

# The Brazilian Chemical Industry and Sustainable Development

Jorge Juan Soto Delgado,<sup>a</sup> Alessandra Magrini,<sup>b</sup> Rogério Valle<sup>c</sup>

<sup>a</sup>Companhia Vale do Rio Doce SA. Address: Rua Graça Aranha, 26, Rio de Janeiro (RJ), CEP 20.030-900, Brazil; jorge.soto@cvrd.com.br (for correspondence)

<sup>b</sup>Energy Planning Program, COPPE/UFRJ - Federal University of Rio de Janeiro, Rio de Janeiro, RJ, Brazil

<sup>c</sup>Production Engineering Program, COPPE/UFRJ - Federal University of Rio de Janeiro, Rio de Janeiro, RJ, Brazil

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*A way of classifying companies' postures concerning sustainable development is presented, which forms the basis for an evaluation of 36 companies from the Brazilian chemical industry. It was found that most of these companies have a more mature posture to this issue. The findings of the analysis reinforced the hypothesis that a company's strategic planning process is a determinant factor in defining its business postures towards sustainable development. By grouping the companies in the sample, it was also possible to reinforce the hypothesis that those companies with a more proactive posture give greater importance to sustainable development in the short-and long-term and have better results than those companies with a more reactive posture. © 2007 American Institute of Chemical Engineers Environ Prog, 26: 59–70, 2007*

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## INTRODUCTION

Sustainable development is increasingly being seen as the only way forward to ensure the mutually beneficial management of the societies and ecosystems on this planet [1–3]. If this is the case, then it is worth asking who the main players are in this process and what stance they should take, given the gravity of the issues at stake. At the 2002 World Summit on Sustainable Development organized by the UNEP (United Nations Program for the Environment) held in Johannesburg, South

Africa, it became clear that only through the combined action of governments, non-governmental organizations (NGO's), and private organizations will it be possible for Agenda 21 [4] to be implemented. At the same event, a consensus was expressed that both sustainable production and consumption must be addressed.

As far as sustainable production is concerned, the chemical industry is definitely one of the most highly criticized for producing pollution. In Brazil, a survey carried out in 2001 by the Brazilian chemical industry association ABIQUIM (Associação Brasileira da Indústria Química) (internal report) found that the country's population considered the chemical sector (together with the oil sector) the greatest cause of harm to the environment. Yet it is also making an increasing contribution to the economy. From 1990 to 2004, its share in the Brazilian GDP (Gross Domestic Product) climbed from 3.1 to 3.9%. It employs over 320,000 people and its net revenues in 2005 were approximately US\$ 59.4 billion, or 2.64% of the world chemical industry [5].

For these reasons, it is clearly worth analyzing how the Brazilian chemical industry is preparing itself for the sustainability challenge.

This study looks into two hypotheses concerning sustainable production in light of the undeniable fact that companies are increasingly bound to use sustainable development concepts in their management processes [6–8].

The first hypothesis is that businesses' strategic planning practices are determinant factors in defining their posture to sustainable development. Of the many definitions that exist of strategic planning, the following definition based on Chiavenato and Sapiro [9] is adopted: "Strategic planning is the process of

