

SYSTEMATIC LITERATURE REVIEW ON ECO-INNOVATION DETERMINANTS

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Abstract

The purpose of this paper is to enhance the existing research on eco-innovation by investigating the recent scientific literature on eco-innovation determinants and analyzing relevant publications in the field and topics of interest. A review of previous literature based on Web of Science Core Collection (Thomson Reuters) search has been carried out by selecting relevant keywords. The 11 articles analysed after the search have revealed that there is a clear trend of increase in the relevance of this subject within academia as well as a huge variety of eco-innovation determinants which makes it difficult to group them. The main theoretical contribution of the paper is the holistic review on eco-innovation determinants while focusing on systematizing findings from empirical studies.

Keywords: eco-innovation determinants, systematic review, heterogeneity of the studies

1. INTRODUCTION

The world faces significant environment problems, such as climate change, depletion of natural resources, air pollution and biodiversity loss. All these aspects could have disastrous consequences for life on Earth. In the modern world, the globalization and liberalization as well as the rapid increases in consumption determine people to move toward a sustainable organic growth (Turkalj et al., 2013). Moreover, both producers and consumers are becoming eco-conscious.

To avoid or reduce the impact of such problems, innovative solutions and more technologies protecting the environment should be developed. In this regard, eco-innovation becomes the best option, providing complementary solutions to industrial production without sacrificing the resources of the future generations.

Eco-innovation represents a new way of response to environmental issues. While traditional environmental aspects had focused on specific issues such as water or soil pollution, elimination of dangerous products from the market, recycling or climate change prevention, eco-innovation plays a more active and decisive role, working to create new products and competitive services, new jobs as well as a change in the behavior of individuals in relation to the environment.

Although it has its own definitions, eco-innovation can be found under other names like sustainable innovation, green innovation, environmental innovation.

There are several accepted definitions regarding eco-innovation which have required a clarification process in the long run (Moisoiu, 2015). It is generally accepted that eco-innovation brings up all types of innovation, such as technological and non-technological ones (Ciocoiu et al., 2014), new devices, materials and services as well as new business practices (James, 1997) which create new business opportunities, are environmentally friendly (Carrillo-Hermosilla et al, 2010) and optimize the use of resources, including energy (Diaconu, 2011; Sarkar, 2013; Melece, 2015). Eco-innovation is strongly linked to the improvement and use of environmental technologies (Canon de Francia et al., 2007) as well as to the notions of eco-efficiency and ecological industry (OECD, 2012). The common purpose is to increase production and create more sustainable consumption patterns.

There are some studies (Porter and van der Linde, 1995; Belin et al., 2011) showing that eco-innovation generates a win-win situation both for the economy and for the environment: it contributes to increasing economic competitiveness as well as to improving the quality of life. Compared with other innovations, eco-innovation can help the companies to solve not only the economic concerns, but also the environmental protection issues.

Furthermore, the activities of innovation open up a new field, eco-innovation, which offers tremendous opportunities to the society, not only as regards saving the resources, but also from a social perspective (Bleischwitz, 2009; Sabanci Ozer, 2012). Eco-innovations that are most likely to succeed in terms of economic development are those that take into account the social and institutional dimension (Vollenbroek 2002; Smith et al., 2010; Gjoksi, 2011a). Moreover, even when eco-innovation leads to enhancing the production process, the social system with its entities, the consumption patterns and the society's lifestyle will establish some restrictions for the technological development.

Some international evidences show that eco-innovation leads to lower or constant costs, development of companies, increases turnover as well as competitiveness. However, eco-innovations that contribute to energy savings could generate an increase in energy prices in the long run. Therefore, the involvement in the eco-innovation process requires a good knowledge of the immediate benefits as well as of the long term effects (Kowalska, 2014). Moreover, both the determinants and the results depend on the field where eco-innovation is implemented. Furthermore, there are a lot of reports and studies that highlight the importance of the rules in every field, especially rules established nationwide.

However, eco-innovation has been promoted quite slowly, excepting the aspects of climate protection and energy saving. Moreover, according to the European Commission, eco-innovation processes should be hastened in order to promote resource productivity, protect the environment and create a climate of social welfare (European Commission, 2011; Voßwinkel and Reichert, 2012).

