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Environmental management systems in small and medium-sized enterprises: an analysis and systematic review

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ABSTRACT

This article seeks to answer the following question: based on the scientific publications on this topic, what aspects of environmental management systems are small and medium enterprises incorporating into their production processes? A bibliometric analysis and systematic review was performed to formulate a response. The study yielded a portfolio of 27 articles directly related to the research available online in the Web of Knowledge and Scopus databases. The bibliometric analysis identified the most relevant articles, authors, keywords and journals published without time slicing on studies between 1999 and 2013, while the systematic review allowed for the compilation of definitions, authors, research types, results and research opportunities. The primary aspects of the environmental management systems incorporated by small and medium enterprises were (1) certification, (2) fault analysis and improvement implementation, (3) environmental responsibility and (4) impact mitigation. Most of the articles in the portfolio database were associated with the study of environmental management systems implementation in small and medium enterprises with an emphasis on results, such as: (1) lack of knowledge on environmental impacts, (2) the need for training, policy, consulting, business cooperation and the integration of systems, (3) high costs at the beginning of implementation and (4) moral gains and cost reduction paired with sustainability in the medium term. Image improvement and the acquisition of new customers were also factors cited in the studies, highlighting the possibility of acquiring competitive advantages through environmental management systems.

1. Introduction

Market requests and increasingly conscientious consumers have demanded that companies exhibit greater concern for environmental issues, regardless of their size (Campos, 2012). Among the specific actions available for managing environmental impacts is the implementation and certification of environmental management systems (EMS).

However, small and medium enterprises (SMEs), in particular, are often unaware of their impact on the environment and lack the knowledge and expertise needed to implement and manage EMS (Ortiz et al., 2013). These companies have exerted significant pressure on the environment, either individually or through a combination of sectors. For example, the SMEs in Europe have been responsible for approximately 64% of the region's industrial contamination (DG Enterprise, 2010). This context has heightened the need to implement systems for monitoring and promoting improvements in the environmental management performed by SMEs.

Thus, the focus on EMS in SMEs has grown due to the challenge of improving their production processes to consider environmental aspects. The SME's heterogeneity and lack of strategic action has made it difficult to generalize about its practices (Hillary, 2004). However, adopting EMS has been stimulated through recognition of its importance in developing a sustainable economy (Campos, 2012).

Several studies about the implementation of environmental management in SMEs have been performed around the world in recent years (Hillary, 2004; Seiffert, 2008; Gunnarsson et al., 2010; Zorpas, 2010; Atanase and Visan, 2011; Roxas and Coetzer, 2012; Campos, 2012). Other studies of SMEs, such as Labodová (2004),

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Clancy (2001), Coşkun and Karaca (2008), Rao et al. (2009), Codreanu et al. (2009) and Shi et al. (2010), have focused on researching aspects related to risks, barriers to innovation, cost, technical and technological innovations and environmental indicators, respectively. Some studies have highlighted the importance of EMS as a potential tool for implementing environmental management at SMEs (Ammenberg et al., 1999; Hillary, 2004; Ardente et al., 2006; Burke and Gaughran, 2006; Labodová, 2004; Zobel, 2007; Nawrocka, 2008; Seiffert, 2008; Zorpas, 2010; Campos, 2012).

Given this context, the research problem guiding this study emerged: what aspects of environmental management systems (EMS) are small and medium enterprises incorporating in their production processes according to the scientific publications on this topic? Turning the main objective of this study. The following aspects of environmental management systems (EMS) were considered in this paper: (1) corporate environmental policy and planning sets, (2) resource availability, (3) environmental management training, (4) planning, documentation, measurement, monitoring, and evaluation of implementation goals for environmental responsibility, (5) certification and compliance with ISO standards, (6) failure analysis, course corrections and improvements to environmental policy, and (7) minimizing environmental impact and improving environmental performance.

The article is presented in five sections, with the first being this introduction. The second part presents the methodology used in the study, while the third section presents the theoretical issues associated with the use of environmental management systems in SMEs. The fourth section exhibits the results and the discussion, highlighting what aspects of EMS are small and medium enterprises incorporating into their production processes. Finally, the fifth section presents the conclusions and a number of recommendations.

2. Methodological procedure

This section presents the classification of research and the methodological procedures used in the construction and analysis of the bibliographic portfolio on EMS in SMEs. These methodological procedures have been developed to identify references with high relevance in academic databases accessed via websites, using bibliometric analysis to select the articles for further systematic analysis of the subject content. Campbell et al. (2010) have claimed that bibliometric analysis is a tool supported by a scientifically recognized theoretical basis that enables the use of statistical and mathematical methods to map information from bibliographic records of documents stored in databases. This technique helps the researcher to understand the behavior of a particular knowledge area through the measurement, mapping, interpretation, assessment and collection of indicators on the scientific results (Tasca et al., 2010). Within this process, systematic analysis allows researchers to identify the year of publication, title, authors, objectives, constructs and concepts, methodology, results and future recommendations in articles selected from the database.

2.1. Research classification

The research on this topic is of a theoretical nature. That concerned with technical procedures has been categorized as a bibliographical study because it analyzes already-published studies on the subject (Creswell, 2009). The objectives are exploratory and descriptive, seeking specific information on what is being studied. In accordance with Tasca et al. (2010), this type of study has been classified as a mixed method because it combines quantitative (the bibliometric study) and qualitative methods (the systematic analysis of articles, which also includes the analysis of content) (Bardin, 2011).

