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Review

Eco-innovation measurement: A review of firm performance indicators

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ABSTRACT

Increased awareness on sustainability has influenced business organizations to improve their environmental performance and efficiency. In this context, eco-innovation implementation is positioned as a target for organizations to be more sustainable in order to reduce negative externalities and reach governments' green requirements and consumers' demands. The aim of this paper is to provide a critical review of literature on eco-innovation performance indicators. This study identifies the 30 firm performance indicators most cited by researchers and classifies them into four different green innovation types, i.e. product, process, organizational and marketing. A substantial gap has been found throughout the literature on this issue as studies do not include a complete combination of the key performance indicators across the four types of eco-innovation. This information is necessary to obtain an accurate measurement of eco-innovation level and it is useful to companies and stakeholders for performance evaluation. Moreover, understanding which performance indicators are more suitable for measuring the level of environmental innovation affords governments the possibility to draft policies that encourage companies to be more sustainable and firms to implement green practices in a more efficient way.

Contents

1. Introduction

In recent years, a great deal of research has focused its attention on the impact that the improper use of natural resources has on the environment. This trend, along with the heightened awareness about environmental problems, the limitation of natural resources and the increasing world population, highlights the need to discover new ways of using these resources more efficiently in order to achieve a balance between consumption requirements and sustainability.

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According to the OECD (2012), the world population will surpass 9000 million in 2050. Thus, at a time when it will be necessary to increase production of food and other products, topical problems like global warming, deforestation, water pollution, biodiversity loss, excessive generation of waste, and the use of chemical substances will imply a decrease in both productivity and the availability of goods and services. In this context, firms and industries receive special attention as they are considered to contribute most to perpetuating these problems, yet they have the capacity to provide appropriate solutions instead (Remacha, 2017). However, in order to do so, new environmental-friendly production methods as well as improvements in product characteristics, organizational capabilities and marketing practices are required to achieve greater respect for the environment. This objective can be reached by encouraging firms and countries to implement eco-innovations, especially in sectors with considerable environmental impacts in terms of pollution and water and energy consumption, such as agriculture (FAO, 2017).

These innovations, also known as green innovations or environmental innovations, are attracting increasing interest among researchers as a key factor for achieving economic, social and environmental objectives (Läpple et al., 2015). Defining eco-innovation (EI) is not an easy task, although several authors address this topic. According to Kemp and Pearson (2007, p.7), EI is “the production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organization (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use) compared to relevant alternatives”. Oltra and Saint Jean (2009, p.1) defined it as “innovations that consist of new or modified processes, practices, systems and products which benefit the environment and so contribute to environmental sustainability”, while Kemp and Arundel (1998) and Rennings and Zwick (2003) define environmental innovations as new and modified processes, equipment, products, techniques and management systems that avoid or reduce harmful environmental impacts. For Fussler and James (1996), eco-innovation is the process of developing new products, processes or services which provide customer and business value but significantly decrease environmental impact. Other definitions are also found in works such as Carrillo-Hermosilla et al. (2010), Jänicke (2012) and Tamayo-Obergozo et al. (2017). But, the discussion relative to the definition of EI not only concern researchers, also world organizations discuss this topic. The Eco-Innovation Observatory (2012, p.8) considers it the “introduction of any new or significantly improved product, process, organizational change or marketing solution that reduces the use of natural resources and decreases the release of harmful substances across the whole life-cycle.” In the case of the European Commission (2013, p.4), “eco-innovation projects will therefore aim to produce quality products with less environmental impact, whilst innovation can also include moving towards more environmental-friendly production processes and services. Ultimately, they will contribute towards the reduction of greenhouse gases or the more efficient use of various resources.” The Oslo Manual (OECD, 2005) defines innovation as the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organizational method in business practice. According to Europe INNOVA (2006), eco-innovation is the creation of novel and competitively priced goods, processes, systems, services, and procedures designed to satisfy human needs and provide a better quality of life for all, with a minimal life-cycle use of natural resources (materials including energy, and surface area) per unit output, and a minimal release of toxic substances. Furthermore, it is necessary to mention that each author and organization considers different points of view, but all the definitions include two main effects of EI (Hojnik and Ruzzier, 2016b): fewer adverse effects on the environment and more efficient use of resources. These common issues are taken into consideration in this study as the eco-innovation concept.

A wide range of studies on eco-innovation concepts, consequences and drivers have been published, primarily because EI is commonly believed to play a key role in the quest for greater efficiency and sustainability. Nevertheless, studies on its implementation are rather scant (Kemp, 2009). Implementation refers to realization for use according to a European project entitled “Measuring eco-innovation (MEI)" (Kemp and Pearson, 2007, p.7). Therefore, this study focuses on those indicators that measure the implementation of eco-innovations in economic activity. A great deal more of comprehensive research on EI implementation is considered essential in order to identify those eco-innovation performance indicators (EIPI) which allow it to be efficiently measured. In consequence, it would promote progress towards the constitution of a body of knowledge that facilitates not only companies but also governments to implant environmental plans that ensure higher sustainability. As Triguero et al. (2013) mention, a lack of effectiveness of environmental regulation exists. For this reason, a change in the current regulatory framework is needed to enhance EI because environmental regulations play an important role in stimulating EI and combating negative environmental externalities (Ekins, 2010; Demirel and Kesidou, 2011).

The main aim of this article is to offer an overview of the key performance indicators which measure EI at firm level, particularly from the product, process, organizational and marketing perspectives, according to the classification introduced by Macron et al. (2017). To this end, we review the academic literature on EIPI utilizing 104 full articles. No studies were found which provided a comprehensive analysis of the subject from the four EI perspective types. Thus, the paper contributes to the literature in three ways. Firstly, this study provides an academic contribution. As Cooper and Edgett (2008) and Ehrenfeld (2008) note, you cannot manage what you do not measure. In this line, this study offers an overview of key EIPI, contributing to develop a body of knowledge to analyze the level of EI implementation from the point of view of product, process, organizational and marketing perspectives and helping to fill the existing gap concerning this subject. Furthermore, an overview of EIPI makes it possible to create compound indicators for measuring level of environmental innovation and, subsequently, comparing said levels between countries, sectors or companies (Angelo et al., 2012). Secondly, providing a set of EIPI is a useful base for managers to know which of them should be used to evaluate its performance and diagnose in which EI perspective improvements could be introduced to reduce negative externalities and at the same time add more environmental value and provide a competitive advantage. Finally, due to the fact that EI policies require a holistic view according to Cheng et al. (2014), the current study helps to understand the possible performance indicators for implementing EI.

The remainder of this paper is organized as follows. Section 2 explains the research method and the lines of research used to find and select the publications analyzed. Section 3 shows a descriptive analysis of the findings highlighting the evolution of the research on this subject. In addition, this section analyzes the countries, journals and sectors in which the topic is most widely discussed. Next, Section 4 presents the discussions and contains reviews on EIPI, grouping them into four types of green innovation. This section also introduces a set of key EIPI. Finally, Section 5 concludes the study, discussing the main findings and giving suggestions for future research.

