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Artigos

SUSTAINABLE PRACTICES AND ECO-INNOVATIONS ADOPTED BY INDUSTRIAL COMPANIES

PRÁTICAS SUSTENTÁVEIS E ECO-INOVAÇÕES ADOTADAS POR EMPRESAS INDUSTRIAIS

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Abstract: This study aimed to analyse the level of adoption of sustainable and eco-innovations deployed in the processes of industrial enterprise practice. The study was conducted in 300 industrial enterprises located in southern Brazil. It consists of a survey questionnaire that made use of itemized measurement. The questionnaire was formed through the theoretical basis of studies in literature on eco-innovation and sustainable practices. Thus, the descriptive analysis evaluated the distribution frequency of the answers, ascertaining whether they obtained the central tendency and dispersion for scalar variables and frequency distribution for categorical variables. The indicators, ranging from never to always, were assigned a numerical score from one to seven for the purposes of evaluation. Data analysis was performed based on the frequency distribution, mean, standard deviation and variance. Kurtosis and skewness were also calculated to understand the nature of the data distribution. The results show that the surveyed companies have increased investment in social and marketing areas, in the perception of the subjects. Types of eco-innovation that obtained the highest average and lowest standard deviations were evaluated. The improvements needed are innovation in products, as the average lowest and highest variance, followed by the organizational dimension. Therefore, the main contribution of this study is to know the eco-innovation stage of adoption in industrial companies, which allows the development of an agenda for action to contribute to the consolidation of these practices in Brazilian companies, since the understanding of those surveyed is that they are fundamental in improving the quality of the image and the industries' management.

Keywords: Sustainability, Eco-Innovations, Industrial Enterprises, Sustainable Practices, Innovation.

Resumo: Este estudo teve como objetivo analisar o nível de adoção das práticas sustentáveis e eco-inovações implantadas nos processos de empresas industriais. O estudo foi desenvolvido em 300 empresas industriais localizadas no sul do Brasil. Consiste em uma survey que fez uso de questionário escalar de mensuração itemizado. Atribuiu-se um escore numérico que vai de 1 a 7, variando de Nunca Adota a Sempre Adota, para cada um dos indicadores avaliados. A elaboração do questionário foi constituído por meio da fundamentação teórica dos estudos realizados na pesquisa bibliográfica sobre eco-inovações e práticas sustentáveis. Assim, a análise descritiva buscou avaliar a distribuição de frequência das respostas, se estas obtiveram as medidas de tendência central e de dispersão para as variáveis escalares e distribuição de frequência para as variáveis categóricas. A análise dos dados foi realizada com base na distribuição de frequência, média, desvio padrão e variância. Também foram calculados curtose e assimetria para compreender a natureza da distribuição dos dados. Os resultados

evidenciam que as empresas pesquisadas possuem maiores investimentos na área social e marketing, na percepção dos sujeitos pesquisados. Foram os tipos de eco-inovação avaliados que obtiveram as maiores médias e menores desvios padrões. Como necessidade de melhorias encontram-se a inovação em produtos como sendo a média mais baixa e com maior variância, seguido da dimensão organizacional. Portanto, a principal contribuição desse estudo consiste em conhecer o estágio de adoção de eco-inovações em empresas industriais, o que permitiu a elaboração de uma agenda de ações para contribuir na consolidação dessas práticas nas empresas brasileiras, já que no entendimento dos pesquisados, elas são fundamentais na melhoria da qualidade, da imagem e da gestão das indústrias.

Palavras-chave: Sustentabilidade, Eco-inovações, Empresas Industriais, Práticas Sustentáveis, Inovação.

INTRODUCTION

Sustainability has become an increasingly dominant practice for industrial enterprises. In particular, the food industry has focused on sustainable practices and ecoinnovations for gaining competitive advantage (Darkow, Heiko and von der Gracht, 2015). Organizations and society are sensitized towards that the environment is finite and their use inadequate will lead to a global collapse (Rosa et al, 2014).

Sustainability arouses intense debate, mobilizing hearts passionately and minds of environmental movements, communities, governments and business managers. The transition from traditional management models for sustainable business strategies is done by devious ways. The challenges that Companies face are many, even because issues such as global environmental degradation, hunger, social inequality and armed conflict They have never been incorporated into the agenda of the organization private institutions or occupied second place in corporate strategies (Teodósio & Barnieri & Scillag, 2006).

Pagell and Wu (2009) note that there is a need to incorporate the three dimensions of sustainability— economic, social and environmental supply chain—for achieving a more sustainable performance. Seiffert (2011) mentions that practices that have been adopted frequently in the supply chain are reverse logistics; changes in the production process; replacement/modification of the product; the use of inputs and raw materials in the process; the implementation of infrastructure improvements in the process; preventive approach to waste control; capacity building (training and awareness) for environmental control; environmental monitoring and performance indicators of the establishment; and the adoption of continuous improvement tools. Xue (2014) also points out that since the 1990s studies concerning production have focused on the introduction of the green manufacturing concept in the supply chain—namely: a) the concept of a green manufacturing process; b) green technologies and manufacturing processes; c) applied research in green manufacturing; d) evaluation of the green production system. However, Morali and Searcy (2013) argue that corporations have come to consider the product lifecycle and have introduced into their production processes various management principles and practices such

as cleaner production, Valdez Principles, environmental management systems, and the guidelines of the technical standard ISO 14001.

research in green manufacturing; d) evaluation of the green production system. However, Morali and Searcy (2013) argue that corporations have come to consider the product lifecycle and have introduced into their production processes various management principles and practices such as cleaner production, Valdez Principles, environmental management systems, and the guidelines of the technical standard ISO 14001.

In addition, Morali and Searcy (2013) point out that the integration of social and environmental principles within a company and its suppliers requires integration upstream or downstream with other organizations in the supply chain. This integration can be implemented at an operational or strategic level and helps generate risks and environmental and social standards management measures such as ISO 14001 for environmental and SA8000 for social purposes and accountability.

