Journal of Cleaner Production 198 (2018) 1251–1261

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Environmental management practices in industries of Brazil, Russia, India, China and South Africa (BRICS) from 2011 to 2015

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ARTICLE INFO

Article history:
Received 12 March 2017
Received in revised form
10 June 2018
Accepted 5 July 2018
Available online 11 July 2018

Keywords:
BRICS
Environmental management
Environmental management practices

ABSTRACT

This study aimed to identify and analyze the environmental management practices in the industry carried out in Brazil, Russia, India, China and South Africa (BRICS) in the period from 2011 to 2015, with the aid of scientific literature published in the Scopus database. Due to the expansion of the bloc's development, these countries presented a high potential to impact the environment. Therefore, this study is relevant because it identifies trends about the Environment Management Practices that have been followed in industries of BRICS, increasing the theoretical allowance for discussions concerning Environment Management Practices in these countries. Consequently, a survey on environmental management practices was conducted using the keyword "industrial environmental management practices" and the name of each country. Besides that, a "second quest" was added with the term "case study" to refine the results. We found out that China, India, South Africa and Brazil have been studying solutions for the CO_2 emissions by employing different environmental management practices. In addition, in the studies on China, India and Brazil, environmental management practices recurrently approached topics concerning the supply and water quality, the regulatory standards of environmental management and the practice of Green Supply Chain Management. However, we did not find papers concerning the environmental management practices in Russia through the employed methodology. We concluded that China, India and Brazil tend to present papers on the issue of environmental management (in English and in the database, from which they were gathered) because these countries show a more sustainable development, thus publishing a higher number of researches in this field, whereas Russia and South Africa do not follow this trend due to a weaker environmental engagement. With regard to that, it is suggested that further studies investigate the environmental management practices in other developing and developed countries, which would allow to draw a comparison with other groups.

1. Introduction

Several topics arise from the worldwide concern about the "Sustainable Development", among which the environmental management is to be highlighted. In this manuscript, this concept is understood as a set of policies, procedures, and guidelines that outline the environmental activities of a specific organization (Bindal and Dwivedi, 2013). The relation between this concept and sustainable development implies the idea of what is necessary for the convergence to the strategies concerning economic growth. This occurs by means of the production of non-polluting goods, processes and systems, which preserve the natural resources and energy and are at the disposal of consumers, communities and industries (Glavic and Lukman, 2007), thus addressing a social concern.

The concern about making natural resources available for the social and economic use emphasizes the importance of environmental management, which is founded upon three aspects: (i) the social benefits; (ii) the environmental benefits; (iii) the economic

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https://doi.org/10.1016/j.jclepro.2018.07.046
0959-6526/

benefits. It is reasonable to highlight that the social, environmental and economic benefits are crucial to the construction of a sustainable society (Broman and Robert, 2017).

In terms of the environmental management, the social benefits are the outcome from the increase of human and social capital, whereas the environmental benefits derive from the increase of the natural capital through the preservation of natural resources and the biodiversity (Moser, 2001; Delai and Takahashi, 2013). The economic benefits result, in turn, from the increase of productive capital based on growth, development and efficiency (Delai and Takahashi, 2013).

With regard to the economic benefits, there is a group of researches that believe that the environmental protection may slow down the economic growth. Notwithstanding, the theory which claims the reduction of the economic development on account of the environmental protection is not founded on solid ground. In 2014, it was possible to maintain the emission levels of carbon dioxide (CO_2) and still make the gross domestic product (GDP) increase by 3% (IEA, 2015). Furthermore, there are indicators that the efficient management of natural resources through growth-oriented environmental politics can lead to global economic benefits up to US$ 2.4 trillion in 2050 (Hatfield-Dodds et al., 2017).

From the perspective of the economic aspect, the environmental management is also regarded as a competitive advantage (Bindal and Dwivedi, 2013; Kuei et al., 2013; Soda et al., 2015; Lannelongue et al., 2017) that is achieved if the corporative management turns its attention to sustainability in a way that is still aligned with economic, social and environmental expectations. The South Korean cluster case can be specifically mentioned as an example of sustainable production that generated economic and environmental gains (Yoon and Nadvi, 2018). Furthermore, so that the environmental management be more efficient, it is fundamental that the strategies aim at a cleaner production. This leads to the adoption of "environmental management practices", which are defined as actions that ought to be followed in order to achieve the environmental conservation and contribute for the human well-being (Glavic and Lukman, 2007; Joshi et al., 2016; Salvioni et al., 2016).

The environmental management practices have to be carefully selected, so that the profitable outcomes be achieved and the company's (and the company's location) policy guidelines be followed. In addition, specific criteria have to be met, such as the use of durable goods, the investment in their maintenance, the minimization of transport costs and the use of disposable packages (Retamal, 2017). It is noteworthy that a constant evaluation and comparison of natural resources concerning environmental management practices is of particular importance. This evaluation shall not be limited to water or energy consumption, but rather encompasses global indicators in order to measure the efficiency of the conducted processes (Carrasquer et al., 2017), so that the adoption of environmental management practices be a differential for the organization and the society.

