Original Article

Environmental sustainability in Higher Education Institutions, a bibliometric study on national publications

Sustentabilidade ambiental em Instituições de Ensino Superior, um estudo bibliométrico sobre as publicações nacionais

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Abstract: Some Higher Education Institutions (HEIs) are becoming a reference to practice environmentally sustainable, contributing to the formation of its academics and for sustainable development, to the extent that there is in sustainability a guideline for managing the campuses of the institutions. The objective of this article was to investigate the profile of research and the development of the theme of environmental sustainability in HEIs located in Brazil. It is a study of bibliometric analysis to examine the scientific literature on the topic and guide future directions and strategies for future research. These studies are dispersed in a large number of journals because there is no nationally a particular publication for the theme. The studies are dispersed in fifteen different journals and twenty-seven articles were found. The surveys were developed by eighty-nine authors and there is no individual research. The evolution of academic learning obtained by the experience of researchers isbringing a mature work, which already has a history of research, concepts and results that are being aggregated over time, building up the knowledge in the area.

Keywords: Higher Education Institution; Environmental sustainability; Environmental practices.

Resumo: *Algumas Instituições de Ensino Superior (IES) estão se tornando referência em práticas ambientalmente sustentáveis, contribuindo assim para a formação dos seus acadêmicos e para o desenvolvimento sustentável, na medida em que têm na sustentabilidade uma diretriz para gerir os campi das instituições. O objetivo deste artigo foi investigar o perfil das pesquisas sobre o tema sustentabilidade ambiental em IES localizadas no Brasil. Trata-se de um estudo de análise bibliométrica para examinar a produção científica sobre o tema e nortear rumos e estratégias de futuras pesquisas. Verificou-se que não existe nacionalmente uma publicação específica para a temática. Os estudos estão dispersos em quinze periódicos diferentes, sendo encontrados vinte e sete artigos. As pesquisas foram desenvolvidas por oitenta e nove autores e não há pesquisas individuais. Observou-se que a evolução do aprendizado acadêmico obtido pela experiência dos pesquisadores vem trazendo um amadurecimento nos trabalhos, que já apresentam um histórico de pesquisas, conceitos e resultados que estão sendo agregados ao longo do tempo, construindo-se assim o conhecimento na área.*

Palavras-chave: *Instituição de Ensino Superior; Sustentabilidade ambiental; Práticas ambientais.*

1 Introduction

Some Higher Education Institutions (HEIs) are becoming a reference in environmentally sustainable practices, thus contributing not only to the training of its academics from a theoretical and practical point of view, but also to the sustainable development, as they have adopted guidelines to manage the institutions' campuses.

Historically, research around the theme of sustainability is recent, having started in the 1970s. In addition, the debate on sustainability in Brazilian

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organizations is even more recent, having started only in the 1990s. In HEIs, initial interest in sustainability by organizational management appeared as a topic of research that inspired researchers to investigate organizations. Subsequently, there was an expansion in the nature of the researched institutions, reaching out to other spheres, such as public agencies and higher education institutions themselves.

Thus, the aim of this study was to investigate the profile of research on the theme of environmental sustainability in Higher Education Institutions (HEIs) located in Brazil. The bibliometric analysis of this a study aims to examine the scientific production on the subject to guide the directions and strategies of future research. The following research question has been defined: What is the profile of research on environmental sustainability in HEIs in articles published in national journals from 2006 to 2015?

The article is organized from the introduction, followed by the theoretical rationale that addresses the following themes: sustainable development and environmental sustainability; international initiatives for environmental sustainability in HEIs; environmental sustainability in HEIs in Brazil. Next, the methodology is presented; followed by results and discussion, and finally, conclusions and recommendations. At the end, the references used in the study are listed.

1.1 Sustainable development and environmental sustainability

The beginning of the global environmental movement came to fruition in 1962 after the publication of Rachel Carlson's book, "Silent Spring". The book criticizes the use of pesticides and insecticides, drawing the attention of humanity to the consequences of technological advances for human health.

Later, in 1972, the report *The Limits to Growth* was published. Despite the fact that the report was 'catastrophic' about the future of mankind, it served as an alert to the finiteness of resources (The Club of Rome, 2015).

Also in 1972, the United Nations Conference on Human Environment pointed out the need for common criteria and principles to preserve and improve the human environment. This conference was marked by the antagonism between the developed and developing countries (Barbieri, 2007).

In 1987 the report *Our Common Future* defined sustainable development as the process that "[...] meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 46).

In 1992, at the United Nations Conference on Environment and Development in Rio de Janeiro, 179 participating countries came to an agreement and signed Agenda 21. Chapter 36 of Agenda 21 discussed

the promotion of education, training, and awareness towards sustainable development (Brasil, 2015).

