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ECO-INNOVATION IN CORPORATE MANAGEMENT: A SYSTEMATIC REVIEW

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ABSTRACT

In recent decades, companies from various segments have adopted eco-innovation practices and integrated them into their business models to increase their competitiveness. Such companies need to adjust planning and investments by integrating eco-innovation practices to improve their economic, social and environmental development. This study aimed at understanding the theme Eco-Innovation by surveying its state-of-the-art. The theme was analyzed quantitatively and qualitatively using the systematic review method. At first, the study method selected 110 articles on eco-innovation and corporate management between the years 2011 and 2020.With the research protocol, 36 articles were chosen for a thorough analysis that composed the results of this study. From the results, the state-of-the-art of eco-innovation and corporate management was mapped, realizing its main contributions by the synthesis of strengths and weaknesses found in the articles. Companies that have adopted some type of eco-innovative practice stood out for improving their business performance, reducing environmental impacts, valuing their ventures, in addition to showing positive relationships with social capital and better use of financial investments.

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INTRODUCTION

This study aims to know more about the eco-innovation theme with sufficient information to allow a critical survey of its state-of-the-art. Economic, social and environmental sustainability has been a growing concern in our society due to climate change, increased pollution and the threat of scarcity of resources. Especially companies in the industrial sector are recognized as the main impactors of the environment. In recent decades, the importance of corporate management of negative externalities, such as environmental pollution and human rights violations, has been the subject of wide-ranging debates (Galvão, 2014). In this context, political and market pressures have led companies to innovate in economic and environmental aspects (He *et al.,* 2017), with sustainability basing innovation and changes in the way of managing (Nidumolu*et al.*, 2009). The debate on the adoption of eco-innovation (EI) practices for sustainable business models (Kleiwitz and Hansen, 2014) gained strength with the Brundtland Report (WCED, 1987), which emphasized the importance of healthy environmental technologies.

But it was in the 2000s that EI was widely disseminated in the corporate, productive and research sectors (Karakaya et al., 2014). Defining eco-innovation is not an easy task, as several concepts and definitions have emerged over the years (Carrillo-Hermosilla et al., 2010). This study adopts the traditional EI concept by Fussler and James (1996): "new products and processes which provide customer and business value but significantly decrease environmental impacts". In many organizations the adoption of socio-environmental management tools to improve processes and products are understood as innovation focused on sustainability. Such tools create new ways that make companies more profitable, competitive and effective (Louette, 2007). Both academics and market professionals agree that significant changes are needed in the way business practices interact with the environment, especially where companies operate (FranceschiniandPansera, 2015; Vivanco*et al*., 2015; Lee and Min, 2015; Segarra-Oña*et al*., 2015; Lopez and Montalvo, 2015; Caiand Li, 2018). This issue was articulated in at least 11 of the 17 United Nations (UN) Sustainable Development Goals (SDGs). EI practices are critical to achieving the SDGs.

They bring innovations that can redesign existing business models or, at the very least, reduce the social and environmental impact caused by these models. Jabbour et al. (2015) show that several solutions can reduce the environmental impact at all stages of the supply chain for sustainable production, consumption and disposal.Alternatives to corporate management and public policies play an important role in the development of EI and in the adoption of its practices (Daddi*et al*., 2016). Companies are currently adopting EI practices and integrating them into their corporate strategies to increase their competitiveness. According to Cai and Li (2018), EI creates value forthe client and the company, contributing to sustainable development, reducing costs and environmental impacts. To improve economic, social and environmental development, companies need various financial and planning adjustments to adapt the EI to their business models. In the last decade, social and environmental issues were fundamental to link economic growth, innovation and sustainable development (Galvão, 2014). It is known that companies committed to sustainability, especially those that demonstrate environmental and social efforts, create value for their brands and increase their reputation (Hansen *et al*., 2009; Vitorino, 2014). It is also known that eco-innovation represents changes and has positive impacts in many sectors (Cai and Li, 2018). However, a question remains:What are the current research gaps in EI studies and what are the EI trends in corporate management? So far, there was not enough information in the literature to answer this research question.

THEORETICAL BASIS

In recent decades, the eco-innovation theme has gained prominence as companies have changed their operating strategies with the adoption of EI practices. However, due to the lack of data and theories that link business, economics and eco-innovative performance, many discussions on the subject persist. Therefore, it is important to develop more research that addresses the EI theme in more depth(Santos et al., 2019). The lack of a unanimous concept of eco-innovation makes it difficult to understand the topic (Diaz-Rainey and Ashton, 2015).Thus, to establish the basis for this review, the definitions and conceptualizations of EI found in the international literature were summarized in Frame 1.

Frame 1. Concepts of eco-innovation, environmental innovation, green innovation and sustainable innovation found in the international literature

