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ESTRATÉGIA

ADOÇÃO DE ESTRATÉGIAS ECOINOVATIVAS NA INDÚSTRIA QUÍMICA BRASILEIRA

ADOPTION OF ECO-INNOVATION STRATEGIES IN BRAZILIAN CHEMICAL INDUSTRY

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RESUMO

Neste estudo são apresentados os resultados de pesquisa realizada na indústria química brasileira, que analisou a adoção de estratégias de ecoinovação. A metodologia envolveu um survey em 124 indústrias químicas de tamanhos variados, que operam em várias regiões do Brasil. Os resultados categorizaram as empresas com base nas dimensões dos adotantes de estratégias reativas de ecoinovação, ações ambientais e estratégias de ecoinovação proativas. Este estudo mostra que as empresas da amostra tinham maior tendência para desenvolver ações ambientais, que são práticas relacionadas ao uso de tecnologias end-of-pipe, para reduzir os recursos utilizados aos processos de trabalho administrativos e de produção. Isso sugere que as empresas consideram as questões ambientais em relação ao curto prazo, estratégias reativas. No entanto, adotando as questões ambientais a longo prazo, por meio das estratégias proativas, poderia revelar-se mais eficaz e promissor para o meio ambiente e as empresas.

PALAVRAS-CHAVE

Inovação Tecnológica. Ecoinovação. Estratégias Reativas. Estratégias Proativas. Indústria Química.

ABSTRACT

In this study we present the results of research conducted in the Brazilian chemical industry that analyzed the adoption of eco-innovation strategies. The methodology involved a cross-sectional survey of 124 chemical companies of various sizes operating in all regions of Brazil. The results categorized the companies based on the dimensions of the adopters of reactive eco-innovation strategies, environmental actions, and proactive eco-innovation strategies. This study shows that the sample firms had a greater tendency to develop environmental actions, which are practices related to the use of end-of-pipe technologies, to reduce the resources used for administrative work and production processes. This suggests that companies consider environmental issues in relation to short-term, reactive strategies. However, considering environmental issues as long-term, proactive strategies could prove to be more effective and promising for the environment and businesses.

KEYWORDS

Technologic Innovation. Eco-innovation. Reactive Strategies. Proactive Strategies. Chemical Industry.

INTRODUCTION

In recent decades, environmental concerns have been on the agenda for the scientific field of study, government policies, civil society organizations, and the business community. The competitive landscape for organizations is changing due to the necessity to pursue sustainability, requiring organizations to become environmentally friendly.

According to Freeman (1996), since the 1960s there has been widespread questioning of future possibilities for continuous economic growth due to the success of mass production, education, tourism, and increased consumption of goods and services. It was suggested that the world economy and population would collapse in the early twenty-first century due to this continuous growth and potential exhaustion of materials, pollution, and famine. Historically, the word sustainability was associated with development, "[...] in the mid-1980s, with the backdrop of the environmental and social crisis, and which since the early 1960s had begun to be perceived as a crisis of planetary scale" (BARBIERI, 2007, p. 92). Thus, a shortage of resources could cause a different pattern of growth that requires a significant reduction in consumption.

According to Fussler and James (1996), following a series of disasters in the 1980s, attention was focused on the health and environmental implications of the activities of the chemical and nuclear industries. To discuss these issues, the first World Conference for the Industry on Environmental Management was held in 1984 and again the second in 1991, which launched the Business Charter for Sustainable Development (SCHMIDHEINY, 1992). From these

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events that groups of entrepreneurs from various countries adhered to this charter, establishing codes of conduct for their environmental activities.

However, the concern for the environment increased in the 1990s, particularly in Brazil where the United Nations Conference on Environment and Development (UNCED) was held in Rio de Janeiro in 1992 (referred to as Rio-92 or Eco-92). These concerns were reflected in the chemical industry coming under pressure from regulators, NGOs, and society as a whole to improve its environmental performance (YOUNG; PODCAMENI; MACKNIGHT *et al*., 2009). In some organizations, managers understood "[...] the extent of their firms' impact on the environment and recognized that pollution stems from inefficient use of material and human resources" (HART, 1995, p. 992). This did not necessarily indicate "[...] a hypothetical diffusion of environmentally awareness [...]" (ROMEIRO; SALLES FILHO, 2001, p. 103) by organizations, but rather represented competitive goals.