Considering the importance of the adoption of efficient environmental practices and the environmental management, several researches have addressed this phenomenon in a worldwide context with the goal to measure the benefits of the environmental management, project the outlook of extraction of resources and the CO_2 emission, as well as investigate related themes, such as air pollution and the use of wastewater and dangerous solid residues (Bindal and Dwivedi, 2013; Hatfield-Dodds et al., 2017). In this respect, recent researches pointed out, for example, that: (i) subsidiaries of multinational corporations *"need to meet market stakeholders' pressures in order to achieve social legitimacy in host countries, and that the implementation of formal environmental management systems"* (Kawai et al., 2018, p. 1); (ii) the concern of manufacturers about social, environmental and financial impacts in Spain (Muñoz-Villamizar et al., 2018); (iii) when analyzing the effect of a program to classify the efficiency level of environmental preservation in a mining industry in Ghana, findings revealed that *"overall environmental performance over the three-year period under review was poor (2009 − 56.6%; 2010 − 65.6%; 2011 − 59.1%) with none of the years meeting the expected minimum limit, with the exception of legal requirements and corporate social responsibilities"*, and the company failed in all other criteria, specially in the emission of toxic and non-toxic residues (Bawua and Owusu, 2018, p. 11); (iv) in a simulation of scenarios for the gas emissions from beef production in Western Canada, 6 out of 11 scenarios were considered economically and environmentally sustainable for the researched farms. The results suggest that it is possible to implement in a profitable way several strategies to mitigate the greenhouse gases on cattle production farms; (v) the results of an analysis on environmental policies for greenhouse gas emissions reduction and energy transition in the medieval historic centre of Siena (Italy) show *"a balance far from carbon neutrality and offer ideas for testing appropriate environmental policies based on improving energy efficiency (such as energy saving and integrated waste management) as well on transition towards renewable energies"* (Marchi et al., 2018, p. 829); (vi) in order to obtain a better management of air quality and to protect human health, the Chinese government reviewed the national patterns for air quality per particle in 2012. By means of meta-analyses, the conducted research concluded that the current air quality per particle in China "*could be sufficient in mitigating the excess mortality risk from short-term exposure*" (Wu et al., 2018, p. 1). The aforementioned examples show that the concern about sustainable environmental management is present both in countries with high and low economic and social development.

Still in terms of the relevance of the adoption of sustainable environmental management practices, the state of the art of this theme shows that the countries are under constant pressure to adapt to sustainable development. On the other hand, some countries find it difficult to align their industries such as their economic and population growth with a rational extraction of natural resources without overburdening the environment (Pereira, 2013; Dong et al., 2014; Zhang and Wang, 2014). Furthermore, it is predicted that within a period of 35 years, between 2015 and 2050, the extraction of resources shall increase by 119%, and on account of the value of global activity, the amount of greenhouse gases is expected to increase by 41% (Hatfield-Dodds et al., 2017).

Among this group of countries with difficulties to adapt their sustainable environmental management practices are Brazil, Russia, India, China and South Africa (BRICS), which are the focus of this study due to their political cooperation and their influent role worldwide. This study aims to emphasize the reasons why the countries of this group have the potential to pollute the environment, as well as to delineate the production characteristics of each country and their specific themes (Vieira and Veríssimo, 2009; Yao and Liu, 2011; Ardichvili et al., 2012; Dai et al., 2016; Klafke et al., 2016 Shen et al., 2017).

Regarding the production characteristics of the BRICS countries, the literature points out that China is described as one of the main worldwide producers, whereas India is regarded as a service exporter and a high-quality information technology jobs provider. Brazil, in turn, is a powerful exporter of grains in Latin America. Russia is acknowledged as a worldwide energy exporter. South Africa detains the greatest power in Africa and has adopted a competitive strategy in terms of primary and manufactured goods (Vieira and Veríssimo, 2009; Yao and Liu, 2011; Ardichvili et al.,

2012).

What concerns the potential to pollute the environment, the literature shows that the emerging BRICS countries have a greater chance to pollute the environment due to: (i) the rapid growth of these countries; (ii) the elevated number of industries settled in these places; (iii) the process of continuous urbanization. These factors lead to problems, such as air pollution, traffic jam in big urban areas, the constant consumption of energy, the destruction of wild habitats, the higher emission of carbon dioxide in the atmosphere and the reduction of agricultural land (Dai et al., 2016; Klafke et al., 2016; Shen et al., 2017). Those are the challenges that these countries have to face.

Besides that, there are other challenges that each country must overcome in terms of environmental factors. In this sense, Brazil must overcome a high CO_2 emission, problems with public transportation and the need of improvements in energy efficiency (Bouzon et al., 2014; Jabbour and Jabbour, 2014). Russia faces the challenge to invest in the production of biofuel and energy, which is delayed due to local and technological factors (Tikhomirov et al., 2016). India is a country that suffers from car pollution and the potential industrial and household water shortage (Rai, 2011; Laghari et al., 2012; Mathiyazhagan et al., 2015). China suffers from the increasing generation of residues deriving from the constant increase of construction activities (which led to the constant construction and demolition of structures) in order to improve the local infrastructure and technology (Chi et al., 2011; Li et al., 2015; Zheng et al., 2017). Furthermore, China deals with problems with air quality, given that the country shows the second highest CO_2 emission in the world (Dai et al., 2016). Finally, South Africa faces problems regarding food safety and access to fresh water, which can be traced back to the country's high temperatures (Kloster et al., 2012; Razzaque and Kleingeld, 2013).

Based on the industrial characterization, the economic growth and the aforementioned environmental factors, it may be verified that the BRICS countries operate in different economic segments and that all of them have presented an economic increase over the last decades (Vieira and Veríssimo, 2009), which consequently led to an increase of their indexes of environmental pollution and extraction of natural resources. However, the absence of sustainable mechanisms in these countries jeopardizes the BRICS' growth in the next decades (Ozturk, 2015).

