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RESEARCH FOR ECO-INNOVATIVE TECHNOLOGIES IMPLEMENTATION MODEL AT ROMANIAN COMPANY LEVEL

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Abstract: *The role of the eco – innovative technologies implementation model at Romanian company level is to provide a useful tool for checking the user's own eco – innovative technologies by analyzing influence factors that act in the process. The user can access an Excel application, which presents a model applicable to the product, giving the possibility to analyze and to test several technologies versions, under different influence factors; the company goal is to obtain the optimal eco - technology. The eco – innovative technologies implementation model at the Romanian firm level is basically a way to eco - innovation, helping the development and bringing to market of new ecological technologies, products and services, that reduce the overall environmental impact. The influence factors analysis can lead to sustainable solutions achievement, that can use more economically the resources and reduce environmental impacts.*

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Key words: *Eco-innovative, technology, SMEs, sustainability*

1. Introduction

Current production and consumption of goods and services are focus on sustainable direction, in order to satisfy human needs and well-being without harming environment, depleting natural resources and damaging ecosystems. Friendly environmentally practices as reducing or eliminating waste levels and pollutants emissions, improving waste treatment, reducing raw materials demand and natural resources usage, are more and more present [1]. Sustaining these ideas, EU promotes sustainable consumption and production as overall objective in the EU Sustainable Development Strategy (EU SDS), "by addressing social and economic development within the carrying capacity of ecosystems and decoupling economic growth from environmental degradation and Improving the environmental and social performance of products and processes and encouraging their uptake by business and consumers". One of the direction to follow by EU countries is " to increase global market share in the field of environmental technologies and eco – innovations" [2].

The concern about eco-innovation shows the society commitment on environment protection, the eco-innovation being defined as "any innovation that makes progress towards the goal of sustainable development by reducing impacts on the environment, increasing resilience to environmental pressures or using natural resources more efficiently and responsibly"[3].

2. Theoretical Framework

In 2008 the European Commission presented the *Sustainable Consumption and Production and Sustainable Industrial Policy (SCP/SIP) Action Plan,* which includes proposals on sustainable consumption and production "that will contribute to improving the environmental performance of products and increase the demand for more sustainable goods and production technologies" [1]. On 3 March 2010 European Commission proposed a 10-year strategy: *Europe 2020*, for advancement of the EU economy. It aims at "smart, sustainable, inclusive growth" with greater coordination of national and European policy [4]. The Eco-innovation Action Plan (EcoAP) development focuses on "specific bottlenecks, challenges and opportunities for achieving environmental objectives through innovation", by complementing

other Europe 2020 Flagship Initiatives. Sustainable growth of EU capacities represents a priority for Europe 2020 Strategy, also the transition towards a green economy is a target for the Eco-innovation Action Plan, this issues being tackled by two flagship initiatives:

- The achievement of a "Resource efficient Europe", where the economic growth is related to a rational use of resources. "It supports the shift towards a low-carbon economy, an increased use of renewable energy sources, the modernization our transport sector and promotes energy efficiency". Resources efficiency main ideas are promoted in "The Roadmap to a resource efficient Europe".
- Business environment improvement and the key-role of small and medium enterprises (SMEs) to support sustainable industrial development are presented in "the Industrial Policy for the Globalization Era", the purpose being to obtain "the development of a strong and sustainable industrial base able to compete globally" [5].

EcoAP is defined like a "tool to identify and implement measures for the deployment of key environmental technologies"; also, it takes account of cooperation possibilities between EU and Member States, disseminations of new innovative technologies and promoting appropriate skills development.

Regarding the involvement in eco – innovation, there are substantial differences across the EU, considering innovation in environmental technologies, products and services. "The eco – innovation index is based on 16 indicators in five areas: eco-innovation inputs, eco-innovation activities, eco-innovation outputs, environmental outcomes and socio-economic outcomes" [6] and it shows the performance level of an individual Member State compared with the EU average.

As the Fig. 1 presents, " in 2013 ten Member States performed better than the EU average in terms of eco-innovation activities". The eco – innovation leading group was formed by Finland, Sweden and Germany, with the highest scores, obtained especially from "a moderate correlation observed between a relatively high eco-innovation score and material consumption and greenhouse gas emissions"[7]. At the end of the scale the countries with a low eco-innovation index were Bulgaria, Poland, Cyprus and Slovakia.