Therefore, the aim of this paper is to analyze the adoption of eco-innovation strategies by chemical product industries in Brazil and categorize them into different dimensions of adopters. This work is part of a larger study to examine the various aspects of the relationship between contextual factors and the adoption of eco-innovation strategies in the chemical industry.

The study of this sector is justified by its high potential for pollution and use of natural resources (Brazil, 1981). Moreover, this sector is innovative according to the data from the Industrial Survey of Technological Innovation - PINTEC 2009-2011, in which 60% of the Brazilian chemical companies analyzed had introduced product and/or process innovations and 22% reported having implemented organizational and/or marketing innovations (IBGE, 2011b).

According to the Brazilian Institution of Geography and Statistics (IBGE) (2011a), manufacturing chemicals is one of the activities with the highest participation, 6.7%, among Brazilian industries. Chemical manufacturing is also one of the "[...] five industrial sectors of greatest share of value added in the domestic industry [...] [representing] about 48.5% of value added to Brazilian industry" (IBGE, 2011a, p. 7). According to the Brazilian Chemical Industry Association (ABIQUIM, 2013), in 2012 chemical manufacturing accounted for 2.8% in Brazilian total GDP and 10.5% in industry GDP. In 2011, Brazilian chemical manufacturing had net sales of 166 billion, which is 6th worldwide, behind China, the United States, Japan, Germany, and Korea.

Thus, the importance of the chemical industry to the development of the Brazil is extremely relevant. However, this industry is a potential polluter and user of natural resources demonstrating the value of studying strategies for eco-innovation.

This paper is organized as follows. The second section presents a literature review of the concepts and context of the integration of eco-innovation, as well as the issues related to the development of reactive and proactive eco-innovation strategies. The third section presents the empirical research methodology used to determine the sample collection techniques and data analysis. The fourth section presents the empirical analysis including the cleaning data details and an assessment of the reliability of the scales and sample characterization. The fifth section provides the Exploratory Factor Analysis (EFA) of the construct of eco-innovation strategies, followed by a descriptive analysis of the variables of the construct. The sixth and final section presents the conclusion with the main results and discussion.

LITERATURE REVIEW

Since 1990, scholars have argued for strategies for organizations to anticipate environmental problems and the limitation of natural resources for environmental remediation and to improve financial performance. Thus, appropriate environmental strategies could reduce environmental impacts and improve corporate reputation, which is transformed into satisfactory financial performance (ARAGÓN-CORREA; RUBIO-LÓPEZ, 2007).

In this context, eco-innovation reduces the environmental impact, whether intentional or not. The scope can be larger than the conventional boundaries of how companies innovate, such as being engaged in the broader social system and causing changes in the socio-cultural norms and institutional structures (ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT - OECD, 2009). Eco-innovation can be regarded as a change that benefits the environment, judged by improved economic and environmental performance (EKINS, 2010). Kemp and Pearson (2007, p. 7) defined eco-innovation as

> [...] the production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organisation (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use) compared to relevant alternatives.

In addition, according to the Organisation for Economic Co-operation and Development (OECD) (2009), eco-innovation can be further characterized as of marketing, organizational and institutional. Eco-innovations for products and processes tend to rely heavily on technological development, while for marketing, they depend more on non-technological development. According to Rennings and Rammer (2011, p. 257), "[...] an environmental innovation can also be an incremental novelty […] does not matter if environmental improvements have been the primary goal of a new product or process but whether an innovation produced positive environmental impacts." It is in this context that eco-innovation operates and is realized through the combination of technological and non-technological changes, often referred to as system innovations.

This study focuses on eco-innovation strategies in industrial companies, which may be related to the products, processes, marketing, and organizational strategies associated with environmental issues. According to Tidd, Bessant, and Pavitt (2008, p. 128), "a strategic innovation must adapt to a foreign environment that is complex and continually changing, with considerable uncertainty about current and future technological developments, competitive threats and market demands (among others)." Thus, organizations must be prepared to adapt their strategy when faced with new and unexpected market changes and or environmental restrictions, and eco-innovation is a strategic trend.