2.2. Research procedures

The method used to perform bibliographic research was comprised of three different stages: data collection, data analysis and synthesis of the results.

These three stages led to the following procedures.

a) Criteria for choices and database fields:Web of Knowledge and Scopus were chosen as databases for this study.
   - **Web of Knowledge** was chosen for consultation due to its status as a multidisciplinary index with the most cited journals in their respective areas. The database has more than 9000 indexed journals. It was also chosen for its broad scope, and it is the only database to allow full integration with the software used in this research.
   - **Scopus** is a database of abstracts and citations of scientific literature and information sources on the Internet at the academic level. Scopus contains over 15,000 indexed journals, nearly 265 million websites, 18 million patents, and other documents.

b) Criteria for inclusion or exclusion:
   - The selected articles contained a title, abstract, or the presence of keywords referring to terms concerning EMS and SMEs within the body of the text.
   - The articles were available with full text access through CAPES (Coordination of Improvement of Higher Education), Google®, Google Scholar®, Microsoft Academic Search® or sent by email to the authors.

c) Terms used in the research:

The strategic search was based on the following query: (“environ*manage*syste*” OR ems) AND (“small and medium enterp*” OR “small and medium business*” OR “small and micro enterp*” OR sme OR smb OR “Small companie*”). This same query was used in the databases, resulting in the bibliographic portfolio.

d) Software: EndNote X6 software was used to manage and treat the collected references. This tool is a reference manager produced by Thomson Scientific that can be integrated with the databases consulted. EndNote X6 facilitates research and scientific writing by gathering references from online databases, importing metadata and grouping them in various ways.

e) Criteria for the selection of articles for bibliometric analysis: In addition to noting the title, abstract, and location of keywords in the body of the text, articles were selected by identifying whether they included terms concerning EMS at SMEs. It was found that the prior reading of articles allowed greater for reliability in analysis. Thus, it was possible to find cohesion with the theme or assess the article’s potential contribution and level of connection with the main goal of the bibliometric research. Articles available in their entirety were also the subjects of bibliometric research. The following fields of expertise were defined to meet the criteria of the systematic analysis: year, author, title, key EMS settings, article type (theoretical/empirical, qualitative/quantitative), main results and recommendations for future research. It was also necessary to account for analytical ability and subjective researcher interpretation (Maanen, 1979; Denzin and Lincoln, 2006; Bardin, 2011).

f) Criteria for the systematic analysis: the following criteria for the systematic analysis were defined according to the model

Table 1
Thresholds in enterprise category.

Category	Headcount or annual work units (AWU)	*Annual turnover*	← OR →	Annual balance sheet total
Medium	<250	≤ 50M €	← OR →	≤ 43M €
Small	<50	≤ 10M €	← OR →	≤ 10M €
Micro	<10	≤ 2M €	← OR →	≤ 2M €

Source: Adapted from Zorpas (2010)

established by Bardin (2011): (1) analyze the content for the definitions of EMS in conceptual terms and (2) configure opportunities for future research.

The data analysis and synthesis results were performed through an understanding of the theoretical framework presented in Section 3 and the creation and interpretation of tables and graphics, presented in Section 4.

3. Theoretical framework

This section presents the study's theoretical framework, which consisted of a literature review on aspects of EMS relevant to SMEs. The concepts of EMS and SME are presented and these relevant aspects are described for the implementation and use of EMS, environmental performance indicators, cost reduction and innovation from an environmental perspective.

3.1. Environmental management systems (EMS)

Environmental management systems should be part of a company's broad plan to be successful. Fryxell and Szeto (2002) have stated that ISO 14001 offers a useful framework for promoting efficient EMSs. According to Labodová (2004) EMSs should be part of an integrated systems of management to become an effective part of the business administration. In this sense, they should belong to a wider strategy that includes systems of quality management, health and job safety. Corroborating these precepts, Seiffert (2008) has clarified that EMS is essentially aimed at reconciling economic growth with environmental issues.

Nawrocka (2008) has stated EMS is a tool broadly used to address environmental issues at facilities, noting that many corporations have highlighted the benefits gained due to its implementation. According to Heras and Arana (2010), EMS is also a tool that supports a company with systematic processes for implementing environmental goals, policies and responsibilities, as well as regular auditing of its elements.

Reinforcing these concepts, Campos (2012) has emphasized that an environmental management system must consider a company's organization through a thorough review of operations, and has analyzed how a company's actions affect environmental issues. To this author, these concepts arise from the ISO 14001 principles and are directly related to the procedures in place for the environmental certification of companies.

The concepts presented here are those that better defined EMSs in the resulting bibliography portfolio. It should be noted that EMSs have been used as part of a group of administration tools to control impacts and promote improvements to the environmental actions of companies. Further, the use of EMSs in SMEs can help with the implantation of environmental policies and, in most cases, follow the principles outlined by ISO 14001 (Hillary, 2004; Mckeiver and Gadenne, 2005; Nawrocka, 2008; Cordano et al., 2010; Campos, 2012).

The review also showed that implementing an EMS into other administration systems in an integrated manner, using a cooperation modality between companies and contextually enlarged, would generate better results for environmental risk evaluation, policy implementation and continuous improvement (Ammenberg et al., 1999; Labodová, 2004; Cordano et al., 2010).

A more detailed analysis of the use of EMSs in SMEs is presented in the results section.