2. Research method

The manner by which EI is measured is evaluated to identify the potential performance indicators necessary for achieving greener and more sustainable procedures. Thus, a systematic literature review has been carried out following the methodology suggested by Tranfield et al. (2003). This approach is also in line with the previous systematic reviews on eco-innovation (e.g., De Medeiros et al., 2014; De Jesús Pacheco et al., 2016; or Hojnik and Ruzzier, 2016b).

This method was chosen as it makes it possible to include large amounts of information contributing to provide a comprehensive view of the field for researchers, answers questions regarding this specific topic and discover new opportunities for future research (De Jesús Pacheco et al., 2016). Furthermore, a systematic review effectively provides a practical perspective as an overall view of EIPI, contributing to create a body of knowledge on this subject in order to determine how to implement ecological practices and policies in the future.

The methodology followed for the literature review included two main phases: Firstly, the extraction and selection of publications in the desired areas; and, secondly, the analysis of the publications retrieved to identify key EIPI. In particular, the systematic literature review followed a five-step scheme according with Tranfield et al. (2003) that included: (i) problem definition; (ii) selection of sources; (iii) selection of studies; (iv) critical appraisal and evaluation; and (v) synthesis.

First, the problem is defined: in line with the overall objective of the research, the aim of the systematic review was to identify the most cited performance indicators used for measuring the level of EI implementation. Then, the selection of sources and studies is conducted, followed by the description.

Taking into consideration that a systematic literature review must be focused not only on published articles in journals but also on "gray literature" as well (Petticrew and Roberts, 2012), we based the bibliometric analysis on Scopus and Web of Science (WoS) databases in the first stage (Díaz-García et al., 2015; Morioka and de Carvalho, 2016). These databases are considered the most important source of data for scientific research and include titles from Emerald, Elsevier, Springer, Willey, Taylor & Francis or JStor (Bonisoli et al., 2018). Then, a cross-reference analysis and a search in the databases of the main international organizations were conducted with the two-fold aim of analyzing those references that are of interest to the present subject of study and completing the literature review.

Once the literature sources were established, a search based on determining keywords combinations was carried out to select studies. Keywords were selected taking into consideration the main words related to this field and the words most used by researchers. According to Angelo et al. (2012), "environmental innovation" is the term most commonly used in review papers (65%), followed by "eco-innovation term" (22%) and "green innovation" (13%). Therefore, the keywords used for this stage are mainly combinations of the aforementioned terms, along with some eco-innovation implementations. Table 1 presents the keyword combinations used for the search mechanism and the corresponding results for each database. Keyword combinations are reported in rows while databases are reported in columns. The research timeframe covered the period from January 1990 to December 2017.

The key terms "environmental innovation", "eco-innovation" and "green innovation" embrace an extensive range of sub-topics in spite of being used in conjunction with the four types of EI and also with green practices like "design product", "renewable energy" or "recycling materials". Therefore, search strings were established with the aim of filtering the review and articles being searched. The following fields were selected: Agricultural and Biological Sciences, Environmental Science, Business Science, Economic Science, Ecological Science and Engineering Science. This defined a specific scope for the search and excluded papers whose focus was not relevant to the present study. From this search method, 2,491 papers were found and, as the word combinations were introduced into both databases, 1,969 duplications (79%) had to be removed. Then the title and abstract of each paper were read. Thus, 203 were potentially relevant to this review. After analyzing these complete papers, only those focusing on the EI implementation, i.e. on indicators that measure the implementation of eco-innovations in economic activity, became our set of sources.

The previous procedure led to an initial list of 53 pre-selected articles on eco-innovation implementation. After that, we conducted a cross-reference analysis in order to identify other relevant contributions. Consequently, 51 new references were added.

After analyzing the papers that represent the object of our analysis, the EIPI retrieved were clustered in four different types of EI (product, process, organizational and marketing EI) according to Macron et al. (2017). This classification is described in more detail in the following sections.

3. Results

The selection process described in the previous section yielded a list of 104 publications. This literature review focused on four types of publications. Most of the publications have been classified as journal papers (85), followed by books or book chapters (15) and other related academic publications (4). Table 2 summarizes the range and frequency of the reviewed journals in the field of eco-innovation implementation. A notable 41% (35 articles) of the articles were published in the Journal of Cleaner Production, and approximately 7% (6 articles) were published in Research Policy. An additional 2% came from the Academy of Management, Journal of Sustainable Development, Journal of Business Ethics, Technovation, Business Strategy and the Environment, Ecological Economics, Packaging Technology and Science, International Journal of Production Economics, Research Technology Management, and Journal of Business Logistics; each respectively contributing 2 articles. Finally, 25 other articles were taken from 25 different journals.

An analysis was then conducted in order to determine the main areas of research, the years with the most studies published, and the countries on which most literature is focused (Dangelico, 2015; Caldera et al., 2017).

Over the past two decades, EI has been addressed from different perspectives with the main aim of understanding the motivation for its implementation and how it could be promoted. It should first be noted that studies on this subject have focused on the main factors that prompt firms to innovate in this field. These factors are called "drivers". Research on this topic presents and describes the various dimensions that characterize EI. In contrast, the most recent articles focus on the indicators which measure EI in different sectors and countries (Cheng and Shiu, 2012). Fig. 1 shows how the number of publications on the environmental innovation field has significantly increased, up to four times since 2007. This result emphasizes the relatively novel interest on this field of research and the increasing attention that it is receiving. Specifically, in the year 2015 there is a high point in the number of publications due to an increase in studies about which factors motivate the introduction of green practices and about the analysis of eco-innovation impact at environmental and firm levels, particularly in the Journal of Cleaner Production and Innovation Management Policy and Practices. Figs. 2 and 3 below display the countries and sectors that have caused this increase in publications.

Fig. 2 shows the geographic distribution and number of articles

Table 1
Keyword combinations used for the search mechanism and the results for each database.

Key Concept	Search String	Scopus	WoS
Eco-innovation	"Eco-innovation"	382	418
Eco-innovation	"Environmental innovation"	317	314
Eco-innovation	"Green innovation"	173	276
Eco-innovation	"Ecological innovation"	47	58
Eco-innovation	"Measuring innovation" AND "Environment"	12	8
Eco-innovation and product innovation	("Eco-innovation" OR "Environmental innovation" OR "Green innovation") AND ("Product innovation" OR "Product Design" OR ("Product innovation" AND "Recycling materials"))	173	145
Eco-innovation and process innovation	("Eco-innovation" OR "Environmental innovation" OR "Green innovation") AND ("Process innovation" OR "Process efficiency" OR ("Renewable energy" AND "Process improvement"))	66	46
Eco-innovation and organizational innovation	("Eco-innovation" OR "Environmental innovation" OR "Green innovation") AND ("Organizational innovation" OR "Organizational change")	32	16
Eco-innovation and marketing innovation	("Eco-innovation" OR "Environmental innovation" OR "Green innovation") AND ("Marketing innovation" OR "Marketing practices")	5	3

Table 2
Number of articles published in different journals (1990–2017).