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Hart and Dowell (2011) described how these challenges require bold innovation, but most companies focus on incremental eco-innovation strategies, which are likely to be insufficient. Innovative strategies are needed to actually solve environmental problems, "[...] rather than simply reducing the negative impacts associated with their current operations" (HART; DOWELL, 2011, p. 13). Traditional approaches to sustainable production, such as end-of-pipe reactive strategies, are often costly and ineffective. More proactive actions, such as adopting cleaner production within the product life cycle or establishing a production system in a closed circuit (OECD, 2009) are necessary. Ashford (2005, p. 49) argued "[...] that production, consumption, environment, and employment ought to be *co-optimized* and considered simultaneously. This means technological, organisational, and social innovations need to be *proactive and anticipatory*, rather than reactive."

The end-of-pipe approach is traditionally considered reactive because these are one-off solutions at the end of the production process. According to Van Berkel (2000, p. 1), "end-of-pipe, pollution control, methods often result in increased costs with no appreciable benefits to the firm in terms of enhanced materials or energy efficiency." Buysse and Verbeke (2003, p. 454) further added that the "investments in end-of-pipe technologies reflect a reactive posture to environmental issues, whereby limited resources are committed to solving environmental problems: product and manufacturing process improvements are made to conform to legal requirements."

In the case of proactive strategies, preventive attitudes are considered for environmental issues with actions being performed throughout the product life cycle to prevent impacts and make conscious use of natural resources. "Pollution prevention implies that firms continually adapts their products and production processes in order to reduce pollution levels below legal requirements" (BUYSSE; VERBEKE, 2003, p. 454).

This proactive approach is a tendency for companies to initiate strategic changes in all activities in anticipation of environmental regulations and changes to their environment of operation (ARAGON-CORREA, 1998). "Therefore, proactive environmental approaches [...] are innovative and rare and can provide more valuable management capabilities for an organization than reactive approaches, placing the organization in a better competitive position than other firms in the same general business environment" (ARAGON-CORREA; SHARMA, 2003, p. 80).

Therefore, based on the literature, proactive approaches to manufacturing processes are needed so that change can be considered as an opportunity for organizations, and not as a cost or threat. Thus, eco-innovation can be seen as appropriate for sustainability and as an ally in the development of preventive technologies.

METHODOLOGY

The methodology of this study consisted of a cross-sectional survey of chemical manufacturing companies of various sizes and from various regions of Brazil. Data were collected from April to June 2014 using a computerized questionnaire sent by the Qualtrics® system. The questionnaire was designed by Maçaneiro (2012), and minor adjustments and some changes of scale were made. Based on these modifications,

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a validation was conducted by three doctorate professors from the innovation and technology area. A pre-test was also conducted with two industrial managers responsible for environmental management, which resulted in some improvements. Statistical analysis of the reliability of the scales is presented in the next section.

Respondents invited to participate in the research were preferentially managers, directors, or business owners responsible for the area, sector, or division of environmental management. The survey sample was non-probable (non-random), meaning that the probability of the elements being selected from the population was not the same. The sample was defined by membership, in which certain people were invited to answer the questionnaire and could decide whether to participate (COOPER; SCHINDLER, 2011).

Data analysis of the survey was based on the descriptive statistics from the statistical package Statistical Package for the Social Sciences (SPSS). In short, specific tests for each type of analysis, such as graphical analysis, analysis of missing values, Exploratory Factor Analysis (EFA), the Kaiser-Meyer-Olkin test, the Bartlett's sphericity test, and reliability analysis of the scales by Cronbach's alpha, were performed, along with descriptive analysis of the measures of central tendency (mean), dispersion (standard deviation), and shape (skewness and kurtosis).

This analysis was based on the construct of eco-innovation strategies presented in the study designed by Maçaneiro (2012) with minor changes. The original construct consisted of 13 variables and the study was subdivided into reactive and proactive strategies.