3.2. Small and medium enterprises (SME)

The definition criteria for SMEs vary around the world, but certain descriptive definitions have been established in the literature. Countries in Europe such as Britain and Sweden (Hillary, 2004; Gunnarsson et al., 2010; Zorpas, 2010), the Philippines, Southeast Asia (Rao et al., 2009) and Brazil (SEBRAE, 2012) are examples of countries with the highest rate of entrepreneurship at an early stage among the G20 countries, according to the Global Entrepreneurship Monitor (GEM, 2010).

A company in Europe is considered a SME if it has fewer than 250 employees and an annual turnover not exceeding 40 million EUR (€1 = $1.43, GBP 0.887, JPY 138.31 in June 2009) or an annual balance of €27M, and also 25% of the capital or voting rights is allowed to be controlled by a public body (EC, 2003; Zorpas, 2010), as indicated in table 1.

As Hillary (2004) has documented, approximately 90% of businesses in Europe were classified as SMEs in 1996, and there were 3.7 million businesses in the UK in 1998, of which 99% employed less than 50 people. In Sweden, over 98% of all private companies are classified as small and approximately one million people, or 35% of all employees in the country, work in these enterprises (Gunnarsson et al., 2010).

In the Philippines, the most common categorization method for SMEs is based on a company's asset size or number of employees, being much smaller than the operations of multinational companies (Rao et al., 2006). SMEs employ a large proportion of workers in Southeast Asia, with a significant presence in densely populated areas. A large number of SMEs operate in highly competitive markets with small profit margins.

In Brazil, the Brazilian Service to Support Micro and Small Enterprises (SEBRAE, 2012), part of the 1999 Statute of Micro and Small Enterprises, was established as a criterion for conceptualizing micro and small enterprises, the annual gross revenue of which, using values updated by Decree n#5.028/2004 on March 31, 2004, are as follows:

- **Micro company**: annual revenue equal to or less than R$ 433,755.14 (four hundred thirty-three thousand, seven hundred and fifty-five reais and fourteen cents), equivalent to €170,581.70[2]
- **Small company**: gross annual revenues exceeding R$ 433,755.14 and less than or equal to R$ 2,133,222.00 (two million one hundred thirty-three thousand, two hundred and twenty-two reais), equivalent to €838,926.38.

A simplified system of taxation called SIMPLES adopts different criteria to define micro and small enterprises. The limits, as established in Provisional law 275/05, are as follows:

[2] R$1.00 = 2.5428 € (quotation made on 03.13.2013).

- **Micro company**: annual revenue equal to or less than R$ 240,000.00 (two hundred forty thousand reais), equivalent to €94,384.14.
- **Small company**: gross annual revenues exceeding R$ 240,000.00 (two hundred forty thousand reais) and equal to or less than R$ 2,400,000.00 (two million four hundred thousand reais). SEBRAE uses the number of employees working at a companies as a criterion:
- Micro company:
  a) up to 19 employees in industry and construction, or
  b) up to 9 employees in trade and services.
- Small company:
  a) between 20 and 99 employees in industry and construction, or
  b) between 10 and 49 employees in trade and services.

According to the Global Entrepreneurship Monitor (GEM, 2010), Brazil has the highest rate (17.5%) of Entrepreneurs in the Early Stage (TEA) among the 17 member countries of the G20 considered in the 2010 survey, followed by China with 14.4% and Argentina with 14.2%. This is the largest TEA obtained since the survey's inception, highlighting a tendency for growth in Brazilian entrepreneurship (Kelley et al., 2011). The GEM (2010) report also shows that Brazil has the most entrepreneurial population among the countries studied. According to data from DIEESE, Brazil already had a total of 5.486.649 micro and 300.047 small enterprises in 2008.

In addition to the normative and quantitative criteria that determine the scope relevant to SMEs, there are contextual characteristics that define the particular way in which these companies operate their management. As Spence (1999) has indicated, SMEs tend to be independent, controlled by informal mechanisms and managed by the owner, who is responsible for various functions. The bureaucracy in these companies is minimal and financial resources are, in most cases, limited. Informality prevails in relation to standardized mechanisms for management and acts as a form of resistance to the adoption of best practices, including those indicated by international standards such as ISO 9000 and ISO 14001 (Spence, 1999).

According to Tilley (2000), the lack of institutional reform and shortage of restructuring in the public economic system has limited the opportunities for improvements to environmental ethics in SMEs. Other factors, such as the large presence of SMEs in the global economic context and the resulting major environmental impacts caused by these firms, should not be underestimated.

Although large companies also have significant impacts on the environment, one must consider the peculiar features of SMEs when deploying EMS (Spence, 1999; Tilley, 2000; Ortiz et al., 2013). Resource shortages, high deployment costs, the absence of specific policies for this type of business and the lack of knowledge and experience all have had negative impacts on the adoption of EMSs by SMEs (Burke and Gaughran, 2006; Santos et al., 2011; Ortiz et al., 2013). Such scenarios have highlighted the importance of developing specific methods for implementing EMSs in SMEs.

3.3. Environmental management systems in SMEs

Environmentalists believe that encouraging SMEs to implement an EMS is an appropriate corporate method of achieving sustainability (Rao et al., 2006). Wells and Galbraith (1999) have suggested that the use of ISO 14001 as a model for SME certification is an important source of discipline that can ensure sustained attention to continuous improvement and provide market advantages. Correa et al. (2008) have highlighted that SMEs seeking superior financial performance can achieve it by adopting proactive environmental practices.

