# ARTICLES

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# FACTORS RELATED TO THE MATURITY OF ENVIRONMENTAL MANAGEMENT SYSTEMS AMONG BRAZILIAN INDUSTRIAL COMPANIES

## *Fatores relacionados com a maturidade dos Sistemas de Gestão Ambiental de empresas industriais brasileiras*

## *Factores relacionados con la madurez del sistemas de Gestión Ambiental de Empresas industriales brasileñas*

**BLÊNIO CEZAR SEVERO PEIXE**[1]
**bleniocsp@gmail.com**
ORCID: 0000-0001-8271-0628

**ANDRÉA CRISTINA TRIERWEILLER**[2]
**andrea.ct@ufsc.br**
ORCID: 0000-0002-9435-8083

**ANTONIO CEZAR BORNIA**[3]
**cezar.bornia@gmail.com**
ORCID: 0000-0003-3468-7536

**RAFAEL TEZZA**[4]
**rafaeltezza@yahoo.com.br**
ORCID: 0000-0002-6539-4608

**LUCILA MARIA DE SOUZA CAMPOS**[3]
**lucila.campos@ufsc.br**
ORCID: 0000-0002-1610-7617

[1]Universidade Federal do Paraná, Departamento de Ciências Contábeis, Curitiba, PR, Brazil

[2]Universidade Federal de Santa Catarina, Araranguá, SC, Brazil

[3]Universidade Federal de Santa Catarina, Departamento de Engenharia de Produção, Florianópolis, SC, Brazil

[4]Universidade do Estado de Santa Catarina, Escola Superior de Administração e Gerência, Florianópolis, SC, Brazil

## ABSTRACT

This study evaluates the factors that have a significant relationship to the level of maturity of the Environmental Management Systems (EMS) among Brazilian industrial companies, using a multiple linear regression model. The variables consider the respondents' characteristics, their categories, and other dummy variables. The results, in ascending order of their influence on the EMS maturity level, were possessing ISO 14001 certification, participation in the carbon market, disclosing information in reports (environmental disclosure), having a project to reduce water consumption, having a professional management model, having insurance against environmental accidents, company age, operating in the textile sector, and the legal constitution of the company Ltda.

**KEYWORDS** | Environmental Management System, environmental disclosure, environmental maturity, ISO 14001 certification, Brazilian industrial companies.

## *RESUMO*

*O objetivo do artigo foi avaliar os fatores que apresentaram relação significante com o nível de maturidade dos Sistemas de Gestão Ambiental (SGA) de empresas industriais brasileiras, por meio de um modelo de regressão linear múltipla. Considerando as características dos respondentes, chegou-se às variáveis, suas categorias e variáveis dummy decorrentes do estudo. Os resultados, pela ordem dos fatores relacionados que influenciam o nível de maturidade dos SGA, foram: a empresa possuir certificação ISO 14001; possuir participação no mercado de carbono; divulgar suas informações em relatórios (disclosure ambiental); possuir projeto para redução do consumo de água; possuir modelo de gestão profissional; possuir seguro relacionado a acidentes ambientais; idade da empresa; atuar no setor têxtil; e a constituição jurídica da empresa ltda.*

***PALAVRAS-CHAVE*** */ Sistemas de Gestão Ambiental, disclosure ambiental, maturidade ambiental, certificação ISO 14001, empresas industrias brasileiras.*

## *RESUMEN*

*El objetivo del artículo fue evaluar los factores que presentaron relación significante con el "nivel de madurez del Sistemas de Gestión Ambiental (SGA)" de empresas industriales de Brasil, por medio de un modelo de regresión lineal múltiple. Considerando las características de los encuestados, se llegó a las variables, sus categorías y variables resultantes del estudio. Los resultados, por el orden de los factores relacionados que influencian el "nivel de madurez del SGA" fueron: poseer certificación ISO 14001; participación en el mercado de carbono; divulgar informes (divulgación ambiental); poseer un proyecto para reducir el consumo de agua; tener un modelo de gestión profesional; tener seguro relacionado con accidentes ambientales; edad de la empresa; en el sector textil y la constitución jurídica de la empresa Ltda.*

***PALABRAS-CLAVE*** */ Sistemas de Gestión Ambiental, divulgación ambiental, madurez ambiental, certificación ISO 1400, empresas industriales de Brasil.*




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# INTRODUCTION

Climate change and environmental degradation, evidenced by the constant loss of biodiversity, are pressuring companies to adopt environmental management practices (Boiral, 2006; Jabbour, Jabbour, Teixeira, & Freitas, 2012). Perez, Ribeiro, Cunha, and Rezende (2008) noted that the search for strategies to revert or mitigate the consequences of global warming, which arises from climate change, led to discussions and actions aimed at reducing gas emissions, *e.g.*, the Kyoto Protocol and the carbon market.