In 2002, the United Nations Organization (UNO) held the World Summit for Sustainable Development, in Johannesburg, South Africa. The conference, Rio+10, aimed to take stock of the lessons learned and practical results obtained from the agreements signed among the countries that participated in the Rio Conference in 1992.

In 2012, Rio + 20 took place. It celebrated the twentieth anniversary of Rio-92, and helped to define the sustainable development agenda for the coming decades. The goal was to renew political commitment towards sustainable development.

In 2015, leaders from 196 nations gathered in Paris for the 21st Conference of the Parties, to negotiate a new global agreement to cut down greenhouse gas emission and ensure that the average temperature increase of the planet would not exceed 2 °C.

In view of the aforementioned events, one could say that economic, social and environmental considerations were present in the debates around development. These aspects were ratified by Elkington (1999) upon the concept of the *Triple Bottom Line*, which encompasses economic, social, and environmental perspectives. In addition to these, Sachs (1993) had already defined sustainability as having five dimensions: social, economic, ecological, spatial (territory) and cultural. Considering all perspectives mentioned above, the present article will mainly discuss environmental sustainability.

1.2 International initiatives and research on environmental sustainability in HEIs

Although this study addresses research at the national level, it is relevant to consider what has been published on the topic in other countries, so this review begins by contextualizing international agreements and studies that concern environmental sustainability in HEIs.

The records of HEIs' actions in the pursuit of sustainability date back from the 1990s, and are consistent with the milestones of the environmental movement.

One of the first documents formalizing the commitment to environmental sustainability in higher education was the Talloires Declaration. Written in 1990 at an international conference in Talloires, France, it was a plan of action to incorporate environmental sustainability into colleges and universities. It was signed by over 350 university rectors in over 40 countries (The Talloires Declaration, 1990).

The second international commitment of great impact was the Declaration of Halifax, signed in Halifax, Canada, in December 1991. The universities

were said to be responsible for the process of designing policies and actions towards sustainability (The Halifax Declaration, 1991).

The Swansea Declaration was signed in Swansea, Wales, in August 1993, when over 400 universities from 47 different countries gathered for a meeting. The Swansea meeting was inspired by the examples of Talloires and Halifax, and also due to the negligible presence of universities at the Rio de Janeiro and Agenda 21 conferences (The Swansea Declaration, 1993).

In 1995, the International Organization of Universities for Sustainable Development and the Environment was established in San José, Costa Rica (OIUDSMA, 2002). In 2000, the *Global Higher Education for Sustainability Partnership* (GHESP) was launched. In 2005, the UN established the Decade of Education for Sustainable Development. In 2007, the *Principles for Responsible Management Education* (PRME) initiative was founded under the coordination of the United Nations Global Compact and important academic institutions worldwide (Termignoni, 2012).

Also from this perspective, Europe has since 2006 boasted the Ecocampus project, an environmental management system directed to the HEIs. The project allows the recognition of colleges and universities for their environmental sustainability practices (Blewitt, 2001).

In addition to the international agreements aforementioned, the International Journal of Sustainability in Higher Education (IJSHE) was also analyzed in order to contextualize the scenario of international research in relation to sustainable practices in HEIs, as this was the first international publication to highlight the need to disseminate research, studies and projects on sustainability in HEIs. According to the IJSHE tutorial, sustainability in higher education is a recent topic, and the journal has been an important instrument for this field of research. Eleven studies were selected ranging from 2011 to 2015, all of which address environmental sustainability practices on HEI campuses, and all state their HEI location (city, state, country or continent) in the title.

From the summaries, it was possible to describe a little of what has been researched around the world.

León-Fernández & Domínguez-Vilches (2015) analyzed trends in implementing initiatives towards environmental management and sustainability in universities in Spain. The study analyzed information available on the Internet and data collected from a questionnaire answered by Spanish HEIs. The research concluded that the Spanish University System is guided by the following international trends: permanent work structures, environmental and sustainability management tools and other activities related to the environment and sustainable development.

Zhao & Zou (2015) examined green initiatives in China, at Tsinghua University. It was a case study in which they conducted participant observation and document analysis. The principle of the green university at Tsinghua is divided into three dimensions (green education, green research and green campus).

Wu et al. (2015) have explored sustainability in the curricula of higher education in Asia. They conducted content analysis based on Education for sustainability in higher education. Online courseware, instructional methods, and instructor education were investigated. They suggested that Asian universities should add an international dimension and implement the promotion of sustainable education on their websites.

Vagnoni & Cavicchi (2015) outlined the current status of implementing sustainable practices in the context of Italian public universities.

Their work took a qualitative approach, an exploratory study focusing on the Deming Cycle. The Plan-Do-Check-Act components of the model were used as a tool for collecting and analyzing data from official websites and other related Web pages of Italian universities. They described a university system that responds to international agendas in a fragmented way. Many universities were characterized as being mainly in the "Do" dimension.