CONCEPTS	REFERENCES
ECO-INNOVATION	
'new products and processes which provide customer and business value but significantly decrease environmental impacts'	Fussler and James (1996)
"… the additional attribute of innovations toward sustainability is that they reduce environmental burdens …"	Rennings (2000)
Environmental innovation is innovation that serves to prevent or reduce anthropogenic burdens on the environment, clean up damage already caused or diagnose and monitor environmental problems"	Vinnova (2001)
'the production, assimilation or exploitation of 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'.	Kemp and Pearson (2007)
"Eco-innovation is any form of innovation aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment or achieving a more efficient and responsible use of natural resources, including energy"	European Commission (2007)
'… means the creation of novel and competitively priced goods, processes, systems, services, and procedures that can satisfy human needs and bring quality of life to all people with a life-cycle-wide minimal use of natural resources (material including energy carriers, and surface area) per unit output, and a minimal release of toxic 'as innovations which are able to attract green rents on the market.	Reid and Miedzinski (2008)
(…) the concept is closely related to competitiveness and makes no claim on the "greenness" of various innovations. The focus of eco-innovation research should be on the degree to which environmental issues are becoming integrated into the economic process'	Andersen (2008)
"the production, assimilation or exploitation of a novelty in products, production processes, services or in management and business methods, which aims, throughout its lifecycle, to prevent or substantially reduce environmental risk, pollution and other negative impacts of resource use (including energy)"	European Commission (2008)
'a new concept of great importance to business and policy makers. It is about innovations with lower environmental impact than relevant alternatives. The innovations may be technological or non-technological (organizational, institutional or marketing-based). Eco- innovations can be motivated by economic or environmental considerations. The former includes objectives to reduce resource, pollution control, or waste management costs, or to sell into the world market for eco-products'.	Arundel and Kemp (2009)
"there is a need for a management and investment process that facilitates the achievement of objectives that, ultimately, drive the organization to achieve business sustainability"	Bocken et al. (2014)
ENVIRONMENTAL INNOVATION	
"are new and modified processes, equipment, products, techniques and management systems that avoid or reduce harmful environmental impacts"	Kemp and Arundel (1998), and Rennings and Zwick, (2003)
'as innovations that consist of new or modified processes, practices, systems and products which benefit the environment and so contribute to environmental sustainability'	Oltra and Saint Jean (2009)
GREEN INNOVATION	
'a rather pragmatic definition', stating that it 'does not have to be developed with the goal of reducing the environmental burden. (…) It does however, yield significant environmental benefits'	Driessen and Hillebrand (2002)
'as hardware or software innovation that is related to green products or processes, including the innovation in technologies that are involved in energy-saving, pollution-prevention, waste recycling, green product designs, or corporate environmental management'	Chen et al. (2006)
SUSTAINABLE INNOVATION	
"as a process where sustainability considerations (environmental, social, financial) are integrated into company systems from idea generation through to research and development (R&D) and commercialization. This applies to products, services and technologies, as well as new business and organization models"	Charter and Clark (2007)

Despite the different wording, the concepts cover environmental and economic components (Huppes*et al*., 2008). EI's connotations consist of new or modified products, processes, services and management practices that reduce environmental impacts and guarantee economic gains (Kemp and Horbach, 2007). Hansen et al., (2009) consider that EI feeds the tripod of sustainability - environmental, economic and social responsibility. In addition, the scope of eco-innovation can "go beyond the conventional limits of the organization to innovate in order to cause changes in socio-cultural norms and institutional structures" (Carrillo-Hermosilla *et al*., 2010). EI has become increasingly important to management over time. It links economic efficiency to saving resources and energy, increasing competitiveness based on innovation. Environmental performance is also a focus of EI, which results in innovative green practices.This change leads to new learning, values and beliefs, including the adoption of standardization and control mechanisms, such as ISO certifications and new resources for organizations (Foxonand Anderson, 2009).

However, the products and services generated by EI practices must be offered at fair prices, as solutions must be designed to meet human needs and improve people's quality of life (ReidandMiedzinski, 2008). According to Arundel and Kemp (2009) theEI must address institutional innovations that reduce environmental impacts, such as changes in values, beliefs, knowledge, standards, management, laws and governance systems.Thus, EI can be understood as a process of technological advancement and social change that implies improving environmental performance and making society more sustainable (BoonsandLudeke-Freund, 2013). The EI, which was initially based on "traditional" innovation, aimed mainly at reducing environmental impacts, today encompasses economic and social aspects with a remarkable potential for sustainability (Tsengand Bui, 2017). The interdisciplinary EI concepts involve aspects of engineering, economics and administration, among other areas. The term EI (eco-innovation) is often used interchangeably with other terms, such as environmental innovation, green innovation and sustainable innovation. Therefore, these terms were also considered in this systematic review. The EI research proposes a global approach to sustainability, including functional changes in products and structural changes in business models (Carrillo-Hermosilla*et al*., 2010). This is because sustainability is not only understood as a practice of operational excellence, but as an innovation that requires different organizational dynamics (VanOppenandBrugman, 2011). In addition, to achieve sustainable goals, innovation is an important mechanism driven by continuous improvements in the quality of products, services and processes, as well as by regulatory policies and standards (Hallenga-Brink and Brezet, 2005). In this perspective, the concept of sustainable development, which implies the interdependence of the economy and the environment, has aroused great interest from society and political powers in recent years.Growing concerns about pollution have led industries to adopt clean production methods that measure the environmental impact throughout the product's life cycle. Thus, they were able to integrate environmental strategies into their business models (Machiba, 2010). The term "innovation" is increasingly used by business managers and environmental politicians, given the speed of sustainable manufacturing initiatives and the urgency of changes in the productive sector (Carrillo-Hermosilla*et al*., 2009). In addition to the many restrictions imposed on industries, which illustrate the challenges of environmental sustainability, there is still an urgent need for approaches to significantly improve the environmental performance of products. EI is an approach with the potential to address this urgency (O'Hareand McCaloone, 2014). The number of researches addressing EI has increased considerably in the past decades, in various areas of knowledge and in several countries. Santos et al., (2019) studied the performance of companies that adopted EI in emerging and developed countries. The authors assessed the EI structure of these companies and the influence of EI on their financial performance over 2 years. The study revealed that most of the environmental and social variables of EI were significant in developed countries, which were in more advanced stages of EI. In emerging countries, only two environmental and social variables were significant.