Another area of interest related to eco-innovation is that of the determinants/ drivers for adoption of eco-innovation by companies.

Identifying the role of eco-innovation determinants has been the subject of numerous studies since the 1990s. However, the studies are heterogeneous as regards the methods and techniques used, reaching different conclusions (Belin et al., 2011). Moreover, eco-innovation determinants are different depending on regional situation and position (Cainelli et al., 2011; Horbach, 2014) as well as on the different environmental areas (Horbach et al., 2012).

The structure of the paper is as follows:

- Section two carries out a detailed theoretical analysis on the concept of eco-innovation and its determinants;
- Section three explains the method used: the research adopts the systematic review in order to develop insights into the evolution of eco-innovation determinants in literature;
- Section four focuses on the systematic review of eco-innovation determinants by synthesizing the results of several studies;
- Section five draws conclusions.

2. THEORETICAL BACKGROUND

The concept of eco-innovation is mostly discussed in the literature, a simple search using the word 'eco-innovation' generates about 1,900,000 results in Google and about 14,700 results in Google Scholar (in april 2017).

Similar to the previous research conducted by Bossle et al. (2016a) we found out that some concepts are usually used synonymously in different papers, that is, 'green', 'environmental', and 'sustainable'.

In Web of Science Core Collection a total of 524 documents (1975-2017) met the preset criteria for eco-innovation as topic.

The new technologies for the sustainable development are one of the most debated issues in the context of eco-innovation (OECD, 2009; Gjoksi, 2011b; Rusu, 2013).

As regards the effective and sustainable use of resources, there is a growing recognition of eco-innovation positive effects. The last decades have been marked by numerous studies regarding the characteristics of eco-innovation and its results as well as the ways of improving the technologies (Fussler and James, 1996; Kemp and Arundel 1998; Kemp, 2010; Berkhout, 2011; Kemp and Oltra, 2011; Mathieu et al., 2015). However, there are authors (Klewitz and Hansen, 2014; Diaz-Garcia et al., 2015) who consider that this demanding field of research is still in its infancy.

Many authors in literature (Jang-Hwang et al., 2015; Davidescu et al., 2015; Pansera, n.d.) link the concept of eco-innovation to the concept of sustainable development. In fact, the literature offers four different words to present innovations aiming to protect the environment: eco, green, environmental and sustainable (Nidumolu et al., 2009; Diaz-Garcia et al., 2015; Mele and Russo-Spena, 2015). According to different authors (Schiederig et al., 2012; Diaz-Garcia et al., 2015), when comparing the four terms by taking into account the definition given by the Brundtland report, it can be concluded that the first one refers to the economic, ecological and social aspects, while the other three contain only the economic and ecological aspects.

Additional studies focus on the concept of eco-innovation and its two components: corporate social responsibility (CSR) and innovation (Dangelico and Pujari, 2010; Wagner, 2010; Peng and Liu, 2016). CSR turns into an essential component of the companies' activities aiming to promote values within the society and increase the market competitiveness. Furthermore, innovation is gradually becoming one of the main factors of competitiveness (Rexhepi et al., 2013).

Moreover, the literature highlights the importance of the social perspective when discussing about eco-innovation (Freeman, 1996; Hellstrom, 2007; Mele and Russo-Spena, 2015). On the one hand, eco-innovation contributes to enhancing social cohesion by promoting the change of the citizens' and companies behavior as regards environmental problems. On the other hand, eco-innovation building should be supported by social agreement as well as institutions in order to be successful (Arundel and Kemp, 2009; OECD, 2012; Xavier et al., 2015).

Few generic approaches to the classification of eco-innovation could be found in the literature. Thus, according to some researchers in the field (Kemp and Arundel 1998; Andersen, 2004; Andersen, 2008; Sarkar, 2013), eco-innovation can be technical, organizational or marketing, provided that it does not lose its purpose of increasing the companies' green competitiveness. Other authors (Montesor, et al, 2013; Jakrobsen and Clausen, 2014; Pinget et al., 2014; Kunapatarawong and Martinez-Ros, n.d.) consider that eco-innovation can be divided into two categories: environmental eco-innovation and non-environmental eco-innovation. The former type is very important in ensuring the sustainable development.