Journal name	Number of articles	Percentage
Journal of Cleaner Production	35	41%
Research Policy	6	7%
Academy of Management Journal	2	2%
Sustainable Development	2	2%
Journal of Business Ethics	2	2%
Technovation	2	2%
Business Strategy and the Environment	2	2%
Ecological Economics	2	2%
Packaging Technology and Science	2	2%
International Journal of Production Economics	2	2%
Research Technology Management	2	2%
Journal of Business Logistics	2	2%
Administrative Science Quarterly	1	1%
Environmental Innovation and Societal Transitions	1	1%
Management Service Quality	1	1%
Resources, Conservation and Recycling	1	1%
Policy Sciences	1	1%
Harvard Business Review	1	1%
International Journal of Operations and Production Management	1	1%
Journal of Marketing Channels	1	1%
Journal of Remanufacturing	1	1%
Interfaces	1	1%
California Management Review	1	1%
Futures	1	1%
Strategic Management Journal	1	1%
Dyna	1	1%
Clean Technologies and Environmental Policy	1	1%
Energy Economics	1	1%
Journal of Environmental Economics and Management	1	1%
SAM Advanced Management Journal	1	1%
Energies	1	1%
Environmental and Resource Economics	1	1%
Journal of Economic Literature	1	1%
The Leadership Quarterly	1	1%
Academy of Management Review	1	1%
Sustainability	1	1%
Management Decision	1	1%
Total	85	

by countries, analyzing the literature published in this field since 2007, the year in which the number of publications about EI began to increase considerably. The graph shows that Spain is the country with the highest number of publications, followed by the United Kingdom, Italy, France and China.

Moreover, Fig. 3 displays the main subject areas of EI studies. The field with the most research is Business and Management (42.1%), followed by Engineering (29.9%) and Social Science (22.1%). This distribution of publications could indicate that the research findings were also likely applied to the industrial and energy sectors. In contrast, the green innovation field receives scant attention in Agricultural literature (4.4%), particularly when we consider how closely linked this sector is to the environment.

Analyzing Figs. 2 and 3, we can come to the follow conclusion. The countries with a greater number of publications on EI are those with a business network constituted by small and medium size firms. In this context, it is evident that they focus their EI studies on the Business and Management sector, making this sector the main subject area for EI papers. However, countries like Spain, Italy or France have a strong agricultural economic sector which is the engine of the economy in many of its regions. Thus, more studies about this sector would be necessary taking into account the

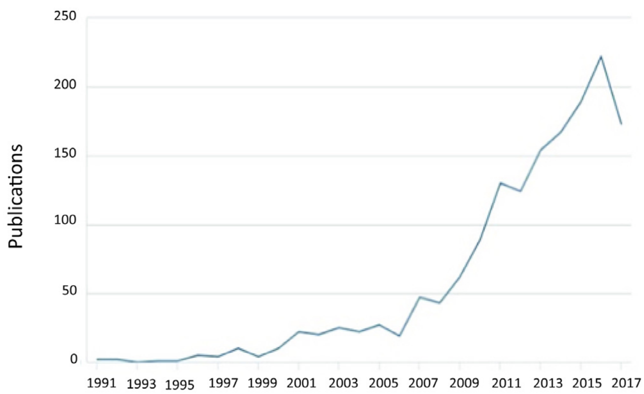

Fig. 1. Eco-innovation publications by year (1990–2017).

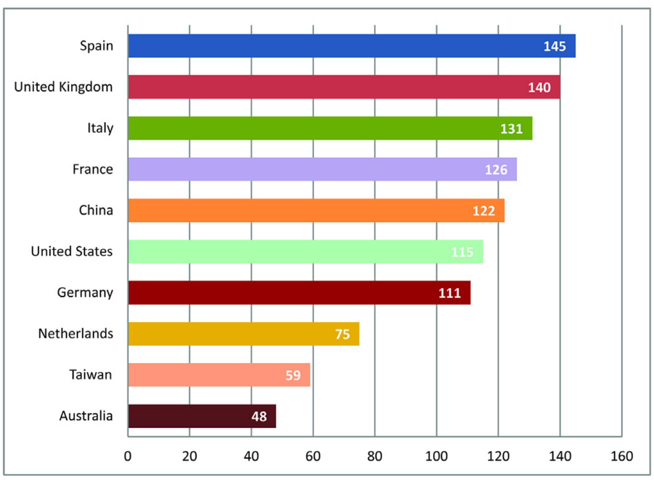

Fig. 2. Eco-innovation publications by country (2007–2017).

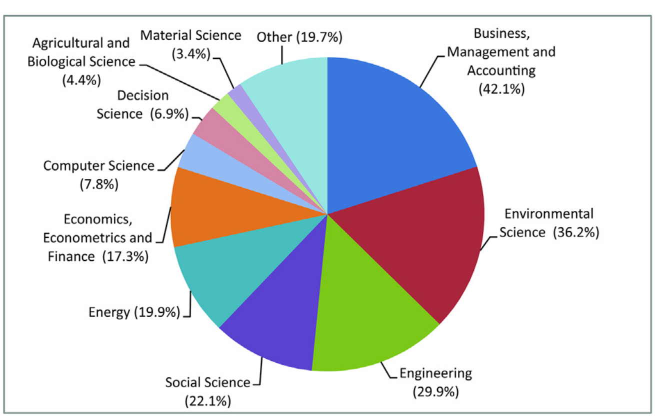

Fig. 3. Eco-innovation publications by subject area (2007–2017).

considerable impact that the agriculture has on the environment and its close relationship with the use of natural resources.

4. Discussion: overview of research on eco-innovation performance indicators

Key findings from the systematic literature review are detailed below. The findings emphasize 30 key EIPI. In this study they were clustered into four groups, as was shown in Table 3: (i) product innovation; (ii) process innovation; (iii) organization innovation; and (iv) marketing innovation. Thus, this Section is structured into four parts, one for each type of EI, as it has been mentioned in previous sections. To construct this classification, we followed the review by Macron et al. (2017, p. 84). According to this work, product innovations (i) “can take the form of major or minor changes in the material used, in the technical specification and in the characteristics of the product or service”; process innovations (ii) “are intended to reduce costs, increase quality and provision of the products or services and include improved techniques in auxiliary support activities”; organizational innovations (iii) “refer to new or significantly improved routines, business models, methods and actions that change firms’ practices, relations and decisions”; and marketing innovations (iv) “can occur through changes in product design, product placement, communication, new methods of product delivery, promotion or pricing strategies. Moreover, significant changes in product packaging are also considered important marketing innovations”.