EMPIRICAL ANALYSIS

This section first details cleaning the data, assessing the reliability of the scales, and sample characterization. Next, the EFA of the construct of eco-innovation strategies is presented as well as a descriptive analysis of the variables that make up the construct.

Cleaning the Data, Reliability Assessment of Scales and Sample Characterization

The population consisted of 1,144 companies operating throughout Brazil, from which we obtained e-mail and telephone data. From this population of firms, 144 accessed the Qualtrics® system to respond to the questionnaire, but only 127 of them completed the entire questionnaire. The 17 companies that were excluded from the analysis had started but not finished the questionnaire. Missing values were not detected since the Qualtrics® system prevents the respondent from failing to answer any of the response options.

Prior to executing the data analysis, validation and data cleaning were performed by checking each variable through a Boxplot chart. Three outliers were detected among the responses, which were then excluded from the analysis. Therefore, **the final sample was 124 companies**. To calculate the normality of the data in this sample, Cooper and Schindler (2011, p. 485) parameters were used, because "when the sample size approaches 120, the sample standard deviation becomes a very good estimate of the population standard deviation (σ); beyond 120, the distributions T and Z are literally identical."

To initially characterize the sample, the country of origin of the companies participating in the research was determined. From the 124 companies, 113 were from Brazil; three from the United States; two from Germany; two from France; and one each from Saudi Arabia, Denmark, and Spain, plus one joint venture between Brazil and Austria.

Other characteristics of the data indicated that the majority, 81%, of the companies had an exclusively national capital controller. Furthermore, the time that the company had operated in the market (mean age) was around 31 years, and had between 5 and 102 years of business operation.

Regarding size, the majority of the responding companies, 46%, were small according to the SEBRAE criterion (2014) of having 20 to 99 employees. Another significant portion was medium-sized companies, 35%, with 100-499 employees. The micro-sized companies were also significant, 19%, with up to 19 employees. The sample did not include large companies, which have over 500 employees.

Concerning market performance, most of the respondent companies operated in the domestic market (71%), followed by the state (14%), international (12%), and the location (3%), which was regarded as having coverage up to 200 kilometers from the company. It is noteworthy that the market defined by the companies is according to their highest acting in the sector.

Exploratory Factor Analysis of the Construct of Eco-innovation Strategies

It was also used the multivariate statistical technique of Exploratory Factor Analysis (EFA) to determine if the construct of the strategies for eco-innovation were proactive or reactive. Although this technique was also used in the study designed by Maçaneiro (2012) that was adopted for this construct, factorial analysis was conducted since this research was of a different sector of activity. In other words, the EFA was conducted to prove whether this differentiation works in terms of the adoption of proactive and reactive strategies.

In terms of operation, the tendency to develop strategic eco-innovation was determined by using 13 variables measured on a five-point Likert scale. Respondents were asked to assess the degree of their company's environmentally related strategies, based on the variables shown in Table 1. The results of the measurement of the adequacy of factor analysis by the Kaiser-Meyer-Olkin test (KMO) were 0.759, which is considered a good value, indicating that the EFA was suitable. In addition, the Bartlett's sphericity test was highly significant where p equaled 0.000 (FIELD, 2009). Thus, the factor analysis first conducted with two factors was not adequate, but the test indicated an adaptation of the construct for loading three factors, as shown in Table 1.

As shown in Table 1, the variable order is non-sequential, but is in accordance with the load of each of the factors. According to Hair Jr., Babin and Money *et al.* (2005, p. 396),

> [...] the higher the absolute value of a load factor, the more important it is in naming and interpretation of a factor. Typical guidelines used by researchers in management for important factor loads are: + / 0.30 are considered acceptable; + / 0.50 are moderately important; + / 0.70 are very important.