Lo (2015) examined the focus, motivation and challenges for sustainable campuses in Chinese HEIs. He carried out a multiple case study through structured interviews in eight HEIs. According to Lo, HEIs are motivated by government and financial pressures and face challenges in limited access to funding. The government is advised to increase funding for higher education institutions in relation to sustainability and to make funding more equitable.

Further, higher education institutions are advised to engage students in the governance of sustainability.

White (2014) described and analyzed the use of integrative plans for sustainability within North American college campuses. The document also provided a preliminary framework for the assessment of these plans. Twenty-seven sustainable campuses plans were examined, and it was concluded that sustainability plans for campuses in the USA are extremely diverse - this, on top of the fact that environmental factors take promence over social ones.

Pereira et al. (2014) examined the relationship between environmental management practices espoused at a campus of the University of São Paulo (USP) and the greening of its organizational culture. The main framework for this research was the model proposed by Harris and Crane. The authors noted that USP's environmental management program is limited by university bureaucracy and hierarchy. The general perception was that the phrase "environmental management" is almost synonymous with "solid waste management".

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Sayed & Asmuss (2013) conducted a study at the University of Saskatchewan, Canada, where they identified five key campus areas for improving university sustainability performance: teaching, research, operations, governance, and community participation.

Palma et al. (2011) identified the number of sustainability-related subjects offered in bachelor's degree courses in Business Administration at Brazilian federal universities. The process of mapping the universities enlisted data from the Registry of Institutions of Higher Education of the National Institute of Studies and Educational Research (*Instituto Nacional de Estudos e Pesquisas Educacionais* - INEPE). According to the authors, only 33% of the HEIs studied offer related courses.

Mitchell (2011) sought to prepare the main campus of Brock University, St. Catharines, in Ontario, Canada, for a sustainability audit. The results indicated the initiatives of the tip on Brock University, including a power plant co-generation and the building of the "green" of new buildings.

Fonseca et al. (2011) described sustainability reports in Canada's higher education sector, with the aim of finding who is reporting on sustainability performance, how information is being reported and what is being reported.

The researchers employed a tool based on the Global Reporting Initiative (GRI).

Broadly speaking, the themes addressed in the international literature can thus be said to be largely related to 1. environmental education, by including sustainability in course curricula; 2. research; and 3. the green campus, including water and energy conservation, and reduced waste generation. Sustainability plans and reports also comprise the research themes, with GRI standing out particularly stongly.

1.3 Environmental sustainability in Higher Education Institutions in Brazil

There are two main currents of thinking when it comes to the role of HEIs in environmental sustainability. The first highlights the practice of environmental education in the qualification of students; the second involves the implementation of campus Environmental Management Systems as models and practical examples of sustainable management for society (Tauchen & Brandli, 2006).

Thus, two challenges are proposed for HEI: The first one can be referred to here as ACADEMIC and lies in knowledge transfer, training professionals to respond to questions in the various spheres of life and society, aware of their own socio-environmental impacts and of collective demands for changes in the current unsustainable systems. The second challenge, referred to here as OPERATIONAL, falls within the performance of managers in the implementation of socio-environmental responsibility practices, including the physical operations and services offered to the internal and outside community (Aglieri et al., 2009; Otero, 2010).

2 Methodology

The methodology that guided the project herein described was descriptive in nature and quantitative, by way of a bibliometric study. Bibliometrics quantifies the production, dissemination and use of recorded information, and can include citation analysis, analysis of co-citations, bibliographic groupings and co-word analysis (Caldas et al., 2003). Among its benefits, bibliometrics can allow one to do the following: identify trends and knowledge growth; map journal coverage; identify the main journals in a given theme; analyze literature dispersion and obsolescence; verify productivity in terms of authors and institutions; and shed light on the emergence of new themes (Spinak, 1998; Vanti, 2002; Francisco, 2011).

Operationally, the study investigates the production of Environmental Sustainability in Higher Education Institutions, spanning years 2006 to 2015, as this period is a watershed in the literature dealing with sustainability in HEIs in Brazil. It was in 2006 that the work of Tauchen and Brandli was published, becoming one of the seminal studies on the subject in the country.

The following categories of analysis were listed: Distribution of articles by periodical; Number of journals by classification; Annual distribution of articles; Distribution of articles by institutional affiliation; Distribution of articles by research approach; Classification of articles by data collection technique; Classification of articles by data analysis technique; and Principal authors.