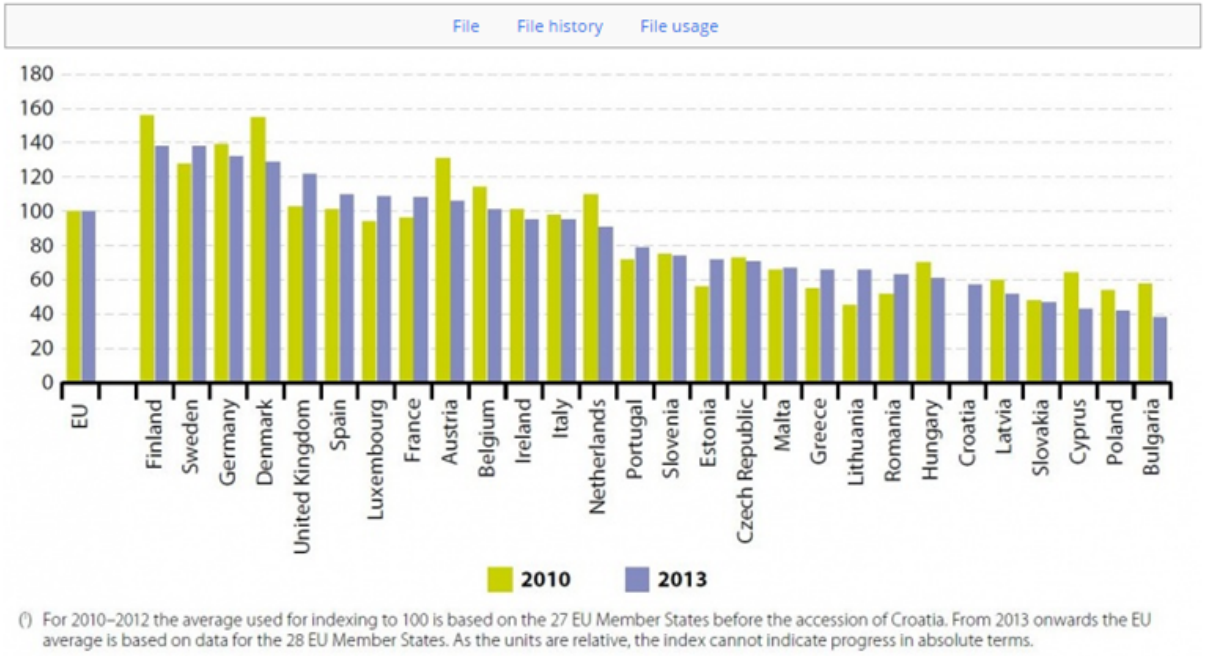

Fig. 1. *Eco-innovation index, by country, 2010 and 2013 (Eurostat)*

According to European Council environment targets and to the Kyoto Protocol, Romania aligns to Members States to the implementation of energy-climate change package, that requires the development of "a new economic model to integrate environmental concerns into the production process and the resulting products" [8].

Romanian efforts to increase eco-innovation level of enterprises are present in the participation in the "Framework Programme for Competitiveness and

Innovation 2007-2013" (CIP) – Eco-innovation component. The main idea was to improve competitiveness and innovation capacity of the European Community companies by supporting projects that aim first application or reproduction on the market of eco –innovative techniques, products or services relevant to the European Union, that have demonstrated technological success, but they didn't yet penetrated on market because of residual risk. The program is composed of a sub-program regarding entrepreneurship and innovation, providing a budget of 430 million euros for investment activities in eco-innovation projects and facilitating the access to finance for the SMEs creation and development.

The importance of eco –innovation and attracting investments in new green technologies are relevant for the achievement of sustainable economic growth. Despite some ecological recent improvements, Romania is still lagging behind the EU average, in the field of companies eco-innovation, and especially in small and medium enterprises (SMEs), where the funds to support eco-innovation are insufficient.

One of the programme areas under the Norway Grants assistance is Green Industry Innovation, where Norway gave a total contribution more than EUR 110 mill., for the financial period 2009-2014. The overall objective was to "increase the competitiveness of green enterprises, including greening of existing industries, green innovation and green entrepreneurship. The expected outcomes from this programme area are: Realization of business opportunities of greening the European economy - Reduced production of waste and reduced emissions to air, water and ground - More use of environmentally friendly technologies - Increased green job creation and entrepreneurship"[9]. In the Green Industry Innovation Programme for Romania, financed by Norway, were available 26,6milions € to increase competitiveness of involved enterprises and informing the public about the benefits of ecological production and green products / services. The supported projects are for 53 Romanian private enterprises and NGOs and they are distributed all over the country.