**Table 1.** Proposed corporate classifications regarding sustainable development.

<b>Author</b>	<b>Proposal</b>
Shrivastava, 1995 [13]	The author suggests that there are three possible postures: to believe in market forces, to believe that reforms are enough, and to believe that only radical change in the economy will enable companies to solve the problems.
Porter and Linde, 1995 [14]	The authors suggest that companies can choose from three alternatives for integrating the environmental dimension into their management: focusing on pollution control, preventing pollution, or focusing on the productivity of resources (expanding the focus of prevention to encompass the efficiency and efficacy of all resources used in the production chain).
Hart, 1997 [15]	The author analyzes the development challenge of a sustainable global economy and argues that large companies are the only organizations with the resources, technology, and motivation to attain sustainability. Nevertheless, he concludes that seldom have environmental variables been related to an organization's strategy. The author suggests that there are three stages for companies to go through before they reach sustainability: pollution prevention, product management, and clean technologies.
Hedstrom <i>et al.</i> (1998) [6]	The authors analyze the potential of sustainable development to become the new trend in business. They suggest that there are five possible strategies for organizations to take: introverted (when they focus on maintaining the status quo), extroverted (when they focus on promoting their image), economic results-oriented (aiming for cost leadership), focused on differentiation and transforming (when they use sustainable development to change the organization and build the future).
Aragon-Correa, 1998 [16]	The author uses the environmental posture rating proposed by Roome (1992) [17]: non-compliant (a company that does not use any type of environmental measure), compliant (a company that focuses on complying with legislation), beyond conformity (a company that meets legal requirements and embarks on improvement challenges based on its environmental management system), commercially and environmentally excellent (a company that focuses on prevention in general), and leaders (a company that sets the benchmarks that will be followed by all other companies in the future).
Stead and Stead, 2000 [11]	Based on Hart [15, 18] the authors suggest three possible strategic stages for organizations: pollution prevention (use of technology to minimize environmental impacts), product management (minimization of products' impacts throughout their life cycle and influence on consumption habits), and sustainability (guiding businesses to sustainability and support for the improvement of communities' quality of life).

**Table 1.** Proposed corporate classifications regarding sustainable development.

Author	Proposal
Hoffman, 2000 [19]	The author analyzes corporations by the extent to which they internalize environmental and social issues in their management. He puts forward three stages: traditional (reaction to governmental and social pressures), emerging (environmental issues start to tally with the company's economic, market and political interests and influence organizational decisions, and sustainable (social equity starts to be part of the decision process).
Abreu, 2001 [20]	The author proposes the application of Post and Altman's [21] change model to the environmental behavior of companies, developing a strategic environmental position matrix that takes into account three environmental behavior stages: strong (set and implemented environmental policies), intermediate (set but not implemented environmental policies), and weak (without any environmental policy). According to the author, companies with "strong" environmental behavior anticipate the concerns of their clients, attaining a competitive advantage through environmentally proactive behaviors. In this case, their competitive edge is the differentiation of the products or services they offer on the market. The author analyzes the practices of three industrial sectors in Brazil through a survey. Among the petrochemicals companies involved, the author found 79% of the companies to have "strong" behavior and 21% to have "intermediate" behavior.
Bieker, 2003 [22]	The author suggests that sustainability strategies can be ranked according to their market or society orientation and their behavior (whether reactive or pro-active). This offers five alternatives: a focus on safety (the company manages and reduces the business risks and impacts resulting from sustainability-related issues), focus on credibility (the company strengthens and develops its credibility and reputation, positioning itself as a "good corporate citizen"), focus on efficacy (the company increases productivity and efficacy from both an environmental and a social viewpoint), focus on innovation (use of environmental and social aspects to differentiate the products and services on the market), and focus on transformation (the company changes the existing markets and as a consequence, society itself).
Winsemius and Guntram, 2004 [7]	The authors propose four responses to the environmental demands on companies, which may be understood as strategic positioning alternatives: reactive (companies merely respond to legal obligations), functional (companies gradually start to take on new responsibilities and regard them as central to meeting their requirements at the most effective cost), integrated (companies start to integrate environmental considerations into their business strategies and to establish partnerships with other companies, the government and NGOs), and proactive (environmental issues start to be assumed as a corporate value).

formulating and implementing organizational strategies in which the success of a company's mission is sought in the environment in which it is operating. It is a continuous process of making decisions, carrying out those decisions, and ensuring systematic feedback based upon a comparison between expectations and the results obtained. It is related to medium and long-term strategic objectives that affect the direction or feasibility of the company."

The second hypothesis is that when companies have more mature behavior towards sustainable development, they experience a positive impact on their economic, social, and environmental results. A sample of companies from the Brazilian chemical industry was analyzed to evaluate both hypotheses.