From the perspective of Rao et al. (2006), SMEs have generally been perceived as lacking a sense of commitment to the environment, and have even been branded as environmentally irresponsible. SMEs are known for taking environmental action only in response to threats and sanctions from regulatory authorities or the government. Generally, they have responded with end-of-pipe environmental control solutions, which are less effective than total process control or the implementation of more comprehensive environmental policies, such as cleaner production. However, this perception cannot be generalized to all SMEs, many of which have shown themselves to possess an environmental conscience, and SMEs created since the rise in popularity of companies with environmental consciences and concerns have made their visions and missions 100% aligned with this issue.

Burke and Gaughran (2006) have affirmed that most SMEs are unaware of relevant environmental legislation and the impact of their actions on the environment. Such actions appear to be related to existing legislation on reducing costs and waste disposal. However, several forms of environmental management integration exist in SMEs.

The integration an EMS into the fundamental concept of an SME has been defended by Labodová (2004), who indicates a need to establish effective ways of integrating quality management, environmental management and health and safety systems. To this author, EMS is a useful information-gathering tool for decision-making. Seiffert (2008) has concluded that an EMS can promote the prescription and enforcement of environmental goals, policies and responsibilities, as well as regular audits of its elements. To Zorpas (2010), an EMS can help reconcile economic factors with environmental issues.

According to Rao et al. (2006), environmental indicators have helped researchers summarize the extensive data on a company's operations because these indicators are associated with the company's environmental aspects and impacts. A key feature of environmental indicators is that they allow for the quantification of environmental and business initiatives, providing a framework with which to compare them over time and helping to detect the absence or diversion of policies.

Zorpas (2010) has argued that environmental indicators can be used to verify whether a company has fulfilled goals. Furthermore, the use of these indicators helps to identify market opportunities, potential opportunities for cost reduction when comparing an industry's environmental performance, feedback to motivate team members, and support for the eventual implementation of EMS or ISO 14001 standards (Rao et al., 2006). The use of an environmental indicator system has therefore been recommended for SMEs to improve their environmental performance.

The ISO 14001 standard (ISO 14001, 2004) has enabled the deployment of EMS as standard certification of quality. This standard considers EMS to be part of a larger system that includes a company's entire organizational structure, planning activities, responsibilities, practices, procedures, processes and resources to develop, integrate, implement, monitor and progressively improve its environmental policies. As stated by Campos (2012), the application of EMS according to the requirements of ISO 14001 allows for the alignment of an organization's environmental policies with legal issues relevant to the assessment of its environmental impacts.

Burke and Gaughran (2006) have developed a method for implementing practices in SMEs and aligning them with ISO 14001 certification requirements. The method includes the following steps, which must be supported by the information stored in an EMS: (1) establishment of an environmental policy, (2) initial

environmental review, (3) gap analysis, (4) definition of objectives and goals, (5) systematic review and classification, and (6) implementation of environmental management programs. The implementation process of the EMS consists of an audit at the end of each phase.

According to Shi et al. (2010), environmental innovations in SME may be relevant measures that: (i) develop new ideas, behavior, products and processes, or applications and (ii) contribute to the reduction of environmental burdens or specific goals in ecological sustainability. The use of lead-free soldering technologies, for example, involves lower peak processing and reduces material costs and damage to the environment (Codreanu et al., 2009). However, the lack of strategic capabilities and institutional policies, along with weak managerial skills, have inhibited environmental innovation in the SMEs (Clancy, 2001).

Thus, environmental management practices in SMEs may lead to sustainable success through the study of a business environment and identification of necessary adjustments to environmental impacts (Atanase and Visan, 2011). Planning, supervision, involvement, analysis and reduction of risk and cost, evaluation, corrective action, constant innovation and continuous improvement are key elements in the development of good practice in this area. The benefits of a company adopting a sustainable attitude and behavior are increasingly well-understood, and the importance of close, effective collaboration between SMEs and the environment has become ever more evident (Ballester et al., 2008).

4. Results and discussion

Table 2 shows the number of articles found in the databases that summarized the strategies being searched for.

The search returned 62 documents. 11 of these were duplicates, resulting in 51 documents, only 35 of which were available for full text reading. After the reading analysis, 8 documents were not aligned with the theme and were discarded from the portfolio, resulting in 27 relevant documents made up of 23 journal articles, 4 proceedings or books and 0 patents. The selection process can be better understood through Fig. 1, and Fig. 2 shows the publication years of the documents in the resulting portfolio.

Table 3 presents a list of 27 articles in our portfolio with the number of citations for each. The article "Environmental management systems and smaller enterprises" was the most frequently cited (Hillary, 2004), with 272 citations. The second most cited was "Developing sustainable products and services" (Maxwell and Van Der Vorst, 2003), with 231, followed by "Implementing integrated management systems using a risk analysis based approach" (Labodová, 2004), with 133 citations. Four articles had not yet been cited at the study's conclusion. The number of citations per article was verified in *Google Scholar* ® on November 5th, 2013.

We identified 23 journals and 4 proceedings in the literature portfolio. Table 4 shows the journals and proceedings comprising the portfolio, and highlights the Journal of Cleaner Production as the most frequently cited, with publications focused on environmental management.

The authors of the literature in the portfolio are listed in Table 5. Each author had only one publication.

Table 2
Number of articles found per database.

Database	Journals	Proceedings/books	Patents	Total
Scopus	33	0	0	33
Web of knowledge	15	11	3	29
All	48	11	3	62

Source: Authors.