The search for articles was carried out in the journals affiliated with ENGEMA (International Meeting on Business Management and Environment, *Encontro Internacional de Gestão Empresarial e Meio Ambiente* in Portuguese), namely the following: ReA UFSM (*Revista de Administração da Universidade Federal de Santa Maria* - Management Journal of the Federal University of Santa Maria); GeAS (*Revista de Gestão Ambiental e Sustentabilidade* - Journal of Environmental Management and Sustainability); RGSA (*Revista de Gestão Social e Ambiental* - Journal of Social and Environmental Management); and GEPROS (*Gestão da Produção, Operações e Sistemas* - Production, Operations and Systems Management). In addition to the aforementioned, a search was also performed using the CAPES periodicals website. The selection of articles occurred by way of a number of key words: *sustainability*, *environmental management*, *Higher Education Institution* and *university*. The journals

were as follows: *Revista GUAL* (*Gestão Universitária na América Latina* -University Management in Latin America); *Revista de Gestão, Finanças e Contabilidade* (Journal of Management, Finance and Accounting); *CERNE*; RAM (*Revista de Administração Mackenzie* - Mackenzie Management Review); *UNOESC & Sciences*; *Ambiente & Sociedade* (Environment & Society); *Revista de Contabilidade da UFBA* (Accounting Journal of UFBA); *Revista de Gestão e Produção* (Journal of Management and Production); AUGMDOMUS (*La Revista Electrónica del Comité de Medio Ambiente de AUGM* - The Digital Journal of the Environment Committee of AUGM); *Avaliação* (Revista da Avaliação da Educação Superior - Higher Education Assessment Review); *REUNIR* (*Revista de Administração, Contabilidade e Sustentabilidade* - Journal of Administration, Accounting and Sustainability).

Only articles covering the relationship between sustainability and environmental management, on the one hand, and university or institutions of higher education, on the other, were selected. In all, 27 articles in 15 different journals were selected.

3 Bibliometric study: results and discussion

3.1 Articles comprising the study

This section shows the results of the bibliometric analysis, beginning with a general review of the articles therein contained. The works were grouped according to contents and covering two strands: ACADEMIC (Environmental Education in HEIs and Evolution of Research) and OPERATIONAL (Proposal and application of models, Waste Management and Environmental Management Practices). The division into the academic and the operational is based on the propositions that affirm that there are two strands for sustainability in HEIs. The first one here referred to as ACADEMIC, composing 11 articles, highlights the practices centered on teaching and research; and the second, called OPERATIONAL, is comprised of 16 articles and describes the management of the campuses (Tauchen & Brandli, 2006; Aglieri et al., 2009; Otero, 2010).

In the OPERATIONAL strand, most of the articles (seven) deal with the Proposition and application of models in HEI located in Brazil; the first article analyzed, by Tauchen & Brandli (2006), brought a theoretical approach, contextualizing, through bibliographical research in secondary data, a historical and current panorama of the environmental issue in HEIs. They concluded with the proposed model for the implementation of an EMS based on the PDCA cycle (Plan, Do, Check and Action), adapted to the HEIs that will start the implantation in a university campus.

De Marco et al. (2010) carried out a systematization of procedures, considering a model for the implementation of an Environmental Management System (EMS) adapted to HEIs, permitting control over environmental impacts and compliance with legislation. This model is based on the work of Tauchen & Brandli (2006), as well as the NBR ISO 14001 standard (ISO, 2015).

Likewise, analyzing a possible model for sustainability in a HEI, Kruger et al. (2011) innovated upon proposing a study to evince the compliance of a community college to the Environmental Agenda in Public Administration (A3P).

This institution met the proposed objectives, but with the need to improve its actions regarding quality of life of its employees. The biggest bottleneck observed concerned sustainable purchases.

Another proposed model appeared in Keunecke et al. (2012), in which the authors analyze the degree of sustainability of a Teaching Institution based on the SICOGEA (*Sistema Contábil Gerencial Ambiental* - Environmental Management Accounting System) method. As a result they proposed the implementation of an environmental management plan using the 5W2H tool.

A case study to present the Environmental Management methodology used at the Federal University of Rio Grande do Sul (UFRGS) in Brazil was carried out by Sgarbi et al. (2013) using the LAIA (*Levantamento de aspectos e impactos ambientais* - Survey of environmental aspects and impacts) management tool. The tool proved to be adequate to adapt to any situation diagnosed so far without losing quality of analysis, and is thus endorsed by the authors for use in other institutions.

Similarly, through the creation of a socioenvironmental sustainability index for teaching, and test of its environmental, technical and economic feasibility at the HEI CEFET in Rio de Janeiro, Trigo et al. (2014) carried out documentary research, interviews, and questionnaires covering each of the proposed indicators: electric energy consumption; Water consumption; consumpt ion of fuels; degree of awareness in the use of office paper; quality of waste disposal; and social and environmental responsibility.

Warken et al. (2014) proposed to evaluate the level of environmental sustainability at the Fronteira Sul Federal University, Chapecó (Santa Catarina) campus in Brazil, based on the application of the Socio-Environmental Sustainability Assessment Model (*Modelo de Avaliação de Sustentabilidade Socioambiental* - MASS) developed by Freitas (2013). They concluded that the HEI provides the opportunity to better prepare and sensitize its employees, teachers and students to engage in this cause for the maintenance of economic, social, environmental and educational sustainability.

