Sustainability in Manufacturing: Environmental Performance in the São Paulo Metropolitan Area

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Abstract

The rapid urban development observed in major cities has made the lessening of the resulting environmental impacts a key objective for sustainable development. As a consequence, companies have been required to consider economic, environmental and social actions in their culture, strategies and decision-making processes. The Sao Paulo Metropolitan Area is one of the largest urban zones in the world, accommodating more than 20 million inhabitants, 10 million motor vehicles and the most intense industrial activity in South America. As a result, environmental concerns have imposed severe environmental requirements to the industries located in the region. Hence this paper aims to evaluate to what extent the manufacturing companies are responding to those challenges. This was done through a survey considering 63 manufacturing firms of different sizes and from several sectors located in the area. The statistical analysis performed and the results of the research suggest that in the São Paulo Metropolitan Area the actions taken by the industries in general to face their ecological challenges have been effective and surpass in several ways the law enforced environmental demands. Comparisons among researched firms also allowed a better understanding of their respective environmental performances and how they are responding to the environmental issues they have been facing.

Keywords: environmental performance; industrial pollution; sustainable development; Sao Paulo; Brazil.

1 Introduction

The environmental impacts of urban enlargement have been extensively analyzed, showing adverse effects on air, water, and soil (Brehemy, 1992; Camagni et al., 2002; Pare´s-Franzi et al., 2006). In fact, as production and consumption expand, environmental degradation is intensified (Jabbour and Santos, 2008), which makes the reduction of the environmental impacts resulting from accelerated urban expansion a key objective for sustainable development (Pare´s-Franzi et al., 2006). As a result, businesses in general have been pushed to incorporate economic, environmental and social performances in their culture, strategies and decision-making processes (Brent and Visser, 2005).

The Sao Paulo Metropolitan Area (SPMA) is one of the largest urban zones in the world, accommodating more than 20 million people or about 10% of the Brazilian population in only 7,943 Km^2 of geographic space (0.09% of the country territory) (IBGE, 2010). The region has a fleet of more than 10 million motor vehicles and the most intense industrial activity in Brazil, with more than 2,000 thousand industries with high pollution potential (PRODESP, 2010). As a result of such enormous human concentration and dense economic activity, environmental issues could be expected. In fact, in 2009 emissions in the SPMA amounted to 1.6 million tons of carbon monoxide, 382 thousand tons of hydrocarbons, 376 thousand tons of nitrogen oxides, 63 thousand tons of particulate material and 26 thousand tons of sulfur oxides (CETESB, 2010). It is true that most of those emissions are motor vehicle related (Tavares et al., 2011). However, in order to minimize pollution problems, public authorities have put a lot of pressure on the industrial sector.

Hence the main purpose of this paper is to analyze to what extent the industries located in the SPMA are responding to current environmental challenges. This has been done through a survey considering 63

industries of different sizes, from several sectors, nationals and multinationals. The results obtained allowed the understanding of the current environment related practices actually employed by the researched industries in the area and how they contribute to their present environmental performance.

2 Environmental Performance Evaluation

In summary, sustainable development can be understood as meeting the needs of the current generations without impeding future generations to meet theirs (Smith and Rees, 1998). The sustainable development cannot be achieved without the effective implementation of environmental management in companies, where it has become critical for their survival in a competitive globalized world (Preston, 2001). Thus, business sustainability requires the integration of the three pillars of sustainable development (social justice, economic efficiency and environmental performance) into a company's operational practices. Firms have been increasingly demanded by external stakeholders to commit to and report on their respective sustainability performances of operational initiatives (Labuschagne et al., 2005).

According to Srebotnjak (2007), many different definitions of environmental performance exist. However, the ISO 14001 standard – environmental management system specification and use – defines the environmental performance as *"measurable results of an organization's management of its environmental aspects"* (ISO, 2004). According to May et al. (2002), companies should know their respective environmental performance in order to formulate proper environmental policies, plans, and programs for their activities. Furthermore some scholars have developed researches on the correlation between environmental and business performances. For instance, results from Klassen *et al.* (1996), King and Lenox (2001) and Koner and Cohen (2001) indicate that businesses with better environmental performance and less pollution have shown a higher financial performance.