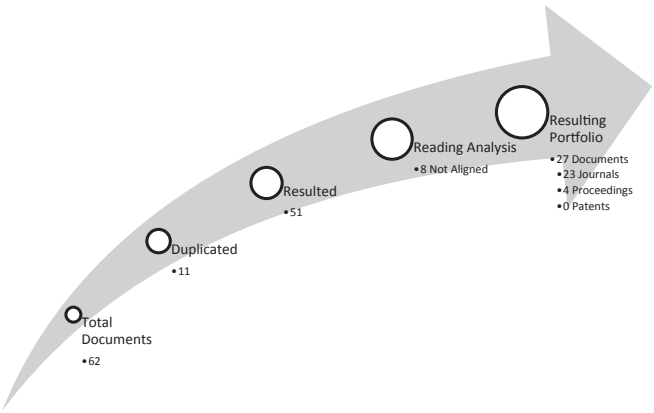

Fig. 1. Bibliographic portfolio.
Source: Authors.

The searches returned 99 unique keywords used by the authors in the portfolio, the most cited of which are listed on Table 6.

Of the analyzed articles, 15 were empirical studies, 6 theoretical, and 6 both practical and theoretical (Table 7).

14 of the portfolio articles exhibited a qualitative perspective, 9 were quantitative, and 4 both qualitative and quantitative at the same time, as shown in Table 8. The methodologies compounding the portfolio included 8 Cases, 3 Experience Reports, 3 Literature Reviews, 12 Surveys and 1 Vote-Ranking Methodology, as displayed in Table 9.

The methodological strategies used in the papers included 7 Case Studies, 13 Descriptive Statistics, 2 Experience Reports, 2 Interviews, 1 Data Envelopment Analysis (DEA), 1 Action Research, 1 Prototype, 1 Reporting Research and 1 Exploratory Research. More than one strategy was sometimes used in the same paper, principally those employing both qualitative and quantitative methods. Some articles gave more detailed information about the method being used, as seen in Table 10.

The sectors represented in the bibliographic portfolio included agribusiness, commerce, construction, industry, service and telecom. Some articles investigated more than one sector, while others did not provide information about the sector researched. Table 11 lists the number of times each sector occurs.

By analyzing the sectors, it was clear that industry caused the most damage to the environment (Ilomäki and Melanen, 2001; Burke and Gaughran, 2006; Ortiz et al., 2013). The adoption of an EMS created high added value to the market and facilitated compliance with

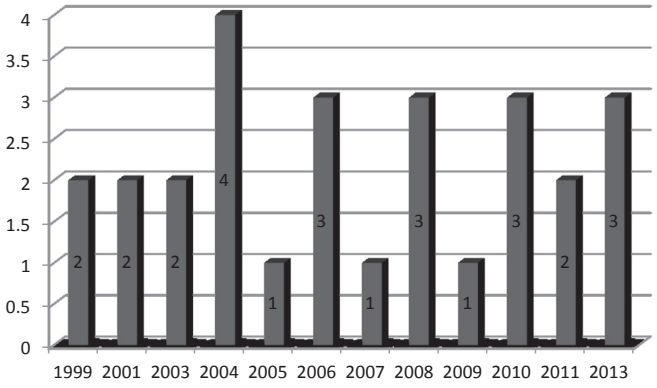

Fig. 2. Number of articles published per year.
Source: Authors.

Table 3
Portfolio: number of citations.

Year	Author	Title	# of citations
2004	Hillary, R.	Environmental management systems and the smaller enterprise	272
2003	Maxwell, D. and Van der Vorst, R.	Developing sustainable products and services	231
2004	Labodova, A.	Implementing integrated management systems using a risk analysis based approach	133
2005	McKeiver, C. and Gadenne, D.	Environmental management systems in small and medium businesses	73
2001	Ilomäki, M. and Melanen, M.	Waste minimization in small and medium-sized enterprises—do environmental management systems help?	47
2001	Williamson, D. and Lynch-Wood, G.	A new paradigm for SME environmental practice	45
2010	Cordano, M. et al.	How do Small and Medium Enterprises Go Green? "A Study of Environmental Management Programs in the US Wine Industry"	45
2008	Seiffert, M. E. B.	Environmental impact evaluation using a cooperative model for implementing EMS (ISO 14001) in small and medium-sized enterprises	41
1999	Wells, R. P. and Galbraith, D.	Proyecto Guadalajara: Promoting sustainable development through the adoption of ISO 14001 by small and medium-sized enterprises	37
2006	Ardente, F. et al.	POEMS: A case study of an Italian wine-producing firm	36
1999	Ammenberg, J. et al.	Joint EMS and group certification: A cost-effective route for SMEs to achieve ISO 14001	35
2006	Burke, S. and Gaughran, W. F.	Intelligent environmental management for SMEs in manufacturing	34
2010	Zorpas, A.	Environmental management systems as sustainable tools in the way of life for the SMEs and VSMEs	28
2006	Rao, P. et al.	Environmental indicators for small and medium enterprises in the Philippines: An empirical research	26
2010	Heras, I. and Arana, G.	Alternative models for environmental management in SMEs: the case of Ekoscan vs. ISO 14001	24
2011	Santos, G. et al.	Certification and integration of management systems: the experience of Portuguese small and medium enterprises	21
2008	Nawrocka, D.	Environmental Supply Chain Management, ISO 14001 and RoHS. How Are Small Companies in the Electronics Sector Managing?	20
2007	Zobel, T.	The 'pros' and 'cons' of joint EMS and group certification: A Swedish case study	17
2004	Yiridoe, E. K. and Marett, G. E.	Mitigating the high cost of ISO 14001 EMS standard certification: Lessons from agribusiness case research	15
2012	Campos, L. M. S.	Environmental management systems (EMS) for small companies: a study in Southern Brazil	7
2009	Codreanu, N. D. et al.	Lead-Free Electronic System integrated in a Vapor Phase Soldering Equipment Prototype	4
2003	Hussey, D. M. et al.	Validating an environmental performance improvement model for large and small companies	0
2004	Edinbarough, I. A. et al.	Cooperative effort in training small and medium scale industries in the Lower Rio Grande Valley in Environmental Management System (EMS) certification	0
2008	Hai, H. L.	Assessing the SMEs' competitive strategies on the impact of environmental factors: A quantitative SWOT analysis application	0
2011	Singh, P. et al.	Product and Process Characteristics for Green Manufacturing: Evidence from Indian SMES	0
2013	Ortiz, A. et al.	Environmental management in industrial SMEs	0
2013	Ramos, T. B. et al.	Corporate sustainability reporting and the relations with evaluation and management frameworks: The Portuguese case	0