Data show that the SME segment is interested in obtaining grants for eco –innovation, on account of limited ability to access capital markets. Analysis of implemented projects reveals that more than 50% focuses on improvements processing facilities, equipment to increase productivity, optimization of the costs of raw materials, utilities, reducing CO2 emissions and creation of approximately 470 new jobs.

Another example of Romanian interest in eco – innovation is represented by ECOPartner -the Swiss - Romanian Cooperation Program sustaining the Partnership for eco-innovation. The project was initiated in may 2015 in Timisoara, by the Association National Centre for Sustainable Production and Consumption from Romania, in partnership with the Genovese Association for Circular Development of Circular Economy from Switzerland and the Romanian Clusters Association. Its goals are to promote eco-innovation in the Romanian enterprises, to support eco-innovation services by Romanian experts, by giving contribution and models for businesses and policy makers. The project brings together representatives experts from businesses, academia specialists, research institutions and clusters, in order to participate in the project's activities and encouraging eco – innovation partnerships.

3. Methodology

The development of Romanian "clean" technologies market is due to legislation which obliges polluting companies and intensive resources consumers to retrofit. Aided by research institutes and participating in various consortia, they develop solutions and "clean" process technologies.

State and private companies have developed own solutions and green technologies in their research - development - innovation departments, some of them being patented [10].

Creating a model for the implementation of eco – innovative technologies is a part of an extensive research, being a component of a virtual hub for eco-innovation to increase the competitiveness in recycling of waste electrical and electronic equipment (EcoInnEWaste).

By identifying Romanian successful examples and presenting them in the eco – innovation Library of the EcoInnEWaste platform - authors provide the opportunity for an analysis of a relatively wide large range of eco - innovative technologies. It is a chance for entrepreneurs to be informed and to find possible solutions, compatibility or cooperation possibility with other companies involved in waste field [11].

The development of the eco – innovative technologies implementation model is based on the analysis of Romanian enterprises with successfull green technologies and on the possibility to bring their influence factors to a common denominator.

The user can access an .xlsx application, which presents a product applicable model, giving the possiblity to analyze and to test one or more variants of technologies, under the constraint of many influence factors; the target is represented by

the achievement of the optimal eco-innovative technology.

The model uses the 6-4-3-5 method, a relatively new method, which is proposed and used in the management of innovative products and services, in order to find the best managerial decision, in a rapid manner, with minimal risk. It represents a morphological analysis which is obtained from the combination of two methods:

- the 6-4-3 method, commonly used for innovative products;
- the 6-3-5 method, normally used to determine the response time limits for the function application to product development [12].

Developing new products, technologies or services, achieving their variants or enhancements are done by using morphological analysis, being based on functions analysis that describe their performance.

The model offers to Romanian entrepreneurs the possibility to choose optimal eco- innovative technologies variants by using functions and influence factors analysis that occur in the process.

The 6-4-3-5 method involves the organization of a 6 people team, which materializes every function in 3 constructive variants (or 3 ideas) in 5 minutes and it scores each variant from 1 to 4, where 4 represents the maximum severity. The most optimistic goal is to get 18 functions for each member of the team. Often, in the same defined period of time, each member is working, but he can not find only new solutions, different from others.

For shortening the working time, while a team member materializes the "i" sub-function, another one works on "i + 1" or "i-1" sub-function. Finally, it is obtained the materialization of events conditions.

$$F_i = \begin{pmatrix} a_{11} & \cdots & a_{13} \\ \vdots & \ddots & \vdots \\ a_{61} & \cdots & a_{63} \end{pmatrix}; i \in \{a; b; c; d; e; f\}. \quad (1)$$

To get different viable solutions, for each function there are carried out different combinations between proposed solutions of the team, with the remarks that not all of these solutions are safe. Fig. 2 presents an example of possible solutions selection.