To help organizations to measure their environmental performance, the International Standard Organization (ISO) has developed the ISO 14031 standard – environmental management and environmental performance evaluation and guidelines (ISO, 1999). According to ISO, the environmental performance evaluation is *"an internal process and management tool designed to provide management with reliable and verifiable information on an ongoing basis to determine whether an organization's environmental performance is meeting the criteria set by the management of the organization"*. Therefore, environmental performance evaluation is considered a process and a tool dealing with the utilization of indicators (Jasch, 2000; Tsoulfas and Pappis, 2008). ISO 14031 also proposes a methodology to measure the environmental performance of companies in terms of definitions, working structure, and different kinds of quantitative indicators such as environmental performance indicators, management performance indicators and operational performance indicators. As can be noticed, indicators are the main tools of this standard, and are defined as the *"specific expression that provides information about an organization's environmental performance"* (ISO, 1999).

Despite an increasing focus on various environmental performance indices at the national, sectorial and company level (Srebotnjak, 2007; Mayer, 2008), unfortunately the environmental performance measurement remains one of the greatest challenges for the organizations (Johnston et al., 2001) because a factor often neglected is the uncertainty of measurements in relation to the indicators used. On the other hand, the uncertainty of raw data is a critical issue, because an indicator can only reveal a true picture of the environmental performance if it is based on good-quality data (Perotto et al., 2008).

In addition, the basic objective of environmental performance evaluation through the use of indicators is to assure that industrial activities evolve in line with sustainable principles which are acceptable to society and the environment. In practice, environmental performance indicators may be used in several decision situations by internal and external stakeholders to assure a continuous process of environmental impact reduction either in products or in processes. Internal stakeholders require detailed indicators to monitor and control the environmental performance of their products and activities in the business processes. Conversely the external stakeholders need broader indicators that enable them to put pressure on the company for a continuous improvement of firm's environmental performance (Thoresen, 1999).

3 Methodology

As stated before, the main purpose of this paper is to investigate to what extent the industries located in the SPMA are responding to current environmental challenges. To do that, the authors decided to scrutinize which are the key environmental practices being executed by the industries in the area and how those practices could express the environmental performance of each one. Also, to investigate the relationships between the firm's environmental performance and some of their key characteristics the following research questions were posed:

RQ1. Does companies having ISO 14001 certification would have a better environmental performance than those that do not have it?

RQ2. Does the discipline imposed by other certification other than ISO 14001 influences environmental performance?

RQ3. Do the multinational companies have a better environmental performance than the Brazilian national firms?

RQ4. When considering the environmental performance, does firm size matter?

RQ5. Do companies belonging to the auto industry have better environmental performance when compared to other industrial segments?

In order to evaluate the environmental practices employed by the industries in the SPMA and the aforesaid research questions, a survey was conducted as per Forza (2002). For this purpose a questionnaire with closed questions was sent by e-mail to the person in charge of environmental management in 150 industries randomly chosen in the list of the industrial companies associated to the São Paulo Industrial Federation and located in the research area. Subsequent phone contacts by the researchers requested for the questionnaire fulfillment. From the total sent, 63 or 42% were received back dully answered and were used to support the analysis and findings considered by this paper.

The questionnaire comprised 11 questions covering: a) current environmental license status (1 question); b) solid and liquid waste disposals (4 questions); c) environmental consideration in product design, manufacturing process and purchasing (3 questions); d) potential pollution problems affecting the neighborhood (1 question) and e) environment as a key strategic factor (2 questions). Each question presented for the potential interviewees five statements describing different approaches for each one of the subjects considered. Those statements described typical practices ranging from those with high level of environmental awareness / commitment (best practices) to those involving no environmental concern at all (worst practices).

Even though the literature provides several alternatives to measure the environmental performance of a company (Verfaillie and Bidwell, 2000; OECD, 2002, 2005; Huppes and Ishikawa, 2005; Styles et al., 2009a, 2009b;), this study proposes an environmental performance evaluation method based on the best environmental practices actually used by organizations. This approach identifies which are the environmental practices being utilized by a given company in predefined areas and grants a certain number of points to each one. A maximum number of points is given to those practices reflecting high environmental commitment and a minimum number of points is granted to those practices involving no environmental concerns at all. Proportional points are given to different situations in-between those two extremes. Adding all the points obtained by a particular company, it will be possible to calculate a score that could be a measure of its environmental performance. Hence, to measure the company environmental performance, 5 points were granted to each question where a best practice was selected by the interviewee. On the other hand, 1 point was considered whenever the answer indicated a non-environmental related practice. For the other 3 intermediate alternatives, 2, 3 or 4 points were granted depending on the statement chosen. The overall environmental performance of a given company was measured by adding the points obtained by the 11 questions answered, ranging, as a consequence, from a minimum of 11 points to a maximum of 55.