Environmental Management Systems (EMS) cover a wide range of aspects and principles, with implications on strategic environmental policies and quality control systems of modern companies; they act as a competitive strategy in the information integration plan (Alperstedt, Quintella, & Souza, 2010; Boiral & Henri, 2012; Rodríguez, Alegre, & Martínez, 2011). Business management identifies, controls, evaluates, monitors, and seeks to reduce environmental impact to acceptable levels (Balzarova & Castka, 2008). In addition, significant advances in EMS are among the factors that result in investigations to determine the requirements of different organizations and their desire to achieve results and EMS compliance (Stevens, Batty, Longhurst, & Drew, 2012).

In this line of research, the environmental maturity of companies is associated with the EMS level or evolution stage (Jabbour, 2015). Assessing the maturity level in relation to each associated factor enables identifying possible improvements in different areas of the company (Fischer, Jan-Hendrik, Pfeiffer, Hellingrath, Scavarda, & Roberto, 2014).

The factors listed in this article will be analyzed in terms of their relationship with the EMS maturity level. Peixe (2014) developed a scale to measure the EMS maturity level of industrial companies using the Graded Response Model (GRM) of the Item Response Theory (IRT). Thus, the following factors may be associated with EMS maturity level: company age, sector of activity, management model, legal constitution, disclosure of information via reports (environmental disclosure), ISO 14001 certification, project to reduce water consumption, project to reduce energy consumption, project to reduce the consumption of raw material, insurance against environmental accidents and participation in the carbon market.

However, the research gap in this context leads to a problem. Which factors are associated with the EMS maturity level of industrial companies in Brazil? Therefore, the objective of this study was to evaluate significant factors in the EMS maturity level of industrial companies in Brazil. The variables, their categories, and resulting dummy variables were obtained using a multiple linear regression model to assess these factors, considering the characteristics of the respondents.

This study investigates these factors to bridge a research gap, considering corporate sustainability, and compensation to companies in environmental disclosure shared with stakeholders (Castka & Prajogo, 2013; Fonseca, 2015; Marimon, Casadesús, & Heras, 2010). Moreover, the EMS adds important benefits to several sectors, validating the environmental quality policy for products and services offered to consumers and society (Castka & Prajogo, 2013; Marimon, Llach, & Bernardo, 2011).

We now present the theoretical framework, methods, analysis, discussion of the results, and lastly, the final considerations.

# THEORETICAL FRAMEWORK

## Environmental management system

Studies on EMS are important because they comprise requirements and aspects of corporate sustainability of organizations in recent years (Zobel, 2013). A company that adopts an EMS demonstrates proactivity and considers environmental issues in its decision-making process (Boiral, 2006; González-Benito & González-Benito, 2006; Halila & Tell, 2013).

The strategic approach to environmental issues by implementing the requirements of ISO 14001 defines a company's environmental policy, plans, and actions (Corazza, 2016; To & Lee, 2014). Another strategic approach is a comparative analysis of the intensity of major nations in diffusing ISO 14001, per sector of activity (Marimon et al., 2010; Marimon et al., 2011). Thus, this certification has proven to be fundamental, because of its direct relationship with image, compliance, and prevention of environmental incidents, considering its strategic scope or worldwide dissemination (Singh, Jain, & Sharma, 2015).

The EMS is a complex process, often with a great impact on business activity. Its adoption suggests that the company recognizes the importance of environmental excellence in business, which may lead to new opportunities, rather than as a limiting factor for performance and profitability (Halila & Tell, 2013). After all, the demands of stakeholders and market globalization, among other factors, led to the consideration of quality control systems and EMS as a part of competitive strategy (Alperstedt et al., 2010; Rodríguez et al., 2011).

The maturity of EMS, based on ISO 14001 and other factors, can lead to effective control of environmental aspects, principles, and impacts, improving the environmental maturity levels of the company, and acting as an improved tool for sustainability (Fonseca, 2015; Marimon et al., 2011).




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## Maturity of environmental management systems

"Maturity" primarily refers to mastering managerial processes over time (effectiveness), performance, and efficient resource management (Trierweiller et al., 2012). Maturity models predict structures for systematic and continuous evaluation, allowing companies to compare their processes with the best practices, including those of its competitors, *i.e.*, the greater the maturity of its management systems, the better a company's performance.

The use of environmental (e.g. energy and water consumption), human and organizational resources (workforce qualification, training, and organizational culture) may influence a company's environmental performance, and consequently, its environmental maturity (Jabbour, 2015; Melnyk, Sroufe, & Calantone, 2003). This is evidenced by the awareness of employees and organizations to reduce the consumption of natural resources by modernizing equipment and processes, among other factors (Oliveira, & Serra, 2010; Oliveira, Serra, & Salgado, 2010).

Maturity models applied to the environmental sector are developed in stages, levels, or evolutionary phases, from the initial moment of mere existence to the most advanced levels, when there is dominance and leadership in management activity. EMS maturity is presented under different names through a *continuum*, from reactive to passive models, and from preventive to active and proactive models (Haddock-Freser & Tourelle, 2010; Jabbour., Teixeira., Oliveira, & Soubihia 2010; Jabbour 2015; Jabbour & Jabbour, 2009; Ormazabal & Sarriegi, 2014). Thus, EMS models are evolutionary, from early incipience to achieving a high level of maturity (Okongwu, Morimoto, & Lauras, 2013; Ormazabal & Sarriegi, 2014). Costa and Rosa (2017) ranked business competence in evolutionary stages, from inexperience to full mastery.