The aspect of risk management is vital for companies in a global economy, where increasing integration demands have increased the supply chain definition. This is because the brand enterprises, their image and competitiveness in the market may be dependent practices of its suppliers, defying the principles of sustainability.

Sustainability is driven by legislation, public interest and competitive opportunities (Zaabi, Dhaheri and Diabat, 2013). It is difficult for industries to eradicate all barriers in the early stages of adoption of sustainable concepts (Zaabi, Dhaheri and Diabat, 2013). The following barriers are described by Carboni, Moatti and Vinzi (2012):

§ Very high cost for the disposal of hazardous waste.
§ Cost of environmentally friendly packaging.
§ Lack of clarity on sustainability.
§ Cost of economic conditions and sustainability.
§ Lack of sustainability standards and appropriate regulations.
§ The short-term misalignment and long-term strategic targets.
§ Lack of effective assessment of sustainability.
§ Lack of training and education on sustainability.
§ Complexity of design to reduce the consumption of resources and energy.
§ Improper installation of adoptions reverse logistics practices.
§ Lack of implementation IT.
§ Inadequate industrial self-regulation.
§ Lack of top management commitment to start sustainability efforts.

In this context, the literature also introduces the concept of eco-innovation and sustainable innovation. Eco-innovation is the creation of new merchandise at competitive prices, as well as new processes, systems, designed services and procedures to meet human needs and provide a better quality of life for all, with emphasis on lifecycle assessment, minimum use of natural resources (materials including energy and surface area) per unit of output, and a minimal release of toxic substances (Reid and Miedzinski, 2008). According to Garcia-Pozo, Sánchez-Ollero and

Marchante-Lara (2015), this definition has traditionally been used in studies developed in industrial sectors.

Therefore, all new processes that are more efficient in their use of resources are eco-innovations. All new solutions that are more environmentally benign than the relevant alternative is eco-innovations. The alternative may be relevant technology now in use in an industry or technology (e.g. power plants and coal gas for electricity generation). In this case, innovations in coal burning technology can be described as eco-innovations to reduce emissions.

To measure eco-innovation in Brazilian industrial firms, a questionnaire was prepared with a list of environmental, social and economic practices derived from theoretical studies previously developed on the subject. Respondents were asked about the stage of adoption of these practices in their production processes. Alternatives allowed each question to be rated from one to seven, one meaning the company never adopted the practice and seven when it was fully adopted.

To analyse the mapped eco-innovations, the typology proposed by EIO (2013) and replicated by Dias (2014) was used. It consists of an eco-innovation typology widely quoted in international studies and classifies the innovations adopted by organizations in the following types: products, processes, marketing, organizational and social systems.

This paper contributes to research in three ways, namely by addressing the following research areas:

1. 1 Implementation stage of eco-innovations in Brazilian industries, highlighting the importance of sustainability in the supply chain of companies' research;
   2 Motivators, hindrances and benefits arising from the adoption of sustainable and eco-innovated practices in industrial companies;
   3 Creating a schedule of eco-innovative practices for incorporation into industrial enterprises through the mapped weaknesses.

Sustainable Practices and Eco-Innovation

The emergence of sustainability as a competitive advantage generation factor involves new ways of thinking and acting for society and businesses, as sustainable practices and eco-innovations are not static and linear (Galvão, 2014). Rammell (2003) points out that this competitive environment is forcing companies to change their practices in terms of processes, technologies, products and new forms of sustainable business. Nidomolu, Prahalad and Rangaswami (2009) emphasize that the essential element contributing to progress in the issue of sustainability is a focus on innovation. Companies that incorporate sustainability as a strategic factor need to develop new skills to place them ahead of their competitors. In addition, sustainability becomes an integral part of economic development.

Still, Díaz-García, González-Moreno and Sáez-Martínez (2015) emphasize that eco-innovation is a young area of research. However, it has attracted the attention of policy makers, academics and professionals. In their bibliometric study, Díaz-García, González-Moreno and Sáez-Martínez (2015) found that most existing studies focus on the pioneers, the early adopters of eco-innovative practices. Analysis of studies shows contemplation of elements at macro, meso and micro levels.

At the macro level, as well as different policy instruments, the literature highlights the relative importance of regional factors. This includes the so-called 'transition regions', with decentralized governance in economic development and innovation issues and industrial districts where innovation density, level of knowledge and externalities are concentrated. These particular contexts foster the development, implementation and diffusion of eco-innovations. These specific contexts and their parts should be noted by policy makers and other stakeholders who are willing to learn from the successful development of eco-innovations achieved by early adopters. At the meso level, market dynamics, pressure groups and networks are key elements in promoting innovations aimed at reducing the negative impact of economic activity on the environment. Finally, at the micro level, visionary management and managerial concerns are considered two of the most important factors for the development of ecoinnovations, along with key features and capabilities such as qualified personnel, networking, capacity to absorb and green organizational identity (Díaz-García, GonzálezMoreno and Sáez-Martínez, 2015).

