for Germany at the firm level, *Journal of Economics and Statistics* 230(4): 403–419. https://doi.org/10.1515/jbnst-2010-0403

Horbach, J. 2014. *Determinants of eco-innovation from a European-wide perspective – an analysis based on the Community innovation survey.* Sustainability environment economies and dynamics studies, Working paper 7/2014. University of Applied Sciences Augsburg. Available from Internet: http://www.sustainabilityseeds.org/

Horbach, J.; Rennings, K. 2013. Environmental innovation and employment dynamics in different technology fields–an analysis based on the German community innovation survey 2009, *Journal of Cleaner Production* 57: 158–165. https://doi.org/10.1016/j.jclepro.2013.05.034

Hroncová Vicianová, J.; Hronec, Š. 2017. Environmental impact of application on the concept of corporate social responsibility in selected EU countries, *Problemy Ekorozwoju-Problems of Sustainable Development* 12(2): 79–88.

Jaffe, A. B.; Newell, R. G.; Stavins, R. N. 2003. Technological change and the environment, in K.-G. Maler, J. Vincent (Eds.). *Handbook of environmental economics*. Amsterdam: North-Holland/Elsevier, 1: 461–516.

Jaffe, A. B.; Newell, R. G.; Stavins, R. N. 2005. A tale of two market failures: technology and environmental policy, *Ecological Economics* 54: 164–174. https://doi.org/10.1016/j.ecolecon.2004.12.027

Jeck, T. 2012. *Eco-innovation: theoretical and economic-policy contexts*. Bratislava: Economic Institute SAV [online], [cited 11 October 2016]. Available from Internet: http://ekonom.sav.sk/uploads/journals/216_wp42_tomas_jeck_2012.pdf

Kemp, R.; Foxon, T. 2007.*Measuring eco-innovation. Typology of eco-innovation* [online], [cited 02 May 2013]. Available from Internet: http://www.merit.unu.edu/MEI/deliverables/MEI%20D2%20Typology%20of%20eco-innovation.pdf

Kemp, R.; Pearson, P. 2008. *Measuring eco-innovation.* Final report. MEI project about measuring eco-innovation, Project No: 044513. Brussels: European Commission [online], [cited 02 January 2014]. Available from Internet: https://www.oecd.org/env/consumption-innovation/43960830.pdf

Kim, J.; Wilemon, D. 2002. Focusing the fuzzy front-end in new product development, *R&D Management* 32(4): 269–279. https://doi.org/10.1111/1467-9310.00259

Klewitz, J.; Zeyen, A.; Hansen, E. G. 2012. Intermediaries driving eco-innovation in SMEs: a qualitative investigation, *European Journal of Innovation Management* 15(4): 442–467. https://doi.org/10.1108/14601061211272376

Ladomerský, J; Janotka, I.; Hroncová, E.; Najdená, I. 2016. One-year properties of concrete with partial substitution of natural aggregate by cupola foundry slag, *Journal of Cleaner Production* 6(131): 739–746. https://doi.org/10.1016/j.jclepro.2016.04.101

Lanoie, P.; Laurent-Lucchetti, J.; Johnstone, N.; Ambec, S. 2011. Environmental policy, innovation and performance: new insights on the Porter hypothesis, *Journal of Economics & Management Strategy* 20(3): 803–842. https://doi.org/10.1111/j.1530-9134.2011.00301.x

Loučanová, E; Trebuňa, P. 2014. Eco-innovation as a tool for competitiveness, *Transfer of Innovations* 29: 76–80.

Maráková, V.; Lament, M.; Wolak-Tuzimek, A. 2015. Reporting standards in socially responsible enterprises, *Ekonomičnij Časopis – XXI* 20(9–10): 56–59.

Mazzanti, M.; Zoboli, R. 2009. Environmental efficiency and labour productivity: trade-off or joint dynamics? A theoretical investigation and empirical evidence from Italy using NAMEA, *Ecological Economics 68*(4): 1182–1194. https://doi.org/10.1016/j.ecolecon.2008.08.009

Musová, Z. 2013. *Corporate social responsibility in marketing practice.* Banská Bystrica: Univerzita Mateja Bela, Ekonomická fakulta.

OECD. 2009. *Sustainable manufacturing and eco-innovation framework, practices and measurement* [online], [cited 2 October 2016]. OECD. Available from Internet: http://www.oecd.org/sti/innovationinsciencetechnologyandindustry/ 43423689.pdf

OECD. 2010. *Eco-innovation in industry: enabling green growth*. Synthesis report. OECD, Paris.