Most of the factor loadings ranged from

TABLE 1 – Exploratory Factor Analysis (EFA) of the Construct of Eco-innovation Strategies

Factor	Variables		Loading			Explanation of Variance
1	Var12	Company offers environment development programs for managers and employees	0.818			22%
	Var10	Company performs environmental analysis for the life cycle of its products.	0.724			
	Var11	Company performs partnerships/agreements with other companies/ institutions for environmental actions.	0.702			
	Var09	Company performs environmental supervisions periodically.	0.627			
	Var13	Company invests in a prevention system for environmental accidents that may occur.	0.583			
	Var06	Company uses marketing resources for environmental management issues.	0.509			
2	Var04	Company invests in environmental actions and technologies only as a strategy to solve problems with activists and the media.		0.835		21%
	Var03	Company invests in environmental actions and technologies only to comply with environmental legislation.		0.799		
	Var05	Company considers environmental management as an additional cost that can damage business growth.		0.724		
	Var01	Company is only concerned with pollution by the end of the production process, using remedy technology, such as degraded soil decontamination.		0.671		
3	Var07	Company develops environmental actions in administrative work, such as paper recycling, recycled material use, material use reduction, and energy reduction.			0.766	16%
	Var02	Company acquires only pollution control technologies (end-of-pipe), which the main goal is to treat pollution before it is thrown in the environment, such as effluent treatment stations, cyclones, electrostatic precipitators, filters, and incinerators.			0.712	
	Var08	Company develops environmental actions in the productive work, such as residual reduction, renewable energy use, water reuse, treatment and safe discharge of dangerous residual contents, CO2 production reduction, and raw material reuse.			0.698	

Source: Prepared by the authors.

moderately important to very important, as shown in Table 1. Following the EFA and the characteristics of the variables of each factor, three dimensions of the construct of eco-innovation strategies were named and defined as:

i. The reactive dimension of eco-innovation strategies, composed of the variables of factor 2, and defined as responses to environmental regulation, with concerns only in the remediation of damage without major changes to their processes and products (static practices);

ii.The dimension of environmental actions, composed of the variables of factor 3, and having practices to reduce consumption in administrative work and production processes with pollution control technologies (short-term strategies);

iii. The dimension of proactive

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eco-innovation strategies, composed of the variables of factor 1, and defined by voluntary pollution prevention practices that involve continuous learning and create competitive advantage (long-term strategies).

Although the total variance was around 59%, the number of factors is justified because they are theoretically significant and explain the original variance (HAIR JR.; BABIN; MONEY *et al*., 2005). Furthermore, this variance was above that of the study by Maçaneiro (2012), which was 57%, and is justified by the option of determining the number of factors as defined in the literature.

Considering the changes to the original construct, it was necessary to verify the reliability of the scales. This was performed by using the indicator of internal consistency Cronbach's alpha, which calculates the mean correlation of the attributes that design the scales, or the degree to which the items that comprise the scales are integrated. The results are shown in Table 2.

The dimensions of the construct of reactive and proactive strategies for eco-innovation had Cronbach's alpha values above 0.7, which is considered a good level of reliability based on the parameters of Hair Jr., Babin and Money *et al*. (2005). The dimension of the construct of environmental actions had a moderate loading, but was also acceptable for the analysis, because, according to Malhotra (2006, p. 277), it was at least 0.6, while lower values may indicate unsatisfactory internal consistency. Therefore, the dimensions of the constructs proved reliable in term of scales.

Therefore, the results of the EFA proved to be different from those from the study designed by Maçaneiro (2012), resulting in the expansion of the types of eco-innovation strategies to include the dimensions of reactive eco-innovation strategies, environmental actions, and proactive eco-innovation strategies. This extension details the strategies and analysis that can be used more appropriately.

Descriptive Analysis of Constructs Variables

A descriptive analysis of the construct was performed to calculate the measures of central tendency (mean), dispersion (standard deviation), and shape (skewness and kurtosis). These aspects of the component variables of each dimension of the construct of eco-innovation strategies are presented and analyzed in Table 3.

As Table 3 indicates, the means of the variables that comprised the reactive strategies are smaller than those that comprised environmental actions and proactive strategies. However, the highest means were calculated for environmental actions, suggesting that they are more effectively used by companies than proactive and reactive strategies. These values are visualized in Figure 1.