Table 1

Eco-innovation categories

Categories	Description
Further eco-innovation (pollution and manipulation of technological resources and services)	Technologies and services in general have limited systemic effects because they are usually added on to existing practices of production and consumption (becoming profitable) without influencing them significantly. The product itself does not need to be environmentally friendly. This type of eco-innovation is the product or service that is performed on the outputs (the various technologies and cleaning services, dilution, recycling, measurement control, emissions control, and transport) and the supply side (natural extraction natural and energy) resources.
Integrated eco-innovation (technological processes and clean products)	This type of eco-technical innovation can be organizational or technical or both, and may involve both the production process and the product, proving more ecologically efficient than other processes and similar products. It contributes to the solution of environmental problems of organization within the company or other organizations (public, family, etc.); in this sense it is that these eco-innovations are integrated. Thus, integrated eco-innovations can provide environmental solutions within the organization or to other organizations and increase eco-efficiency. These eco-innovations enable efficient consumption of energy and resources, increase recycling, or allow the substitution of toxic materials. Innovations are essentially technical in nature, but can also be organizational, i.e. changes in the organization of production and management within an organization. The greening of these products is ongoing (when compared to similar products' greening) and can therefore change over time. This category emphasizes the greening as a moving target. It represents technological continuity.
Eco-innovation alternative product (new technological paths)	This type of eco-innovation is a radical technological discontinuity. It is not cleaner than similar products, but offers something very different (a new technological trajectory): environmentally benign solutions to existing products. These radical eco-innovative products have large systemic effects, are based on new theories, skills and practices, and may require a change in patterns of production and consumption. The environmental dimension is in the production or design of the product, being supposedly greener than the alternative, or different. The production method in itself need not be cleaned and, in some cases, attracts little attention. Examples are renewable energy technologies (as opposed to use of fossil fuels) and organic agriculture (as opposed to conventional farming).
Macro-organizational eco-innovation (new organizational structures)	These innovations require new solutions to find an eco-efficient way to organize society, which implies new functional interactions between organizations—for example, between companies (industrial symbiosis), between families and workplaces, and new forms of organization in cities and technical infrastructure (urban ecology). They emphasize the importance of the space dimension to the eco-innovation and the need for organizational and institutional change. Innovations are organizational, but could include technical innovations. This type of eco-innovation is mostly within the domain of public authorities who need to cooperate with companies to develop new solutions of this type.
Eco-innovation for general purposes	Some general purpose technologies deeply affect the economy and, more specifically, the process of innovation, as they feed a number of technological innovations. Changes in general purpose technologies
	are so fundamental that they will have a major effect on eco-innovation and special attention should be given to their evolution. The influence may be derived directly or indirectly; technologies may have positive and negative effects, such as ICT, biotechnology and more recently nanotechnology, and such eco-innovations should have special attention.

Based on these prior studies on eco-innovation, some typologies are highlighted, as can be seen in Tables 1 and 2.

In addition, the typology proposed by EIO (2013, p.3) and replicated by Dias (2014, p.137–138) is very often adopted in theoretical and empirical studies and is described in Table 2.

Table 2
Types of eco-innovation

Kind	Description
Product	Product eco-innovation includes goods and services. Eco-innovative properties are produced so that the overall impact on the environment is minimized, and eco-design is a keyword in this area. The future of product design will take into account resource constraints with a higher priority than is happening today. Designing a product in a way that leads to reduced environmental impact and lower resource usage during operation and which allows recovery options such as repair, reuse or recycling should become the main business strategy, not only to reduce costs but also to improve the security of supply and resilience of markets. Eco-innovative services include green financial products (such as credits for renewable energy, green credit card, etc.), environmental services (including waste management) and less service intensive resources (e.g. car sharing).
Process	Eco-innovative processes reduce the use of materials, provide the lowest risk and result in cost savings. Examples include substitution of harmful inputs during the production process (for example, the replacement of toxic substances); optimization of the production process (for example, to improve energy efficiency); and reduction of the negative impact of production output (such as emissions). In addition, the reduction of inputs—material inputs into production processes and consumption—can also be captured by the process of eco-innovation. Common terms related to ecological process innovations include cleaner production, zero emissions, zero waste and material efficiency.
Organizational	Organizational eco-innovation is the introduction of organizational methods and management systems to deal with environmental issues in production and products. These organizational changes are the socio-economic dimension of the innovation process, and are especially closely linked to learning and education. Such eco-innovation includes pollution prevention schemes, environmental management and audit systems, and management of the supply chain (business cooperation to strengthen the material bonds and to avoid environmental damage throughout the value chain). As such, organizational eco-innovation can also include an investigation into the various collaborative organizational forms and possible eco-innovative quality, which can range from business networks and clusters to advanced industrial symbiosis solutions.
Marketing	Eco-innovation marketing involves changes in product design or packaging, product placement, promotion of products or prices. It looks at how marketing techniques can be used to drive people to buy, use or implement eco-innovations. In marketing, the brand (a collection of symbols, experiences and associations connected with a product or service by potential customers) is the key to understanding the process of marketing products and services. While green branding is important, in practice it is not the function or way to sell eco-innovations. Labelling is also an aspect of eco-marketing innovation, namely eco- labelling.
Social	Social eco-innovation considers the essential human element in any discussion about resource consumption. This includes behavioural dimensions based on the market and change of lifestyle and the resulting demand for goods and green services. Some companies are experimenting directly with stakeholders, developing the functionality of new goods according to their interests, and thus minimizing the risk of use of luxury goods resources. Another important aspect is the sharing of the product, which can lead to an absolute reduction in the use of materials without diminishing the quality of services provided to users. The social dimension also involves the creative potential of society with examples of innovative concepts of green living.
System	A series of connected innovations improve or create entirely new systems with specific functions with a reduced overall environmental impact. A key feature of a system of innovation is that it is a set of changes implemented by the project. For example, a system of eco-innovations related to a residence involves not just insulation of windows or use of a better heating system: it aims to innovate the overall design to improve functionality. The idea of green cities is another example of an innovation system, where innovation and planning efforts lead to a combination of changes to improve the functioning of the city and facilitate the greenest city life. This includes, for example, new concepts of mobility considering not only the traditional public transport services (e.g. bus), but also shared bicycle systems (and related infrastructure such as bike stations), as well as planning to reduce the need to travel (which requires that supermarkets, nurseries, etc. are incorporated into new developments).

EIO (2013, p.3) and Dias (2014, p.137–138).

The study of eco-innovation is complex because of the various relationships, types and determinants. For this reason, there are different methodologies to assess its spread. In addition to the aforementioned, the OCDE (2009) presents the main ways to measure ecoinnovations as being input measures, interim output measures, direct output measures and indirect impact measures. This is also a methodology widely quoted in international studies. However, it remains an issue that strengthens studies, especially in companies that pioneered the adoption of eco-innovations. Examples include the studies of Triguero, Moreno-Mondéjar and Davia (2015), Garcia-Pozo, Sánchez-Ollero and Marchante-Lara (2015), Duran-Romero and Urraca-Ruiz (2015), Martínez-Pérez, García-Villaverde and Elche (2015), Melece (2015), Kijek (2015) and Cecere et al. (2014), among others.