Another classification highlights four categories of eco-innovation: technological, organizational, social and related to business parks. The third one could be associated with an eco-friendly lifestyle as well as with innovations in consumers' habits (Esders, 2008; Sarkar, 2013). However, other authors consider (Gjoksi, 2011a) that eco-innovation is mainly oriented towards the ecological aspects of the market economy and not towards the social innovation. According to Vollenbroek (2002), the concept of eco-innovation requires technological solutions strongly connected with the social values and lifestyles contributing to the progress of the society.

Many areas of eco-innovation, such as renewable energy and electro mobility are relatively new, thus requiring more information and researches.

Lastly, the company specific mechanisms have also a significant role in motivating eco-innovation decisions. There are few studies (Kammerer, 2009) highlighting that knowledge transfer mechanisms and involvement in networks are the main factors that act as drivers of eco-innovation.

Mazzanti and Zobloi (2008) conducted a survey of 257 SMEs from various industrial areas in Italy and have identified several determinants of eco-innovation: structural variables of the company, research and development focused on sustainability, compliance with the requirements imposed by environmental policy, the company's past performance as well as the quality and characteristics of labor relations.

According to Maçaneiro et al. (2013) there are certain key elements having a significant influence on obtaining favorable results when implementing eco-innovation: law on the environmental protection, incentives, support provided by leadership, company's reputation in the community, technological research and environmental formalization.

An overview of eco-innovation determinants described by various authors in the literature is given by Pacheco et al. (2017). The literature in the field is quite rich, the researchers identifying 23 determinants of eco-innovation in small and medium enterprises. Furthermore, the paper classifies all the determinants in 7 categories (external as well as internal content, strategies, learning, structure, operations and results) highlighting that there is no category dominating a certain SME production sector.

Furthermore, Bossle et al. (2016a) divide the determinants influencing eco-innovation in two categories: internal and external. The internal ones include efficiency, adoption of certifications, environmental leadership, environmental culture, human resources, performance, etc., while the external determinants refer to normative pressure, cooperation, expanding market, technology, the role of governments, etc.

Other authors (Medeiros et al., 2014) identify four critical determinants for the success of developing environmentally sustainable product innovation, tested by experts from Brazilian companies working in the field. They are related to market, legislation, collaboration, learning directed towards innovation, investments in research and development.

3. METHOD AND PLANNIFICATION OF THE REVIEW

In order to identify the main determinant factors of eco-innovation, a systematic review of the literature was undertaken. In this context, the authors identified, selected and evaluated the relevant publications in the field in order to collect and analyze information about eco-innovation determinants.

The systematic review has several characteristics: objectivity, transparency and coherence. It is based on an extensive systematic search process aimed at identifying studies related to the research topic (Aromataris and

Pearson, 2014). Furthermore, it offers the possibility to analyze, systematize and integrate the search results about a field of knowledge in order to highlight the recent tendencies (Centre for Reviews and Dissemination, 2008).

In the first step our approach begins with setting the keywords. The keywords identification has been carried out taking into account the main aspects analyzed in this paper, namely eco-innovation determinants.

Considering that many pertinent papers in the literature use not only the concept of eco-innovation but also its synonyms, we have expanded the search by taking into account the following keywords: "eco-innovation determinants", "green innovation determinants", "environmental innovation determinants", "sustainable innovation determinants".

The exploratory search was performed in June 2017 in the ISI Web of Knowledge database. This is one of the most important sources of scientific documentation worldwide. It allows searching after topic, author, group author, editor, publication name, etc. Moreover, the database provides access to the latest information from any field of interest published in internationally recognized journals, most with an ISI impact index from 256 disciplines (Thomson Reuters, n.d.).

The search was done in an orderly manner in English in the field "topic" in all scientific papers from 1975-2017 with the aim of collecting as much relevant data as possible. Using the keywords mentioned above, the search generated the following results: *eco-innovation determinants* - 114 papers, *green innovation determinants* - 183 papers, *environmental innovation determinants* - 629 papers, *sustainable innovation determinants* - 244 papers.