Peixe (2014) defined six maturity levels: (1) Reactive Initiative (Real), (2) Reactive (Rea), (3) Preventive Initiative (Prevl), (4) Preventive (Prev), (5) Proactive Initiative (Proal) and (6) Proactive (Proa), developing a scale to measure the EMS maturity level of industrial companies using IRT. To do so, Peixe (2014) used an instrument composed of 55 items (Exhibitions 1 to 5). The instrument was sent to medium and large companies (with more than 100 employees) affiliated to the Industry Federation. The information was collected using an online survey. The companies were contacted by email and telephone. In addition, a workshop was held in companies affiliated to the Industry Federation.

The companies tasked their employees in the environmental division to take the survey using the link or send their responses in a Word file via email. The instrument was sent to 2,994 companies and yielded 354 responses from the following complexes of economic activity: agro-industrial; metallurgical, mechanical and electro-electronic, textile, mineral, forestry, technological, chemical, civil construction, and energy (Peixe, 2014).

The parameters were estimated using the Maximum Marginal Likelihood (MML) available in the Multilog software (Thissen, Chen, & Bock, 2003), and a *z* scale (zero mean and standard deviation) was created, to measure the EMS maturity level. The maturity level was estimated using the Bayesian expected a posteriori (EAP) procedure, and the Gradual Response Model of the IRT, creating a *z* scale, considering the items in Exhibits 1 to 5.

Exhibit 1. **Environmental policy (EP)**

| | |
|---|---|
| 1 | The company considers EP in its strategic planning |
| 2 | The company considers the environmental risks related to its operation in the process of designing its EP |
| 3 | The company considers whether the competitors are certified or have an EMS when analyzing the EP scenario in its strategic planning |
| 4 | There is a person responsible for developing and implementing the EP in the company |
| 5 | The company has an adequate structure (location, computerized system, and equipment) to conduct the process of EP implementation |
| 6 | The company defines financial resources to implement EP |
| 7 | The company periodically identifies the environmental legislation applicable to its activities, products, and services |
| 8 | The company considers competition in the process and design of its EP |
| 9 | The company considers the funding bodies in the process and design of its EP |
| 10 | The company considers the certifying bodies in the process and design of its EP |

Source: Peixe (2014).

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## Exhibit 2. Planning (plan)

| | |
|---|---|
| 11 | When defining objectives and targets, the company takes into account the opinion of the stakeholders |
| 12 | In defining objectives and goals, the company includes technological changes |
| 13 | In defining objectives and goals, the company includes changes and revisions of the environmental legislation |
| 14 | In defining objectives and goals, the company includes information on its public image regarding the environment |
| 15 | The programs foresee the reduction in the consumption of water, energy, raw material, and volume of waste |
| 16 | The company defines resources (human, financial, technological, and material) compatible with the goals and objectives for implementing EMS programs |
| 17 | The company defines who is responsible for implementing the programs aligned to achieve the goals and objectives |
| 18 | In planning, the company considers investment forecasts for research and development in the EP area |
| 19 | The company defines the indicators to monitor and evaluate the fulfillment of environmental objectives and goals |

Source: Peixe (2014).

## Exhibit 3. Implementation and operation (Do)

| | |
|---|---|
| 20 | The company considers whether resources (material, financial, human, and technological) are used efficiently to implement EMS programs |
| 21 | The company has a plan to make employees aware of the importance of the EMS |
| 22 | The company's employees receive training to operate according to the EMS |
| 23 | The company has a structured communication plan to disclose its environmental actions to internal and external opinion makers |
| 24 | The company documents the actions carried out annually on the EP |
| 25 | The company adopts procedures to control its operational activities that may cause changes to the environment |
| 26 | The company performs procedures to identify, prevent, and respond to environmental risks, and posts the procedures in areas of the company |
| 27 | The company works to adjust its products for clean production |
| 28 | The company adopts cleaner production in its operations |
| 29 | The company adopts the concept of the Brazilian solid waste policy of Law no. 12.305/2010 (return, recycling, reuse, and reprocessing) |
| 30 | The company adopts recycling programs |
| 31 | The company maintains procedures to monitor the results of its operations that may cause changes in the environment |

Source: Peixe (2014).




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## Exhibit 4. Verification and corrective action (Check)

| | |
|---|---|
| 32 | The company periodically checks the non-compliance reports to implement preventive and corrective actions |
| 33 | The company conducts diagnosis for preventive and corrective actions by accredited bodies |
| 34 | The company carries out compensatory actions to recover degraded areas |
| 35 | There are procedures for verifying the effectiveness of preventive actions in the company |
| 36 | There are procedures for verifying the effectiveness of corrective actions in the company |
| 37 | The impacts, costs, and risks associated with non-compliance with the EMS are assessed |
| 38 | The company has an environmental audit structure to check for EMS compliance |
| 39 | The company can measure financial gains from environmental practices |
| 40 | The company uses indicators to assess compliance and non-compliance of preventive and corrective actions |
| 41 | The company uses indicators to monitor EMS implementation |

Source: Peixe (2014).