Methodology

This research analyses data from 300 companies affiliated to the Federation of Santa Catarina State Industries (FIESC), Brazil. The questionnaire was administered by telephone by the Agribusiness Studies Centre of the Federal University of Rio Grande do Sul.

It consists of a survey questionnaire that made use of climbing itemized measurement. The indicators, ranging from never to always, were assigned a numerical score from one to seven for the purposes of evaluation. The questionnaire was formed through the theoretical basis of studies in literature on eco-innovation and sustainable practices. Thus, the descriptive analysis evaluated the distribution frequency of the answers, ascertaining whether they obtained the central tendency and dispersion for scalar variables and frequency distribution for categorical variables. Data analysis was performed based on the frequency distribution, mean, standard deviation and variance. Kurtosis and skewness were also calculated to understand the nature of the data distribution.

The relevant elements were analysed to identify sustainable practices in the production process of industrial companies and along the supply chain, considering stage of adoption of eco-innovations; difficulties in implementing sustainable practices; motivators for the adoption of sustainable practices; and benefits derived from the adoption of sustainable practices. Based on the mapped results, an action agenda is proposed for incorporating eco-innovations and organizational brand products where eco-innovation is incipient and/or non-existent in the companies surveyed.

Presentation and Analysis

In this section the survey data are described and analysed. The first four tables present elements related to the characterization of the surveyed organizations. Table 3 shows the field of activity of the companies surveyed.

Table 3
Activity branch

Branch	Absolute frequency	Relative frequency	Cumulative frequency	Standard deviation
Food products	158	52.67%	52.67%	
Wood	1	0.33%	53%	
Transport equipment	1	0.33%	53.335	71.23
Metallurgical	112	37.33%	90.66%	
Textile	28	9.34%	100%	
Total	300	100%	100%	

Source: Research data

In this study there was a predominance of food product industry and metallurgy companies surveyed, totalling 90 per cent of the sample. The dominance of these companies was intentional, since the state of Santa Catarina stands out in these two sectors, seen as complementary. The two

consolidated sectors went against the premise that these organizations would be more likely to have incorporated sustainable practices. The following Table 4 presents the number of employees in the companies surveyed.

Table 4
Number of employees

Total employees	*Absolute frequency*	*Relative frequency*	*Cumulative frequency*	*Standard deviation*
Up to 100 employees	217	72.33%	72.33%	
From 101 to 200 employees	27	9%	81.33%	
From 201 to 300 employees	17	5.67%	87%	
From 301 to 400 employees	7	2.33%	89.33%	63.42
From 401 to 500 employees	7	2.33%	91.66%	
From 501 to 600 employees	5	1.67%	93.33%	
From 601 to 700 employees	4	1.33%	94.66%	
From 701 to 800 employees	2	0.67%	95.33%	
From 801 to 900 employees	0	-	95.33%	
From 901 to 1000 employees	2	0.67%	96%	
Above 1001 employees	12	4%	100%	
Total	300		100%	

Source: Research data

It is noted in Table 4 that 72.33 per cent of the surveyed sample consists of companies with up to 100 employees. Only 25 companies have over 500 employees and these are internationalized companies which have branches in different countries. The standard deviation for the number of employees in the companies surveyed is 63.42; the company which has the largest number of employees has 3,000 employees and the one with the lowest number has just one employee. Table 5 highlights the profile of the companies surveyed.

Table 5
Companies surveyed

Companies surveyed	Absolute frequency	Relative frequency	Cumulative frequency	Standard deviation
Matrix	276	92%	92%	
Branch	24	8%	100%	178.19
Total	300	100%	100%	

Source: Research data

Note in Table 5 that 92 per cent of companies surveyed were the industry headquarters staff and only in eight per cent of cases was the questionnaire applied to a person belonging to a branch of the company.

Table 6
Number of branches each company has

Number of branches	Absolute frequency	Relative frequency	Cumulative frequency	Standard deviation
It has no branches	169	56.33%	56.33%	
Up to ten branches	123	41%	97.33%	
Between 11 and 30 branches	6	2%	99.33%	124.23
More than 31 branches	2	0.67%	100%	
Total	300	100%	100%	

Research data

As can be seen in Table 6, 56.33 per cent of the sample studied does not have branches, but 131 of the companies surveyed do have branches, ranging from one to 133 affiliated units. The following Table 7 shows the degree of importance of environmentally friendly practices in production processes of the companies surveyed.