Popp, D.; Newell, R. G.; Jaffe, A. B. 2010. Energy, the environment, and technological change, *Handbook of the Economics of Innovation* 2: 873–937.

Porter, M. E.; Van der Linde, C. 1995. Toward a new conception of the environment-competitiveness relationship, *The Journal of Economic Perspectives* 9(4): 97–118. https://doi.org/10.1257/jep.9.4.97

Rajnoha, R.; Lesníková, P; Krajčík, V. 2017. Influence of business performance measurement systems and corporate sustainability. Concept to overall business performance: "Save the planet and keep your performance", *E&M Ekonomie a Management* 20(1): 111–128. https://doi.org/10.15240/tul/001/2017-1-008

Rennings, K. 2000. Redefining innovation – eco-innovation research and the contribution from ecological economics, *Ecological Economics* 32(2): 319–332. https://doi.org/10.1016/S0921-8009(99)00112-3

Rosenberg, N. 2010. Schumpeter and history, in N. Rosenberg (Ed.). *Studies on science and the innovation process.* New Jersey: World Scientific Publishing Co.

SBA. 2014. *Analyzes and surveys of the business environment* [online], [cited 2 October 2016]. Slovak Business Agency. Available from Internet: http://www.sbagency.sk/analyzy-slovenskeho-podnikatelskeho-prostredia#.WNN1ZCi25C4

Schaltegger, S. 2011. Sustainability as a driver for corporate economic success. Consequences for the development of sustainability management control, *Society and Economy* 33(1): 15–28. https://doi.org/10.1556/SocEc.33.2011.1.4

Schumpeter, J. A. 1937. *Theorie der wirschaftlichen entwicklung.* Reprinted in Essays of J. A. Schumpeter. Cambridge, MA: Addison-Wesley.

Schumpeter, J. A. 1939. *Business cycles: a theoretical, historical and statistical analysis of the capitalist process.* New York: Mc Graw-Hill.

Schumpeter, J. A. 1943. *Capitalism, socialism, and democracy*. Reprinted in Essays of J. A. Schumpeter. Cambridge, MA: Addison-Wesley.

SIEA. 2013. *Innovative Slovakia* [online], [cited 02 October 2016]. Available from Internet: https://www.siea.sk/materials/files/inovacie/publikacie/publikacia_Inovativne_Slovensko_vychodiska_a_vyzvy_SIEA.pdf

Štreimikienė, D.; Mikalauskienė, A. 2016. Green growth and use of EU structural funds in Baltic states, Czech Republic and Slovakia, *E&M Ekonomie a Management* 19(2): 55–72. https://doi.org/10.15240/tul/001/2016-2-004

Svidroňová, M. 2013. Sustainability strategy of non-government organisations in Slovakia, *E&M Ekonomie a Management* 16(3): 85–100.

Varga, H. 2013. *Eco-innovation in Slovakia.* Country profile 2013: Slovakia. Eco-Innovation Observatory [online], [cited 15 September 2013]. Available from Internet: www.eco-innovation.eu

Žabkar, V.; Čater, T.; Bajde, D.; Čater, B. 2013. Environmental strategy: a typology of companies based on managerial perceptions of customers, environmental activeness and deterrents, *E&M Ekonomie a Management* 16(3): 57–74.

Jana HRONCOVÁ VİCİANOVÁ. PhD works in the Faculty of Economics of Matej Bel University in Banská Bystrica on Department of Corporate Economics and Management. She teaches the subjects as Corporate Economics, Corporate Finance and other. Her area of researchers is Corporate Social Responsibility, Environmental Responsibility of SMEs and Eco-Innovation.

Jana JAĎUĎOVÁ. PhD works in the Faculty of Natural Sciences of Matej Bel University. Her area of researchers is Corporate Social Responsibility, Environmental Responsibility and Environmental Management.

Martin HRONEC. PhD works in the Faculty of Economics of Matej Bel University in Banská Bystrica on Department of Economics. He teaches the subjects as Macroeconomics, Economics of Education and other. His area of research is Socio-Economic Context of Education and the Labor Market, Human Capital and Unpaid Work.

Silvia ROLÍKOVÁ obtained Ing. on the field of study Business Economics and Management in the Faculty of Economics of Matej Bel University in Banská Bystrica.