## Exhibit 5. Exhibit 5 Continuous improvement (Act)

| | |
|---|---|
| 42 | The company holds periodic meetings to map the strengths and weaknesses identified in the EMS |
| 43 | The company analyzes threats and opportunities related to the environmental policy |
| 44 | The company analyzes threats and opportunities related to the stakeholders of the organization |
| 45 | The company analyzes threats and opportunities in response to changing technologies |
| 46 | The company analyzes threats and opportunities that arise in the development of new products and services |
| 47 | The company checks the EM for significant aspects beneficial to understanding and creating competitive advantage |
| 48 | There are persons responsible for verifying and periodically reviewing environmental aspects and impacts |
| 49 | Periodic analysis is conducted to define continuous improvement in the EM |
| 50 | Periodic analysis is conducted to identify the most critical areas related to the EM |
| 51 | The company develops activities for raising the awareness of employees in the designing and adoption of cleaner processes |
| 52 | The company conducts a general EP analysis and indicates paths for future steps |
| 53 | Within the approach of continuous improvement, the company prioritizes areas with environmental risk |
| 54 | The company uses the consolidation of indicators to issue a general diagnosis of the EM aligned with its EP |
| 55 | The company's suppliers are selected following the criteria of good environmental practices |

Source: Peixe (2014).




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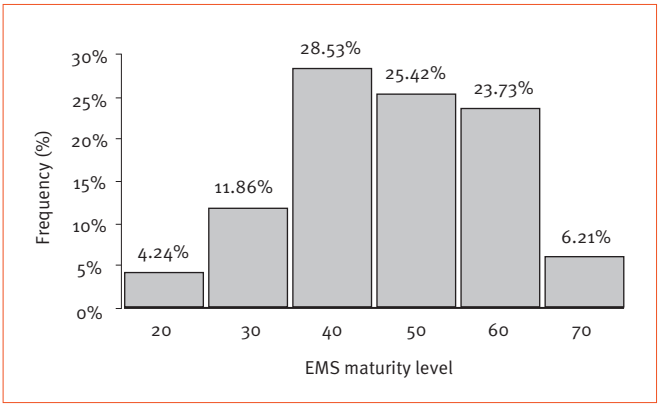
For ease of understanding, Figure 1 shows the EMS maturity level of the respondent companies as a latent trait, considering the conversion of the *z*-transformed scale to one with mean and standard deviation of 50 and 10, respectively.

Figure 1. **Maturity level of the environmental management systems (EMS)**




Source: Peixe (2014).

The histogram (Figure 1) shows the EMS maturity level in the converted scale, considering the levels 20 (4.24% of the companies), 30 (11.86%), 40 (28.53%), 50 (25.42%), 60 (23.73%), and 70 (6.21%), of companies that took the survey.

## Factors associated with the maturity of environmental management systems

Several factors are associated with EMS maturity. The most obvious seems to be an ISO 14001 certification. However, Zobel (2013) states that ISO 14001 demands compliance with regulations but does not establish minimum levels of environmental performance to be achieved and evaluated periodically to maintain the certification. Thus, the criteria and requirements indicated in the actions to implement EMS are defined and used to monitor and evaluate the continuous improvement in environmental performance (Stevens et al., 2012). Thus, it is natural to associate an ISO 14001 certification with the EMS maturity level and the benefits from environmental prevention activities undertaken by a company's internal management (Peixe, 2014).

Measurement and communication of environmental performance are key factors that help decision makers and the public (Calixto, 2007; Ramos & Melo, 2006). Xu, Zeng, and Tam (2012) analyzed the stock market reaction to the disclosure of environmental violations by Chinese companies (57 companies) and found that negative environmental events have a weak effect on the stock market. Trierweiller, Peixe, Tezza, Bornia, and Campos (2013) conducted a study on environmental management disclosure, evaluating the websites of 638 Brazilian companies in 10 activity sectors, and concluded that environmental fines had the lowest disclosure.

According to Oliveira et al. (2010), the cost reduction in hiring insurance was investigated upon the disclosure of benefits obtained by implementing an EMS based on the ISO 14001 standard (Gupta & Innes, 2014; Marimon et al., 2011; To & Lee, 2014). Cost reduction, fines, energy savings, waste and environmental impacts are factors that can contribute to the implementation of an EMS (Trierweiller et al., 2013).

The demands of stakeholders and market globalization are primary factors that led to the inclusion of quality control systems and EMS in the competitive strategies of companies (Alperstedt et al., 2010; Rodríguez et al., 2011). Another factor is the demand for qualified professionals in environmental issues (green teams) in organizations with greater EMS maturity (Jabbour, Santos, Fonseca, & Nagano, 2013). Therefore, professional management is associated with a higher EMS maturity level, *i.e.*, demonstrating a company's progression through its rating system, reflecting its effectiveness and efficiency (Gupta & Innes, 2014; Singh et al., 2015).