Source: Authors, based on Google Scholar ®.

regulations for creating products that met environmental standards in sectors such as manufacturing and construction, despite the high costs of implementation (Campos, 2012).

The use of integrated systems supported by a variety of management tools available to organizations to facilitate communication with supply chain partners (suppliers, customers, regulators, consumers, etc.) is required to assess the environmental profile of a product (Ardente et al., 2006). Therefore, this sector could significantly improve environmental management by monitoring environmental impacts with the support of an EMS.

A certified EMS has implied an organization's commitment to continuously improving its environmental management and performance (Ardente et al., 2006). The planned implementation and certification of EMS are essential to decisions made on the enforcement of environmental policies and improvements, such as reducing waste and environmental impacts (Cordano et al., 2010).

The adoption of EMS in the service and commerce sectors could contribute to the promotion of environmentally responsible behavior through the interaction between consumers and supplier employees, as well as in industry (Mckeiver and Gadenne, 2005). Communication channels, skills, knowledge and attitudes have improved in SMEs that adopt EMSs, generating ethical and normative internal and external benefits compared to the market and extending gains (Zorpas, 2010).

However, it has been noted that there are difficulties concerning SMEs in and environmental legal obligations, which motivate many companies to implement an ISO-certified EMS in reaction, despite the high costs of deployment (Hillary, 2004). The usefulness of the EMS as an analysis method for environmental risks, impacts, and improvements to environmental compliance, when combined with a precise environmental policy, was noted in all of the surveyed sectors (Williamson and Lynch-Wood, 2001; Yiridoe and Marett, 2004; Seiffert, 2008; Ramos et al., 2013).

Environmental training has brought about greater interest in environmental conservation education, helping to educate SMEs on the benefits of improving their environmental performance (Ammenberg et al., 1999; Hussey and Eagan, 2003; Edinbarough et al., 2004). The establishment of a standard procedure based on ISO standards aimed at improving the environment, adding value and legitimacy and aligning interests with market necessities has been proposed as a reference for SMEs (Heras and Arana, 2010).

The major concepts of EMS are related to (1) certification and compliance with the ISO 14001 standards, (2) analysis of environmental improvement policy failures, (3) implementation of goals for environmental responsibility, and (4) minimization of environmental impact and improvement of environmental performance.

In general, there has been a preponderance of computerized systems composed of quantitatively measurable environmental indicators. These systems are, in most cases, constructed from a cooperation between companies, governments and universities. By mapping the environmental impacts of a group of small companies in a given region, the EMSs are constructed as tools for the

Table 4
Location and number of published papers in the portfolio.

Journal	Quantity
Journal of Cleaner Production	10
Greener Management International	2
Corporate Social Responsibility and Environmental Management	2
WSEAS Transactions on Information Science and Applications	1
TQM Magazine	1
Robotics and Computer-Integrated Manufacturing	1
Proceedings of the ASME International Manufacturing Science and Engineering Conference 2010, Vol. 1	1
Journal of Business Ethics	1
International Small Business Journal	1
International Food and Agribusiness Management Review	1
Gestión Ambiental en Pymes Industriales	1
Environmentally Conscious Manufacturing IV	1
Environmental Management	1
Bioresource Technology	1
32nd International Spring Seminar on Electronics Technology	1
IEEE International Symposium on Electronics & the Environment, Conference Record	1

Source: Authors.

evaluation of performance and implementation of improvements based on the ISO 14001 standards when attempting to achieve certification. In brief, the EMSs are composed of groups of environmental indicators created to monitor and guide the implementation of standards and environmental improvements.

The main results of analyzing the articles related to EMS in SMEs were summarized as follows.

(1) EMS facilitates the improvement and innovation in environmental terms
(2) EMSs make viable improvements to business performance and work environments.
(3) The high costs of individual EMS implementation can be reduced by up to 50% using systems of cooperation.
(4) EMSs stimulate the control of environmental risks, waste reduction and recycling.

Table 5
Portfolio authors and years.