PrzychodzenandPrzychodzen (2015) analyzed how EI affected financial performance in publicly traded companies in Poland and Hungary.The authors explored four types of EI (product, process, market and sources of supply) and their impact on financial performance indicators, using public information provided by the companies. The results indicated that EI generated higher returns on companies' assets and equity and less profit retention. Cai and Li (2018) investigated the relationship between the determinants of EI and their impact on the performance of Chinese companies. The authors showed that EI can significantly improve a company's environmental performance, positively and indirectly influencing the economic performance of businesses. Analyzing the mentioned studies, it is observed that EI has been worked and discussed in several areas of knowledge and in different ways. It is a current, interdisciplinary and complex theme, with scientific, ethical, economic, cultural and political dimensions and in constant construction.

METHODS

This article makes a qualitative and quantitative assessment of eco-innovation through a theoretical-conceptual analysis and provides a systematic review that makes it possible to know, through the literature already produced, the state-of-the- art of the subject. According to Denyer and Tranfield (2009), systematic review is a specific methodology that searches for existing studies, selects and evaluates contributions, analyzes and synthesizes data and reports evidence, allowing reasonably clear conclusions on the topic. The method used to map and synthesize a specific topic provides rigor and a reliable basis for the literature review (Biolchin*et al*., 2005; Brereton*et al*., 2007). The methodology used in this systematic review followed a five-step procedureof content analysis proposed by Denyer and Tranfield (2009), as shown in Figure 1.

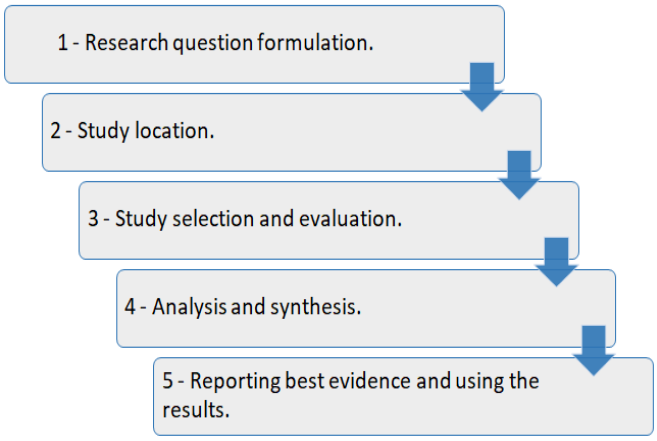

Figure 1. Systematic review methodology, adapted from Denyer and Tranfield (2009)

Research question formulation: The systematic review started with a clear, objective and well-formulated research question: What are the current research gaps in EI studies and what are the EI trends in corporate management?The question guides the analysis and defines which studies should be included, which research strategy should be used to identify relevant studies and what information should be extracted from each study (Counsell, 1997).

Study location: The systematic review proceeded with the identification of "strings" (search terms) that were built from the study scope (Tranfield et al., 2003). Before searching relevant studies, a research protocol must be developed incorporating the review questions (Petticrew and Roberts, 2006). This study used a protocol for locating studies (Figure 2) that ensured systematization, transparency and replicability - the main characteristics of a systematic review (Briner and Denyer, 2012). Then, the most appropriate research steps for the study were defined. The research results provided a complete list of articles and their main contributions, on which the review was based (Tranfield*et al*., 2003).
In this study, the source selection criteria were defined by international databases, since they have greater coverage and higher impact factor. The option went to Web of Science and Scopus, with the search started on February 18, 2020. At first, three refinement criteria were established to exclude grey literature and limit the sample size: year (2011-2020), language (English) and type of publication (articles and reviews). Given the wide variety of contexts and ambiguities, the following terms, often used interchangeably in the literature, were analyzed: "*ecoinnovation*", "*environmental innovation*", "*green innovation*" and "*sustainable innovation*" (Carrillo-Hermosilla*et al*. 2010; Schiederig*et al.* 2012; Karakaya*et al.* 2014). We search by title, abstract and keywords using the following search strings: "*eco-innovation**" AND "*decision making**" OR "*ecoinnovation** AND *decision making**" OR "*environmental innovation** AND *decision making**" OR "*green innovation** AND

*decision making** " OR "*sustainable innovation** AND *decision making**".

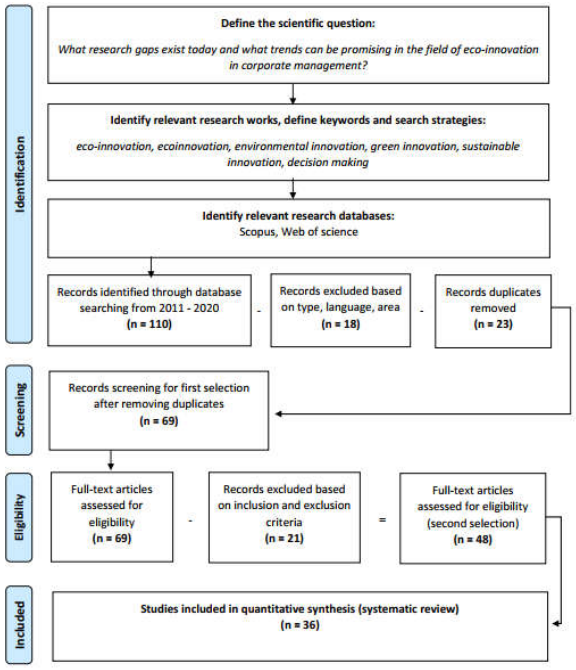

Figure 2. Systematic review: design of the research protocol, adapted from Bossle et al. (2016)