In this context, it may be ascertained that in-depth studies concerning environmental management and their practices are fundamental for the BRICS countries, given that the proper sustainable environmental management and development lead to social, environmental and economic benefits. Yet, the researches that approach environmental management and their practices inside the BRICS countries have been carried out in an isolated manner. There have been so far no researches that analyze the environmental management practices in an integrated way.

This original proposal is justified due to its potential to fill a prominent academic gap, as well as due to the theme's current relevance. In addition to it, this proposal may blaze a trail for further researches in this area of knowledge, thus expanding the information and strategies adopted in these countries, as well as the environmental management practices, constituting a source of consultation for industrial managers to underpin their decision-making process when adopting environmental management practices.

In view of the above, the present contribution aims to analyze the environmental management practices carried out in Brazil, Russia, India, China and South Africa (BRICS) during the period of 2011–2015 by investigating the scientific literature published in the Scopus database. It is worth mentioning that the establishment of 2011 as the research's starting point is due to admittance of South Africa in the BRICS.

In order to fulfill this goal, the present contribution shall be organized as follows: introduction (1); methods (2); results and discussion (3); conclusions (4); and, in the end, the references. Accordingly, the methods section shall be presented next.

2. Methods

The present study is a qualitative research. Specifically, a bibliographical research was adopted considering the publications of the Scopus database resulting in the period between 2011 and 2015 on the subject of environmental management practices. The present methodological process was based upon Klafke et al. (2016).

In this sense, the subject was developed during the research. The present study opted for the theme "Environmental management in the industry in the context of emerging countries", under the premise of growing worldwide concern to maintain productivity without degrading the environment and the need for adjustments in the production process (Almeida et al., 2013).

First of all, there were the identification and location of the management practices. The keywords "industrial environmental management practices Brazil", "industrial environmental management practices Russia", "industrial environmental management practices China", "industrial environmental Management practices India" and "industrial environmental management practices South Africa" were used with the aim of obtaining academic articles related to the topic under examination in Brazil, Russia, China, India and South Africa, respectively. Due to the fact that English is widely regarded as the scientific language (Gibbs, 1995), the corpus contains only articles written in this language.

The database chosen for data collection was Scopus, as it was launched by the publisher Elsevier in 2004 and is considered the largest database of abstracts and references in the world, with more than 18 million references to articles from scientific journals (Grácio and Oliveira, 2012). Besides that, the Scopus database offers a 20% wider coverage of articles for citation analysis, including a wider periodical spectrum than Web of Science and Pubmed (Falagas et al., 2007).

Secondly, the criteria used in the data collection stage of this study were the following:

a) On the Scopus website, "document search" was selected as the characteristic search;
b) In the "Search" field, the keyword "industrial environmental management practices" and the name of the country to be searched were added;
c) In the "Search Tips" option, only "Article, Title, Abstract and Keywords" were selected;
d) The range of dates was established from 2011 to 2015, considering that this was the period in which South Africa entered the block of emerging countries;
e) In the item "document type" the option "Article or review" was selected;
f) After completing the first stage, a second quest was added, in which the word "case study" was inserted, in order to select only the case studies that cover the proposed theme.

Table 1 shows the number of articles found at each stage of the research carried out using the methodological procedures mentioned above:

After completing the aforementioned step, the data collection, logging, analysis and interpretation stage for the articles obtained in the search were performed. The compilation and recording took

Table 1
Number of papers found at each stage of research.

Research stage	Brazil	Russia	India	China	South Africa
N Papers – First search	21	4	32	68	4
N Papers – Second research	17	1	21	53	2
N Papers – Out of the theme	5	1	0	15	0
N Papers – Total to interpretation	12	0	21	38	2

Source: Authors (2017).

place during the collection of bibliographical data, using the Microsoft Excel® tool for the elaboration of the tables with the data pertinent to the environmental management practiced in the industries of each country.

For the analysis and interpretation stages, the four phases were: (i) a critical analysis of the collected bibliographic material was carried out, followed by; (ii) decomposition of the essential elements and their classification and, subsequently; (iii) generalization and analysis of the previous stage; (iv) analysis of the previous steps was performed through the interpretation of the data and the writing of the present text.

According to the aforementioned structure of the present article, the results and the discussion shall now be presented.

3. Results and discussions

Regarding the Chinese academic environment, 38 articles were analyzed. Table 1 presents the environmental management practices applied in Chinese industries, the frequency in which they appeared in the industries and the demand that the management practice aims to solve. (See. Table 2).

It was verified that the most frequent environmental management practices in China were Water Resources Management (6), Eco-industrial parks (5), Management and recycling of electronic equipment (4), Supply-Chain-Wide EM Programs (4) and Carbon Emission Reduction (2).

In China, the parameters of assessment and management of water are limited and there are no clearly established indicators. The Water Resources Management is based upon three main aspects: meeting the basic demands on a residential and industrial level, protection of the population from possible grievances regarding public health, and promotion of strategies that assure the sustainable ecological functioning of freshwater resources (Hao et al., 2012).

Regarding the Eco-industrial parks practice, the literature highlights that there is a connection to the industrial symbiosis and to the adoption of environmental guidelines, which correspond to the expectations of the businesses that constitute the Eco-industrial parks. This practice is strongly supported by the Chinese government and has obtained significant results in the environmental protection and the resource economy. On the other hand, China faces some problems, such as low profitability, instability and the impediment to sustainable development of Eco-industrial parks by industrial chains (Qu et al., 2015a, b).