However, only those documents containing in title the keywords mentioned have been selected because we considered they focused primarily on studying the eco-innovation determinants. This resulted in 22 papers: eco-innovation determinants - 8 papers (7 articles, 1 review), green innovation determinants - 6 papers (all 6 are articles), environmental innovation determinants - 4 papers (2 articles, 2 proceedings papers), sustainable innovation determinants - 4 papers (3 articles, 1 review).

The two proceedings papers were excluded from our study because we did not have access to their content when searching in the IT platform Web of Science. This platform includes the most important databases for the academic community. A similar situation occurs with other 6 articles whose content was not available on the platform mentioned above. Another paper was removed because it focused on other aspects of eco-innovation, namely the determinant factors of sustainable innovative bee products.

Eventually, 11 publications were included in the analysis of this paper published during the period 2006 - 2017, all of them focusing on studying the determinant factors of eco-innovation. As regards the document type, they are all articles, reporting original research of the authors. That is why the two review papers were not taken into account in this analysis.

4. DISCUSSIONS

The 11 selected papers are distributed in 9 different journals: 2 articles belong to *Ecological Economics* and other 2 to *Sustainability*, while the remain 7 articles belong to the other 7 journals (*Environmental Innovation and Societal Transitions*, *Technological and Economic Development of Economy*, *British Food Journal*, *Asian Journal of Technology Innovation*, *Journal of Food Products Marketing*, *African Journal of Business Management*, *Research Policy*).

Although the temporal range is quite wide (35 years), only a few original research articles on eco-innovation determinants were found. However, the positive aspect is that all of these papers focus especially on the factors influencing eco-innovation. Moreover, there is a growing trend in the number of publications on eco-innovation determinants in the last 5 years, since 7 of the articles under analysis were published after 2013.

The results of content analysis based on systematic reviews point out a varied classification of determinants (Table 1). The heterogeneity of the studies cannot lead to a conclusion as regards the preponderance of certain factors in a particular field. Moreover, almost all the researches are recent and prove to be insufficient for reaching a reasonable conclusion.

TABLE 1. THE STUDY OF ECO-INNOVATION DETERMINANTS IN THE LITERATURE

No.	Determinants	Paper	Key word
1.	1. Regulation 2. Market pull factors 3. Technology push and firm specific factors	Horbach Jens, Rammer Christian, Rennings Klaus, (2012). Determinants of eco-innovations by type of environmental impact — The role of regulatory push/pull, technology push and market pull , <i>Ecological Economics</i> , vol. 78, pp. 112-122.	Eco-innovation determinants
2.	1. Technological capabilities (supply side) 2. Appropriation problem and market characteristics (supply side) 3. (Expected) market demand (demand pull hypothesis) (demand side) 4. Social awareness of the need for clean production; environmental consciousness and preference for environmentally friendly products (demand side) 5. Environmental policy (incentive-based instruments or regulatory approaches) (Institutional and political influences) 6. Institutional structure: e.g. political opportunities of environmentally oriented groups, organization of information flow, existence of innovation networks (Institutional and political influences)	Horbach Jens. (2016). Empirical determinants of eco-innovation in European countries using the community innovation survey , <i>Environmental Innovation and Societal Transitions</i> , vol. 19, pp. 1-14.	
3.	1. Relevance of a healthy financial situation 2. Energy and material cost savings 3. Environmental regulation	Del Rio Pablo, Romero-Jordan Desiderio, Penasco Cristina. (2017). Analysing firm-specific and type-specific determinants of eco-innovation ,	