Table 7

Level of importance of environmentally friendly practice indicators

Indicators	Valid numbers	Average	Standard deviation	Variance	Asymmetry	Standard error asymmetry	Kurtosis	Standard error of kurtosis
1	301	4.04	2.112	4.462	-.172	.140	-1.275	.280
2	301	5.05	1.730	2.994	-.808	.140	-.133	.280
3	301	5.99	1.558	2.426	-1.736	.140	2.251	.280
4	301	5.26	1.868	3.491	-1.000	.140	.011	.280
5	301	4.18	2.446	5.983	-.172	.140	-1.621	.280
6	301	3.05	2.289	5.238	.586	.140	-1.234	.280
7	301	3.36	2.370	5.618	.361	.140	-1.487	.280
8	301	4.25	2.076	4.308	-.302	.140	-1.176	.280
9	301	3.20	2.101	4.413	.362	.140	-1.296	.280
10	301	3.14	2.079	4.320	.351	.140	-1.346	.280
11	301	2.51	1.912	3.657	.879	.140	-.695	.280
12	301	3.75	2.201	4.843	-.010	.140	-1.446	.280
13	301	3.24	2.223	4.941	.334	.140	-1.446	.280
14	301	2.54	1.896	3.596	.901	.140	-.504	.280
15	301	2.50	1.973	3.891	.918	.140	-.599	.280
16	301	2.09	1.816	3.299	1.514	.140	.914	.280
17	301	3.71	2.093	4.380	-.003	.140	-1.346	.280
18	301	4.23	2.226	4.957	-.311	.140	-1.367	.280
19	301	3.77	2.146	4.606	-.013	.140	-1.391	.280
20	301	2.50	1.976	3.904	.958	.140	-.527	.280
21	301	2.93	2.250	5.061	.712	.140	-1.060	.280
22	301	3.61	2.326	5.412	.220	.140	-1.484	.280
23	301	4.27	2.254	5.082	-.218	.140	-1.395	.280
24	301	3.67	2.350	5.520	.124	.140	-1.558	.280
25	301	3.17	2.464	6.070	.462	.140	-1.554	.280
26	301	2.51	2.241	5.024	1.100	.140	-.493	.280
27	301	3.70	2.410	5.809	.120	.140	-1.616	.280
28	301	4.20	2.065	4.265	-.295	.140	-1.162	.280
29	301	3.62	2.238	5.009	.126	.140	-1.463	.280
30	301	4.31	2.154	4.640	-.390	.140	-1.228	.280
31	301	3.41	2.266	5.136	.204	.140	-1.548	.280
32	301	3.05	2.229	4.970	.543	.140	-1.279	.280
33	301	3.03	2.182	4.759	.526	.140	-1.277	.280
34	301	3.76	2.428	5.894	.015	.140	-1.664	.280
35	301	2.81	2.096	4.392	.638	.140	-1.121	.280

Research data

It is important to be mentioned that the sequence of environmental practices presented to researchers and described in Table 7 includes reverse logistics; cleaner production; waste separation; 5Rs (reduce, rethink, refuse, reuse and recycle); industrial wastewater treatment; recycling water; water reuse; pollution control; eco-efficiency; eco-innovation; biotechnology; environmental management system; clean energy; ecodesign; composting; incineration; sustainable consumption; zero waste (internal recycling); prevention and control integrated pollution; green chemistry; use of environmentally friendly packaging; audits to suppliers; auditing of internal processes; environmental audits in production processes and management of effluents and waste; use of surface water in the process; environmentally sound management of hazardous waste; technology process that reduces waste levels; mitigation

of environmental impacts; the use of fuels derived from renewable sources; using technology to reduce the emission of greenhouse gases; assessment of the lifecycle of products; and voluntary environmental agreements.

It can be seen in Table 7 that indicator 3 (waste separation) had the highest average importance of all indicators analysed as perceived by managers, corresponding to 5.99. Second is indicator 4 (5Rs), averaging 5.26, followed by indicator 2 (cleaner production) with an average of 5.05, indicator 30 (process technologies that reduce waste level) averaging 4.31, and indicator 23 (audits of internal processes) that scores 4.27.

At the other extreme is the indicator 16 (incineration—mass burn) which obtained the lowest average, amounting to a value of 2.09 followed by indicators 15 (composting) and 20 (green chemistry), where both had an average of 2.5 according to the perception of the subjects. Indicators of skewness and kurtosis were also calculated.

According to Hair et al. (2005), asymmetry is the degree of deviation or departure from the symmetry of a distribution. It is positive for asymmetric distributions to the right and negative for those to the left. For symmetric distributions, the value is zero. Note in Table 7 that there was a predominance of deviation in asymmetric distributions to the right, resulting in predominantly positive asymmetry indicators. Therefore, a distribution has positive skewness when there is a concentration of values in the lower sample values. In the study, indicators 16 (incineration), 26 (use of water, underground processes) and 20 (green chemistry) obtained the most positive asymmetry index, being respectively 1.51, 1.1 and 0.96. Indicators 3 (waste separation), 4 (5Rs) and 2 (cleaner production) were the ones with the higher negative asymmetry indicators, being respectively -1.73, - 1 and -0.8. Table 8 shows the degree of importance attributed by respondents to the indicators depicting social practices.

Table 8

Degree of importance of indicators depicting social practices

Indicators	Valid numbers	Average	Standard deviation	Variance	Asymmetry	Standard error asymmetry	Kurtosis	Standard error of kurtosis
1	301	5.12	1.926	3.710	-1,017	.140	.034	.280
2	301	5.41	1.898	3.602	-1.092	.140	.043	.280
3	301	3.64	2.399	5.757	.155	.140	-1.619	.280
4	301	5.36	1.771	3.137	-1.119	.140	.430	.280
5	301	5.13	1.812	3.284	-.720	.140	-.497	.280
6	301	5.51	1.895	3.591	-1.188	.140	.269	.280
7	301	4.76	2.361	5.576	-.534	.140	-1.327	.280
8	301	5.06	2.018	4.073	-.768	.140	-.646	.280
9	301	5.50	1.812	3.284	-1.110	.140	.216	.280
10	301	4.89	1.972	3.887	-.656	.140	-.644	.280
11	301	1.85	1.777	3.157	2.039	.140	2.749	.280
12	301	3.94	2.140	4.580	-.132	.140	-1.312	.280
13	301	3.76	2.102	4.418	.107	.140	-1.297	.280
14	301	3.92	2.217	4.914	.035	.140	-1.432	.280
15	301	4.75	2.060	4.243	-.530	.140	-.981	.280
16	301	4.36	2.154	4.638	-.351	.140	-1.217	.280
17	301	4.16	2.147	4.610	-.170	.140	-1.333	.280
18	301	2.80	2.119	4.491	.712	.140	-1.005	.280
19	294	4.55	2.163	4.678	-.470	.142	-1.118	.283

Table 8 describes the social responsibility indicators: labour practices based on internationally recognized universal standards; hiring employees discriminating quotas; granting benefits to regular full-time employees of the organization; monitoring and recording types of injury; training sessions related to health and safety at work; training sessions related to the handling of hazardous waste; conducting training on accident prevention in the workplace; conducting training on aspects of human rights relevant to the organization's operations; hiring indigenous tribal employees; formal reporting procedures for complaints and claims by local communities; reporting significant risks related to corruption identified on the basis of risk assessments; communicating the anticorruption policies and procedures adopted by the organization; monitoring the number of complaints and claims of customers and suppliers; observation of ergonomic aspects in processes; communicating sustainable performance to stakeholders via specific reports; green marketing; communicating ethical principles and values of the company.