In the second group are five papers on Waste Management in HEIs, starting with Juliatto et al. (2011). Through a case study at Federal University of Santa Catarina (UFSC), they proposed a systematization of integrated procedures. The focus was on waste as a shared responsibility, involving the university community in the planning and management of waste.

Another case study that addressed waste management was that of Santos et al. (2012), with the aim of improving the quality of the activities at laboratories of UNIVASF's experimental farm, as well as minimizing or eliminating environmental contamination caused by incorrect disposal of liquid and solid waste, arising from the institution's daily activities. They proposed a procedure for storage and transport, as well as a manual containing data on substances used.

The reverse logistics of technological waste was analyzed by Faro et al. (2012), in a study on e-waste collection at a Brazilian university. According to the authors, the study contributed to addressing a paucity of studies involving reverse logistics of electronic equipment in universities.

Eco-friendly practices and selective collection were reviewed by Souza et al. (2013) at the State University of Paraíba. The authors concluded that the selective collection is still flawed since irregularities were found concerning the frequency of garbage collection and placement of collectors on campus.

In a technical study, Carli et al. (2013) proposed guidelines for the water management of the laboratories at the University of Caxias do Sul to reduce waste. They included consumption control, waste minimization actions and reuse alternatives such as water recirculation and direct reuse in laboratories.

In the third group, four papers sought to identify, describe and analyze the Environmental Management Practices in HEIs.

In the study by Boff et al. (2008), three HEI administrators were interviewed, with the aim of describing environmental management in a community HEI, in the view of its leaders. In the view of the authors, Environmental Management in HEIs tends to create benefits for the environment and for the institution itself, aiding in improvement of its image, in the reactions to work, both with the community and environmental groups.

In 2009, Engelman et al. carried out interviews with managers in four different universities, with a view to identify if there is a commitment on the part of the institutions involving environmental management, and if so, which practices were in place. They concluded that, despite financial and cultural barriers, there exist initiatives and practices for environmental management and an increasing process of awareness-raising among people involved with HEIs.

Borges et al. (2013) administered a questionnaire on environmental management practices in 82 campuses of Federal Institutes of Education, Science and Technology in Brazil to analyze their environmental profile. They concluded that the environmental performance of the HEIs evaluated suggested a a low degree of concern for the environment.

In the same year Machado et al. (2013) carried out a telefone survey in 75 HEIs to identify Environmental Management practices in Brazilian universities. A list of 22 practices carried out by most HEIs was pointed out by the authors as evidence that the institutions that possess Environmental Management Systems and a specific department for its management present a higher level of adoption of practices.

The ACADEMIC strand begins in the fourth group, composed of six studies that deal with Environmental Education in HEIs.

The study of Oliveira et al. (2010) deals with environmental sustainability through the lens of education, To that end, 41 professors from business administration programs were interviewed to evaluate the importance attributed by them and to Environmental Management, as well as to analyze the future intentions of these professionals in relation to the same area. They considered that Environmental Management is a relevant area and that there is a moderate need for this topic in course curricula; on the other hand, the level of involvement of professors with Environmental Management was found to be low.

The aim of Jacobi et al. (2011) concerning sustainability education was to contribute to the debate on the role of higher education, particularly in Business Administration and Management programs. As a result of this theoretical study they advocate the integration of knowledge, and see sustainability as a window of opportunity in Management courses. They further suggest that such training goes beyond management training, educating individuals to be responsible and committed to sustainability.

Gomes et al. (2012) presented a proposal for the teaching of environmental oversight in the accounting sciences courses of Brazilian Higher Education Institutions. Education for sustainability in Gomes et al. calls for accounting professionals who understand social and environmental impact management tools.

Education for environmental sustainability was evaluated by Brandli et al. (2012) in UPF undergraduate courses, making it possible to identify priorities regarding the quest for environmental sustainability. They found substantial heterogeneity among UPF courses, which may be related to the strategic vision of the university.

Courses that deal with environmental issues in Business Administration course curricula in Paraíba were investigated by Lacerda et. al (2014).

Document-based research revealed that 77% of the Business courses in Paraíba have subjects that deal with the environmental problems in their curricula.

Munaretto & Busanello (2014) explored how environmental management practices are incorporated and developed in the teaching objectives of the undergraduate courses of the Northern Higher Education Center of Rio Grande do Sul (CESNORS), Federal University of Santa Maria (UFSM). They found that the curricular content of CESNORS courses did not include chapters or specific items linked to environmental education, despite claims to a different effect in institutional literature.

Still within the ACADEMIC strand, with five articles that show the Evolution of research on sustainability in HEIs, we can make the following observations.