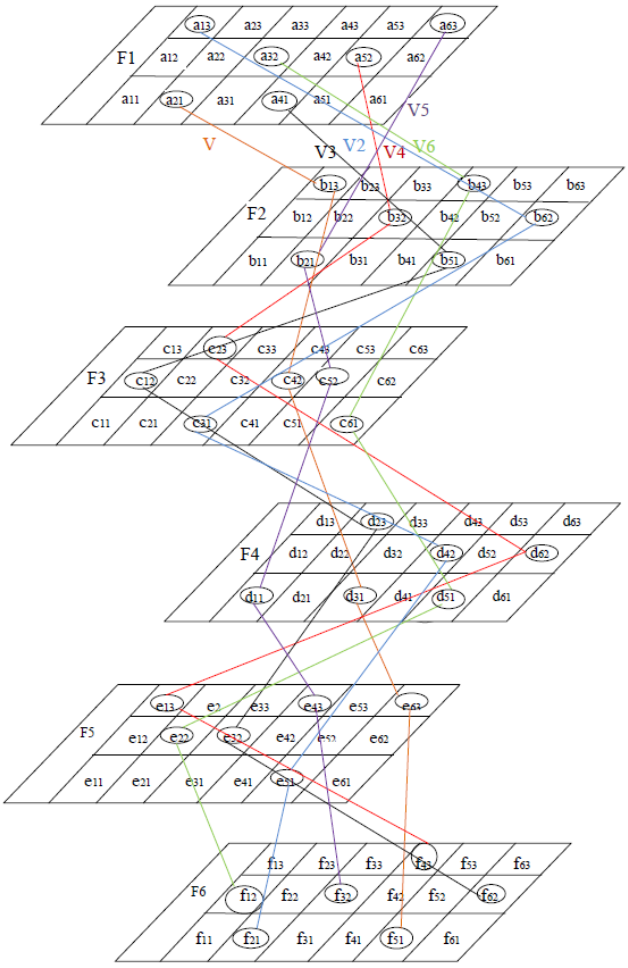

Fig. 2. *An example of possible solutions selection in 6435 method*

4. Results and Discussion

The chapter presents results and discussions for a product analysis example: an electric grill as model, in terms of sustainable development. The same procedure is offered to business environment to analyze and compare different environmental technologies solutions to find the best.

There is chosen a number of product variants selected to be analyzed comparatively. For these manufacturing versions there are analyzed most relevant factors and corresponding sub-factors, appreciating their shares over the total. For each version there will be specify the sub- factors shares involved in manufacturing, then it will be awarded with marks from 1 to 4. Finally, it results the sub-factor share over the total, for the analyzed versions. The highest value resulting for the sum of the shares of analyzed sub -factors will indicate the optimal version to choose. First step of the methodology is represented by the materialization of product functions variants (Fig. 3).

Application	Sustainable development project: *electric grill*																							
									EXAMPLE															
									1 Grant any number of variations you desire to analyze - for provided functions : A 1.1....H 4.3.															
									2 Note the factors involved in product realization and appreciate their influence score.															
Functions	The materialization of product functions versions								3 Choose product variants from the matrix elements combination that you are satisfied, in terms of product development.															
for storage	A 1.1.	A 1.2.	A 1.3.																					
	A 2.1.	A 2.2.	A 2.3.																					
	A 3.1.	A 3.2.	A 3.3.																					
	A 4.1.	A 4.2.	A 4.3.																					
seating				B 1.1.	B 1.2.	B 1.3.																		
				B 2.1.	B 2.2.	B 2.3.																		
				B 3.1.	B 3.2.	B 3.3.																		
				B 4.1.	B 4.2.	B 4.3.																		
supply							C 1.1.	C 1.2.	C 1.3.															
							C 2.1.	C 2.2.	C 2.3.															
							C 3.1.	C 3.2.	C 3.3.															
							C 4.1.	C 4.2.	C 4.3.															
electrical										D 1.1.	D 1.2.	D 1.3.												
										D 2.1.	D 2.2.	D 2.3.												
										D 3.1.	D 3.2.	D 3.3.												
										D 4.1.	D 4.2.	D 4.3.												
folding													E 1.1.	E 1.2.	E 1.3.									
													E 2.1.	E 2.2.	E 2.3.									
													E 3.1.	E 3.2.	E 3.3.									
													E 4.1.	E 4.2.	E 4.3.									
accessory																F 1.1.	F 1.2.	F 1.3.						
																F 2.1.	F 2.2.	F 2.3.						
																F 3.1.	F 3.2.	F 3.3.						
																F 4.1.	F 4.2.	F 4.3.						
baking																			G 1.1.	G 1.2.	G 1.3.			
																			G 2.1.	G 2.2.	G 2.3.			
																			G 3.1.	G 3.2.	G 3.3.			
																			G 4.1.	G 4.2.	G 4.3.			
waste disposal																						H 1.1.	H 1.2.	H 1.3.
																						H 2.1.	H 2.2.	H 2.3.
																						H 3.1.	H 3.2.	H 3.3.
																						H 4.1.	H 4.2.	H 4.3.