TABLE 2 – Reliability of Scales Dimensions of Construct of Eco-innovation Strategies

Dimensions	Number of Variables	Cronbach's Alpha
Reactive Eco-innovation Strategies	4	0,772
Environmental Actions	3	0,613
Proactive Eco-innovation Strategies	6	0,776

Source: Prepared by the authors.

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TABLE 3 – Mean, Standard Deviation, Skewness, and Kurtosis of Construct Indicators of Eco-innovation Strategies

Dimension/Variable			Mean	Standard Deviation	Skewness	Kurtosis
Reactive Strategies	Var01	Company is only concerned with pollution by the end of the production process, using remedy technology, such as degraded soil decontamination.	2.21	1.061	0.606	-0.668
	Var03	Company invests in environmental actions and technologies only to comply with environmental legislation.	2.86	1.107	0.130	-1.006
	Var04	Company invests in environmental actions and technologies only as a strategy to solve problems with activists and the media.	2.21	0.904	0.577	-0.009
	Var05	Company considers environmental management as an additional cost that can damage business growth.	2.28	0.959	0.754	0.330
Mean			2.39			
Dimension/Variable			**Mean**	**Standard Deviation**	**Skewness**	**Kurtosis**
Environmental Actions	Var02	Company acquires only pollution control technologies (end-of-pipe), which the main goal is to treat pollution before it is thrown in the environment, such as effluent treatment stations, cyclones, electrostatic precipitators, filters, and incinerators.	3.35	1.155	-0.455	-0.846
	Var07	Company develops environmental actions in administrative work, such as paper recycling, recycled material use, material use reduction, and energy reduction.	4.07	0.828	-1.359	2.833
	Var08	Company develops environmental actions in the productive work, such as residual reduction, renewable energy use, water reuse, treatment and safe discharge of dangerous residual contents, CO2 production reduction, and raw material reuse.	3.99	0.860	-0.997	1.113
Mean			3.80			
Dimension/Variable			**Mean**	**Standard Deviation**	**Skewness**	**Kurtosis**
Proactive Strategies	Var06	Company uses marketing resources for environmental management issues.	2.64	1.046	0.127	-0.797
	Var09	Company performs environmental supervisions periodically.	3.07	1.237	0.070	-1.027
	Var10	Company performs environmental analysis for the life cycle of its products.	2.96	1.143	0.213	-0.809
	Var11	Company performs partnerships/agreements with other companies/ institutions for environmental actions.	3.08	1.138	-0.194	-0.950
	Var12	Company offers environment development programs for managers and employees	3.15	1.087	-0.139	-0.740
	Var13	Company invests in a prevention system for environmental accidents that may occur.	3.72	1.017	-0.728	-0.046
Mean			3.10			

Source: Prepared by the authors.