Uehara et al. (2010), analyzed the historical evolution of the different approaches of environmental management research at the University of São Paulo (USP), based on a search for information in the CNPQ research directory. They found that there are a limited number of research groups in Environmental Management and that there is no interaction between them.

In addition, they highlighted the lack of an institutional policy that has Environmental Management as an integrating principle.

In 2010, Vaz et al. (2010) carried out a systematic review, presenting a reflection on the development of scientific research related to the Environmental Management System in Institutions of Higher Education. They concluded that HEIs are under-explored and restricted in relation to their environmental management, but show concern for sustainable development, both in teaching students and in environmental practices.

Taking a bibliometric approach, Chaves et al. (2013) wrote on the subject of social and environmental management in Teaching Institutions, using the Knowledge Development Process - Constructivist (Pro Know - C) as an intervention tool. They found that the most frequently cited journals were the *Journal of Sustainability in Higher Education* and *Journal of Cleaner Production*. They used the available

international databases in the CAPES periodical search interface.

Feil et al. (2015) identified the environmental management practices employed by Brazilian HEIs, looking for correlations that influence the implementation of Environmental Management Systems. They carried out secondary documentary research with data published in annals, scientific journals, books and the porta *Scientific Electronic Library* (SCIELO). They applied a meta-analysis of the data in 34 scientific studies of 23 HEIs referring to models and practices of waste management published between 2001 and 2012.

Viegas & Cabral (2015) analyzed the ways in which HEI works in the construction of a new management model that incorporates the socio-environmental dimension and contributes to sustainability. They considered that HEIs are at the forefront of constructing knowledge and sustainable values, as well as incorporating such knowledge and values into their management models.

In the next section we begin to describe the data found in the bibliometrics.

3.2 Analysis of results

There was a great dispersion of publications on sustainability in HEI (Table 1), and there is no specific Brazilianl journal on the subject, such as the international *Journal of Sustainability in Higher Education.*

The jornal *GUAL – Gestão Universitária na América Latina* is the one that has shown the greatest predisposition for publications involving this subject (22.2%). Among the journals associated with Engema, the publications are present in greater numbers in the *RGSA - Revista de Gestão Social e Ambiental* (14.8%).

Table 2 shows the ratings of journals according to QUALIS - CAPES in the classifications: Business Administration, Accounting and Tourism; and Environmental Sciences. Within the classification in Business Administration, of particular note are Accounting and Tourism, with four articles ranked B1, eleven B2, eleven B3 and one B4. In the classification

Table 1. Distribution of articles by journal.

Journals	N of articles per journal	%
GUAL	6	22.2
RGSA	4	14.8
ReA UFSM	3	11.2
GEPROS, GeAS	2 (total of 4)	14.8
RGFC, CERNE, RAM, Unoesc & Ciência, Ambiente & Sociedade, Revista de Contabilidade da UFBA, Gestão & Produção, AUGMDOMUS, AVALIAÇÃO, REUNIR	1 (total of 10)	37
Total	**27**	**100%**

Source: Prepared by the authors.

in Environmental Sciences it was not possible to acccess three journals. For the rest, there are two articles B1, a B2, seven articles B3, and 11 articles B4. Thus, the journals in question are better assessed in Business Administration, Accounting and Tourism.

Table 3 shows the annual distribution of the articles, which became more representative as of 2010 when more journals began to publish works on sustainability in HEI. The year with the highest volume of publications was 2013, making six articles in six different journals. The year 2015 is still in progress and has already seen two articles in the journal GUAL, and it is important to follow the publications on the subject at present.

We found 89 different authors for the 27 published works, according to Table 4, totaling an average of 3.3 authors per paper.

There were only six authors with more than one published work. This situation shows the recency of this area of study, as researchers are still just beginning to publish in the discipline.

The distribution of authors by institutional affiliation is provided in Table 5. Authors who published more than one article had the institutions counted every time they published. Some published by different institutions, as is the case of the author Engelman, who published an article by Feevale and the other by UFRPGS.

Table 2. Number of journals by rating: Business Administration, Accounting and Tourism; and Environmental Sciences – QUALIS – CAPES.

Journals	Rating Business Administration, Accounting and Tourism	Rating Environmental Sciences	Number of articles
Gestão & Produção	B1	B2	1
RAM	B1	B1	1
Ambiente & Sociedade	B1	A2	1
CERNE	B2	B1	1
ReA UFSM	B2	B3	3
AVALIAÇÃO	B2	NO INFORMATION	1
GUAL	B2	B4	6
RGSA	B3	B3	4
GEPROS, GeAS, REUNIR	B3	B4	5
RGFC, AUGMDOMUS	B3	NO INFORMATION	2
Unoesc & Ciência, Revista de Contabilidade da UFBA	B4	NO INFORMATION	2
Total			

Source: Prepared by the authors.