Fig. 3. *The materialization of product functions variants for the electric grill example*

Version 1	**A 1.1.**	**B 1.2.**	**C 4.3.**	**D 4.3.**	**E 2.3.**	**F 4.2.**	**G 2.2.**	**H 2.1.**
Version 2	**A 2.2.**	**B 2.2.**	**C 1.2.**	**D 3.1.**	**E 2.2.**	**F 3.2.**	**G 1.1.**	**H 1.1.**
Version 3	**A 1.3.**	**B 1.3.**	**C 4.2.**	**D 3.2.**	**E 4.1.**	**F 4.3.**	**G 3.1.**	**H 1.3.**

Fig. 4. *Three manufacturing options to obtain the product*

The possible solutions selection corresponding to 6-4-3-5 method (Fig. 2) is used to obtain main manufacturing options for best versions of product (technology); in our case, for the product to be analyzed are mainly presented 3 manufacturing options, (Fig. 4).

To analyze the factors involved in product (technology) development (Fig. 5) is necessary to list them (e.g. ENVIRONMENT, COST, UTILITY, DESIGN) and to give them marks from 1 to 4 based on their importance. Next step is to divide the given mark to the total of all factor grades.

(For example: you have given the following marks: 1 - 4 - 4 - 2, the notes total will be 11, each factor reference will be: 1 / 11 - 4 / 11 - 4 / 11 - 2 / 11).

Listing the sub-factors involved in product (technology) carrying out (e.g. for ENVIRONMENT: phonic pollution, chemical pollution) and giving them marks from 1 to 4 are based on their importance; after that there is established the percentage over the sub-factors marks total. Finally, it is set overall share of the analyzed sub-factor over the properly factor.

(For example:

Phonic pollution mark = 1, the total marks = 3,

the score = 1/3, the overall score of sub-factor =

= 1/3 * 1/11 = 1/33).

Chemical pollution mark = 2, the total marks = 3, the score = 2/3, the overall score of sub-factor =

= 2/3*1/11 = 2/33).

When product (technology) variants are analyzed, all factors are listed with their total shares. For each proposed version it will be appreciated each factor by a mark, then it will be calculated the appropriate related share, as a multiplication between the mark and initial share. By adding the factors shares for analyzed versions it will be chosen the version with the highest value of the sum of factors shares, (Fig. 6). (In our example case, the optimal version is version 2, having the highest sum = 2.44).

To choose the optimal technological solution for environment may be done in the same way, the SMEs manager must know all information related to specific parameters and influence factors involved in the analyze.

By adding the factors shares of analyzed versions the user can choose the optimum solution – the variant with the highest value of the factors shares sum.