In the second section, a literature review of sustainable development from a business perspective is presented, and a method is proposed for categorizing

different corporate behaviors. In the third section, the different postures taken by a sample of companies from the Brazilian chemical industry are analyzed, and clusters are formed based on these postures. In the fourth section, the clusters are analyzed as to the degree of importance the companies in each cluster give to sustainable development and their economic, social, and environmental results. The study is concluded by analyzing all the information obtained.

#### CORPORATE POSTURES AND SUSTAINABLE DEVELOPMENT

Sustainable development has been described in many ways. The Brundtland Commission describes it as development that meets the needs of the present without affecting the ability of future generations to meet their needs [10]. In other words, it is a process of change in which the use of natural resources, investment decisions, technological development, and institutional change are in line with present and future requirements. For Stead and Stead [11], "sustainability" is the quest for a high quality of life for the present and future generations of human and non-human beings through the creation of a synergic balance among economic prosperity, the feasibility of ecosystems and social justice. This is where the well-known "triple-bottom-line" comes in, which expresses economic, environmental, and social results. Additionally, Gladwin *et al.* [12] have classified sustainability as the process of achieving human development in an inclusive, connected, equitable, prudent, and secure manner (five characteristics), because development should occur across the board both temporally and spatially. It is connected because the ecological, social, and economic variables are interdependent; equitable because intergenerational, intragenerational, and interspecies fairness should be taken into account; prudent because it implies prevention and precautions of a technological, scientific, and political order; and secure, since it requires attention to and protection from harmful disruption.

In this study, sustainable development was understood as a way of conducting and developing business whilst satisfying the needs of all the stakeholders (shareholders, clients, suppliers, employees, communities, etc.) without hampering their capacity to meet their future needs, and whilst considering a balance between economic, social, and environmental issues.

#### Corporate Postures

The growth of the adoption of sustainable development by different agents in society has forced companies to take a stance. Several schemes for rating and analyzing corporate postures towards sustainable development have been proposed. Table 1 describes each of them.

#### Proposed Classification of Corporate Behaviors Concerning Sustainability

By taking all the earlier options into account and analyzing their common denominators, a classification was designed for corporate behaviors depending on their application of sustainable development prin-

ciples. The four proposed categories are the following:

- Reactive: the company focuses on its survival and only complies with environmental and social legal requirements;
- Functional: the company focuses on its growth and on profit generation for its shareholders. As such, it aims to comply with environmental and social legal requirements at a minimum cost and starts to integrate environmental and social dimensions (especially those regarding the working environment) into its operational processes;
- Integrated: the company focuses on its perpetuity, for which it starts to integrate environmental and social dimensions into its organizational strategy;
- Proactive: besides focusing on perpetuity, the company also takes an active role in changing society with a view to achieving sustainability. Its vision, values and culture are aligned with environmental and social issues.

Table 2 summarizes the factors that characterize the four categories proposed, one of which concerns the planning process with regard to environmental and social issues. This was done intentionally to gather data on the first hypothesis of this study (the relationship between strategic planning and companies' postures towards sustainable development).

#### ANALYSIS OF THE POSTURE TAKEN BY THE BRAZILIAN CHEMICAL INDUSTRY

An exploratory survey was made of the Brazilian chemical industry by means of a questionnaire that was sent to all the members of ABIQUIM. This association was selected because its members tend to be large and well-organized companies. According to Winsemius and Guntram [7], the bigger a company, the more likely it is to adopt more mature postures towards sustainable development.

Thirty-six of the 145 companies contacted responded to the survey. These companies correspond to 25% of the entire membership of ABIQUIM, and their net revenues account for 72% of the total of the ABIQUIM members who publish their financial statements, as well as 31% of all the companies that annually report their results about health, safety, and the environment to ABIQUIM, in compliance with Responsible Care, an industry corporate responsibility program.<sup>1</sup>

The companies that participated in the survey were as follows: Acrinor, Akzo Nobel, Araquímica, Barlocher, Basf, Bayer, Boeralis, Braskem, Carbocloro, Companhia Brasileira de Estireno, Clariant, Cognis, Copesul, Crompton, Deten, Dow Chemical, DuPont, Elekeiroz, Getec, Hunstman, Innova, Kemira, Kodak, Lonza, Lubrizol, Millenium, Montana, Oxiteno, Petroflex, Petroquímica União, Polibrasil, Rhodia, Scandiflex, Solvay, Synteko and Videolar. In this text, the

<sup>1</sup>Responsible Care is an international chemical industry program brought to Brazil by ABIQUIM in 1992, which aims to improve these companies' performance in health, safety and the environment.