Returned questionnaires were tabulated and data were processed using the Statistical Package for Social Science for Windows Version 13 (SPSS, SPSS Inc., Chicago, IL, USA). Analyses performed included, where appropriate: descriptive statistics and hypotheses testing using two samples mean comparisons through an independent t test and several sample mean comparisons applying the one way ANOVA. Significant coefficients were identified at $p<.05$ as per Dancey and Reidy (2007).

4 Results and Discussions

As alluded to before, the survey was answered by 63 companies with the following characteristics: a) ownership: 23 are subsidiaries of multinational companies operating in Brazil and 40 are national firms; b) size: 15 are small (less than 100 employees), 26 are medium (between 100 and 499 employees), 13 are big (between 500 and 1,999 employees) and 9 are very big (more than 2,000 employees); c) industrial sector: 17 belong to the automotive sector, 5 to the electrical component manufacturing, 25 to the metal-mechanical segment and 16 to other 12 different industrial activities; and d) certifications: 25 of the researched companies have both ISO 9001 and ISO 14001 certifications, 30 are only ISO 9001 certified, 2 have only ISO 14001 and 6 do not have any ISO certifications.

Initially the survey results are evaluated on a question by question basis. Here the objective is to identify the most common environmental practices used by the researched companies and their influence on their respective environmental performance. Then statistical analyses are developed to evaluate if variables such as ownership, size, industrial sector or quality and environmental certifications could induce different environmental performance on the researched companies. This is called the performance comparisons.

4.1 Question by Question Analysis

After analyzing the returned questionnaires it was possible to group the results as summarized in Figure 1, where A represents the statement reflecting the best environmental practice and E the worst. B, C and D represent statements with intermediary environmental concerns. The first question posed for the interviewees asked about the current status of their companies' environmental license. 59 (94%) of the companies indicated that their license is in full compliance with local legislation, showing that being legally accountable is a major concern among industries in the SPMA. From the remaining 4 companies, 1 affirmed that it is in process of fixing pending problems and only 3 small companies stated that they do not have the necessary documentation.

In relation to dangerous solid wastes, 15 firms (24%) indicated that they do not generate any. From the remaining 48, 47 (98%) said they provide an adequate waste disposal in accordance with local regulations and under direct supervision of the environmental authorities. The other company stated that it disposes the dangerous solid wastes according to the legal requirements, but with no previous authorization from environmental authorities. No other environmental issues have been reported here.

19 companies (30%) mentioned that they do not generate any industrial effluents besides conventional sewage material. From the other 44, 24 (55%) indicated that they perform an adequate treatment prior to returning the effluents to the environment since they do not reutilize them in the manufacturing process. 6 firms (14%) do some reutilization and the remaining 14 (32%) fully return the effluents for further use. As can be noticed, all the researched companies provide an adequate effluent disposal. Only the effluent reutilization degree varies among them.

The situation is not that comfortable in relation to sewage disposal. 43 companies (68%) either have their own treatment plant reutilizing the water (13 firms or 20%) or dispose the sewage effluents into the public system where proper treatment is done (30 companies or 48%). 10 (16%) said they dispose the sewage effluents into the public system, but they end up in a nearby river with no treatment at all. The remaining 10 (16%) indicated they dispose sewage material in septic tanks or directly into a nearby river.

		Adequate environmental licensing	Adequate solid waste disposal	Adequate effluent disposal	Adequate sewage disposal	Adequate non-industrial garbage disposal	Environ'l considerations in product design	Environ'l considerations in mfg. process design	Environmental considerations in purchasing	Relationship with neighboring communities	Environment protection as its own initiative	Environment protection as a key strategic thrust
Best environmental practice	A	59	15	19	13	42	32	53	12	48	41	27
	B	0	47	14	30	14	12	4	15	15	16	15
	C	0	1	6	4	2	12	0	11	0	2	0
	D	1	0	24	6	3	1	6	20	0	3	20
Worst environmental practice	E	3	0	0	10	2	6	0	5	0	1	1
	Total	63	63	63	63	63	63	63	63	63	63	63

Figure 1: Number of companies indicating environmental practices currently in use (A represents the statement reflecting the best environmental practice and E the worst. B, C and D represent statements with intermediary environmental concerns).