In the long term, eco-industrial parks caused some problems, such as low stability and profitability (Qu et al., 2015a, b). In the main, the establishment of environmental rules for the companies that belong to the eco-industrial parks, as well as the construction of industrial symbiosis, the diffusion of eco-industrial knowledge and the orientation for companies are considered essential strategies for the implementation and the success of eco-industrial parks (Qu et al., 2015a, b).

The Management and recycling of electronic equipment practice occurred due to the accelerated growth of the use of electronic

Table 2
Environmental management practices implemented in Chinese industries.

Total Quantity Control of Pollutants Discharged into the Sea (TQCPS)	Pollution Discharges in Sea	1	Zhao et al. (2015).
Membrane technology	Reusing Industrial Wastewater	1	Zheng et al. (2015).
Waste generation rate (WGR)	Construction waste management	1	Lu et al. (2015).
Recycling and environment-related taxes	Manufacturing	1	Wu et al. (2015).
Carbon Benefit Project (CBP)	Fossil Fuel	1	Wang et al. (2015).
Cleaner production practice	Sewage Treatment Plant	1	Zhang et al. (2015).
Eco-industrial parks	Industrial Symbiosis Sustainable development	5	Qu et al. (2015a, b); Li et al. (2014); Liu et al. (2014); Tian et al. (2014); Qu et al. (2015a, b).
Waste of electrical and electronic equipment	Electronic waste	4	Chi et al. (2011); Xu et al. (2012); Tong and Yan (2013); Li et al. (2015).
Interval fuzzy chance-constrained land-use allocation (IFCC-LUA)	Land-use planning management	1	Zhou et al. (2015).
Carbon Emission Reduction	CO_2 emission	2	Dong et al. (2014); Zhang and Wang (2014).
Sustainable management of the agro-ecosystem	Agricultural irrigation water	1	Li et al. (2014).
Reuse programs of wastewater	Water quality	1	Chen et al. (2014).
Government sustainable development national policy	National policy	1	Xi et al. (2014).
Ecological restoration	Coal industry	1	Wu et al. (2014).
Industrial Symbiosis	Iron/steel industry	1	Dong et al. (2013).
Green supply chain management	firm's performance	4	Zhu et al. (2011a, b); Liu et al. (2012); Kuei et al. (2013).
Water environment security	Water quality	6	Cai et al. (2012); Hao et al. (2012); Laghari et al. (2012); Zhang et al. (2012); Liu et al. (2013); Sun et al. (2013).
Ecological modernization theory (EMT)	Industry	1	Yee et al. (2013);
Industrial ecology of the Hai Hua Group (HHG)	Water utilization	1	Liu and Zhang (2013)
Waste Management	Building industry	1	Yu et al. (2013).
ISO 14001	National policy	1	Zhu et al. (2012).
Ecological engineering	Marine sediments	1	Huang et al. (2012).
Certification of products	Importation	1	Nyambok and Kastner (2012).

Source: Authors (2017).

devices, as well as to the manufacturer's liability for the ecologically feasible disposal of goods. In China, this environmental management practice is strongly related to the informal recycling and to regulatory requirements imposed by the legislation, which constantly spurs the debate on the challenge to improve the practice through governmental actions (Chi et al., 2011; Li et al., 2015).

The use of the Supply-Chain-Wide practice by Chinese companies is currently at early stage, mainly concerning the cooperation with external members of the distribution chain. Such environmental practice presents as indicators factors such as Regulatory, Competitor, Community, Support, Education and Training, and they are to be understood as a strategy for sustainable production, achieving a better performance on an economic, environmental, operational and social level (Liu et al., 2012; Geng et al., 2017).

Regarding the Carbon Emission Reduction practice, which aims to diminish the CO_2 emission, the chief factor that motivates Chinese companies to adopt this practice is the requirement of standards and/or of other companies who show interest in the industrial chains. At the same time, the lacking infrastructure makes it difficult to adopt this practice (Zhang and Wang, 2014).

Nevertheless, it was observed that water supply and quality, industrial symbiosis and environmental regulations, electronic waste, the relation of environmental management to the performance of companies/industries and, the emission of CO_2 were also explored in China.

As for Water Resources Management, a regulation was established at the 1992 United Nations World Conference, in Scotland. In order to reduce excessive water consumption, the Dublin Declaration set four basic principles for Water Resources Management, considering fresh water to be finite and essential for the development and the environment. Also, all agents of water consumption must be involved in its preservation. The document also highlights the importance of women in water resources management and that water ought to be regarded as an economic good (ICWE, 1992).

Given the number of studies that have been carried out covering the theme of Water Resources Management (6) in the internationally linked academic environment, China seems to be aware of the importance of water as an economic good and an essential requirement for the maintenance of life, Another widely used environmental management practice in China are eco-industrial parks (5). Given the Chinese government's support to create the eco-industrial parks, this area of study of industrial ecology receives significant attention (Tian et al., 2014).

In relation to the management and recycling of electronic equipment (4), the use of this practice of environmental management is associated with the fact that China is an important producer of electronic devices, which demands an evolution in the treatment of electronic waste (Tong and Yan, 2013). In this way, it is possible that the country will be engaged in order to solve this problem, tending to boost the research related to the subject.