Study selection and evaluation: To keep the search transparent, an explicit set of selection criteria was applied, through which the relevance of each study to the research question was assessed.Detailed, accurate decisions should be recorded specifying the basis on which the sources of information are included or excluded (DenyerandTranfield, 2009). Following this logic, the main criteria used in this work to select and evaluate the studies were:

- Criteria for including articles: papers that presented and described eco-innovation and corporate management; who analyzed eco-innovation in creating value for companies; who cited eco-innovation linking forms of business investment; who cited eco-innovation as the basis for decision making.
- Criteria for excluding articles: papers that did not present a description of eco-innovation in its context; who presented modeling or techniques focused on the areas of energy, environmental impacts, logistical engineering or areas that were not directly linked to the research question; when search engines did not find the "full paper" version of the study.

The selection of articles started with the search strings (described in sub-item 3.2). 110 articles were found, 52 in the Scopus database and 58 in the Web of Science (Figure 2). Subsequently, only articles and reviews in English and in the areas related to the objective of this study were selected. Thus, 13 articles were excluded from the Scopus database and 5 from the Web of Science. Then, 23 duplicate articles were excluded, 14 in Scopus and 9 in Web of Science. The StArt Software, developed by the Software Engineering Research Laboratory (LaPES) of the Computing Department of the Federal University of São Carlos (UFSCar), was used to exclude duplicates. At the end of these steps, 69 articles remained, evaluated by title, summary and methodology, with another 21 exclusions. Thus, only 36 articles from the initial selection (32.73%) were carefully evaluated by the StArt and Mendeley software.

Analysis and synthesis: After collecting and evaluating the selected studies, a systematic review was carried out involving critical analysis and synthesis (BrinerandDenyer, 2012). The purpose of the analysis was to separate the studies into constituent parts to describe the relationship between them, while the purpose of the synthesis was to associate the parts identified in individual studies. The synthesis must go beyond mere description, reformulating information for a new or different arrangement and developing knowledge that was not apparent in isolated studies (DenyerandTranfield, 2009). After applying the selection and evaluation criteria, each selected study was analyzed and classified. Thus, it was possible to synthesize, integrate and accumulate information and results on the topic researched in different studies, according to the research question formulated and initial objective.Based on the main information extracted from the abstracts, objectives and methods used in each article, it was possible to relate results and objectives defined in the research questions with some pre-established criteria in this study.

Reporting best evidence and using the results: Systematic reviews can provide to researchers a solid understanding of the current frontier of knowledge on the topic studied. The findings expose what is known and unknown about the research question formulated in the review work (BrinerandDenyer, 2012).

In addition, as noted by Higgins and Green (2008), the central objective of a systematic review is to present information, instead of offering advice. Therefore, the discussion and conclusions should help people to understand the practical implications of the evidence found in the review. In this sense, section 5 of this article discusses the main results of the classification and analysis of studies, provides a mapping of the state-of-the-art and identifies gaps for future research in this field of knowledge.

RESULTS

Quantitative view of the reviewed articles: This section presents the results of this study. After the initial selection and filtering in the databases, Figure 3 shows that there is an increase in scientific publications on eco-innovation and decision making as of 2016.Publications on the topic have increased by an average of 18 articles per year in the last 4 years (2016 to 2019). Considering the 10 years researched in this work, the last 2 years (2018 and 2019) presented the largest number of publications.

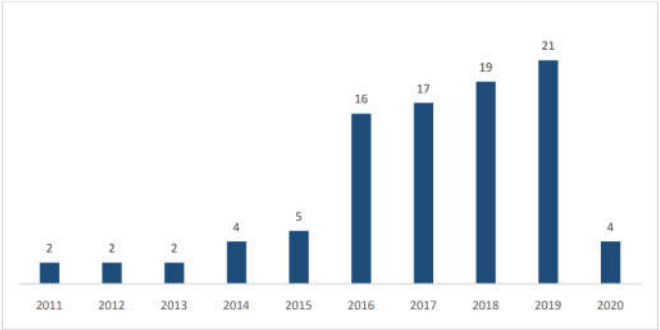

Figure 3. Distribution of articles in the last 10 years

The low number of publications in 2020 is probably due to the collection of studies that occurred at the beginning of the year (February 2020). However, the number of publications is expected to exceed that of 2019 by the end of 2020. After applying the systematic review protocol (Figure 2) and quantitative and qualitative analyzes to map the state-of-the-art of eco-innovation, the sample resulted in 36 articles, as shown in Figure 4. Comparing the results with those obtained after using the initial filters, the last 4 years (2016 to 2019) showed the largest volume of publications with an average of 6.5 articles per year. Considering the period surveyed, the largest number of publications occurred in 2019. As important as knowing the distribution of publications during the study period is knowing the source of the publications.The analyzed sample is distributed among 24 journals. Based on the number of publications by journals (Figure 5), it is observed that the Journal of Cleaner Production holds the largest number of publications on the topic, corresponding to 25% of the total.