As far as the non-dangerous solid wastes are concerned (manufacturing, general garbage and organic materials), 42 companies (67%) reported that they perform the waste separation and send it for recycling purposes. 61 (97%) have their scrap and non-organic garbage removed by third parties for adequate disposal in authorized landfills. Organic wastes are removed by the municipal garbage collection services. Only two firms stated that they send both organic and inorganic wastes for an unauthorized location.

Considering now the product design, 56 companies (89%) indicated that they take into account environmental aspects when designing their products. However, only 31 (49%) consider the environmental impacts resulting from product discharge after its useful life. The remaining 24 (38%) assume that the product final destination is a final consumer's responsibility. Only 6 firms (10%) do not take into consideration environmental issues when they design their products.

On the other hand, in the manufacturing process design the situation is much better. 57 companies (90%) consider raw material / energy conservation along with toxic material elimination, reduction (on the quantity and toxicity) of wastes and gas emissions when designing their manufacturing processes. Only 6 firms (10%) stated that they do consider environmental constraints in their manufacturing process but as long as they do not adversely affect their manufacturing costs.

The purchasing process was also questioned in the survey. 58 firms (92%) consider to some extent the environmental aspects as part of their purchasing process. From this total 12 companies (19%) indicated they purchase materials and services exclusively from vendors having some kind of environmental certification. Other 15 (24%) adopt the same approach but only for items with high pollution potential. The remaining 31 (49%) stated that they have preference for environmental certified vendors provided they have the same commercial conditions as the non-certified sources. Only 5 (8%) firms declared that they do not consider environmental aspects as part of their purchasing process.

The next question was about the relationship the researched company has with their neighboring community considering eventual pollution caused. 48 firms (76%) reported not having any kind of problems at all. The other 15 (24%) indicated that some eventual and minor complaints from neighbors have been reported, but the situation has been quickly settled with no adverse impact on their community relationship.

In relation to the environmental practices used by the searched companies, 59 firms(93%) assured that they were the result of their own an initiative, inspired by the understanding that: a) environment protection is one of the pillars of sustainability (41 companies or 65%); b) modern companies should be concerned with protecting the environment (16 or 25%) and c) this is a concept already adopted by most of their competitors (2 or 3%). 3 firms (5%) indicated that environmental practices have been imposed by their clients and only one company declared not being concerned with environmental issues.

42 companies (77%) assured that environment protection is one of their key strategic elements, which has been perceived by both internal and external stakeholders. 20 (32%) declared that they are concerned with environmental aspects but they are not part of their strategic thinking. Only one company stated that it is not concerned with environmental issues.

As stated before, a given company environmental performance was measured by granting 5 points to each question where a best practice was cited by the interviewee. Also, whenever the answer selected a non-environmental related practice, 1 point was considered. For the other 3 possible alternatives, 2, 3 or 4 points were granted depending on the statement selected. The overall company environmental performance was measured by adding the points obtained by the 11 questions. Applying those assumptions to the 11 questions answered by each one of the 63 companies included in the survey, it was possible to calculate their respective environmental performance. Considering all the 63 firms, the following descriptive statistics for their environmental performance were calculated using the SPSS for Windows 13.0 software: a) performance range: minimum 29 (compared to a possible minimum of 11) and maximum 53 (against a possible maximum of 55); b) sample distribution mean 45.1; c) sample distribution median 46.0; d) sample distribution standard deviation 5.04; e) 95% confidence level interval for the mean $43.8 < \mu < 46.4$. The statistical analysis also indicated that the environmental performance is normally distributed around the mean.

As can be seen, the environmental performances of the industrial companies located in the SPMA show that the ecological concerns represent a lot more than conventional corporate speech. Environmental-friendly practices have been actually used to a great extent by the majority of industrial firms in the area, despite their size, ownership or the industrial sector they belong. And better. This is not the result of law enforcement, since many of the practices described are not imposed by the environmental laws. Some examples follow: a) there is no legal obligation for the companies to select and recycle non-industrial garbage, but 42 out of 63 researched companies (67%) do that; b) there is no provision in the Law requiring environmental considerations when defining manufacturing processes. However 53 firms (84%) indicated they are concerned with conservation of material and energy, elimination of toxic wastes and reduction of toxicity and quantity of wastes and emissions when they develop the fabrication processes for their products; c) the environmental legislation does not impose rules for the company relationship with the community nearby their plants. 48 firms (76%) expressed deep concerns in relation to maintaining their neighboring public immune to eventual pollution problems caused by their manufacturing operations. Therefore, it seems that increased ecological awareness could be considered as a possible source for several of the environmental initiatives taken by the local industries.