## METHOD

This work was based on the scale created by Peixe (2014), which comprises 55 items used to measure the EMS maturity of industrial companies using IRT. The sample included industrial companies that have over 100 employees. The list of companies registered in the Industry Federation was used, with a total of 2,994 companies, of which 354 responded to the survey. Moreover, the agro-industrial (16%); metallurgical, mechanical, and electronic (22%); textile (19%); forestry (16%); technological (7%); chemical (11%); civil construction (5%); energy (1%); and other (3%) company complexes responded. Exhibits 1 to 5 show the items formulated by Peixe (2014) that constitute his proposed scale. In addition, descriptive questions were used for this study. A multiple regression analysis was used to assess the influence of the variables presented in Exhibit 6 regarding the EMS maturity level proposed by Peixe (2014). In this analysis, EMS maturity level was the dependent variable, and the variables listed in Exhibit 6 were independent variables.

Exhibit 6 presents the variables, their categories, and the dummy variables.

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## Exhibit 6. Variables, their categories, and resulting dummy variables

| Variable | Category | Dummy variable | Source |
|---|---|---|---|
| Company age | Number in years | - | Andersen and Jessen (2003); Cooke-Davies and Arzymanow (2003); Grant and Pennypacker (2006); Spenassato et al. (2015). |
| Sector (ST) where the company operates | Agroindustry | ST_Agroind | Marimon et al. (2010); Marimon et al. (2011); Castka e Prajogo (2013); To and Lee (2014); Fischer et al. (2014); Jabbour and Jabbour (2009); Jabbour (2010, 2015); Haddock-Freser e Tourelle (2010); Ormazabal and Sarriegi (2014); Trierweiller et al. (2013). |
| | Metallurgical, mechanical, and electro-electronic | ST_Metalmec | |
| | Forestry, mineral, ceramic, and construction | ST_Fo_Mi Ce_Co | |
| | Textile | ST_Textile | |
| Management model of the company | Professional | Profesional_ management | Gupta and Ines (2014); Singh et al. (2015). |
| | Family | - | |
| Legal constitution (CJ) of the company | Publicly traded | LC_PT | Carvalho (2001); Silva (2002); Barbieri (2008); Miranda (2010). |
| | Privately held | LC_PH | |
| | Private limited company | LC_LL | |
| **Variable** | **Category** | **Dummy variable** | **Source** |
| The company discloses its information through environmental disclosures | Yes/No | Disclosure | Cormier and Magnan (2003); Ramos and Melo (2006); Calixto (2007); Xu et al. (2012); Trierweiller et al. (2013). |
| ISO 14001 certified | Yes/No | ST_Agroind | González-Benito e González-Benito (2006); Boiral (2006); Halila and Tell (2013); To and Lee (2014); Corazza, (2016). |
| Has a project to reduce water consumption | Yes/No | Water | Melnyk et al. (2003). |
| Has a project to reduce energy consumption | Yes/No | Energy | Melnyk et al. (2003); Trierweiller et al. (2013); Jabbour (2015). |
| Has a project to reduce raw material (RM) consumption | Yes/No | RM | Melnyk et al. (2003). |
| Has insurance against environmental accidents | Yes/No | Insurance | Trierweiller et al. (2013); Gupta and Innes (2014); Singh et al. (2015). |
| Company participates in the carbon market | Yes/No | Carbon market | Perez et al. (2008); Jabbour et al. (2010); Sundarakani et al. (2010); Hua et al. (2011). |




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EMS maturity level is the dependent, quantitative variable measured using the TIR from the results presented by Peixe (2014), as previously explained. Age is a quantitative independent variable, measured in years of existence of the company, while the other independent variables are represented by dummy variables (categorical). Thus, the research hypotheses are as follows:

H1: Having ISO 14000 certification influences the maturity of the company's EMS.

H2: Participation in the carbon market influences the maturity of the company's EMS.

H3: Environmental disclosure influences the maturity of the company's EMS.

H4: Having a project to reduce water consumption influences the maturity of the company's EMS.

H5: The management model influences the maturity of the company's EMS.

H6: Having insurance against environmental accidents influences the maturity of the company's EMS.

H7: Age influences the maturity of the company's EMS.

H8: The sector of activity influences the maturity of the company's EMS.

H9: The legal constitution influences the maturity of the company's EMS.

H10: Having a project to reduce energy consumption influences the maturity of the company's EMS.

H11: Having a project to reduce raw material consumption influences the maturity of the company's EMS.

The theoretical basis of each hypothesis is presented in Exhibit 6.

Figure 2 shows the research design, considering phases 1, 2, and 3, to evaluate factors associated with the EMS maturity level (dependent variable of the sample studied).

The analysis was performed by applying multiple linear regression using the Statistical Package for Social Sciences software, while considering the dependent variable, and beginning with the age and other variables listed in Exhibit 6. The forward variables input method was used to obtain the final model.

## Factor analysis

The model was created (Table 1) by applying a regression analysis using the forward method of variable selection.