No.	Determinants	Paper	Key word
	<ol style="list-style-type: none"> 4. Cost savings 5. Economic incentives in the form of subsidies 6. Internal innovation capabilities 7. Information flowing from the parent company 8. Information flowing from knowledge institutions 9. Internal information from knowledge institutions 10. External information from knowledge institutions 11. Market dominance by established firms 12. Penetration in new markets 13. Greater production flexibility 14. Greater production capacity 15. Capital accumulated in the firm though R&D high-technology sectors 16. Knowledge flows as result of cooperation 17. Knowledge flows from the parent company 18. Increases in turnover 19. Cooperation with other actors 20. Increase the quota in existing markets 	<p><i>Technological and Economic Development of Economy</i>, vol. 23, issue 2, pp. 270-295.</p>	
4.	<ol style="list-style-type: none"> 1. Environmental capability 2. Managerial environmental concern 3. Environmental regulations 4. Environmental strategy 5. Top management risk aversion 6. Technology turbulence 7. Importance of human resources 8. Normative pressure 9. Importance of collaboration with: customers/ consumers/clients, within the company, competitors or other enterprises of the same industry, university, research centre or other higher education institutions, government, professional and industrial associations 10. Governmental Support 11. Performance 	<p>Bossle Marilia Bonzanini, De Barcellos Marcia Dutra, Marques Vieira Luciana. (2016b) Why food companies go green? The determinant factors to adopt eco-innovations, <i>British Food Journal</i>, vol. 118, issue 6, pp. 1317-1333</p>	
5.	<ol style="list-style-type: none"> 1. Organizational support (organisational factor) 2. Quality of human resources (organisational factor) 3. Customer pressure (environmental factor) 4. Governmental support (environmental factor) 5. Environmental uncertainty (environmental factor) 	<p>Zailani Suhaiza, Iranmanesh Mohammad, Nikbin Davoud, Jumadi Herina Binti. (2014). Determinants and environmental outcome of green technology innovation adoption in the transportation industry in Malaysia, <i>Asian Journal of Technology Innovation</i>, vol. 22, No. 2, pp. 286–301</p>	
6.	<ol style="list-style-type: none"> 1. Agility (organisational factor) 2. Corporate social responsibility (organisational factor) 3. Relational elements (organisational factor) 4. Legislation and policy (environmental factor) 5. Suppliers (environmental factor) 6. Buyers (environmental factor) 	<p>Tabesh Azadeh Rajabian, Batt Peter J., Butler Bella. (2016). Modelling the Impact of Environmental and Organizational Determinants on Green Supply Chain Innovation and Performance. <i>Journal of Food Products Marketing</i>, vol. 22, issue 4, pp. 436-454.</p>	

Green innovation determinants

No.	Determinants	Paper	Key word
7.	<ol style="list-style-type: none"> 1. Complexity of technology (technological factor) 2. Compatibility of technology (technological factor) 3. Relative advantage of technology (technological factor) 4. Quality of human resources (organisational factor) 5. Organizational support (organisational factor) 6. Environmental uncertainty (environmental factor) 7. Governmental support (environmental factor) 8. Customer pressure (environmental factor) 9. Regulatory pressure (environmental factor) 	Ming-Horng Weng, Chieh-Yu Lin (2011). Determinants of green innovation adoption for small and medium-size enterprises (SMES) , <i>African Journal of Business Management</i> , vol. 5, issue 22, pp. 9154-9163.	
8.	<ol style="list-style-type: none"> 1. Green shared vision 2. Green absorptive capacity 3. Green organisational ambidexterity 	Yu-Shan Chen, Ching-Hsun Chang, Yu-Hsien Lin. (2014). The Determinants of Green Radical and Incremental Innovation Performance: Green Shared Vision, Green Absorptive Capacity, and Green Organizational Ambidexterity , <i>Sustainability</i> , vol. 6, issue 11, pp. 7787-7806	
9.	<ol style="list-style-type: none"> 1. Age (foundation of the firm) 2. Demand (increasing or decreasing turnover) 3. Environmental management 4. High qualified employees 5. Overtime worked 6. Profit situation 7. Region 8. R&D activities 9. Size (number of employees) 9. Subsidies 10. Sector dummies (agriculture, forestry, mining, energy and water supply, food products and beverages, textiles, wood, paper, printing, construction sector, etc.) 11. Cooperation 12. Cost savings 13. Average sale 14. Introduction of new organizational structures 15. Regulation 	Horbach Jens. (2008). Determinants of environmental innovation - New evidence from German panel data sources . <i>Research Policy</i> , vol. 37, pp. 163-173	Environmental innovation determinants
10.	<ol style="list-style-type: none"> 1. Economies of scale (techno-economic system) 2. Sunk costs (techno-economic system) 3. Economies of scope (techno-economic system) 4. Learning by doing (techno-economic system) 5. Network externalities (techno-economic system) 6. Market structure (techno-economic system) 7. Potential/risk (techno-economic system) 8. Extra-demand (techno-economic system) 9. Institutional embeddedness (political system) 11. Interest groups (political system) 12. Asymmetry of knowledge (political system) 13. Parliamentary majorities (political system) 14. Election cycle (political system) 15. Singular constraints (political system) 	Sartorius Christian. (2006). Second-order sustainability - conditions for the development of sustainable innovations in a dynamic environment , <i>Ecological Economics</i> , vol. 58, pp. 268-286.	Sustainable innovation determinants