4.2 Performance Comparisons

RQ 1. The data collected in the survey also enable some interesting comparisons. Initially it would be a fair expectation that companies having ISO 14001 certification would have a better environmental performance than those that do not have it (Fortunski, 2007). Assuming this statement as a research hypothesis, it was tested to verify if it could be accepted at a significant level of confidence. In fact calculating the environmental performance for the ISO certified companies it was possible to obtain a 46.9 mean and a 3.0 standard deviation. For the other firms, the mean was 43.8 and the standard deviation 5.8. But in other to verify if there is an actual statistical difference between the two means, an independent t test was conducted comparing the environmental performance mean for the 27 ISO 14001 certified companies with the mean for the other 36 firms. Using the SPSS for Windows 13.0 it was possible to obtain the results shown in Table 1.

Table 1. Independent t test for equality of means in *RQ 1*.

		Lavine´s test for equality of variances		t test for equality of means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. Error difference	95% confidence interval	
Performance	Equal variances assumed	9.618	.003	-2.472	61	.016	-3.0463	1.23224	-5.51031	-0.58228
	Equal variances not assumed			-2.688	55.034	.009	-3.0463	1.13311	-5.31706	-0.77553

As can be seen, the independent t test for 61 degrees of freedom could demonstrate that if the null hypothesis was true such result would be improbable as $t(61) = 2.47$; $p < .016$. As a conclusion, the research hypothesis could be accepted or there is actually a difference in the environmental performance for the ISO 14001 certified companies as compared to the non-certified ones, as initially expected.

RQ 2. But, does the discipline imposed by other certification other than ISO 14001 influences environmental performance? To test this hypothesis the companies with no environmental certification were grouped together and within this set a comparison between the environmental performances of the 30 ISO 9001 certified and the other 6 non-certified firms was done. The following results were obtained: a) for the ISO 9001 companies the environmental performance mean was 44.8, with a 4.2 standard deviation; b) the other firms presented a 38.7 mean and a 9.8 standard deviation. To verify if a statistical difference between the two means exist, an independent t test was also conducted as per Table 2.

Table 2. Independent t test for equality of means in *RQ 2*.

		Lavine´s test for equality of variances		t test for equality of means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. Error difference	95% confidence interval	
Performance	Equal variances assumed	12.338	.001	-2.541	34	.016	6.16667	2.42717	1.23405	11.0993
	Equal variances not assumed			1.518	5.384	.185	6.16667	4.06369	-4.05897	16.39230

The independent t test for 34 degrees of freedom could demonstrate that if the null hypothesis was true such result would be improbable as $t(34) = 2.54$; $p < .016$. As a conclusion, the research hypothesis could be accepted or, in the absence of ISO 14001 certification, there is a difference in the environmental performance for the ISO 9001 certified companies as compared to the other ones.

RQ 3. Another research question relates to ownership: do the multinational companies have a better environmental performance than the Brazilian national firms? Once again this hypothesis was tested. The results follow: a) for the 23 multinational companies the environmental performance mean reached 47.6, with a 2.6 standard deviation; b) the other 40 national firms presented a 43.7 mean and a 5.5 standard deviation. The statistical difference between the two means was also verified through an independent t test as per Table 3.

Table 3. Independent t test for equality of means in *RQ 3*.

		Lavine´s test for equality of variances		t test for equality of means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. Error difference	95% confidence interval	
Performance	Equal variances assumed	9.375	.003	3.265	61	.002	4,00217	1.22572	1.55120	6.45315
	Equal variances not assumed			3.893	59.284	.000	4.00217	1.02817	1.94501	6.05934

The independent t test for 61 degrees of freedom could demonstrate that if the null hypothesis was true such result would be quite improbable as t(61) = 3.27; p < .002. As a conclusion, the research hypothesis could be accepted or, there is a statistical significant difference in the environmental performance between the multinational and the national companies.

RQ 4. When considering the environmental performance, does size matter? To test this hypothesis the searched companies were divided into four groups: 9 very large, 13 large, 26 medium and 15 small. The descriptive statistics for those groups were: a) very large – mean 47.4 and standard deviation 4.0; b) large – mean 47.1 and standard deviation 2.6; c) medium – mean 45.6 and standard deviation 4.6; and d) small – mean 41.1 and standard deviation 5.2. To verify if a statistical difference exist among those means, a One Way ANOVA test was performed using the SPSS for Windows 13.0 software. Results were obtained as per Table 4.