Figure 2. **Research design**

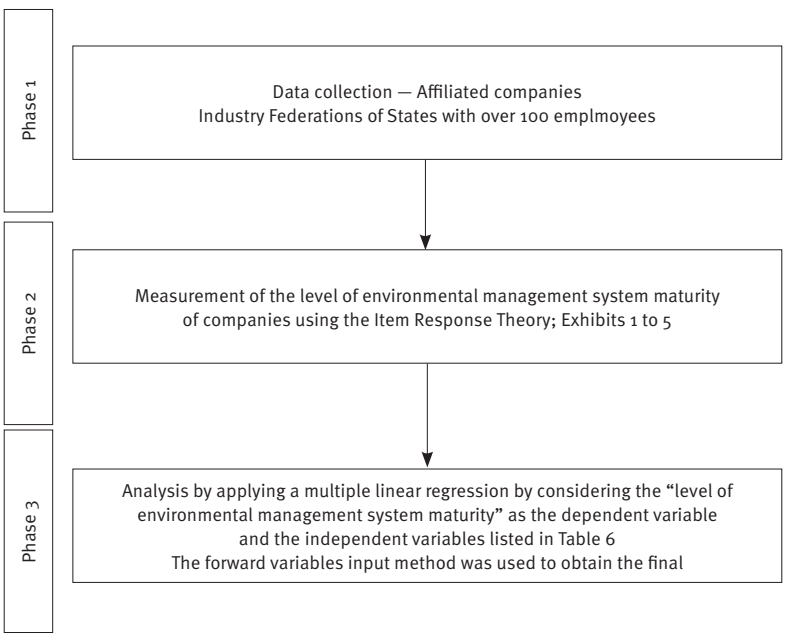


  
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Table 1. **Coefficients of the model**

| Variable | Non-standard coefficient | | Standardized coefficient | t | p-value | Collinearity | |
|---|---|---|---|---|---|---|---|
| | B | Std. error | Beta | | | Tolerance | Variance inflation factor |
| (Constant) | -0.513 | 0.176 | | -2.925 | 0.004 | | |
| ISO 14001 | 1.064 | 0.133 | 0.344 | 7.998 | 0.000 | 0.919 | 1.089 |
| Carbon market | 0.724 | 0.204 | 0.158 | 3.540 | 0.000 | 0.854 | 1.171 |
| Environmental disclosure | 0.419 | 0.131 | 0.155 | 3.189 | 0.002 | 0.724 | 1.381 |
| Water | 0.413 | 0.119 | 0.159 | 3.459 | 0.001 | 0.809 | 1.236 |
| Professional management | 0.367 | 0.126 | 0.131 | 2.910 | 0.004 | 0.838 | 1.193 |
| Insurance | 0.325 | 0.123 | 0.117 | 2.641 | 0.009 | 0.875 | 1.143 |
| Age | 0.022 | 0.006 | 0.181 | 3.905 | 0.000 | 0.794 | 1.259 |
| ST_Textile | -0.287 | 0.134 | -0.092 | -2.138 | 0.033 | 0.919 | 1.088 |
| LC_private limited | -0.326 | 0.129 | -0.119 | -2.533 | 0.012 | 0.777 | 1.287 |

The final model showed that the following variables, ranked by significance at the 95% significance level, influenced the EMS maturity level: ISO 14001, carbon market, environmental disclosure, water, professional management, insurance, age, textile sector, and private limited legal constitution.

Table 2 shows the model's analysis of variance, and Table 3 presents its adjustment indicators.

Table 2. **ANOVA**

| | Sum of squares | Degrees of freedom | Squares mean | F | Sig. |
|---|---|---|---|---|---|
| **Regression** | 251.713 | 9 | 27.968 | 28.638 | ‹ 0.001 |
| **Residual** | 321.300 | 329 | 0.977 | | |
| **Total** | 573.013 | 338 | | | |

The F-test shown in Table 2 indicates that the model is significant; that is, at least one of the estimated coefficients is statistically different from zero.

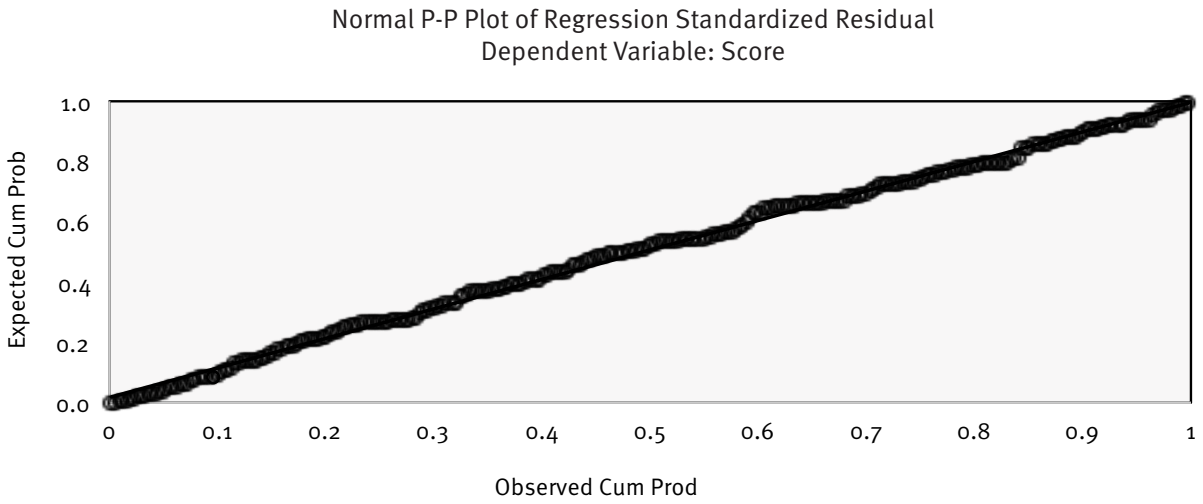
Tabla 3. **Indicators of adjustment for the selected model**

| R | $R^2$ | Adjusted $R^2$ | Standard estimated error |
|---|---|---|---|
| 0.663 | 0.439 | 0.424 | 0.988 |