In the perception of the subjects surveyed, indicators 6 (training sessions related to health and safety at work), 9 (eco-efficiency) and 2 (labour practices based on universal standards recognized internationally) obtained the highest values, with an average respectively of 5.51, 5.5 and 5.41. At the other end, with lower average values, were positioned indicators 11 (biotechnology), 18 (zero waste) and 3 (waste separation) being respectively 1.85, 2.8 and 3.64. Table 9 shows the level of importance of indicators depicting economic practices.

Table 9

Degree of importance of indicators depicting the economic practices

1	301	5.81	1.690	2.856	-1.613	.140	1.809	.280
2	301	5.46	1.803	3.249	-1.203	.140	.424	.280
3	301	5.58	1.634	2.670	-1.227	.140	.755	.280
4	301	4,28	2.094	4.383	-.241	.140	-1.285	.280
5	301	5,00	1.772	3.140	-.782	.140	-.305	.280
6	301	5.07	1.766	3.118	-.947	.140	.117	.280

Research data.

The evaluated indicators described in Table 9 consist of monitoring the cost per unit of output; monitoring the rework and rework index; monitoring the loss ratio in the process; monitoring risks and opportunities for the organization's activities due to climate change; identifying the significant indirect economic impacts, both positive and negative; and prioritizing spending on local suppliers.

According to Table 9, indicators that obtained the highest average from the perception of the subjects surveyed were indicators 1 (monitoring of cost per unit produced), with an average of 5.81; 3 (monitoring the loss ratio in the process) at 5.58; and 2 (monitoring of rework index and reprocessing) at 5.46. The indicators that had the lowest averages were 4 (monitoring of risks and opportunities for the organization's activities due to climate change) at 4.28; 5 (identifying the significant indirect economic impact of the organization) with an average of 5; and 6 (prioritizing spending on local suppliers) with an average

of 5.07. Note that there was a wide variation in the block of indicators related to economic practices. This contributed to the standard deviation of this block being only 0.55. Above all, the economic sustainability of a region also runs through the endogenous conditions sufficiency of resources (Silva & Pereira & Costa, 2014). The following Table 10 shows the length of time that the research subjects had worked in the company.

Table 10
Time that employee has been in the company

Years	Absolute frequency	Relative frequency	Cumulative frequency	Standard deviation
Up to 10 years	192	64%	64%	
From 11 to 20 years	57	19%	83%	
From 21 to 30 years	37	12.33%	95.33%	76.86
Over 31 years	12	4%	99.33%	
Did not answer	2	0.67%	100%	
Total	300	100%	100%	

Research data

Note in Table 10 that 64 per cent of researchers had been working for up to ten years in the company and 16.33 per cent had worked for over 21 years. This indicator is important in the context of the research because it highlights the degree of knowledge of the company and its processes that respondents have. It starts from the assumption that the more company experience the subject has, the more information he possesses and so is better able to contribute consistent information for the development of a qualitative research.

Table 11
Function within the company

Function	Absolute frequency	Relative frequency	Cumulative frequency	Standard deviation
Owner/President/Director/Administrator	82	27.33	27.33%	
Manager/Assistant/Administrative analyst	65	21.67	49%	
Manager/Quality analyst	40	13.33	62.33%	
Manager/Human resources analyst	25	8.33	70.66%	
Purchasing manager/Business analyst/sales	25	8.33	78.99%	
Analyst/Cost/Financial manager	15	5.00	83.99%	
Manager/Analyst/Industrial/Environmental supervisor	15	5.00	88.99%	24,63
Manager/Production analyst	10	3.33	92.32%	
Security technician at work	10	3.33	95.65%	
Executive secretary	6	2.00	97.65%	
Marketing manager	2	0.67	98.32%	
Nutritionist	2	0.67	98.99%	
Sustainability manager	1	0.33	99.32%	
Psychologist	1	0.33	99.65%	
Logistics supervisor	1	0.33	99.98%	
Total	300	100%	100%	

Research data

Table 11 shows that the position held by respondents varies widely. It is necessary to consider that companies of different sizes were surveyed and that they therefore have different hierarchical structures. Overall, 49 per cent of the sample surveyed were professionals working in administrative positions and company management at the strategic level. In addition,

44.32 per cent occupy management positions or are analysts on a technical level.

Table 12
Guidelines implemented in your company

Guidelines	Absolute frequency	Relative frequency	Cumulative frequency	Standard deviation
None	123	30.52	30.52%	
Legal standards Inmetro	94	23.33	53.85%	
5S	69	17.25	71.10%	
ISO 9.000/9.001	60	14.89	85.98%	44.50
Others	37	9.18	95.17%	
ISO 14.001	13	3.23	98.39%	
SA 8.000	4	0.99	99.38%	
OSHAS 18.001	2	0.50	99.88%	
ISO 22.000	1	0.25	100%	
Total	403*	100%	100%	

Research data
* Each company can select more than one guideline, so the value exceeds the 300 companies surveyed.

Among the other practices cited were: Oeko-Tex; Pass; Sun Program Manufacturing Practices; NQS; TS 2008; ABVTEX; ANVISA; Ministry of Agriculture; Good Manufacturing Practices (BPS); FATMA; WASP International Standards; IBAMA rules; rules of the Federal Police; environmental items TS 16949; Standard FAO N.R.12; NS and NT. Note that these are predominantly legal requirements related to service specific legislation for the sector of activity of the companies surveyed. Table 13 presents the associated hindering the implementation of sustainable practices.