Table 1. Description of articles, categories and methods

Identification	Title	Reference	Country	Categories	Method
1	The driving effect of internal and external environment on green innovation strategy. The moderating role of top management's environmental awareness	Cao, H. and Chen, Z., 2019	China	EI in the management	Regression model
2	Making the world a better place by making better products: Eco-friendly consumer innovativeness and the adoption of eco-innovations	Paparoidamis, N.G. and Tran, H.T.T., 2019	França	EI and decision making in firms	Mental models
3	Ecological innovation decision behavior of enterprises in the strategic emerging industrial clusters based on cognitive neuroscience	Li, X. and Liu, L., 2018	China	Consumers opinios in the EI	Experiments
4	Evaluating challenges to implementing eco-innovation for freight logistics sustainability in Nigeria	Orji, I.J. *et al*., 2019	China	EI and decision making in firms	
5	Business models and the diffusion of eco-innovations in the eco-mobility sector	Nicolai, I. and Faucheux, S., 2015	França	Sustantability in firms	Induction and abduction method
6	Role of green innovation and business performance: evidence from Romanian SMEs	Oncioiu *et al*., 2018	Romania	EI increased competitiveness in companies	Review
7	The effect of life cycle cost information on consumer investment decisions regarding eco-Innovation	Kaenzig, J. and Watenhagen, R., 2011	Switzerland	EI and LCC	Review
8	Measurement of the human capital applied to the business eco-innovation	Ortega-Lapiedra *et al*., 2019	Spain	EI and difficulty measuring its impacts	Review
9	Identifying eco-innovation in industrial symbiosis under linguistic preferences: A novel hierarchical approach	Tseng, M. L. and Bui, T.D., 2017	Taiwan	EI in the management	Delphi method and factor analysis
10	Eco-innovation indicators for sustainable development: The role of the technology institutes	Scarpellini *et al*., 2016	Spain	EI and the measurement of human capital	HCSI - Specific human capital index
11	Resource management practice through eco-innovation toward sustainable development using qualitative information and quantitative data	Lee *et al*., 2018	Taiwan	EI and decision making in firms	Delphi method and performance analysis
12	An integrative approach for structuring and prioritizing eco-innovation determinants with a survey in knowledge-based companies	Shahin *et al*., 2020	Iran	EI - Determinants	Review and ISM model
13	Selected indicators for evaluation of eco-innovation projects	Stosic *et al*., 2016	Servia	EI increased competitiveness in companies	Case study
14	Fuzzy approach to eco-innovation for enhancing business functions: a case study in China	Cui, L., 2017	China	EI recicling models	Hierarchy process method
15	Fostering systematic eco-innovation in an industrial symbiosis environment using DEMATEL	Jayakrishna *et al*., 2020	India	EI increased competitiveness in companies	DEMATEL model
16	Strategic orientations, sustainable supply chain initiatives, and reverse logistics Empirical evidence from an emerging market	Hsu *et al*., 2016	USA	Sustentability in firms	SEM technique
17	Material selection for eco-innovation: SPICE model	Prendeville *et al*., 2014	U. Kingdon	EI and selection of materials in production	Case study
18	Factors Influencing Automobile Firms' Eco-Innovation Orientation	Segarra-Ona *et al*., 2014	Spain	EI in the automobilistic sector	SEM technique
19	How past decisions affect future behavior on eco-innovation: An empirical study	Peiró-Signes, A. and Segarra-Oña, M., 2018	Spain	EI in the automobilistic sector	Partial minimum square method
20	System of self-financing strategy for the policies aimed at the eco-innovation in the productive sectors	Albertario, P., 2016	Italy	Innovation and financing	Case study
21	Eco-design application to drive sustainable manufacturing	Abdullah *et al*., 2015	China		
22	Twisting the twist: how manufacturing & knowledge-intensive firms excel over manufacturing & operational and all service sectors in their eco-innovative orientation	Segarra-Oña *et al*., 2016	Spain	EI and the information (orientation)	Absorption capacity model
23	An Eco-Innovative Framework Development for Sustainable Consumption and Production in the Construction Industry	Ma *et al*., 2019	China	EI in the sustainable production	Fuzzy set theory
24	Policy forum: Potential options for greening the Concessionary Forestry Business Model in rural Africa	Atewamba, C. and Boimah, M., 2017	Ghana	Sustainable challenges in forestry companies	Case study
25	Relationship Between Innovation and Performance in Private Companies: Systematic Literature Review	Bach *et al*., 2019	Brazil	EI increased competitiveness in companies	Sistematic review
26	Investment valuation model for sustainable infrastructure systems: Mezzanine debt for water projects	David Gonzalez-Ruiz *et al*., 2019	Colombia	Innovation and financing	Case study

Continue

27	Towards a sustainable industrial ecology: Implementation of a novel approach in the performance evaluation of Italian regions	Arbolino *et al.*, 2018	Italy	EI in the sustainable production	Principal component analysis model
28	A Novel Environmental Performance Evaluation of Thailand's Food Industry Using Structural Equation Modeling and Fuzzy Analytic Hierarchy Techniques	Pipatprapa *et al.*, 2016	Taiwan	EI increased competitiveness in companies	SEM technique
29	Dynamic adjustment of eco-labeling schemes and consumer choice - the revision of the EU energy label as a missed opportunity?	Heinzle, S.L. and Wastenhagen, R., 2012	Switzerland	EI – energy efficience	Review and experiments
30	Sustainability evaluation: diverging routes recombined? Tasks for a new Working Group on Modelling and Evaluation for Sustainability	Huppes, G. and Ishikawa, M., 2011	Netherlands	EI and trade offs to decision making	Review
31	A performance assessment approach for integrated solid waste management using a sustainable balanced scorecard approach	Tsai *et al.*, 2020	Taiwan	EI and decision making in firms	Delphi method
32	Assessing sustainability performance of high-tech firms through a hybrid approach	Cui *et al.*, 2019	China	Sustentability in firms	Cluster analysis
33	Causal sustainable resource management model using a hierarchical structure and linguistic preferences	Wu *et al.*, 2019	Taiwan	Innovation and financing	Factor abalysis
34	On Occupant Behavior and Innovation Studies Towards High Performance Buildings: A Transdisciplinary Approach	Keskin, C. and Menguc, M. P.,2018	Turkey	EI – energy efficience	Review
35	Innovation intermediaries accelerating environmental sustainability transitions	Gliedt *et al.*, 2018	USA	EI increased competitiveness in companies	Sistematic review
36	I don't Want to be Green: Prosocial Motivation Effects on Firm Environmental Innovation Rejection Decisions	Bendell, B. L., 2017	USA	EI and decision making in firms	Case study