**Table 2.** Stages of business regarding sustainable development.

	<b>Posture</b>			
<b>Factor</b>	<b>Reactive</b>	<b>Functional</b>	<b>Integrated</b>	
	<b>Pro-active</b>			
Purpose	To survive and to comply with environmental and social legal requirements.	To grow and generate profit and comply with legal requirements at a minimum cost. To integrate environmental and internal social dimensions to operations.	Perpetuity of the organization. To integrate environmental and social dimensions to the organizational strategy.	Perpetuity of the organization and sustainability of society.
Activities	Control of losses and pollution through means of “end of pipe” (reactive) solutions. Lobbies to minimize “threats.”	Pollution prevention through process optimization and improved product design. A “more refined” lobby (greater personal involvement).	Voluntary commitments. Innovation focusing on environmental and social development. Minimizing indirect impacts (in the production chain). Establishment of partnerships. Influence in formulating legal requirements. Organizational change.	Questioning of business practices. Differentiation based on posture towards environmental and social issues. Influences consumer habits. Influences the quality of life of its community. Co-leadership in matters of global interest. All those mentioned before plus society at large and multilateral organizations.
Relationships	Shareholders, clients, unions, and enterprise associations.	All those mentioned before plus employees, investors, financiers, insurers and governmental agencies.	All those mentioned before plus NGO's, competitors and community.	
Leadership	Specialist or supporting functions	Line Leaders	Business Units Leaders	Corporate Leaders
Environmental and social planning process	No planning, only a reaction to problems.	Established planning process, focused on the shortterm and subordinated to the investment plan.	Planning process focused on the medium term (10 years) and integrated into the company's strategic planning process.	Vision, strategy, values and culture, fully aligned with environmental and social issues. Fully integrated planning process focused on the long-term (over 10 years) and strongly influenced by sustainable development.

**Table 3.** Sample characteristics.

Factor	Result
Source of capital	56% multinational and 44% national
Capital structure	62% private and 38% public (traded on the Brazilian stock exchange or abroad)
Sub-sector	92% producers of basic chemicals, petrochemicals, or thermoplastic resins
Location	São Paulo (69.4%), Rio de Janeiro (27.8%), Bahia (25%), Rio Grande do Sul (25%), Minas Gerais (8.3%), Paraná (8.3%), Amazonas (8.3%), Pernambuco (8.3%), Alagoas (2.8%), Paraíba (2.8%), and Sant Catarina (2.8%).
Markets	Automobile (19.4%), food (16.7%), clothing and footwear (16.7%), manufactured goods (13.9%), industrial packing (13.9%), civil construction (11.1%), agriculture (11.1%), retail (11.1%), pharmaceuticals and cosmetics (8.3%), personal hygiene and cleaning products (8.3%), and products for other sectors (11.1%)
Position held by respondent	72.2% director or top management and 27.8% other positions. 63.9% from the environmental or social responsibility area and 36.1% from other areas (planning, production, marketing, general management, or other supporting areas). 100% hold bachelors degrees or graduate level qualifications.

companies are randomly given letters of the alphabet (A to Z or AA to AJ) so as to assure their anonymity. Table 3 summarizes the nature of the sample.

The fact that 25% of the companies contacted correspond to almost 72% of the total revenues of the association's members is an indication that more large companies responded than smaller ones, as was expected. This was confirmed when the size distribution of the sample was compared with ABIQUIM's entire membership (Table 4). As stated before, this study is exploratory, and in this case the difference was not deemed a major limitation, but the influence of the companies' sizes was considered in the analysis of the results.

### The Questionnaire

The questionnaire covered four topics, as follows.