The coefficient of determination ($R^2$) of the selected regression model (Table 3) showed that 44% of the variance of EMS maturity is explained by the independent variables.

The normality of the residuals is an assumption of linear regression and can be perceived by observing that most of the points are located on the straight line in Figure 3. The Kolmogorov-Smirnov adjustment test was performed to test the normality of the residuals, which was confirmed.

Figure 3. **Normality of residuals**




Another assumption is the absence of multicollinearity, that is, the assumption that independent variables should not be correlated. The variance inflation factor (VIF) and tolerance tests confirm the absence of multicollinearity among the independent variables, as there is no VIF greater than 10 or tolerance less than 0.1.

## DISCUSSION OF RESULTS

The selected regression model is represented by the following equation to discuss the results presented in Table 1: EMS maturity = -0.513 + 1.064 * (the company has ISO 14001 certification) + 0.724 * (the company participates in the carbon market) + 0.419 * (the company discloses its information via reports) + 0.413 * (the company has a project to reduce water consumption) + 0.367 * (the company has a professional management model) + 0.325 * (the company has insurance against environmental accidents) + 0.022 * (company age) - 0.287 * (the company operates in the textile complex) - 0.326 * (the company has the legal constitution of a private limited company). Thus, of the 11 hypotheses formulated, only Hypotheses 10 and 11 were not supported.

The estimated coefficients (B) indicate the direction of the relationship between the dependent and independent variables as well as its intensity, while the p-value indicates the variables' significance. All the variables presented in Table 3 are significant, confirming that EMS maturity is associated with these variables: (1) "the company has ISO 14001 certification", (2) "the company participates in the carbon market," (3) "the company discloses its information via reports," (4) "the company has a program to reduce water consumption," (5) the management model influences the maturity of the company's EMS," (6) "the company has insurance against environmental accidents," (7) "company age," (8) "the company operates in the textile complex," and (9) "the company has the legal constitution of a private limited company".

An analysis of the coefficients showed that most of the independent variables positively influence the EMS maturity level (dependent variable). Moreover, the company having ISO 14001 certification is one of the factors that influenced the EMS maturity level the most, and once having certification increased the estimated EMS maturity value by 1.064 standard deviations. Boiral (2006), González-Benito and González-Benito (2006), and Halila and Tell (2013) agreed with this finding. They stated that proactive action was relevant for environmental issues in the decision-making process and in the strategic approach to evaluate the EMS of organizations according to the requirements of ISO 14001, which define their environmental policy, plans, and

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actions (Corazza, 2016; To & Lee, 2014). EMS maturity can lead to effective control of environmental aspects, principles, and impacts in the process of improving the environmental level of the company, acting as a tool to improve business sustainability (Fonseca, 2015; Marimon et al., 2011).

The second factor, participation of the company in the carbon market, causes an increase of 0.724 standard deviations in the estimated EMS maturity level. This search for reversal or mitigation of the consequences of global warming, resulting from climate change, led to discussions and actions aimed at reducing gas emissions, such as the Kyoto Protocol and the carbon market (Perez et al., 2008). To mitigate global warming, the United Nations (UN), the European Union (EU), and many other countries have adopted legislation and mechanisms designed to reduce carbon emissions, with carbon-emission trading being one of the most effective mechanisms (Hua, Cheng, & Wang, 2011).

There are studies on carbon footprint along the supply chain and on its contribution to making the supply chain greener. Sundarakani, Souza, Goh, Wagner, and Manikandan (2010) analyzed the adoption of carbon footprint in the supply chain, showing that carbon emissions are a significant threat and warning that managers should act preventively in the project phase.

According to Jabbour, Teixeira, Oliveira, and Soubihia (2010), high management must be updated on strategic environmental issues that may influence the future of the company, such as the carbon credit market. Moreover, participation in the carbon market leads the company to develop projects that minimize the consumption of inputs and waste emissions.

The third factor with the greatest positive influence on the level of EMS maturity, accounting for an increase of 0.419 standard deviations, is the disclosure of information via reports (environmental disclosure). The disclosure of environmental information via reports makes public the environmental performance policy (Calixto, 2007; Cormier & Magnan, 2003). In addition to disclosing to stakeholders the actions, plans, and strategies aimed at preserving the environment, disclosure of environmental information via reports influences the EMS maturity level (Calixto, 2007; Ramos & Melo, 2006).