Table 4. One way ANOVA test results for *RQ 4*.

		Sum of squares	df	Mean square	F	Sig.
Performance	Between groups	343.190	3	114.397	5,492	.002
	Within groups	1,229.032	59	20.831		
	Total	1,572.222	62			

The F test for 3 (between groups) and 59 (within groups) degrees of freedom could verify that if the null hypothesis was true such result would be quite improbable as F(3;59) = 5.49; p < .002. As a conclusion, the research hypothesis could be accepted or, there is a statistical significant difference in the environmental performance depending on the size of the company considered. However, *post hoc* analysis considering multiple comparisons as per Tuckey's HSD (honestly significant differences) test indicated that significant difference exists at the .05 level only between the small companies and all the other ones. No differences are significant among the very big, big and medium size firms.

RQ 5. Finally this research could also check a widespread idea in the SPMA indicating that companies belonging to the auto industry have better environmental performance when compared to other industrial segments, due to the stringent environmental requirements imposed by the auto assemblers to their entire supply chain. To test this hypothesis the searched firms were divided into four segments: 17 belonging to the automotive sector, 5 to the electrical component manufacturing, 25 to the metal-mechanical segment and 16 to other 12 industrial sectors. The descriptive statistics for those groups were: a) automotive – mean 44.2 and standard deviation 5.9; b) electrical component manufacturing – mean 46.4 and standard deviation 3.16; c) metal-mechanical segment – mean 44.7 and standard deviation 4.4; and d) all other – mean 46.4 and standard deviation 5.2. To test if a statistical difference exist among those means, once again a One Way ANOVA test was conducted, which produced the results presented in Table 5.

Table 5. One way ANOVA test results for *RQ 5*.

		Sum of squares	df	Mean square	F	Sig.
Performance	Between groups	53.361	3	17.787	.691	.561
	Within groups	1,518.861	59	25.743		
	Total	1,572.222	62			

The F test for 3 (between groups) and 59 (within groups) degrees of freedom could demonstrate that the null hypothesis cannot be rejected as F(3;59) = .69; p < .561. As a conclusion, the research hypothesis could be rejected or, there is not a statistical significant difference in the environmental performance depending on the segment considered.

In summary, what this research can suggest is that in the SPMA, as expected, industries that are ISO 14001 certified have a better environmental performance than those that are not. Also, the same conclusion can be extended to those companies with quality systems certified as per ISO 9001 even in the absence of ISO 14001. It was possible to identify that multinational firms have more environmental friendly practices implemented as compared to the Brazilian nationals. For environmental performance purposes, size matters, but as far as small companies are compared to the other sizes considered. And, no significant environmental performance differences could be significantly perceived among industries of different sectors.

5 Conclusion

As alluded to before, the accelerated urban expansion observed in the SPMA has made the reduction of the resulting environmental impacts a crucial objective for sustainable development. The industrial sector has been challenged by environmental authorities to significantly contribute with the efforts to reduce pollution in the area, through imposing stringent environmental requirements.

However, the results of the survey presented herein can suggest that in the SPMA actions taken by the industries in general to face the ecological challenges have been effective and surpass the mere shallow environmental wording. They have shown more environmental concerns than the "must do" requirements imposed by legislation, as actual practices observed transcend the legal demands in several aspects. In fact, results pointed out that the environmental performance of the companies considered in the research reached a 46 point mean (against a maximum of 55). And more, several of the environmental practices reported by the firms are broader and more ecological friendly than those required by the local environmental authorities. The research also enables the identification of the general characteristics of the companies most committed with utilization of best environmental practices. They are ISO 14000 certified or at least have an ISO 9001 certification, they are usually multinational firms, not small in size and belonging to no specific industrial sector.

The findings presented here are also subject to some limitations. Initially, the validity of the proposed environmental performance measure should be checked by further research comparing it with similar indexes that are already being used. This has not been done because proposing a new method to measure environmental performance was not the central focus of this work. Second, for more meaningful analysis, the initial questionnaire answered by the researched firms should be followed by an in-depth interview where much more detailed information could be obtained to shed light on specific points not covered by the present survey. Additional research will consider this approach and more detailed analysis will be opportunely reported.

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