Source: Prepared by the author.

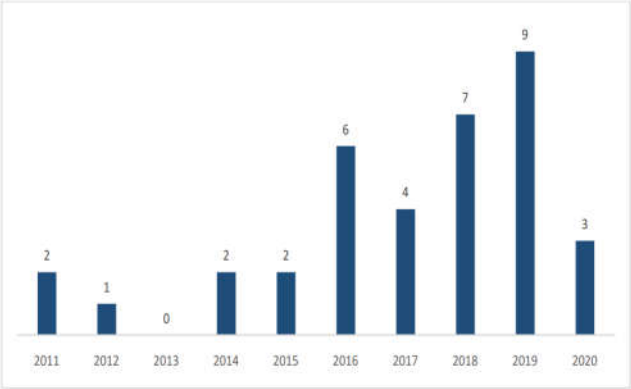

Figure 4. Distribution of articles in the last 10 years after applying the systematic review protocol

Some magazines stood out for the number of citations of their published articles. In 2012, the scientific journal Business Strategy and the Environment published an article that today has 64 citations. Likewise, in 2016, the International Journal of Operations & Production Management released a publication that reached 55 citations and the Journal of Cleaner Production published in 2017 an article that reached 34 citations. Journal of Cleaner Production and Sage Open had the highest impact factor, followed by the Journal of Operations & Production Management and Sustainability (Figure 6).

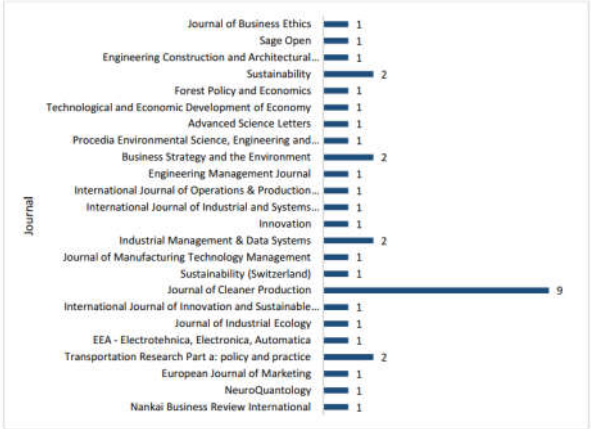

Figure 5. Number of Publications by Journals

Figure 6. Impact factor of Journals

The geographic distribution of the authors of the analyzed articles is shown in Figure 7. The 1-7 blue gradient indicates countries according to the number of publications, where 7 represents the country with the highest number of publications and 1 represents those with the lowest. China is the country with the largest number of publications (19.4%), followed by Spain (13.9%) and Thailand (13.9%). The USA is the third in number of publications (8.4%) and the rest have only one or two publications. It is observed that the three countries that most published the theme added up to almost 50% of the total publications.

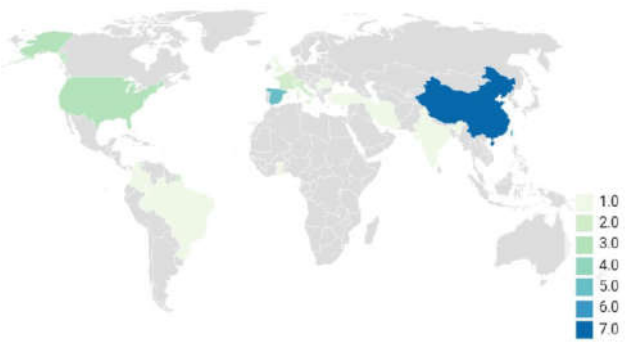

Figure 7. Geographic distribution of the authors

Table 2. Similarity between methods of articles

Method	Identification
Case study	13; 17; 20; 24; 26; 36
Review	6; 7; 8; 12; 29; 34
SEM technique	16; 18; 28
Delphi method	9; 11; 31
Systematic review	25; 35
Factor analysis	9; 33
DEMATEL	15
Absorption capacity model	22
Cluster analysis	32
ISM model	12
Experiments	3; 29
HCSI - Specific human capital index	10
Hierarchy process method	14
Fuzzy set theory	23
Mental model	2
Induction and abduction method	5
Partial minimum square method	19
Principal component analysis model	27
Regression model	1
Performance analysis	11

Source: Prepared by the author.