With the number of occurrences similar to the abovementioned environmental management practice, Green supply chain management (GSCM) (4) also had a recurrence of studies in Chinese industries. They indicate that the implementation of GSCM in Chinese companies is still in the preliminary phase, but the success of the practice is associated with the efficient environmental management and the improvement of the company's overall performance (Liu et al., 2012; Kuei et al., 2013).

Finally, China also pays relative attention to the environmental management practice Carbon Emission Reduction (2). The emission of CO_2 has been widely discussed due to its intense damages to the environment. In China, there is a difficulty in adjusting to rapid industrialization and economic growth with low carbonization, and there is little room for collaboration between companies to reduce CO_2 emissions. Notwithstanding, high CO_2 emission values could be reduced with appropriate strategies (Dong et al., 2014; Zhang and Wang, 2014).

With regard to the research carried out in industries in India, 21 articles covering the theme of environmental management in industry were found, none of which were excluded. However, an article was replicated with the research carried out in Brazil.

Table 3 presents the practices of environmental management carried out in India, the frequency in which they appeared in the industries and the demand that the practice of management aims to solve.

The environmental management practices carried out in India include GSCM (4), water resources management (3) and ISO 14001 (3). In this context, Green Supply Chain Management has been explored in the supply chain, industry and manufacturing. The management of water resources is related to water supply and quality, whereas ISO 14001 is linked to the management of sustainable supply chain and pharmaceutical industry.

As to the Green Supply Chain Management practice, which has been developed as a consequence of production processes, it is to be noted that although its unfolding is stronger in developed countries, it is also accelerated in developing countries. Moreover, this environmental management practice proposes the constitution of an ecological supply chain, without affecting the company's institutional goals, and can also be employed onto all industries (Mathiyazhagan et al., 2015; Soda et al., 2015; Nasir et al., 2017).

Table 3
Environmental management practices implemented in industries in India.

ISO 14000 and 14001	Sustainable supply chain management, Pharmaceutical industry	3	Jayaraman et al. (2012); Bindal and Dwivedi (2013); Jia et al. (2015).
Environmental management	Environmental management	2	Chen et al. (2015); Sen et al. (2015).
Green Supply Chain Management and Supply Chain Management Green	Distribution chain, Industry and manufacturing	4	Soda et al. (2015); Mathiyazhagan et al. (2015); Koh et al. (2012); Al Zaabi et al. (2013).
Eco-innovation	Manufacturing	1	Ganapathy et al. (2014).
Reverse logistics	electronic waste	1	Ravi and Shankar (2014).
Corporate Self-reporting	Tourism industry	1	Ferus-Comelo (2014).
Waste Management	Industrial symbiosis	1	Liao and Ma (2013).
Management practices of handling coal combustion residue	combustion residue	1	Singh et al. (2012).
Management water resource	Water quality	3	Chakraborti et al. (2011); Rai (2011); Laghari et al. (2012).
Environmental audit	Distillery	1	Rao et al. (2012).
Cleaner production practice	Market carbon	1	Hultman et al. (2012).
Demand side management	Electricity	1	Mayakrishnan (2011).
Waste electrical and electronic equipment	Waste electronic	1	Townsend (2011).

Source: Authors (2017)

Specifically in India's case, the adoption of Green Supply Chain Management occurred due to vehicular pollution and the need to convey an image of a sustainable company to the society. This practice has been adopted by mineral and mining industries, as well as by small enterprises and/or multinationals (Mathiyazhagan et al., 2015).

The interest in the Management of water resources practice arose based upon the fact that water availability will be reduced and that the development of long-term strategies on demand management, recycling, conservation and better water management practices. This environmental management practice covers the water supply management, including reservoir management, control of water quality, the use of alternative hydric resources, projects on land use and soil conservation, as well as the management of water supply, the modernization of existing infrastructure, the increase of water productivity for agriculture, the introduction of economic instruments and the limits on post-crop water (Rai, 2011; Laghari et al., 2012).

The practice includes ISO 14001, which concerns an international environmental management certification and is regarded as essential to improve the sustainable performance in industries in India, both in the mining and pharmaceutical industries (Bindal and Dwivedi, 2013; Jia et al., 2015).

While some companies in India are enthusiastic about the practice due to their potential to drive economic gains, the same does not occur in the majority of the companies (Soda et al., 2015).

Another practice of environmental management addressed in China and India was the management of water resources (3). In India, in order to meet the growing demand for water, local government invests in water supply solutions, but there is a need for improvement in water supply and wastewater management (Rai, 2011). Therefore, the management of water resources in India still has potential for expansion.

Unlike the previous context, ISO 14001 (3) was not widely approached in Chinese academia. However, studies in India point out that environmental management strategies based on ISO 14001 improve the overall environmental performance of pharmaceutical industries (Bindal and Dwivedi, 2013). It is assumed, at least preliminarily, that the environmental management in India has been giving more attention to ISO 14001 than the one in China.

With regard to the application of environmental management practices in companies in Brazil, this research identified 17 articles concerning the topic. Out of these, five articles were excluded because they did not specifically address an environmental management practice. In addition, as stated earlier, an article was replicated with research conducted in the academic setting of India. However, as it is a recurrent practice for the two countries, the article was analyzed for both India and Brazil. Table 4 presents the environmental management practices conducted by Brazilian industries, the frequency in which they appeared in the industries and the demand that the management practice aims to solve.

It should be noted that the most frequent environmental management practices in Brazil's industries are reverse logistics linked to recycling (2), environmental policies (2) and waste management (2). Directly or indirectly, all practices of environmental management are associated with recycling.