Table 13
Difficulties in implementing sustainable practices

Difficulties	Absolute frequency	Relative frequency	Cumulative frequency	Standard deviation
The need to invest in capital (new machines and equipment)	171	26.19%	26.19%	
Measuring difficulty	102	15.62%	41.81%	
Corporate culture	98	15.01%	56.82%	
The monitoring of suppliers	79	12.10%	68.92%	46.7
Lack of top management commitment to implement sustainable actions	76	11.64%	80.56%	
Risk management	65	9.95%	90.51%	
Do not know the practices	55	8.42%	98.93%	
Others	7	1.07%	100%	
Total	653*	100%	100%	

Research data
* Each company can select more than one answer, so the value exceeds the 300 companies surveyed.

Leading the ranking for hindering the implementation of sustainable practices are the need to invest in new machinery and equipment, the difficulty of measuring and corporate culture. It is curious that 55 respondents indicated that they did not understand sustainable practices, which could mean a need to disseminate the best practices that currently exist.

Table 14
Reasons for the implementation of sustainable practices

Motivations	Absolute frequency	Relative frequency	Cumulative frequency	Standard deviation
Regulatory concerns	168	10.52%	10.52%	26.84
Awareness by managers of their need and importance	158	9.89%	20.41%	
Increased operational efficiency	157	9.83%	30.24%	
External pressures (customers, shareholders, NGOs, government, community at large)	155	9.71%	39.95%	
The desire to be respected by the community	143	8.95%	48.9%	
Cost reduction	143	8.95%	57.85%	
Concern about the brand	141	8.83%	66.68%	
Impact on corporate image	134	8.39%	75.07%	
Increased profit	107	6.7%	81.77%	
Corporate culture	104	6.51%	88.28%	
Internal pressures (of employees)	101	6.32%	94.6%	
Risk management	86	5.39%	100%	
Total	1597*	100%	100%	

Research data
* Each company can select more than one answer, so the value exceeds the 300 companies surveyed.

Motivations for the implementation of sustainable practices are dominated by regulatory concerns, awareness of managers of their necessity and importance, and operational efficiency, as shown in Table 14.

Table 15
Benefits seen in the adoption of sustainable practices

Benefits	Absolute frequency	Relative frequency	Cumulative frequency	Standard deviation
Quality improvement	236	19.05%	19.05%	46.22
Best picture	209	16.87%	35.92%	
Improved management	157	12.67%	48.59%	
Growth	147	11.86%	60.45%	
Research and development improvement	143	11.54%	71.99	
Low cost	130	10.49%	82.48%	
Higher profitability	121	9.77%	92.25%	
Pioneering	96	7.75%	100%	
Total	1239*	100%	100%	

Research data
* Each company can select more than one answer, so the value exceeded the 300 companies surveyed.

The benefits observed in adopting sustainable practices predominantly are to improve the quality, image and management, as shown in Table 15.

Table 16
Respondents' perception of the profile of the adopted sustainable practices

Profile of sustainable practices	Absolute frequency	Relative frequency	Cumulative frequency	Standard deviation
Not very innovative	115	38.33%	38.33%	49.83
Fairly innovative	110	36.67%	75%	
Not innovative	32	10.67%	85.67%	
Very innovative	31	10.33%	96%	
Are the best practices for industry	10	3.33%	99.33%	
Did not answer	2	0.67%	100%	
Total	300	100%	100%	

Research data
* Each company can select more than one answer, so the value exceeds the 300 companies surveyed.

It is noted from Table 16 that in the perception of the subjects, not very innovative practices predominate (38.33 per cent), followed by fairly innovative (36.67 per cent). Only 3.33 per cent believe that their organizations adopt the best practices for the industry. The results of crossing the data resulting from this survey with the types of eco-innovation advocated by Dias (2014) and EIO (2013) are shown in Table 17.

Table 17
Results of crossed research typologies (Dias; 2014; EIO, 2013) of eco-innovation

Kind	Variables	Average	Standard deviation	Variance
Product	Q1_10	3.14	2.079	4.320
	Q1_11	2.51	1.912	3.657
	Q1_14	2.54	1.896	3.596
	Q1_20	2.50	1.976	3.904
	Q1_21	2.93	2.250	5.061
Process	Q1_1	4.04	2.112	4.462
	Q1_2	5.05	1.730	2.994
	Q1_3	5.99	1.558	2.426
	Q1_4	5.26	1.868	3.491
	Q1_9	3.20	2.101	4.413
	Q1_13	3.24	2.223	4.941
	Q1_15	2.50	1.973	3.891
	Q1_16	2.09	1.816	3.299
	Q1_18	4.23	2.226	4.957
	Q1_19	3,77	2.146	4.606
	Q1_25	3.17	2.464	6.070
	Q1_26	2.51	2.241	5.024
	Q1_27	3.70	2.410	5.809
	Q1_28	4.20	2.065	4.265
	Q1_29	3.62	2.238	5.009
	Q1_30	4.31	2.154	4.640
	Q1_31	3.41	2.266	5.136
	Q1_32	3.05	2.229	4.970
	Q1_33	3.03	2.182	4.759
	Q2_16	4.36	2.154	4.638
	Q3_1	5.81	1.690	2.856
	Q3_2	5.46	1.803	3.249
	Q3_3	5.58	1.634	2.670
Organizational	Q1_5	4.18	2.446	5.983
	Q1_6	3.05	2.289	5.238
	Q1_7	3.36	2.370	5.618
	Q1_8	4.25	2.076	4.308
	Q1_12	3.75	2.201	4.843
	Q1_22	3.61	2.326	5.412
	Q1_23	4.27	2.254	5.082
	Q1_24	3.67	2.350	5.520
	Q3_5	5.00	1.772	3.140
Marketing	Q2_17	4.16	2.147	4.610
	Q3_4	4.28	2.094	4.383
Social	Q1_17	3.71	2.093	4.380
	Q2_1	5.12	1.926	3.710
	Q2_2	5.41	1.898	3.602
	Q2_3	3.64	2.399	5.757
	Q2_4	5.36	1.771	3.137
	Q2_5	5.13	1.812	3.284
	Q2_6	5.51	1.895	3.591
	Q2_7	4.76	2.361	5.576
	Q2_8	5.06	2.018	4.073
	Q2_9	5.50	1.812	3.284
	Q2_10	4.89	1.972	3.887
	Q2_11	1.85	1.777	3.157
	Q2_12	3.94	2.140	4.580
System	Q1_34	3.76	2,428	5.894
	Q1_35	2.81	2.096	4.392
	Q2_13	3.76	2.102	4.418
	Q2_14	3.92	2.217	4.914
	Q2_15	4.75	2.060	4.243
	Q2_18	2.80	2.119	4.491
	Q2_19	4.55	2.163	4.678
	Q3_6	5.07	1.766	3.118

Research data

The analysis described in Table 17 shows that the surveyed companies have increased their investment in the social and marketing areas,

according to the perception of the subjects. Were evaluated the types of eco-innovation that obtained the highest average and lower standard deviations in the notes.