No.	Determinants	Paper	Key word
	16. Decision-making procedures (political system) 17. Scientific confirmation of threat to sustainability (socio-cultural system) 18. Public concern about lack of sustainability (socio-cultural system) 19. Public acceptance of possible solutions (socio-cultural system)		
11.	1. Knowledge innovation capability 2. Production innovation capability 3. Market innovation capability	Si-Hua Chen. (2016). The Influencing Factors of Enterprise Sustainable Innovation: An Empirical Study , <i>Sustainability</i> , vol. 8, issue 5, pp. 1-17.	

Source: The authors, 2017

However, starting from the research of Bossle et al. (2016a), these eco-innovation determinants could be divided into two categories: internal and external ones. The internal factors (cost savings, importance of human resources, potential/risk, etc.) oblige the organizations to operate more efficiently by putting more emphasis on reducing environmental impacts, while the external ones (regulatory pressure, normative pressure, complexity of technology, compatibility of technology, relative advantage of technology, etc.) exert pressure on organizations in order to produce more eco-innovative technologies.

The results also showed that the determinant “regulation” is found in various forms in most of the papers mentioned above (Table 1).

Eco-innovation involves institutional changes, adoption of specific management systems and regulations compliance (Horbach, 2008; Horbach et al., 2012; Horbach, 2016) or legislation and policy compliance (Tabesh et al., 2016). According to Horbach et al. (2012) regulations are used in all environmental areas and are adapted to the specific issues studied. Furthermore, Sartorius (2006), Yu-Shan et al. (2014) and Bossle et al (2016b) points out that eco-innovation occurred due to the companies’ obligation to provide compliance with the environmental legislation. Other authors (Ming-Horng and Chieh-Yu, 2011; Si-Hua, 2016) assert that eco-innovation has not emerged only as a systematic response to legislation because there are also other factors (market conditions, technologies) having a considerable influence in the development of this concept. The organization’s technological capabilities and technical knowledge are extremely important, generating eco-innovations and reducing its deficiencies regarding the new environmental standards and requirements (Horbach et al., 2012).

These characteristics along with other eco-innovation determinants such as different levels of research and innovation development, information from knowledge institutions, cooperation with other actors (Del Rio et al., 2017), governmental support, customer pressure (Zailani et al., 2014) creates differences as regards eco-innovation success in many countries in the world. In this context, the universities and the research institutes are

the suited entities that could provide proper training for future employees in order to use new technologies and adapt to organizational changes.

5. CONCLUSIONS

The paper carries out a review of publications analyzing various eco-innovation determinants by integrating the findings from several recent empirical studies. The review of studies has revealed a huge variety of eco-innovation determinants which makes it very difficult to have a systematic view of this field of research.

The selection of keywords for finding publications and the impossibility of having full-access to some articles matching the research represent the limit of our study because there is a possibility that relevant articles in the field have not been identified or taken into account.

However, the paper provides an aggregated overview of the eco-innovation determinants which could be the starting point for further researches useful for the academic, policy makers and professionals.

ACKNOWLEDGMENTS: This work was supported by MEN – UEFISCDI, Joint Applied Research Projects programme, project number PN-II-PT-PCCA-2013-4-1400, contract 320/2014

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