Reverse logistics refers to a wide research area tied to sustainable logistics, which is underpinned by economically efficient logistics, socially responsible logistics and green logistics. It is worth noting that on account of the social and economic conditions, reverse logistics in Brazil is associated with recycling and show a lack of information technology, facilities, stock control, outsourcing and performance measurement (Bouzon et al., 2014).

The Environmental regulation practice aims to establish an innovative environmental licensing model that bolsters the environmental performance of industries, thus contributing to the feasibility of an increase in environmental quality, with low economic, social and political costs (Ribeiro and Kruglianskas, 2013).

Regarding Waste management in Brazil, this practice has been promoted through informal recycling on the part of waste collectors due to economic, social and environmental benefits. In the state of São Paulo, the results of this practice show an increase of the recycled volume from 140 tons to 208 tons in one month. With the calculated cost of US$ 35/ton, it remains below the national average cost, US$ 195.26/ton (Rutkowski and Rutkowski, 2015).

This scenario is justified by the premise that reverse logistics in Brazil is closely associated with recycling, which is caused by social and economic conditions in specific industrial sectors, as well as due to the fact that Brazil is one of the largest consumers of PET bottles (Coelho et al., 2011; Bouzon et al., 2014). As for recycling, there is a need for cooperation between the industrial sectors and the government, as well as for the development of public policies directed to this problem (Coelho et al., 2011).

With regard to the industries of South Africa, the present research evidenced only two papers that cover the topic of environmental management in practice. Both articles were considered for the analysis, since they refer to a specific environmental management practice. Table 5 presents the environmental management practices adopted in South Africa, the frequency in which they appeared in the industries and the demand that the management practice aims to solve.

Only two environmental management practices were highlighted in South Africa's industries, with the Sustainable Food System (1) and the Coupled-carbon Fire Model (1). Therefore, the demands addressed were, respectively, sustainable food and fire season.

The practice of Sustainable Food System in South Africa, responsible for expanding agribusiness among African countries, has a well-established agri-food sector. However, there is a need and pressure for the country to adapt to sustainable development.

Table 4
Environmental management practices implemented in industries in Brazil.

Ethanol production	Emission Greenhouse gases (GHG)	1	Filoso et al. (2015).
Green Supply Chain Management and Supply Chain Management Green	cleaner production	1	Jabbour et al. (2015).
Waste management	Oil spill management, recycling.	2	Oliveira et al. (2013); Rutkowski and Rutkowski (2015)
Reverse logistics	Recycling	2	Coelho et al. (2011); Bouzon et al. (2014).
Green Teams	Environmental Management	1	Jabbour et al. (2013).
Environmental Management System	Environmental Management	1	Ferrer et al. (2012);
Environmental regulations	Environmental policy	2	Cohn and O'Rourke (2011); Ribeiro and Kruglianskas (2013).
Cleaner production practices	market carbon	1	Hultman et al. (2012).
Integrating toxicity testing Vibrio fischery	Wastewater	1	Rodrigues and Umbuzeiro (2011).

Source: Authors (2017)

Table 5
Environmental management practices implemented in industries in South Africa.

Environmental Management Practices	Demand	Frequency	Authors
Food system sustainable	Food Chain	1	Pereira (2013).
Coupled-carbon-fire model	Fire season and CO_2 emission	1	Kloster et al. (2012).

Source: Authors (2017)

This environmental management practice is a complex process and covers several factors, hence it is fundamental to align the economic factors with the social and environmental ones (Pereira, 2013). In this way, the premise of South Africa presents in the agri-food sector is aligned with the use of the sustainable food system.

The coupled fire-carbon model was applied in order to understand how climate change influences the number of fires by CO_2 emission (Kloster et al., 2012). The authors investigated the influence of CO_2 emissions worldwide, not only addressing the problem of South Africa, and concluded that South America had the highest number of fire emissions, while North America also contributed significantly to global fire carbon emissions.

In Russia's case, no environmental management practices applied in the industries were found in the present methodology. Even though the country has an emerging economy that needs natural resources, such as oil and mining, sustainable development and environmental management practices have not been discussed and published in academia, leading to the assumption that the Russian industry has not felt the need to adopt them on a large scale in the productive sector.

Although in many of the BRICS countries the research on environmental management practices is related to specific demands and gaps of a given region or country, it is possible to report some trends.

Table 6 presents the environmental management practices that were applied in the industries of more than one BRICS country.

In terms of the CO_2 emission, Dai et al. (2016) emphasize that, from 1995 to 2014, China was the BRICS country with the highest rates and showed the fastest annual growth speed of CO_2 per capita. In second place was India, followed by Brazil and South Africa. All countries showed high CO_2 emission rates.

Among the strategies that could facilitate the Carbon Emission Reduction practice are the corporative collaboration and, above all, the Industrial Symbiosis, due to the recycling of plastic residues, of tires and the "recycling of fly ash" (Dong et al., 2014; Zhang and Wang, 2014).

The aforementioned context explains the fact that in all BRICS countries that applied environmental management practices in the industry, an elevated CO_2 emission was directly or indirectly evinced. According to Ozturk (2015), the countries turned their attention to the improvement of economic infrastructure, instead of an effective reduction of CO_2 rates.

Directly, China seeks to reduce CO_2 emissions through the practice of low carbon environmental management. In an indirect way, CO_2 emission was addressed in Brazil and India in order to achieve carbon utilization through the practice of a clean development mechanism. Finally, the study in South Africa is not only related to specific problems of its country, but rather addressed the climate change that the emission of CO_2 has caused over the years on a global scale.