Table 3. Annual distribution of articles by journal.

Journal	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
GUAL	0	0	0	0	0	2	1	1	0	2	6
RGSA	0	0	0	1	0	0	2	1	0	0	4
ReA UFSM	0	0	0	0	1	0	0	0	2	0	3
GEPROS	0	0	0	0	1	0	1	0	0	0	2
GeAS	0	0	0	0	0	0	0	1	1	0	2
RGFC	0	0	0	0	0	0	0	0	1	0	1
CERNE	0	0	0	0	0	0	0	1	0	0	1
RAM	0	0	0	0	0	1	0	0	0	0	1
Unoesc & Ciências − ACET	0	0	0	0	1	0	0	0	0	0	1
Ambiente & Sociedade	0	0	0	0	1	0	0	0	0	0	1
Revista de Contabilidade da UFBA	0	0	1	0	0	0	0	0	0	0	1
Gestão & Produção	1	0	0	0	0	0	0	0	0	0	1
AUGMDOMUS	0	0	0	0	0	0	0	1	0	0	1
AVALIAÇÃO	0	0	0	0	0	0	1	0	0	0	1
REUNIR	0	0	0	0	0	0	0	1	0	0	1
Total	**1**	**0**	**1**	**1**	**4**	**3**	**5**	**6**	**4**	**2**	**27**

Source: Prepared by the authors.

The author Pfitsher published three different articles, all form UFSC. The authors with two articles published were Freitas (UFSC), Petri (UFSC), Fracasso, (UFRGS), and Brandli (UPF). HEIs UFSC, USP and UFRGS were represented by the greatest number of authors. These institutions were also the ones that presented the largest number of case studies published on internal sustainability practices (Ribeiro et al., 2005; Tauchen & Brandli, 2006; Otero, 2010; Sgarbi et al., 2013).

Regarding the distribution of articles by research approach, most studies (19) are of theoretical-empirical

nature, reporting case studies and HEI surveys to reveal their environmental sustainability practices. The more theoretical studies are based on secondary data published on the sustainability in HEIs, totaling 8 papers.

The classification of articles by data collection technique is illustrated in Table 6. Of note is Keunecke et al. (2012), which employed interviews and questionnaires to analyze the degree of sustainability of an Educational Institution based on the SICOGEA method. The work of Trigo et al. (2014) is also included, which made use of three techniques for data collection: interviews, questionnaire and documentary research. The aim was to create an index of socio-environmental sustainability in teaching and test its environmental, technical and economic feasibility in an educational institution.

The interviews were conducted in the case studies on management practices in HEIs. In Engelman et al. (2009), interviews with four university administrators were conducted to identify if there is a commitment with environmental management on the part of institutions that have environmental management practices, and what practices are carried out.

Table 4. Main authors.

AUTHOR	No. of articles
PFITSCHER, Elisete Dahmer	3
FREITAS, Cláudio Luiz de	2
PETRI, Sérgio Murilo	2
ENGELMAN, Raquel	2
FRACASSO, Edi Madalena	2
BRANDLI, Luciana Londero	2

Source: Prepared by the authors.

Table 5. Distribution of authors by institution of affiliation.

Authors' institution of affiliation	Number of authors from each institution
UFSC	12
USP, UFRGS	9
UPF	8
UEPB	7
UNOESC	5
UFLA, FEEVALE, UCS, UNIVASF, UTFPR	4
UECE	3
HORUS FACULDADE, UFBA, IFRO, UFSM	2
UNE, UNOCHAPECÓ, UFRA, UNAMA, Escola de Negócios Internacionais HEC Montreal, CEFET/RIO, UFF, UNIRI, UDESC, UFPR, Secretaria de Meio Ambiente do Estado de São Paulo	1

Source: Prepared by the authors.

Table 6. Classification of articles by data collection technique.

Year	Interview		Questionnaire		Document-based	
	N	%	N	%	N	%
2006	0	0	0	0	1	7.5
2007	0	0	0	0	0	0
2008	0	0	0	0	1	7.5
2009	1	17	0	0	0	0
2010	0	0	1	13	3	21.5
2011	1	17	0	0	2	14
2012	2	33	3	29	1	7.5
2013	0	0	**3**	29	**3**	14
2014	2	33	2	29	2	14
2015	0	0	0	0	2	14
Total	**6**	**100**	**9**	**100**	**15**	**100**

Source: Prepared by the authors.

When the goal was to understand the behavior of a greater number of stakeholders involved in sustainable practices, questionnaires were used.

This was the method used by Machado et al. (2013) to identify Environmental Management practices in place at 75 Brazilian HEIs.

A document-based study was conducted by Viegas & Cabral (2015) upon analyzing the ways in which HEI act in the construction of a new management model – one that incorporates the socioenvironmental dimension - contributes to sustainability. The authors analyzed experiences in Brazilian institutions and in other countries.