Table 3 presents a set of key EIPI retrieved from the analysis of the papers selected in Section 2. The articles were included in at least one category, and some articles are included in more than one. For example, Rodríguez and Wiengarten (2017) was considered to correspond to three different types of eco-innovation (EI), i.e. product, process and organizational, and, accordingly, this reference appears linked to these three types in the classification.

The set of key EIPI established in Table 3 highlights the performance indicators most cited by the EI literature to analyze and measure the EI in different sectors and countries, offering a state of art in this topic. It is discussed in the following section.

4.1. *Product eco-innovation*

The materials used to make a product as well as the product characteristics themselves have an impact on the environment. Thus, numerous research studies on how to implement environmental innovations have focused on improving the type and quality of inputs and product sustainability in order to reach current environmental requirements and to decrease negative externalities. More specifically, this study of the literature found 7 EIPI based on EI products (1).

Related to the determinants of the product's characteristics and, in turn, its environmental impact, the literature enhances the inputs used to make a product as one of the major points to have in consideration to implant EI. In this sense, reducing the use of dirty inputs (1.5) or substituting them for cleaner or less polluting materials (1.1) contributes to decreasing waste and CO^2 emissions. The materials used to make a product comprise one of the EIPI that a great deal of research highlights as one of the factors necessary for creating products that are more environmental-friendly.

Some authors emphasize the importance of reducing or optimizing the use of raw materials (1.3) to obtain products (e.g., Eder, 2003; Hellström, 2007; Crabbé et al., 2013). The utilization of raw materials as an input in product manufacturing has a significant negative impact on the environment for two reasons. Firstly, its consumption ultimately increases (Agrawal and Ülkü, 2011). Secondly, the decarbonation of raw materials increases carbon dioxide (CO^2) emissions (Ishak et al., 2016). Thus, reducing the use of raw materials (1.3) by a sector or a company is a performance indicator that should be taken into consideration for measuring EI and sustainability level. In this line, Pigosso et al. (2010) support products whose raw materials are obtained from other products as a way to reduce contaminants. Also, Eder (2003) focuses attention on the necessity of substituting raw materials (1.3) for cleaner alternatives.

Using new cleaner materials or new inputs with lower

Table 3
Eco-innovation key performance indicators analyzed by the literature.

Eco-innovation types	Eco-innovation performance indicators	References
Product Eco-innovation (1)	Use new cleaner material or new input with lower environmental impact (1.1)	Theyel (2000) Eder (2003) BID (2007) Crabbé et al. (2013) Doran and Ryan (2016) Sierra-Pérez et al. (2016) Castellacci and Lie (2017) Rodríguez and Wiengarten (2017)
	Use of recycled materials (1.2)	Van Hemel and Cramer (2002) Cheng and Shiu (2012) Dalhammar (2015) Macron et al. (2017)
	Reduce/optimize use of raw materials (1.3)	Eder (2003) Hellström (2007) Pigosso et al. (2010) Crabbé et al. (2013)
	Reduce number of product components (1.4)	Hellström (2007) Cheng and Shiu (2012) Doran and Ryan (2016) Castellacci and Lie (2017) Rodríguez and Wiengarten (2017)
	Eliminate dirty components (1.5)	Eder (2003)
	Product with a longer life cycle (1.6)	Van Hemel and Cramer (2002) Hellström (2007) Asif et al. (2012) Ye and Zhang (2013) Bakker et al. (2014) Dalhammar (2015) Aziz et al. (2016)
	Product ability to be recycled (1.7)	Garrod and Chadwick (1996) Bakker et al. (2014) Dalhammar (2015) Castellacci and Lie (2017) Rodríguez and Wiengarten (2017)
Process Eco-innovation (2)	Reduce chemical waste (2.1)	Theyel (2000)
	Reduce use of water (2.2)	Alkaya and Demirer (2015) Azad and Ancev (2014) Piedra-Muñoz et al. (2018)
	Reduce use of energy (2.3)	Van Hemel and Cramer (2002) Cheng and Shiu (2012) Alkaya and Demirer (2015) Doran and Ryan (2016) Castellacci and Lie (2017) Rodríguez and Wiengarten (2017)
	Keep waste to a minimum (2.4)	Shrivastava (1996) Norberg-Bohm (1999) Cheng and Shiu (2012)
	Reuse of components (2.5)	Hellström (2007) Dalhammar (2015)
	Recycle waste, water or materials (2.6)	Van Hemel and Cramer (2002) Cheng and Shiu (2012) Doran and Ryan (2016) Castellacci and Lie (2017) Rodríguez and Wiengarten (2017)
	Environmental-friendly technologies (2.7)	Garrod and Chadwick (1996) Frondel et al. (2008) Guziana (2011)
	Renewable energy (2.8)	Johnstone et al. (2010) Lacerda and Van den Bergh (2014) Nesta et al. (2014) Nicolli and Vona (2016)
	R&D (2.9)	Cohen and Levinthal (1990) Florida (1996) BID (2007) Kemp and Pearson (2008) Cainelli et al. (2015) Rodríguez and Wiengarten (2017)
	Acquisition of machinery and software (2.10)	BID (2007) Kesidou and Demirel (2012) Cainelli et al. (2015) Rodríguez and Wiengarten (2017)
	Acquisition of patents and licenses (2.11)	Griliches (1990) Lanjouw and Mody (1996) Jolly and Philpott (2004) Oltra et al. (2008) Johnstone et al. (2010) Kesidou and Demirel (2012) Cainelli et al. (2015)

(*continued on next page*)

Table 3 (*continued*)