Author	Year
Ammenberg, J. et al.	1999
Ardente, F. et al.	2006
Burke, S. and Gaughran, W.F.	2006
Campos, L.M.S.	2012
Codreanu, N.D. et al.	2009
Cordano, M. et al.	2010
Edinbarough, I.A. et al.	2004
Hui-Lin Hai	2008
Heras, I. and Arana, G.	2010
Hillary, R.	2004
Hussey and Eagan	2003
Ilomäki, M. and Melanen, M.	2001
Labodová, A.	2004
Maxwell, D. and van der Vorst, R.	2003
McKeiver, C. and Gadenne, D.	2005
Nawrocka, D.	2008
Ortiz, A. et al.	2013
Ramos, T. B. et al.	2013
Rao, P. et al.	2006
Santos, G. et al.	2011
Seiffert, M. E. B.	2008
Singh, P. et al.	2011
Wells, R. P and Galbraith, D.	1999
Williamson, D. and Lynch-Wood, G.	2001
Yiridoe, E. K. and Marett, G. E.	2004
Zobel, T.	2007
Zorpas, A.	2010

Source: Authors.

Table 6
Keywords most cited in the research portfolio.

Keyword	# of occurrences
SMEs	12
Environmental Management System (EMS)	10
Environmental management	5
Environmental impact	4
Environmental management systems	4
ISO 14001	4

Source: Authors.

Table 7
Types of research.

Type of research	Occurrence
Empirical	15
Theoretical	6
Theoretical & Empirical	6

Source: Authors.

(5) Legal requirements are important to guiding the implementation of EMSs in SMEs.
(6) EMS is a useful tool for reducing costs by generating environmental improvements, intangible benefits and improving the attitudes of SMEs towards sustainability.
(7) Sustainability is associated with higher profitability and lower costs in the medium term.
(8) EMSs are more effective and efficient when implemented in a progressive mode using rigorous contextual analysis, assuming there is adequate training and integration with other management systems.

The results also pointed to a lack of consensus about the uniqueness of a model describing the mechanisms used to improve corporate environmental performance. This framework is no different in the SMEs, and includes incipient knowledge about environmental impacts, high initial EMS implementation costs, lack of active policies, prevalence of reactive actions forced by regulations, operational difficulties and the need for planning to obtain benefits over the medium-term.

The aspects of EMS incorporated by SMEs that could be perceived as main topics in the research were related to (1) certification, (2) fault analysis and improvement implementation, (3) environmental responsibility, and (4) impact mitigation.

SMEs have possessed a generally reactive attitude towards fulfilling legal requirements by adopting systems that meet ISO 14001 standards. Despite the high initial costs of implementing certifiable EMSs in SMEs, an alternative has been to perform the transition in an integrated procedural manner (Ardente et al., 2006; Burke and Gaughran, 2006).

Fault analysis has been a crucial aspect of EMS because the system can assist in course corrections and the monitoring and reduction of environmental impacts (Burke and Gaughran, 2006; Campos, 2012). In this context, we highlighted the importance of EMS being viewed as a systematic process to help with the prescription and subsequent enforcement of environmental goals, policies and responsibilities, as well as regular audits of its elements (Seiffert, 2008).

Table 8
Research models.

Research models	Occurrence
Qualitative	14
Qualitative and Quantitative	4
Quantitative	9

Source: Authors.

Table 9
Methodologies.

Methodologies	Occurrence
Case	8
Experience Report	3
Literature Review	3
Survey	12
Vote-ranking methodology	1

Source: Authors.

Several studies (Ardente et al., 2006; Burke and Gaughran, 2006; Rao et al., 2006; Seiffert, 2008; Ortiz et al., 2013) have defined EMS in accordance with ISO 14001 to prevent environmental impacts through the use of resource avoidance, reduction or control, seeking continuous improvements to environmental management. The reconciliation between economic factors and environmental impact reduction has also been a goal of SMEs using EMS.

The expansion of environmental responsibility and reduction of environmental impacts have been identified in SMEs when they can overcome the initial barriers of cost and lack of knowledge on the implementation of EMS. All of the investigated studies have indicated positive results from the SMEs in these respects, although only a small percentage have adopted systems with compatible certification standards.

However, all of the studies concerning the implementation of EMS-based methods, especially those integrated with other management systems, have identified improvements in SMEs' environmental sustainability, such as better collaborative networks, image and profitability over time. Therefore, it has been possible to extend aspects of environmental management to SMEs using integrated environmental management systems. It is noteworthy that there has also been a need to develop systems appropriate to the realities of operating SMEs.

Only 9 articles included recommendations for further work. According to the development of academic research on EMS in SMEs, the goal of this study was only to show the current state of literature and identify opportunities for future research on the subject (Table 12).

Table 10
Details on procedures used in different types of research.

# of occurrences	Type of methodology	#	Details of the method used
7	Case	1	Interviews
		1	Single case study
		5	Not directly informed
13	Statistics	3	Likert
		2	*T*-test
		1	"The model focuses on a modification of the Baldrige Criteria for Performance Excellence"
		1	Structural equation modeling (SEM)
		2	Cronbach's alpha
		1	Kaiser-Meyer-Olkin (KMO) test and Bartlett's sphericity test
		1	Cluster analysis
		2	Not directly informed
2	Experience Report		
2	Interview		
1	Data Envelopment Analysis (DEA)		
1	Action Research		
1	Prototype		
1	Reporting Research		
1	Exploratory Research		
1	Literature Review		

Source: Authors

Table 11
Sectors that compound the bibliographic portfolio.

Sector	# of occurrences
Industry	14
Service	8
Construction	5
Not Available	5
Telecom	3
Agribusiness	2
Commerce	2

Source: Authors

The main issues identified for future research were the implementation of integrated environmental management systems in subgroups, incorporation of environmental behavior, support for both positive attitudes and employee empowerment, and a focus on solutions that maximize environmental benefits to the company, people, and society in general, highlighting the use of environmental performance indicators (Table 7).