Table 3. Quality of articles measured by the number of citations

Identification	Author	Citations
29	Heinzle, S.L. and Wastenhagen, R., 2012	64
16	Hsu et al., 2016	55
9	Tseng, M. L. and Bui, T.D., 2017	34
27	Arbolino et al., 2018	25
35	Gliedt et al., 2018	22
18	Segarra-Ona et al., 2014	20
17	Prendeville et al., 2014	16
14	Cui, L., 2017	10
28	Pipatprapa et al., 2016	10
11	Lee et al., 2018	9
22	Segarra-Oña et al., 2016	8
36	Bendell, B. L., 2017	8
19	Peiró-Signes, A. and Segarra-Oña, M., 2018	6
2	Paparoidamis, N.G. and Tran, H.T.T., 2019	4
10	Scarpellini et al., 2016	4
13	Stosic et al., 2016	4

Source: Prepared by the author.

Qualitative view of the reviewed articles: Table 1 presents the synthesis of the main information from the final sample of 36 articles. In it, the column "categories" was created, based on the objectives of the articles. From this column, the results were grouped into categories that synthetically express the central point of each work, making the analysis clearer and more objective. It should be noted that 61% of the total articles analyzed were published by more than 3 authors and 30.5% by two authors. The two most frequent categories "Eco-innovation and decision making in firms" and Eco-innovation increased competitiveness in companies" together represent 27.8% of the total sample, with 5 articles in each. Second, the categories "Sustainability in firms" and "Innovation and financing" together represent 16.7% of the sample, with 3 articles in each.

Table 2 shows the main methods used by the articles and displays in the column "identification" how many articles used similar research methods. It is noted that case study was the most frequent method, used by 6 articles, representing 16.7% of the sample; the 5 systematic review articles accounted for 13.9% of the sample; and the structured equation modeling (SEM) and the Delphi method represented 8.4% of the sample, used by 3 articles each. It is noted that the study methods to contextualize, conceptualize, determine, explain and quantify eco-innovation (and its synonyms) are diverse. Regarding quality, Table 3 shows the articles most cited in the total sample. The first nine authors were cited more than 10 times. The first articlewas cited 64 times, probably due to the year of publication (2012). Among the most recent publications (2016-2018), there are articles with 55, 34, 25 and 22 citations, followed by those with 4 to 20 citations.

DISCUSSION

This section presents a critical content analysis of the 36 articles. The analysis aims to understand eco-innovation and detail the gaps and trends of its application in corporate management and, thus, meet the purpose of this review. This study was challenging because the literature on eco-innovation was widespread among several areas of knowledge in the past decade. Therefore, several studies have been produced to analyze eco-innovation from different points of view. Some authors analyzed EI characteristics and related them with competitiveness (Rennings, 2000; Lee *et al*., 2018) and others investigated fundamental theories about the development of EI and its concepts (Carrillo-Hermosilla *et al*., 2010; Bossle *et al*. 2016), thus supporting the understanding of the theme. Subsequently, some studies analyzed the determinants of EI adoption (Brunnermeier e Cohen, 2003; Rehfeld *et al*., 2007; Horbach, 2008; Vieira de Souza *et al*. 2018) and their effects on business performance (Chen *et al*., 2006; Oncioiu *et al*., 2018; Bach *et al*., 2019). This evolution in the way studies have been developed over the years suggests advances in EI practices and growing recognition of EI's contributions to the environment and corporate management. After analyzing the content, it was possible to find concordant and controversial points between the articles. The first positive information for decision makers is that eco-innovative companies perform better than non-eco-innovative companies (Salomo*et al*., 2008; Doran e Ryan 2012; Lee *et al*., 2018; Bach *et al*., 2019; Tsai *et al.* 2020).

Therefore, eco-innovation is positively related to financial performance (Tajeddini, 2016). Another important finding is that information is essential for decision-making. Prendeville et al. (2014) assert that eco-innovation can be effective in decision-making when information is well disseminated to stakeholders. In the same vein, Segarra-Oña et al. (2014) highlight the importance of sharing information about eco-innovation, as well as market information, for better business results. Likewise, Orji et al., (2019) reaffirm that the lack of clear information negatively affects the adoption of EI. The analysis also showed that incentives and financial investments are essential to increase the adoption of eco-innovation. According to Albertário (2016), financial incentives can encourage the adoption of EI practices to benefit stakeholders and improve innovation processes. Cao and Chen (2019) also agree that financial incentives can positively impact eco-innovation. According to Orji et al. (2019), the lack of resources is one of the main negative influences for the adoption of eco-innovation. Tsai et al. (2020) also state that financial investments and cost efficiency are decisive for the implementation of eco-innovation. Therefore, according to Lee et al. (2018) companies are challenged to improve costs to adopt eco-innovation. Likewise, Orji et al. (2019) state that it is difficult for companies to adopt eco-innovation in a competitive scenario due to its high initial costs, which makes it difficult to meet sustainability goals. Nicolai and Faucheux (2015) demonstrate that social dimensions define the acceptance of EI practices. The authors state that, once the social dimension is positively altered, the impacts will be positive. Likewise, Bendell (2017) and Cao and Chen (2019) state that social pressure can strongly impact the decision to adopt eco-innovation. Cui (2017) affirms that eco-innovation can reduce environmental impacts by creating sustainable solutions to society. Oncioiu*et al*., (2018) also state that eco-innovation is a powerful instrument that combines reduced environmental impacts with positive social and economic impacts. According to Bendell (2017), managers are more willing to adopt eco-innovation when they see opportunities to reduce environmental impacts (preserve nature) and minimize tax burdens, rather than meeting consumer demands. The study showed that managers make decisions about adopting innovation based on competitors, that is, many of their decisions are driven by the actions of competitors and not to meet the needs of the company itself. Tsai et al. (2020) demonstrated that stakeholder involvement is decisive for the implementation of eco-innovation. According to the authors, cost efficiency, stakeholder collaboration, flexibility to environmental changes, availability of local technical staff, acquisition technologies and knowledge dissemination are linking criteria that provides best

results to support decision makers to obtain better business performance. According to the authors, cost efficiency, stakeholder collaboration, flexibility for environmental changes, availability of local technical staff, technology acquisition and knowledge dissemination are the linking criteria that provide the best results to support decision makers to obtain better business performance. Bach *et al*. (2019) show that eco-innovation initiatives generally converge to improve business performance. In the scientific field, initiatives for the development of innovation have had positive effects on business performance. The authors' evidence can help managers make decisions by creating strategies and policies focused on competitiveness.