Eco-innovation types	Eco-innovation performance indicators	References
		Rodríguez and Wiengarten (2017)
Organizational Eco-innovation (3)	Green human resources (3.1)	Amabile et al. (1996) Anderson (1998) Andriopoulos (2001) Halbesleben et al. (2003) Naffziger et al. (2003) O'Connor and Ayers (2005) BID (2007) Kemp and Pearson (2008) Montalvo (2003, 2008) Boons and Lüdeke-Freund (2013) Chen and Chang (2013) Tseng et al. (2013) Hojnik and Ruzzier (2016a) Peng and Liu (2016) Rajala et al. (2016)
	Pollution prevention plans (3.2)	Frosch and Gallopoulos (1992) Tibbs (1992) Kemp and Pearson (2008)
	Environmental objectives (3.3)	Williams et al. (1993)
	Environmental audit (3.4)	Baram and Partan (1990) Garrod and Chadwick (1996) Hamner (2006) BID (2007) Kemp and Pearson (2008) Montalvo (2003, 2008) Eltayeb (2009) Zailani et al. (2012) Boons and Lüdeke-Freund (2013)
	Environmental advisory (3.5)	Del Brío and Junquera (2003) BID (2007) Scarpellini et al. (2012) De Jesús Pacheco et al. (2016)
	Invest in research (3.6)	Porter and Van der Linder (1995) Horbach (2008)
	Cooperation with stakeholders (3.7)	Cramer et al. (1991) Frosch and Gallopoulos (1992) Cramer and Schot (1993) Frosch (1994) Florida (1996) Anderson (1998) Becker and Dietz (2004) Hamner (2006) Chen (2008) Eltayeb (2009) De Marchi (2012) Matos and Silvestre (2013) Segarra-Oña and Peiró-Signes (2014) Ghisetti and Reinnings (2014) Ghisetti et al. (2015) Ghisetti and Pontoni (2015) Roscoe et al. (2015) Bossle et al. (2016) Rodríguez and Wiengarten (2017)
	New markets (3.8)	Blättel-Mink (1998) Niinimäki and Hassi (2011) Loorbach and Wijsman (2013)
	New systems (remanufacturing systems and transport systems) (3.9)	Stock (1992) Blättel-Mink (1998) Carter and Ellram (1998) Moore (2005) El Korchi and Millet (2011) Asif et al. (2012) Ye and Zhang (2013) Bakker et al. (2014) Iritani et al. (2014)
Marketing Eco-innovation (4)	Returnable/reusable packaging (4.1)	Stock (1992) Hart (1995) Shrivastava (1995) Rosenau et al. (1996) Carter and Ellram (1998) Rogers and Tibben-Lembke (1998) Christmann (2000) Duhaime et al. (2001)

Table 3 (*continued*)

Eco-innovation types	Eco-innovation performance indicators	References
		Van Hemel and Cramer (2002) Twede and Clarke (2005) Zailani et al. (2012) Silva et al. (2013)
	Green design packaging (4.2)	Löfgren (2005) Martin et al. (2006) Henriksson et al. (2010) Langley et al. (2011) Cheng and Shiu (2012) Juul (2012) Zailani et al. (2012) Plumb et al. (2013) Wever and Vogtländer (2014) Lindh et al. (2016) Wilkström et al. (2016)
	Quality certifications (4.3)	Hamner (2006) Eltayeb (2009) Chiarvesio et al. (2015) Li and Hamblin (2016)

environmental impact (1.1) is also used in EI literature as an indicator of a product's level of efficiency (e.g., Doran and Ryan, 2016; Castellacci and Lie, 2017; Rodríguez and Wiengarten, 2017). Theyel (2000) highlights the necessity of using cleaner or less polluting materials in a review based on the plastics and resins sector and the ink manufacturing sector in the US chemical industry; while Crabbé et al. (2013), in a study on Flemish production firms, emphasize the importance of innovating to obtain sustainable materials which contribute to making products more respectful of the environment. Also, BID (2007) recognizes the use of new sustainable materials (1.1) as an indicator of the innovation effort of a company. Other empirical market studies note the importance of using cleaner materials (1.1) to reduce the negative environmental impact of firms. According to Sierra-Pérez et al. (2016), introducing the use of cork to replace non-renewable materials in the construction sector decreases ecological impact. Eder's research (2003) highlights eliminating the use of dirty or polluting components (1.5) to make a product in order to obtain fewer contaminant products.

Other performance indicators related to the inputs used in manufacturing show the improvement in product efficiency. One of these indicators is the use of recycled inputs (1.2). According to Dalhammar (2015) and Macron et al. (2017), the use of recycled materials (1.2) is an essential performance indicator of green innovation. In accordance with this concept, Van Hemel and Cramer (2002) and Cheng and Shiu (2012) emphasize that the use of recycled product components (1.2) is another tool for manufacturing more sustainably. Similarly, research conducted by Hellström (2007) highlights the reduction of the number of product components (1.4) as another successful indicator of product EI. Along this line, other authors introduce the indicator “reduce material per unit of output” (1.4) in the research to measure the level of efficiency of a product (e.g., Doran and Ryan, 2016; Castellacci and Lie, 2017; Rodríguez and Wiengarten, 2017).

Analyzing the EI literature is demonstrated the product characteristics are strongly correlated with environmental impact. A product's durability (1.6) and ability to be reused (1.7) are the two most relevant characteristics studied by the EI literature as they are directly linked to product efficiency, reduced consumption of resources, and lower gas emissions. Hellström (2007), Bakker et al. (2014) and Aziz et al. (2016) present the long-life product (1.6) as an effective tool for obtaining a greater level of environment sustainability. Dalhammar (2015) discusses product durability (1.6) and the technical guarantees on life cycle as improvements which can provide more environmental efficiency, while Van Hemel and Cramer (2002), in their study which analyzes the environmental performance of the US chemical industry, introduce an investigation to extend product lifetime (1.6) by providing a list of the main solutions for achieving sustainability. Moreover, Asif et al. (2012), Ye and Zhang (2013) and Bakker et al. (2014) highlight remanufacturing as a strategy to extend product lifetime (1.6).

Additionally, Dalhammar (2015), Castellacci and Lie (2017) and Rodríguez and Wiengarten (2017) introduce the ability of a product to be recycled (1.7) after use as a key performance indicator for measuring EI level. This practice leads to the reduction of waste as it extends product life at the same time. Along this line, Garrod and Chadwick (1996) carried out a survey of companies located in the South of England to determine how firms had handled the increase of environmental pressures. Their analysis identified several firm performance indicators that were implemented, one which was the recycling of part of the used final product (1.7). Also, Bakker et al. (2014), in their study on household products, emphasize the recycling of products (1.7) as an essential tool in order to achieve greener practices.

4.2. Process eco-innovation

The environmental impact of a company is not only due to what the company produces but also how the company manufactures its products. Groenewegen et al. (1996) have established the relationship between the manufacturing processes of a company and negative environmental impact. Thus, it is necessary to take into consideration improvements in manufacturing processes and include relevant EI indicators in order to efficiently measure levels of environmental innovation. This study of the literature has identified 11 EIPI based on improvements in manufacturing processes (2).

The total use of water or energy is a widely-used method in EI literature for analyzing process improvement. Alkaya and Demirer (2015), in a review of the Turkish chemical industry, use the indicators “reduce water consumption” (2.2) and “reduce energy consumption” (2.3) to study the sustainability of the sector's production processes and whether companies attempt to fulfill green requirements. In the same way, irrigated agriculture is one of the sectors where the use of water has been most analyzed. Many studies measure the effects of eco-innovations aimed at optimizing water usage on farmers' environmental impact (Azad and Ancev, 2014; Piedra-Muñoz et al., 2017, 2018). Other works which follow this line include: Van Hemel and Cramer (2002), who analyze a group of 77 small and medium sized companies (SMEs); Cheng and

Shiu (2012), who measure EI from the perspective of implementation; Doran and Ryan (2016), who base their review on the Irish Community Innovation Survey; Castellacci and Lie (2017), who focus their study on manufacturing firms in Korea; and Rodríguez and Weingarte (2017), who study several German industries and highlight energy reduction (2.3) in the manufacturing process as a performance indicator to measure environmental efficiency.