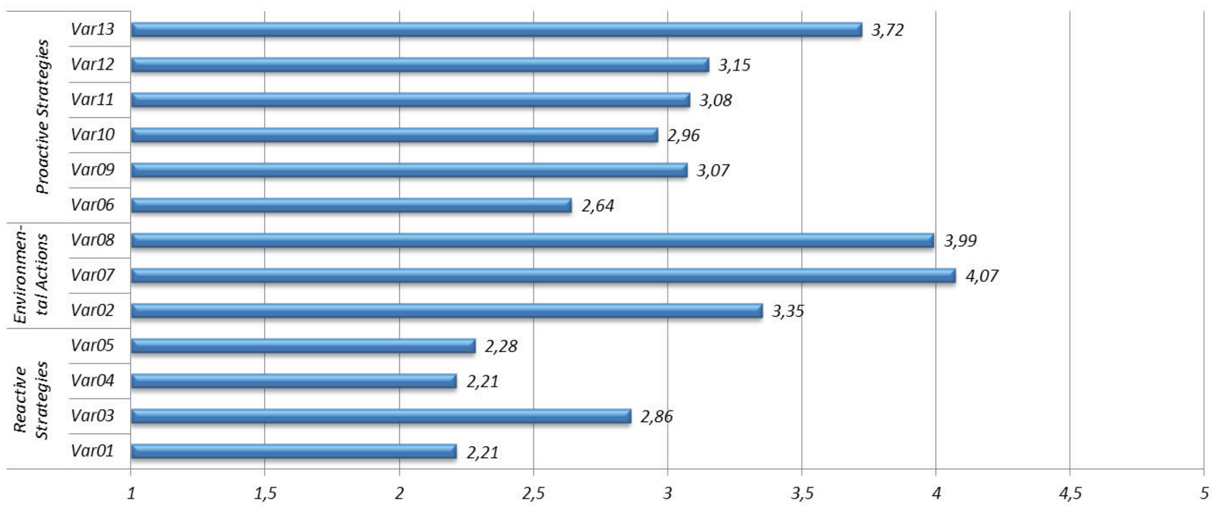

FIGURE 1 – Mean of Response to Variables of the Construct of Eco-innovation Strategies

Source: Prepared by the authors.

As shown in Figure 1, the highest means are concentrated on the development of environmental initiatives in administrative and productive work (Var07 and Var08), which are those basic procedures to reduce environmental impacts on the organization. The lowest means are for the concerns about pollution at the end of the production process (Var01), investment in technology and environmental initiatives as a strategy for solving problems with activists and the media (Var04), and concern from the companies that the management environment is an additional cost and a threat for business growth (Var05).

As for the descriptive analysis of Table 3, the values of the standard deviations indicate some consistency among the respondents. Some figures in the construct are slightly asymmetric negative, tending to the right of the distribution, while others are asymmetric positive, with a greater distribution towards the lower end of the scale. It appears that Var09 had close to perfect symmetry. It should also be considered that the asymmetry of Var07, which is above -1, indicates a substantially skewed distribution (HAIR JR.; BABIN; MONEY *et al*., 2005). In kurtosis, a negative value shows that the variables are somewhat concentrated around the mean (spread) with high variation, while positive values indicate the existence of concentration around the mean (peak) and low variation. Variables Var04 and Var13 had a kurtosis most resembling a normal curve.

CONCLUSION

This paper discussed determining the eco-innovation strategies used to address environmental issues. It analyzed the adoption of eco-innovation strategies in chemical product companies active in Brazil to categorize the different dimensions of adopters.

Unlike the previous study (MAÇANEIRO, 2012), the types of eco-innovation strategies were extended to include three dimensions: i) the dimension of reactive eco-innovation strategies, comprising the companies that adopt strategies in response to environmental regulations, concerned

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only with the remediation of damage without major changes in their processes and products (static practices); ii) the dimension of environmental actions, consisting of companies that adopt practices to reduce consumption in administrative work and production processes with pollution control technologies (short-term strategies); iii) the proactive eco-innovation dimension strategies, consisting of companies with voluntary pollution prevention practices that involve continuous learning and create competitive advantage (long-term strategies). It is inferred that this expansion details the most appropriate forms of eco-innovation strategies, through which the context of adoption can be explored in more depth.

In the descriptive analysis of the variables, these dimensions had different means. The least was the reactive strategies (2.39), middle was the proactive strategies (3.20), and the greatest was environmental actions (3.80). These means indicate that the sampled companies were more likely to develop environmental initiatives, which are practices related to the use of end-of-pipe methods and the reduction of resources in administrative work and production process technologies. These actions are more considered by companies than proactive eco-innovation strategies, such as voluntary actions to prevent pollution and environmental impacts, as well as conducting an environmental analysis of product life cycles, environmental marketing resources, environmental supervision, partnerships and arrangements for environmental initiatives, programs of environmental education for employees, or systems to prevent environmental accidents.

This suggests that companies still consider a relationship of environmental issues with short-term, reactive strategies. However, long-term, proactive strategies could be more effective and promising for the environment and businesses. Considering that the sample companies attributed less importance to reactive strategies, which represent more static practices, as responses to regulatory requirements, activists, and the media, it can be inferred that they are in the intermediate stage of adopting eco-innovation strategies.

Therefore, this paper contributes to the advancement of knowledge in the area of eco-innovation strategies, bringing empirical evidence of an industrial sector that has high pollution potential and use of natural resources. It was anticipated that these companies would adopt more proactive strategies, which would prove more suitable to minimize the use of natural resources and position the companies competitively.

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