Environmental disclosures of 638 websites of Brazilian companies operating in 10 sectors of activity were analyzed, and the factor of environmental fines had the lowest disclosure (Trierweiller et al., 2013). Conversely, Xu et al. (2012) analyzed the stock market for environmental disclosure and found that the negative environmental events of Chinese companies had a weak effect on the stock market.

The fourth factor with the highest positive influence, the company having a project to reduce water consumption, had an increase of 0.413 standard deviations. This was due to the influence of water use on the efficiency of the use of inputs for essential environmental preservation, supporting the findings of Gupta and Innes (2014), Jabbour (2015), Melnyk et al. (2003), and Singh et al. (2015).

The fifth factor that showed positive influence, with an increase of 0.367 standard deviations, is the company having a professional management model, which indicates the extent to which the company has progressed, thus affecting its effectiveness and efficiency (Gupta & Innes, 2014; Singh et al., 2015). Ultimately, professional management supposedly seek market criteria, regulations, institutional analysis mechanisms, and determining factors for decision making (Alperstedt et al., 2010), while family management can largely use the feeling of the founding entrepreneur.

The sixth factor, having insurance against environmental accidents, had a positive influence, with an increase of 0.325 standard deviations. That is, having insurance reduces costs (Oliveira et al., 2010), which is a factor considered in the study of the process of disseminating the benefits obtained with the implementation of an EMS (Marimon et al., 2011; To & Lee, 2014). Thus, implementation of an EMS may contribute to reducing fines, saving energy, and reducing waste and environmental impacts (Trierweiller et al., 2013). Hiring insurance can mitigate the risks of environmental accidents that would impact the continuity of the company's operations, considering that the insurance premium is lower with the reduction of environmental accidents, which pressures the company to improve environmental performance (Singh et al., 2015).

The seventh factor, company age, has a positive influence on the level of EMS maturity, with an increase of 0.022 standard deviations. After all, maturity models define the structure for continuous improvement of actions, showing the extent to which a company has progressed over time in terms of the projects completed (Andersen & Jessen, 2003; Cooke-Davies & Arzymanow, 2003; Pennypacker & Grant, 2003, 2006; Spenassato, Peixe, Trierweiller, Bornia, & Tezza, 2015).

The eighth factor exerted a negative influence on EMS maturity level, with -0.287 standard deviations, and it refers to whether the company operates in the textile sector. Therefore, if a company operates in the textile segment, its maturity level is lower than if it operates in other sectors.

It is noteworthy that some studies, such as To and Lee (2014), analyzed the existence of specific patterns by sector of activity. The textile sector has attracted the attention of environmentalists around the world for its high consumption of water, chemical products, and energy, and for releasing




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contaminated effluents at the end of the process that cause intense pollution, in addition to the atmospheric and noise pollution generated from the production phases (Mangala, 2001). Oliveira-Brasil, Abreu, Silva and Leocádio (2016) stated that the environmental issues are associated with high consumption of water and energy, transportation costs, use of pesticides in cotton plantations, bleaching and washing of fabrics, and the final destination of chemical waste after the fabric is dyed with the use of running water. They also consider animal rights and protection of the community. However, Jones, Hillier, and Comfort (2012) emphasized the development of innovative technologies as a way to mitigate the environmental and social impacts of the textile industry.

Moreover, the textile and apparel industry enables the development of research related to environmental issues, through its significant participation in the Brazilian economic and social scenario as well as its productive potential and job and income generation (Alencar, Simoni, Fiorelli, & Angelis, 2015).

The ninth factor, whether the legal constitution of the company is of a private limited company, has a negative influence on the level of EMS maturity, with -0.326 standard deviations. That is, it can be assumed that private limited companies tend to have less maturity, compared with joint-stock companies. After all, the adoption of standards and legal requirements by publicly traded companies requires the publication of environmental and social reports (Barbieri, 2008). Joint-stock companies have great publicity and exposure when compared with private limited companies. Thus, it is necessary to emphasize the systematized knowledge of the norms and principles that govern the quality of the environment (Carvalho, 2001; Silva, 2002).

## FINAL CONSIDERATIONS

This article aimed to evaluate the factors that exhibited a significant relationship with the EMS maturity level of industrial companies in Brazil. A multiple linear regression analysis was used, and variables that positively and negatively associated with the EMS maturity level were identified. The results showed that possessing ISO 14001 certification, participating in the carbon market, disclosing information via reports, a project to reduce water consumption, a professional management model, insurance against environmental accidents, company age, being in the textile sector, and maintaining the legal constitution of a *company* are factors associated with the EMS maturity level of industrial companies.

The factors (variables) shown in the model support the findings of other researchers cited in the analysis and discussion of the results. Thus, the empirical results show that the EMS maturity level of industrial companies in Brazil is associated with the factors tested in the model.

The main limitation of this study is that only some factors associated with activities of industrial companies in Brazil have been analyzed, which prevents the generalization of the results to other sectors not included in the scope of this study.

We suggest researchers to expand this research to other sectors of activity, using quantitative, qualitative, and explanatory approaches to investigate the factors in this study that are more and less associated with the maturity level of the companies' EMS.

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