The level of waste (2.4) in a process is also analyzed as a cause of pollution. Thus, Shrivastava (1996), Norberg-Bohm (1999) and Cheng and Shiu (2012) emphasize the importance of introducing new technologies with the aim of reducing waste to a minimum. Theyel (2000) expands on this reasoning by proposing the idea of reducing chemical waste (2.1) in production processes as much as possible. According to the Van Hemel and Cramer (2002) study, which focused on the US chemical industry, firms that innovate in terms of reducing chemical waste (2.1) are leaders in adopting environmental practices.

Materials-saving is another key performance indicator for measuring EI and the efficiency level of a process. This indicator can be viewed from two perspectives. On the one hand, the reuse of components or materials (2.5) attracts attention as a positive way of being greener in the manufacturing process (Hellström, 2007; Dalhammar, 2015). On the other hand, the recycling of waste, water, materials or inputs (2.6) is another means of reducing negative environmental impact. Thus, some authors introduce the indicator “recycled waste, water and materials” (2.6) in their studies to measure environmental innovativeness (e.g., Doran and Ryan, 2016; Castellacci and Lie, 2017; Rodríguez and Wiengarten, 2017). Furthermore, according to Van Hemel and Cramer (2002) the eco-indicator “recycling of materials” (2.6) is the most successful among firms to improve their environmental performance.

The level of investment carried out by a company is a relevant performance indicator of its effort to be greener. In this context, some authors analyze company investment in patents (2.11) as a means of achieving environmental innovations to improve energy consumption and material efficiency (Kesidou and Demirel, 2012; Cainelli et al., 2015; Rodríguez and Wiengarten, 2017). In a study on renewable technology, Johnstone et al. (2010) identify the number of patents (2.11) as a measurement indicator of EI. Additionally, Griliches (1990), Lanjouw and Mody (1996), and Jolly and Philpott (2004) shows that patents are a good indicator for measuring innovation activity level. Furthermore, the European Comission contemplates the “eco-patents” as an indicator of the level of innovative activity in the environmental field and as a way for studying eco-innovations (Oltra et al., 2008).

Nevertheless, not all company research efforts and investments are always patented. Thus, in addition to the number of patents, other practices exist that this indicator does not take into consideration (Oltra et al., 2008; Artz et al., 2010). For this reason, although the number of patents is strongly correlated with research and development (R&D) spending, it is necessary to include the indicator “number of patents” along with others such as acquisition of machinery and software (2.10) or R&D investments (2.9) to achieve a more accurate view of the innovative reality of a firm. R&D activity (2.9) is treated by some authors as a key performance indicator in the EI process. In fact, it has been shown that firms which implement R&D activities (2.9) are more likely to be environmentally innovative than firms that are not R&D active since the former have a higher absorptive capacity (Cohen and Levinthal, 1990; Cainelli et al., 2015). According to Florida (1996), firms that are R&D active (2.9) improve their productivity and reduce negative environmental impact. Thus, some authors (e.g., BID, 2007; Kemp and Pearson, 2008; Rodríguez and Weingarte, 2017) introduce the indicator R&D (2.9) to measure EI and subdivide it into internal or external R&D.

In addition, other authors (e.g., Kesidou and Demirel, 2012; Cainelli et al., 2015; Rodríguez and Wiengarten, 2017) focus their studies on the acquisition of machinery (2.10) as a key factor for the purpose of more efficient use of energy and materials. BID (2007) also illustrates the importance of incorporating new capital assets, i.e., hardware and software (2.10), in order to implement ecological innovations in a company.

The use of renewable energy (2.8) and environmental-friendly technologies (2.7) are two more relevant EIPI emphasized by the literature in this field as ways of achieving more efficient manufacturing processes, making them crucial for addressing global environmental aims. Frondel et al. (2008) highlight the environmental benefit of introducing *end-of-pipe* technologies (2.7) in manufacturing processes, whereas Guziana (2011) concludes that clean technologies (2.7) are more proactively innovative than the former. Along this line, Garrod and Chadwick (1996), in their survey of environmental strategies carried out by companies located in the South of England, determined that investment in clean technology (2.7) is a tool that can be implemented to fulfill ecological requirements. Moreover, other articles address the importance of introducing renewable energies (2.8) in company processes in order to improve quality of life for current and future generations and to meet public environmental objectives (e.g., Lacerda and Van den Bergh, 2014; Nesta et al., 2014; Nicolli and Vona, 2016).

4.3. Organizational eco-innovation

Chen (2008) illustrates the importance of the relationship between green intellectual capital and the competitive advantage of firms. Chen's study, which focused on the Taiwanese information and electronics industry, emphasizes the positive correlation between these two indicators. According to its findings, there are three types of green intellectual advantage: green human capital, green structural capital, and green relational capital. Furthermore, the study identified 9 EIPI related to organizational eco-innovation (3). Said indicators are introduced below.

Green human capital (3.1) refers to the collective knowledge, skills, creativity, experience and capabilities of employees. In this sense, based on a study of the In-Bond industry in the northern region of Mexico, Montalvo (2003) highlights the influence of managerial characteristics (3.1) on EI and the environmental-economic risks of developing cleaner technologies and manufacturing processes. Other studies (e.g., Montalvo, 2008; Boons and Lüdeke-Freund, 2013; Chen and Chang, 2013) support this idea arguing that senior staff (3.1) can encourage employees to be more creative, innovative and respectful with the environment. According to Andriopoulos (2001) and Halbesleben et al. (2003), leaders (3.1) with appropriate green perspectives play a key role in facilitating organizational creativity as well as the implementation of environmental innovations. Amabile et al. (1996) highlight creativity (3.1) as a starting point for innovation. Furthermore, Rajala et al. (2016), in a study of the US-based carpet manufacturer Interface, illustrate the role of the managerial agency (3.1) in driving environmentally sustainable practices in a company in order to unite firm culture and firm orientation with a green business model. The relationship between employing managers who are more in tune with environmentally conscious practices and greener business models based on better ecological performance and higher investments in environmental initiatives has also been highlighted by other researchers, e.g., Anderson (1998), O'Connor and Ayers (2005), and Hojnik and Ruzzier (2016a). In this line, Naffziger et al. (2003) and Tseng et al. (2013) establish the relationship between the presence in a company of a manager with a higher level of environmental (3.1) concern and the time and money invested in environmental initiatives. Moreover, Peng and Liu (2016), in a study which explores the determinants of EI, include the indicator "managerial environmental awareness" (3.1) in order to measure green innovation. In addition, BID (2007) and Kemp and Pearson (2008) accentuates the importance of green human resources (3.1) as an indicator which shows the innovative effort of a firm.