However, the analysis of this study allows us to affirm that eco-innovation is an important determinant for successfulcorporate management. According to Bach *et al.* (2019), innovative companies are the most valued by investors. Salomo*et al*. (2008) observe that eco-innovation generates high-value stocks in the market. When establishing a relationship with social capital, innovation positively affects the company's financial performance (Rass*et al*., 2013). Therefore, eco-innovation becomes a differential for sustainable business in competitive markets. This review identified that the analyzed studies had some limitations, mainly in relation to the sample size. Most of the studies were local, carried out in a specific city or company. Therefore, the results could not be extrapolated to other regions and countries. The number and position of the people interviewed were also a limiting factor in the studies. Usually, the interviews were conducted with businessmen specialized in the subject, which may have caused some bias in the results (Bendell, 2017; Lee *et al*., 2018; Orji *et al*., 2019; Tsai *et al*. 2020). Suggestions for future studies were also provided. Some authors have raised the need to include new variables related to the business structure to measure eco-innovation. In addition, the authors suggested increasing the number of people and companies surveyed and repeating studies in other regions and countries to confirm the findings (Bendell, 2017; Tsai *et al*. 2020). According to Tsai *et al*. (2020) there is a need to develop future research with efforts to better understand the relationship between eco-innovation and decision-making in business performance.

In addition to presenting results and a discussion that contributes to the debate on eco-innovation and corporate management, this study innovates by illustrating the state-of-the-art of eco-innovation, addressing the main points raised by the systematic review. Figure 8 presents a word cloud indicating all keywords described in the 36 articles and highlighting the most frequent ones, such as: *eco-innovation, green innovation*and*decision making*. A timeline was drawn showing the analyzed period. The search strings were described, as well as the categories created. The small maps around the word cloud show the number of articles produced in each country. Finally, the red box shows the weaknesses and the green box shows the strengths found in the researches.The blue box shows the limitations of the studies and the suggestions for future research.

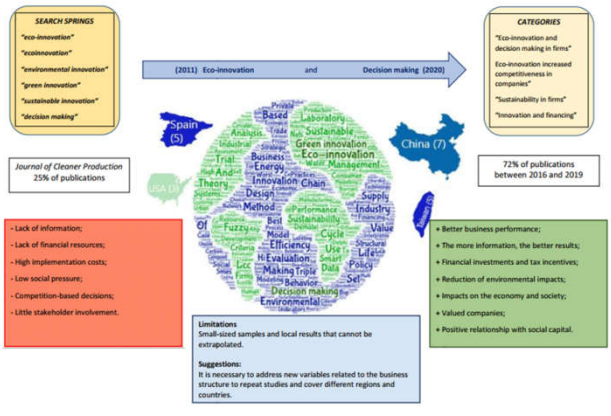

Figure 8. Main points raised by the systematic review

CONCLUSION

The main objective of this study was to understand the theme Eco-Innovation by searching its state-of-art. The study went through a five-step procedure (Denyer and Tranfield, 2009) to answer the following research question: What research gaps exist today and what eco-innovation trends are promising for corporate management?. In view of the results found, eco-innovation has been a current topic that has increased the volume of publications over the years. It is also noted that articles were very different in the way they approach the topic. The main publications were from China, Spain, Thailand and the United States. In the sample, there was only one Brazilian article, suggesting that the topic should be further researched in Brazil. To solve the problem of aligning different approaches to the theme, "categories" were created based on the objectives of the articles, which group them to facilitate the discovery of similarities and differences. The main categories were: *Eco-innovation and decision making in firms*", *Eco-innovation increased competitiveness in companies*", "*Sustainability in firms*" e "*Innovation and financing*".

The results allowed us to map the state-of-the-art of eco-innovation and corporate management. Their main contributions were analyzed based on the synthesis of the strengths and weaknesses found in the 36 articles.It is observed that companies that have adopted some type of eco-innovation have shown improvement in business performance, reduction of environmental impacts, increase in company valuation, positive relationship with social capital and better use of financial investments. Some weaknesses were identified by the studies, such as lack of information, lack of financial resources to cover the costs of implementing and executing eco-innovation projects, little stakeholder involvement and low social pressure. These factors have weakened the application of eco-innovative practices. It is also observed that the sample size was a limiting factor in the studies. The results found in the articles were very punctual, that is, they represented a local reality, of a certain company or municipality and, therefore, could not be extrapolated. It was expected to find a greater number of articles on eco-innovation and corporate management that showed financial and accounting data. These data would allow analyzing other company variables in international accounting standards, which would bring more realistic information about the implementation and application of eco-innovative practices. However, the data found was not sufficient for this analysis. Complementary reviews are suggested, expanding the search to a larger number of databases to better compose and illustrate the state-of-the-art of the subject. Based on this review, studies are needed that include economic and accounting variables, as well as econometric models that allow a deeper understanding of the effects of eco-innovation on corporate management and business performance.

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