In addition, the indicated trend among emerging countries is not an abnormality, given the damages caused by the CO_2 emission to the environment and the adhesion of these countries to the Kyoto Protocol, which attempts a collective effort for the reduction of greenhouse gases (United Nations, 1998).

Another recurring theme of environmental management in emerging countries was the quality and water supply, which was addressed in the Chinese, Indian and Brazilian researches. In a general context, the constant interest in water quality is explained by the premise that shortage of energy and especially water resources jeopardize food safety in these nations, especially in China and India, the most populous countries in the world (Ozturk, 2015).

In China and India, the environmental management practice mentioned was water resource management, water supply and water quality. In Brazil, the focus was on residual water, using the acute toxicity test of Vibrio fishery (Rodrigues and Umbuzeiro, 2011).

The researches that dealt with this theme indicated that the establishment of Water Resources Management indicators consider the participation of experts and are therefore constantly reviewed. Furthermore, a system of indicators ought to be compiled in order to restrict the scope of the indicators by means of relevant data and literature. An identification of the main polluting agents and their frequency in the environment, as well as the recognition of the local characteristics concerning the disposal of pollutants ought to be carried out (Hao et al., 2012). Consequently, these strategies facilitate and improve the water safety work.

The surveys carried out in other studies point out that there are other factors that may potentially compromise the water quality, such as the agricultural use of soil and livestock, domestic consumption and the disposal of domestic garbage, sewage and solid residues. The domestic consumption impacts on a greater scale on surface waters. Important factors for the maintenance of a good water quality are the topographical regions of hydrographic basins, better in mountain or flat regions. The quality of water improves if there is the implementation of control policies for the environmental pollution (Liu et al., 2013; Sun et al., 2013).

In the particular case of India and China, the Indu Basin deserves attention. It is projected that there will be a reduction of the water resources in this region in the long-term, given that there is a demand for domestic, industrial and irrigation purposes. Hence, it is

Table 6
Themes addressed in environmental management practices implemented in industries in BRICS.

Themes addressed in environmental management practices	Brazil	Russia	India	China	South Africa
CO_2 emission	Cleaner production practices (1)	–	Cleaner production practices (1)	Carbon Emission Reduction (2)	Coupled-carbon-fire model (1)
Water Quality	Integrating toxicity testing Vibrio fishery (1)	–	Management of water resource (3)	Management of water resource (6)	–

Source: Authors (2017)

necessary to approach the implementation of the artificial storage of underground water and the management of groundwater, as well as the expansion of investments in water quality, recycling of wastewater, and the planning of use and conservation of soil (Laghari et al., 2012). In addition, another study shows that, in order to solve the problems concerning Water Resources Management, the decision-making strategies should take the potential of reduction of pollution into account, going beyond the monetary costs (Liu et al., 2013). These findings, which refer to Chinese and Indian contexts, may also be reproduced in the other countries of the bloc.

Concern over water in Brazil may have been less justified by the fact that the country has 12% of the world's freshwater in its territory. However, because it is a finite resource, there is a need to perpetuate the resource for life and development (ICWE, 1992).

In the case of South Africa, although no researches on water resources during the investigated (2011–2015) period have been found, Razzaque and Kleingeld (2013) emphasize the necessity to implement the Integrated Water Resource Management as a development perspective. If this practice gains in importance amongst the managers and becomes entrenched by the public awareness, it may lead to improvements in social and environmental issues in the country.

Public policies to promote environmental management have been addressed in China, India and Brazil, either through local regulations or ISO 14001. This scenario highlights the importance of interaction between government and industry for the implementation of environmental management, as stated by Coelho et al. (2011), as well as the need for norms to regulate this procedure.

Regarding environmental management practices, Green Supply Chain Management stood out in China, India and Brazil. However, different contexts were observed in these three countries. In China, Green Supply Chain Management focused on its relationship with company performance. In India, this practice of environmental management was addressed in the terms of the supply chain, manufacturing and industries, while in Brazil, Green Supply Chain Management was related to cleaner production. This indicates that the environmental management practice is diverse and can be used in different contexts.

In a similar manner, waste management was present in researches in China, India and Brazil, respectively with the demands of civil construction, industrial symbiosis and recycling. It is worth mentioning that the demand for recycling has been discussed in China and Brazil, but has not received academic attention in India. Nevertheless, it is emphasized that industrial symbiosis and electronic waste management were addressed in China and India, but are still little explored in Brazil.

Also, China is the country with the greatest number and diversity of research related to environmental management. However it should be noted that India and Brazil also have published some academic research focused on this subject.

Through the conducted methodology, Russia did not show any environmental management practices applied in the industry, and only two surveys with this approach could be found for South Africa, indicating that these countries have not given much attention to this issue. Several studies stress the economic importance of some environmental management practices (Bindal and Dwivedi, 2013; Kuei et al., 2013; Soda et al., 2015), but tend to neglect the environmental aspect of these management practices which cause local industries to become less competitive and lead to the country's failure to comply with the Kyoto Protocol (United Nations, 1998).

Although the outlook shows a higher negligence on the part of Russia and South Africa in terms of environmental management, Shen et al. (2017) suggest that all BRICS countries have not given the proper attention to sustainability, but rather effectively prioritize the economic growth. From the point of view of sustainable development, this demands an effective change in this scenario.