Green structural capital includes organizational capabilities, organizational commitments, organizational culture and philosophies, patents, copyrights, etc. Some of these have been analyzed in the previous section as processes of EI. Nevertheless, organizational cultures and philosophies can also be considered an organizational EI. According to Battisti (2008), it is not only important for firms to generate innovations; innovations must be adopted and used by firms, incorporated into their routines and their company philosophy. Thus, environmentally-oriented culture is another green performance indicator that should be taken into account by the literature for measuring EI. In a review carried out by Williams et al. (1993), this indicator, i.e. environmentally-oriented culture, is measured using the number of environmental objectives (3.3) included in production plans and operations. The reviews of Frosch and Gallopoulos (1992), Tibbs (1992) and Kemp and Pearson (2008) also highlight the inclusion of environmental plans (3.2) in production processes.

From the point of view of several researchers (e.g., Baram and Partan, 1990; Hamner, 2006; Zailani et al., 2012), conducting external environmental audits (3.4) is another good performance indicator for measuring the level of company commitment to environmental requirements. In their study based on a firm survey, Garrod and Chadwick (1996) also introduce environmental audits (3.4) as a growing indicator used to achieve EI. Ecological audits (3.4) provide firms with knowledge as to whether their green innovation is being effective and, depending on the result, firms can implement new ecological practices to reduce their environmental impact. Thus, Kemp and Pearson (2008) enhances auditing systems as a key organizational innovation for the environment. In addition, consulting services (3.5), which ensure compliance with environmental standards, constitute another tool that has the potential to increase the EI level of a company (e.g., Del Brío and Junquera, 2003; Scarpellini et al., 2012; De Jesús Pacheco et al., 2016). According to this, BID (2007) enhances the outsource consulting and technical assistance (3.5) as green innovative strategies.

Investment in research (3.6) is another key point that firms should introduce in their corporate culture. Although controlling pollution can be effective, it is not always the most efficient way to satisfy environmental requirements. Therefore, restructuring a firm's approach toward environmental management, from pollution control to pollution prevention, may be the most ecologically-driven method (Gottlieb et al., 1995). Accordingly, investing in research becomes an effective tool for achieving this goal (Porter and Van der Linder, 1995; Horbach, 2008).

Green relational capital is defined as the relationships of the company with customers, suppliers, network members, and partners regarding environmental management and EI. Accordingly, cooperation with stakeholders (3.7) enhances the creation of competitive advantage and simultaneously helps to achieve environmental objectives (e.g., Matos and Silvestre, 2013; Roscoe et al., 2015; Rodríguez and Wiengarten, 2017). According to Cramer et al. (1991), Cramer and Schot (1993) and Frosch (1994), restructuring firm relationships with pressure groups (3.7) is an important factor for obtaining information about the environment and providing assistance to suppliers and customers. Furthermore, forming partnerships with these groups (3.7) affords greater possibilities to seek out solutions to environmental problems (Frosch and Gallopoulos, 1992) and to renew firm business models to make them greener and more sustainable (Anderson, 1998). Florida (1996) and Chen (2008) also highlight the close positive relationship between firm-supplier ties (3.7) and the creation of new environmental improvement opportunities. Cooperation with suppliers, universities and public research institutions (3.7) has three significant benefits. First, it provides the firm with knowledge (e.g., Ghisetti and Reinnings, 2014; Ghisetti and Pontoni, 2015; Bossle et al., 2016). Second, it allows a firm to obtain information with the aim of improving products and processes (De Marchi, 2012; Segarra-Oña and Peiró-Signes, 2014). Third, it makes it possible for the firm to develop technological capabilities necessary to generate innovation (Becker and Dietz, 2004; Ghisetti et al., 2015).

One well-known cooperation method (3.7) is to create supplier questionnaires. These surveys provide firms with information about their level of environmental commitment and the quality of their environmental characteristics, activities and practices. In addition, firms obtain an idea of what kind of image their activities produce in the eyes of stakeholders (Eltayeb, 2009; Hamner, 2006). This practice allows firms to correct non efficient activities and implement new, greener ones.

The development of new market niches (3.8) is considered by some researchers to be another useful tool for the purpose of implementing green innovations (e.g., Blättel-Mink, 1998; Niinimäki and Hassi, 2011; Loorbach and Wijsman, 2013) and introducing new systems (3.9) (Blättel-Mink, 1998). According to El Korchi and Millet (2011), introducing remanufacturing systems or reverse logistic channels (3.9) allows firms to reduce environmental impact by reducing waste and extending product life cycle. Asif et al. (2012) and Ye and Zhang (2013) believe multiple life cycle products (MLPs) (3.9) constitute an important strategy for developing sustainable products and that remanufacturing is the best tool for achieving this goal. Additional research supporting remanufacturing systems (3.9) has also been published in a number of other relevant works (e.g. Stock and Lambert, 2001; Moore, 2005; Bakker et al., 2014). Finally, implementation of new transport systems (3.9) based on new routes, short distances, and the replacement of diesel fuel is another means of applying green innovation (Iritani et al., 2014) and achieving less pollution through the reduction of CO^2 emissions.

4.4. Marketing eco-innovation

Marketing innovation activities are relevant performance indicators for implementing and measuring EI, as stated by BID (2007). However, marketing green innovation has received less attention than other types of EI in environmental literature, which by no means makes it any less important. This review has identified 3 EIPI based on marketing (4). Recently, certain research has focused on identifying the environmental marketing indicators that can measure the level of EI implementation in order to reduce the negative environmental impacts of companies; achieve greater efficiency; and find new ways to carry out ecological innovation in the four dimensions: product, process, organizational and marketing.