5. Conclusions

Due to the growing concern of scholars and practitioners for the implementation of environmental management systems in SMEs, the goal of this study was to answer the following question: What aspects of environmental management systems (EMS) are small and medium enterprises incorporating in their production processes according to the scientific publications on this topic? To do this we constructed a process for the data collection and analysis of selected references incorporating aspects of environmental management systems in the production processes of SMEs. Opportunities for future research based on the recommendations of the studies under analysis were also identified.

We used the bibliometric technique to achieve this goal, supported by a systematic analysis incorporated into the procedure. The method allowed for the identification of constructs, definitions, article types, results and recommendations for a portfolio that consisted of 27 items aligned with the theme and available in the databases Scopus and Web of Knowledge.

The aspects of EMS incorporated by SMEs that were viewed as main topics of interest were related to (1) certification, (2) fault analysis and improvement implementation, (3) environmental responsibility, and (4) impact mitigation. All of these aspects showed positive results when SMEs could overcome initial cost barriers and lack of prior knowledge on implementing EMSs. However, a minority of the companies achieved effective environmental management with the support of EMS.

This study was concerned with constructs, definitions, results and research gaps. Thus, a consensus was identified from the various concepts of environmental management systems in small companies, stating that EMS is a set of actions meant to have positive effects on the environment. Furthermore, it could be stated that EMS consists of a device for the modernization and competitiveness of productive organizations. SME was defined differently around the world according to criteria such as size, number of employees, turnover and profitability around the world.

Most articles associated with the subject, studied the implementation of EMSs in SMEs, emphasizing the results: (1) lack of knowledge on environmental impacts, (2) the need for training, policy, consulting, business cooperation and systems integration, (3) high initial costs, and (4) the moral gains and cost reduction associated with sustainability in the medium term. Improving the image and acquiring new customers were also factors cited in the studies on EMS in SMEs, highlighting the possibility and importance of acquiring competitive advantage.

Table 12
Recommendations for future research.

Author	Recommendations for future research
Hillary (2004)	A study should be developed that considers parts of the SME sector as sub-groups by size, i.e., micro, small and medium enterprises, or by industry.
Mckeiver and Gadenne (2005)	The first issue is the evaluation of the current impact of SMEs on the natural environment. The second issue is that future research should incorporate actual behavioral measurements, while limiting the number of socially desirable responses to self-reported behaviors. Third, from the employee perspective, Petts et al. (1998) have recommended that as the environment is important to individuals but does not seem to be related directly to their work activities, the organizational context needs to support both positive attitudes and the empowerment of employees. The final issue is that while this study has examined some of the more common factors influencing an owner-manager's decision to implement an EMS, there are many other factors that may influence the level of EMS implementation and that are worthy of investigation.
Ardente et al. (2006)	An improvement program must focus on new solutions to maximize environmental benefits with cheaper options.
Burke and Gaughran (2006)	Future research should focus on the exact nature of and dependence on consultants by SMEs for the implementation and maintenance of an EMS.
Cordano et al. (2010)	A methodology should be developed to directly examine the environmental practices and performance of wineries in the U.S.
Hai, Hui-Lin (2011)	Cross-evaluation can be used to overcome the problem of maverick decision-makers.
Santos et al. (2011)	These authors believe that the compatibility among different standards for the effective integration of different systems should be kept moderate. For this to happen, it is very important to prevent a powerful or rich group of companies from leading a larger platoon of companies forward, as this would cause greater difficulties in implementing and managing the integration of their management systems.
Campos (2012)	The implementation of an EMS in a small company should use the 10 demands obtained from research as the basis of this article, which is a study on the use of environmental performance indicators in a small company with an EMS (even those not certified).
Ramos et al. (2013)	Further research should seek to include a larger sample, beyond the limits of BCSD Portugal, to obtain data related to the small and medium companies examined in this study. Other data collection tools should also be used, such as content analysis of reports, webpage labels and booklets, and interviews with third parties like stakeholders or the media, in addition to self-assessment, to allow for more in-depth associations between the drivers and characteristics of sustainability reporting. Also, other company categories could be considered in future analyses besides size and type of industry, such as ownership and internationalization, among others.

Source: Authors.

We observed some peculiarities when we investigated the application of EMS in the sectors covered here. Because the industrial sector could be considered of greater potential risk to the environment, it was understandable that the majority of studies (14) were conducted on the manufacturing sector. Despite the high costs of implementation, the adoption of EMSs in industrial SMEs and the construction industry encouraged design products that met environmentally responsible standards, adding high market value to these products. In the commerce and service sectors, communication channels, skills, knowledge and attitudes improved in SMEs that adopted EMSs, generating ethical benefits, compliance and better market acceptance.

EMSs were useful for the analysis of environmental risks, impacts, and environmental compliance in all of the sectors under investigation. Nevertheless, it was essential that the EMSs be aligned with appropriate environmental policy and regulatory requirements. It was necessary to invest more in environmental education and the development of simplified and certifiable EMSs based on the context of each SME.

Finally, the study highlighted opportunities for future research: (1) the development of EMS implementation methods for larger groups and different SME categories to generalize results, (2) expansion of studies on the deployment of sustainable technologies for SMEs regarding the use of environmental indicators and (3) research examining the impact of using environmental indicators from different perspectives, such as owners, managers, employees and society.

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