Such observations may imply that companies follow sustainable global trends to meet customer requirements, to have shocked the image and management. However, managers even acknowledge that these practices are not very innovative. What is your level of contribution to the sustainability of the planet and the balance of social, environmental and economic? The practices are aligned with the global guidelines of the United Nations Organization Units, which released guidelines for companies to become sustainable leaders?

Consistent with the assumptions of the report Sustainable Manufacturing and Eco-Innovation: Framework, Practices and Measurement ORGANISATION FOR ECONOMIC prepared by CO-OPERATION AND DEVELOPMENT (OECD, 2009)? Evidence mapped allow inferring that no effective concern for managers in making a difference with their actions.

There is rather a concern with regulatory issues and operational efficiency of industries - which are key elements to generate competitive advantage and contribute to cost reduction.

The main practical contribution that this study brings is to note that despite the different existing metrics to measure sustainability, highlighting the guidelines of the Global Reporting Initiative (GRI), managers still consider to be a major constraint to implement sustainability practices difficulty to measure their results. It had also highlighted the need for investments in infrastructure and corporate culture. From this perspective, a practical implication of this study allows to emphasize that the political interest in sustainability is a key element in promoting agile and effective changes. If the federal government of the country to impose provisional measures they enact benefits for industrial companies that choose to invest in sustainable practices, either through reduction of taxes paid, payment for services environmental services, other tax benefits, changes will occur in a rapid manner. Just the public involvement in decision-making spheres and creating policies that benefit society and not too much burden on entrepreneurs to promote change. Surely this kind of initiative will be vital to create a culture committed to sustainability. That way we will build a society that takes sustainability as a fundamental guideline for the management of competitive industries and create leaders in sustainability.

And so will distort the concept that sustainable practices are adopted to meet legal requirements and to promote businesses via marketing.

In need of improvement is innovation in products, as the average lowest and highest variance, followed by the organizational dimension.

Consideration of these findings of the study means it is relevant to propose an agenda of actions that can contribute to the promotion of the dimensions of ecoinnovation that currently have weaknesses. Thus, Table 18 shows the recommended improvements for the companies surveyed.

Table 18
Eco-innovation propositions for companies investigated

Kind	Eco-innovations suggested
Product	- Focus on the development of standardized products and rework, index and reprocess less - Launch green products - Focus on eco-design - Replace materials used in the manufacture of products (emphasis on reuse, recycling and closed production cycles) - Use biodegradable and environmentally friendly packaging - Join eco-labelling - Join eco-labels - Encourage scrap resale of products - Reduce the net cost of disposal of the product by the customer - Create booster campaigns with reverse logistics of depreciated products - Make better use of by-products generated in the production process
Organizational	- Adopt environmental and social accounting - Adopt pollution prevention measures - Adopt environmental management and environmental audit systems - Create systems of cooperation between companies to prevent environmental damage throughout the value chain - Develop analysis of the product lifecycle - Create collaborative business networks - Adopt industrial symbiosis solutions - Use renewable energy and recycle water

The authors, 2016

Final Considerations

The purpose of this study was to analyse the level of adoption of sustainable practices and eco-innovations deployed in the processes of industrial companies. The main conclusion of this research is that there is concrete evidence of adoption of sustainable practices and ecoinnovations in industrial companies. However, it was found that the adoption stages ranged from incipient adoption to full adoption. The subjects predominantly perceive little innovative practice (38.33 per cent) followed by fairly innovative practice (36.67 per cent). Only 3.33 per cent believe that their organization adopts the best practices for the industry. These results are in accordance with other studies on this subject, like Carter and Dresner (2001); Walker, Di Sisto and McBain (2008); Mont and Leire (2009); Mollenkopf et al. (2010); Bjorklund (2011) and Meixel and Luoma (2015).

The key drivers of the adoption of sustainable practices are improving the quality, image and management of the organization. Another conclusion of the research is that the motivations for the implementation of sustainable practices are dominated by regulatory concerns, awareness of managers of their necessity and importance, and operational efficiency. Motivation for implementation consists primarily of reactive practices that focus on meeting the assumptions of applicable laws for the industrial sector of activity. There are already signs of awareness of the need by managers and commitment to sustainability—and, of course, operational efficiency, which emphasizes reducing waste and cost in companies.

However, that sustainable practices and mapped ecoinnovation are directed towards social and marketing types shows a business concern in meeting assumptions regarded as relevant by the stakeholders and

disseminating the results of their actions to the community. More fledgling practices were mapped in the product and organizational areas: thus, they listed actions construed as relevant to consolidate this kind of ecoinnovation in enterprises.

Despite care over the rigour of scientific study, studies starting from the perceptions of the subjects surveyed do not have full capacity to measure the organizational reality of companies. Each subject has a perception of certain elements from according to their trajectory, their experiences, their training and their level of knowledge.

Thus, it is understood as a limitation of the study to measure the stage of adoption of sustainable practices and eco-innovations from the perception of only one subject from each research firm. It is known that this is a limitation of all research surveys working with databases from multiple businesses.

Future research could apply a multivariate structural equation in the data mapped in the study herein described to test hypotheses about relationships between latent and observed variables. Also, it may be useful to apply a cluster analysis technique to assess the sustainable performance of companies of different sizes.

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