Some environmental policies have focused on packaging, for example, the Directive 94/62/EC in the European Union, the response to the large amount of waste disposable packaging generates and its negative environmental impact (González-Torre et al., 2004). Thus, the use of returnable packaging (4.1), which can be recycled and reused, contributes to EI by increasing product efficiency while reducing waste and resource consumption. Some examples of relevant publications on the environmental benefits of using returnable packaging (4.1) include Rogers and Tibben-Lembke (1998), Duhaime et al. (2001) and Twede and Clarke

(2005). In this line, Stock (1992), Carter and Ellram (1998) and Silva et al. (2013) focus their studies on the reduction of waste and the improvement in resource efficiency resulting from the use of returnable packaging. Furthermore, Zailani et al. (2012) emphasize the need for design innovation in reusable packaging in order to enhance sustainability. Similarly, more authors (e.g., Hart, 1995; Shrivastava, 1995; Christmann, 2000) highlight the importance of packaging design (4.2) that can be reused in order to improve the sustainable performance of firms. Other studies agree with this environmental innovation indicator (e.g., Rosenau et al., 1996; Van Hemel and Cramer, 2002). In the literature the importance of packaging design (4.2) to influence consumer interaction with products is demostrated (Löfgren, 2005). Jelsma (2016) illustrates, for example, that product attributes can determine consumer behavior. Some authors (e.g., Zailani et al., 2012; Wever and Vogtländer, 2014; Wilkström et al., 2016) question the importance of including 'sustainable' packaging design as a means to fulfill ecological requirements, discussing whether it encourages customers to reduce food waste and recycle packaging. In order to measure of the extent to which sustainable packaging has been implemented, a great deal of researchers have debated the attributes packaging must possess in order to be green, such as: easy to empty (Langley et al., 2011; Juul, 2012); easy to clean (Langley et al., 2011); easy to separate into different fractions (Henriksson et al., 2010) easy to fold (Martin et al., 2006); provides information about how to sort (Henriksson et al., 2010; Langley et al., 2011); contributes by extending time between packaging date and expiration date (Plumb et al., 2013; Lindh et al., 2016); and contains the desired quantity (Lindh et al., 2016). According to Cheng and Shiu (2012), simplifying packaging is also a necessary way to obtain sustainable packaging.

Although the main focus in the literature about EI marketing type is on packaging, customer buying decisions are not only influenced by traditional criteria like cost, quality, and delivery but also by green firm image and sustainable firm activities. This is due to the increase in market awareness of environmental problems. In this context, quality certifications (4.3) are the best way to show markets whether a firm is fulfilling environmental requirements. Product certification according to international standards, such as ISO 14001 or Globalgap, is an increasingly necessary requisite for companies wishing to gain entry to numerous markets. This issue has been addressed by various authors, such as Hamner (2006), Eltayeb (2009) and Chiarvesio et al. (2015). Additionally, Li and Hamblin (2016), in a study based on pharmaceutical manufacturing companies in Tianjin (China), introduced the indicator "ISO 14001" to analyze the impact that some factors (CO_2, packaging, waste …) have on cleaner production. In this context, standards certifications related to environmental management can be a good EI performance indicator to measure the efforts to accomplish the environmental requirements.

5. Conclusions and future research

EI implementation has received little attention in comparison with the wide range of studies published on EI concepts, consequences and drivers (Kemp, 2009). Thus, the present study looks to fill the existing gap, analyzing the literature on key EIPI, and synthesizes the most current research on this topic, adding value in the following ways. On the one hand, it offers an overview of which performance indicators are the most cited in the EI literature. In this line, this review contributes to develop a body of knowledge to analyze and measure the level of EI implementation that can potentially guide recommendations for future economic, social and environmental policies in order to reach current environmental objectives (Carrillo-Hermosilla et al., 2010; Boons and Lüdeke-Freund, 2013). This is particularly interesting because EI policies play a key role in the EI implementation as Rennings (2000), Del Río et al. (2010) and Wagner and Llerena (2011) mention. On the other hand, a set of EIPI was developed to show the most important performance indicators that must be included in the four types of EI (product, process, organizational and marketing), which can also be used as a guide to obtain an efficient environmental innovation measurement. Furthermore, this can be useful to create compound indicators for measuring level of environmental innovation and, subsequently, comparing said levels between countries, sectors or companies.

It is clear that the environmental impact of firms' daily activities such as CO_2 emissions, non-efficient use of resources, and high waste levels of water and energy, increases concern regarding their ecological performance. Thus, the implementation of EI is critically important due to the ever increasing demand for a cleaner environment. In this context, research works in business, environmental and economic literature are focused on trying to measure and analyze EI implementation levels in order to discover how environmental actors can reduce their negative environmental impacts, fulfill green requirements and be more efficient to ensure the well-being of current and future generations. The careful study of literature focused on measuring and analyzing EI implementation in different countries and sectors has generated the following conclusions. It is observed that a large portion of the literature on measuring EI are focused on product, process and organizational EI type. Thus, the 36% of the 30 key performance indicators identified corresponding to process EI, 30% to organizational EI and 23% to product EI. In this sense, marketing EI type has received little attention by the literature in spite of its increasingly known environmental impact. Moreover, the vast majority of literature on EI measurement is focused on the Business, Management and Engineering sector; thus, more studies should be carried out in sectors like agriculture due to its close relationship with the use of natural resources and environmental externalities. Our study also identified some weakness on existing studies on EI measurement. Most research has focused on exploring one or two types of EI (product, process, organizational or marketing EI), but not all four types in specific areas. This fact does not afford an efficient, comprehensive study on EI and, instead, offers a very limited vision of the level of EI in firms, sectors or countries. The most complete studies on this subject have been carried out by Doran and Ryan (2016), Castellacci and Lie (2017) and Rodríguez and Wiengarten (2017). However, they only investigate EI implementation in product and process type, so their conclusions do not accurately reflect the reality of the firm, and they can only provide a limited idea of the level of ecological innovation implementation. Another notable weakness in existing research on EI implementation is related to the performance indicators that are included. Choosing a complete combination of indicators in each EI type is not an easy task, and evidence suggests that the majority of studies include indicators that are chosen in rudimentary ways, with little attention given to which indicators add more environmental value in each sector and firm. Although some methods are better than others, no single method or indicator is ideal. Different methods should be applied for analyzing eco-innovation, as Kemp (2009, p.103) mentioned: "to see the whole elephant, instead of just a part". Consequently, it would be particularly interesting for future research to conduct studies in which all types of EI, as well as the most relevant green indicators in each type, are included. Future research that applies new questionnaires in different sectors can help to discover new ways of marketing. The inclusion of new indicators would help to fill existing gaps related to those EIPI that have already been identified. This is particularly useful when seeking to obtain an accurate measurement of EI level.

A number of limitations of this study can be cited. Firstly, it follows a strictly theoretical research method based on previous research. Future works could be aimed at studying actual case studies to identify what companies are actually doing. Secondly, another shortcoming is the search frame, as the database choice for the paper search could be expanded. Thirdly, one more limitation is related to the criteria initially used for the paper selection. Expanding criteria could lead to other EIPI not covered by this study. Thus, all these points are also opportunities for future research.

Finally, the results have corroborated that environmental innovation should be analyzed as a whole in order to have a sound method for measuring EI level including the four dimensions of EI (product, process, organizational and marketing) and a complete indicator combination in each type. Looking to the future, this research has provided much information with implications for industry, governments and academia to understand which EI indicators can be implemented by environmental stakeholders to reduce their negative environmental impact and become greener. This study also supplies a set of EI implementation indicators to aid practitioners and policy-makers in assessing the balance between company activities and sustainability. These are relevant opportunities to advance the academic perspective towards the constitution of a body of knowledge on this research topic.

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