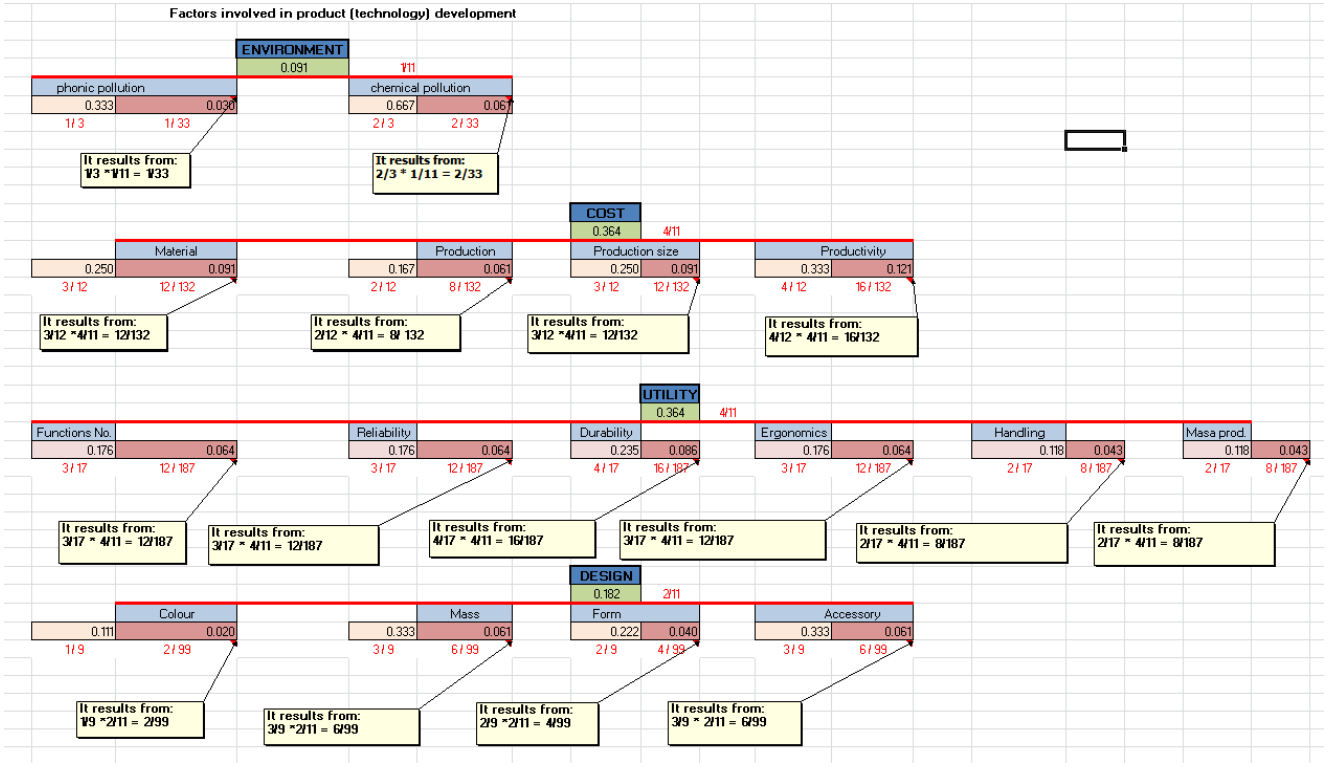

Fig. 5. *Factors involved in product (technology) development*

Analysis of product versions

Influence factors	share		Version 1		Version 2		Version 3	
	(fraction)	decimals	Mark (points)	share	Mark (points)	share	Mark (points)	share
Phonic pollution	1/33	0.030	1	0.03	3	0.09	2	0.06
Chemical pollution	2/33	0.061	3	0.18	1	0.06	3	0.18
Material	12/132	0.091	3	0.27	3	0.27	2	0.18
Production	8/132	0.061	4	0.24	2	0.12	2	0.12
Production size	12/132	0.091	1	0.09	1	0.09	1	0.09
Productivity	16/132	0.121	2	0.24	3	0.36	3	0.36
Functions number	12/187	0.064	3	0.19	4	0.26	4	0.26
Reliability	12/187	0.064	4	0.26	3	0.19	4	0.26
Durability	16/187	0.086	2	0.17	2	0.17	3	0.26
Handling	12/187	0.064	1	0.06	4	0.26	1	0.06
Colour	2/99	0.020	1	0.02	3	0.06	1	0.02
Mass	6/99	0.061	1	0.06	3	0.18	2	0.12
Form	4/99	0.040	3	0.12	2	0.08	4	0.16
Accessory	6/99	0.061	4	0.24	4	0.24	4	0.24
SUM				2.19		2.44		2.38

Fig. 6. *The analysis of product versions*

5. Conclusions

It is necessary for all companies to move towards sustainable development, but SMEs face sometimes numerous and difficult obstacles: lack of knowledge regarding the potential benefits of environmental management, eco-innovation and lifecycle approach, insufficient access to information, tools or proper training activities, poor information on the environmental impact and risks, etc. SMEs can perform both as eco-innovators and users of green technology, so - it is important to sustain their creativity and dynamism, to encourage eco –innovation at their level, to facilitate continuous improvement of quality products and services and their economic performance [8].

SMEs must consider new trends in Europe and in the world, in order to obtain long-term competitive advantages, by increasing their eco-innovation capacity. This work authors want to help enterprises by developing research on eco – innovation database and bringing a tool for business environment. This one may give useful information and increase competitiveness of enterprises on the Romanian companies level. The eco –innovative technologies implementation model is an instrument that aims to develop green technologies in SMEs and to disseminate best practices and technologies in this field of interest.

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