In addition to the works cited, the others that compose the present research fit into one of the three categories of data collection.

Regarding the classification of articles by data analysis technique, in thirteen articles the data analysis technique was not informed. In thirteen other papers, quantitative analysis was reported. Only one of the papers mentioned content analysis, although such an approach may have been taken elsewhere yet not reported.

As an example of quantitative analysis, Borges et al. (2013) aimed to analyze the environmental profile of Federal Education, Science and Technology Institutes (*IF*s) in Brazil, particularly with respect to their environmental management practices. 82 representatives of Brazilian HEIs provided answers for a questionnaire-based interview in order to diagnose environmental management practices.

4 Conclusions and recommendations

In line with the environmental movement, the Environmental Sustainability in HEIs recorded its first international agreement in the 1990s, making these institutional entities responsible and establishing a commitment to sustainable development. The aim of this paper was to therefore investigate the profile of research on environmental sustainability in Higher Education Institutions (HEIs) located in Brazil.

Research at the international level deals with themes that encompass international trends for sustainability in HEIs, sustainable practices, and environmental education in a "green" university; further, they envolve the use of research tools that are inspired by those employed in the area of quality control, such as the PDCA cycle, for example. Some works are more technical and bring solutions for the conservation of water and energy in HEIs. Sustainability reports from organizations in other sectors are also being brought to HEIs, as was the case with GRI at a university in Canada. Unlike the papers published in Brazil, none cited ISO 14000 standards as an environmental sustainability model for an HEI - a finding worth further investigation using a greater number of articles.

As for the profile of Brazilian published literature on environmental sustainability in HEIs (from 2006 to 2015), it was found that such studies are scattered across fifteen different journals. This relative scarcity arises from the lack of a discipline-specific journal, unlike the international reality, where specific publications dedicated to sustainability in HEIs can be found, such as the *International Journal of Sustainability in Higher Education* (Chaves et al., 2013).

There has been a growth in the number of publications starting from 2010, up from just one article in the entire span of 2006 to 2009, to four articles in 2010.

In 2011 three articles were observed; in 2012 there were five. To date, 2013 was the year with the highest number of articles published, totaling six. It is worth noting that the studies that dealt with waste management were published as of 2011 - an interesting fact considering the date of publication of the National Policy on Solid Waste, Law number 12305, in 2010. In this sense the public policy is, in fact, an inducer of external pressure to HEIs to begin to manage the waste systematically.

The studies are also characterized by the fact that the twenty-seven studies were authored by eighty-nine researchers and there are no individual papers. This would seem to indicate that there are still no specialists who publish systematically in the discipline and there is a dearth of Brazilian authors with noteworth record of publication. Indeed, only six names appeared as authors of two to three papers, and these comprise the bulk of authors who have published on the topic.

Moreover, in Brazil, environmental sustainability in HEIs actually has two major strands. The first is the academic strand, emphasizing teaching and research as developers of knowledge for graduates of HEIs. The second strand is on the operational axis, which manifests itself in the daily actions of the campuses for environmental sustainability (Tauchen & Brandli, 2006; Aglieri et al., 2009; Otero, 2010). In this study, the two strands were grouped into five categories. On the OPERATIONAL axis are the following: Proposition and application of models; Waste management in HEIs; and Environmental management practices. On the ACADEMIC axis are: Environmental education in HEIs; and the Evolution of research.

It was also observed that the evolution of the academic learning obtained by the researchers' experience has brought a maturity to the body of work, which is already constructing a record of research, concepts and results that are building up over time, contributing to our growing knowledge in the area.

As a suggestion for future research, the journals already consulted in this paper should be continually followed in order to observe the continuity and evolution of publication in the discipline, as well as

to keep track of the institutions that will still publish the results of their experiences with environmental sustainability. The current authors are, in the majority from UFSC (twelve), USP (nine), UFRGS (nine) and UPF (eight). In view of the fact that these authors may be employed at pioneering HEIs as far as environmental sustainability in Brazil is concerned, one recommendation is the development of studies to explore the practices of these HEIs in the academic and operational axes, which would help reveal the state of the art in Brazil.

There is also the possibility of creating a report and evaluation model specific to educational institutions, with criteria specific to their particular characteristics, avoiding the variety of models and uncertainties arising from each one of them because one does not know which is the most appropriate for each HEI.

Finally, limitations of this article include the fact that it is a very recent area of study and practices, covering ten years in this study, hence there is not much long-term longitudinal information that can demonstrate the learning already achieved. Furthermore, the interdisciplinar nature within the theme brings richness and complexity in dealing with a subject present in several research areas and in diverse contexts, leaving the researcher to tease out the subtleties and unpack the practical experiences and research scattered across numerous publications, each with its own contributions to the evolution of knowledge around sustainability in HEIs.

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