In short, the results indicate that China, India and Brazil brought out a greater number of academic publications concerning Environmental Management Practices. China turns its attention mostly to Water Resources of Environmental Management, suggesting a concern with the demand of industrial water and the population's domestic consumption. Brazilian researches turned their attention to Reverse Logistics – mainly recycling-oriented and often spurred by poor families as source of income. India concentrates its attention to Green Supply Chain Management of Environmental Management, mainly due to the vehicular pollution.

It is also to be highlighted that the number of researches concerning South Africa and Russia was lower. Regarding South Africa, the researches addressed the Sustainable Food System, a practice that was not covered in the other countries and that is closely related to the development of local agribusiness and Fire-coupled, thus going towards the worldwide concern regarding the CO_2 emission. Russia did not publish articles during the examined period.

Now, after the outline of the results and the discussion, we shall present the conclusions of the present research.

4. Concluding remarks

The study aimed to analyze the environmental management practices carried out in the industries of Brazil, Russia, India, China and South Africa within the period from 2011 to 2015 by studying the scientific literature published in the Scopus database.

Environmental management in the industry research required major academic attention in China. In general, the researches in the country address water management practices (6), eco-industrial parks (5), management and recycling of electronic equipment (4), GSCM (4) and Carbon Emission Reduction (2).

In India, the country with the second largest number of relevant studies, the investigations addressed GSCM (4), water resources management (3) and ISO 14001 (3) as a priority. In a similar manner, with significant attention to environmental management, Brazilian research mostly deals with waste management (2) and Reverse logistics linked to recycling (2).

However, in South Africa, only two environmental management practices were found: the Sustainable Food System (1) and the Fire-coupled Model (1).

Nevertheless, Russia did not bring out any studies related to environmental management in industry, which indicates, as in the case of South Africa, a low attention to the discussed topic.

There was also a trend among emerging countries to seek solutions to CO_2 emissions, as this issue was addressed by China, India, South Africa and Brazil. Nonetheless, other recurring themes among these countries were the supply and quality of water and environmental management standards. Nevertheless, in each country, these issues were addressed through different environmental management practices.

Regarding the regulatory norms of environmental management practices, the evident importance of the public policies directed to the promotion of sustainable development is highlighted. Thus, the relation between this premise and the low incidence of academic studies on environmental management in industry in Russia and South Africa brings forth a possible lack of strategies of the governments, which propagates the negligence of academic interest pertinent to this issue.

Due to cultural, geographical and economic differences, some demands regarding environmental management may be a priority in one country, but not in another. Still, the present article reflected

on the use of similar environmental management practices among the BRICS countries and the ones that were neglected by these countries.

It may be concluded that the Chinese researches produced more results, specially with regard to Water Resources Management, stressing the need of technologies and the implementation of policies to control the environmental pollution. Besides that, the studies suggest that the endorsement of Industrial Symbiosis and the collaboration among companies is fundamental to reduce the CO_2 emission. These contributions are useful for businesses, as well as for academic discussions.

Regarding the neglected practices, the disposal of electronic residues ought to be highlighted. China and India brought forth some researches, whereas the other countries overlooked this theme. This tends to be a common problem among the BRICS countries and shall be sooner of later explored.

The management of companies in the BRICS countries may take into account the strategies that have already been adopted by other countries and take action accordingly. Moreover, the academia can identify some gaps in the area, such as the establishment of indicators for Water Resources Management, as well as in-depth researches concerning eco-industrial parks, the assessment of the technology for the treatment of wastewater. All of this in order to ascertain the cost-benefits and the effects of the environmental management practices in the mid and long term.

China, India and Brazil tend to present a greater number of articles about the environmental management practices, which may be explained due to their more sustainable development. China and India occupy superior positions in the 2014 Inclusive Wealth Report (IWR), if compared with the other BRICS countries (United Nations, 2014). The greater number of actions and the greater local interest spurred the number of researches in the area. In turn, Russia showed the worst environmental performance and the lowest number of articles, which may indicate that the theme has still not been given proper attention by the academia.

In light of the described scenario, Brazil's and South Africa's positions in the IWR oscillated: while Brazil was at the front in 2012, South Africa occupied this position in 2014. The deviation score was low, though. Accordingly, it is clear that Brazil does not follow the ground rule: many articles in the area were published, but the country still presents a low sustainable development rate.

It is worth mentioning that the sustainable development, which is closely related to the environmental management practices, was discussed during the 2017 BRICS Business Forum, which took place in Xiamen (China), which shows that the issue is of great importance for the countries. The political interest in this theme is supposed to increase the number of scientific researches concerning the issue within the next years.

It is emphasized that the employed methodology also has its limitations, since the search parameters can be altered, for example: (i) the research period; (ii) the use of other databases. This can bring out new results for Russia and South Africa, as well as an expansion of the possible results of the other countries could be achieved; (iii) the publications source language. In the scope of the present article, English was the chosen language due to its status as *lingua franca*, but can also overlook local researches in other languages.

It is suggested for future studies to extend the comparisons regarding environmental management practices with other emerging countries which were not included in the present study. Another suggestion is to verify the trends in environmental management practices in developing countries, which would allow a comparison between the group of emerging countries and the group of developed countries.

In conclusion, it should be pointed out that the present study fulfilled the objective of analyzing the environmental management practices carried out in industry in the emerging countries, evidencing a divergent scenario among BRICS members. While China, India and Brazil have given relative attention to the subject, Russia and South Africa have not yet presented many studies (in English language) on this topic.

Having outlined the conclusions, the references used during the research's theoretical background and the discussion shall be registered next.

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