- Topic 1 - "Characterization of the company and the respondent": equity, size, respondent's hierarchical level and education, etc.
- Topic 2 - "Characterization of the company's strategic planning process": mission, values, vision, strategic planning process, strategy communication

**Table 4.** Size distribution—ABIQUIM *versus* the sample.

Companies	Size		
	Small (%)	Medium-sized (%)	Large (%)
ABIQUIM	35.9	42.8	21.4
Sample	16.7	41.7	41.7

process, process for following up on objectives and targets, and workforce incentive process.

- Topic 3 - "Characterization of the planning process for sustainable development": inclusion of sustainable development in the strategic planning process, process for identifying environmental and social priorities, alignment of environmental and social objectives with the company's strategic objectives, and degree of formalization of the whole process.
- Topic 4 - "Characterization of the relevance of sustainable development to the management." An assessment of the degree of relevance given to the following aspects in the short and long term: compliance with legal requirements, economic return, triple bottom line, image improvement, cost reduction, product development, market development, focus on long-term value creation, risk reduction, asset use improvement, being seen as a corporate citizen, being seen as a good employer, being seen as an ethical company that follows best corporate management practice, production process improvement, optimization of organizational management, reduction of the impacts resulting from product use, use of innovation, reinforcement of organizational culture, and reinforcement of influence on its value chain.

The questions were all objective so the data could be more easily handled in the statistical analysis.

The replies for topics 2 and 3 were ranked according to the corporate postures presented in Table 2. Thus, the replies to each question were given a score of 1 (reactive), 2 (functional), 3 (integrated), or 4 (proactive). The replies for topic 4 were ranked on a qualitative scale of four levels of relevance: low, medium, high, and very high. A sample of the questions asked is included in Box 1.

Box 1. Some of the questions asked in the questionnaire

<p><b>Topic 1 – Characterization of the company and the respondent</b></p> <p>Size of the company:</p> <p>a) Small company: 1 to 99 employees  b) Medium-sized company: 100 to 499 employees  c) Large company: over 500 employees</p> <p>Position of the respondent:</p> <p>a) Board  b) Top Management  c) Middle Management  d) Does not have a formal leadership position</p>																																	
<p><b>Topic 2 – Characterization of the company's strategic planning process</b></p> <p>Definition of the company's mission, understanding the expression "mission" to be the company's <i>raison d'être</i> (a statement of the main purpose for which the activities are performed):</p> <p>a) Clearly defined and documented mission  b) Defined but not documented mission  c) Undefined mission</p> <p>Definition of the company's vision, understanding the expression "vision" to be the position that the company wants to achieve in the future (statement of how the company wants to be seen and considered in the future):</p> <p>a) Clearly defined and documented vision  b) Defined but not documented vision  c) Undefined vision</p>																																	
<p><b>Topic 3 – Characterization of the planning process for sustainable development</b></p> <p>Extent to which sustainable development issues influence the company's strategic planning:</p> <p>a) Sustainable development issues have no bearing on the company's planning  b) Sustainable development issues have a vague influence on the company's planning  c) Sustainable development issues influence the company's planning  d) Sustainable development issues have a strong influence on the company's planning</p> <p>Degree of alignment between the company's strategic objectives for sustainable development and its overall strategic objectives:</p> <p>a) The sustainable development objectives are not aligned with the company's overall strategy yet  b) The sustainable development objectives are partially aligned with the company's overall strategy  c) The sustainable development objectives are aligned with the company's overall strategy  d) The sustainable development objectives are strongly aligned with the company's overall strategy  e) The sustainable development objectives are the company's overall strategy</p>																																	
<p><b>Topic 4 – Relevance of sustainable development to the management</b></p> <table border="1"> <thead> <tr> <th rowspan="2">Item</th> <th colspan="4">Degree of relevance</th> </tr> <tr> <th>Low</th> <th>Average</th> <th>High</th> <th>Very High</th> </tr> </thead> <tbody> <tr> <td>Meeting environmental and social legal requirements</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Economic results associated to environmental and social improvement initiatives.</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>"Triple bottom-line", balanced improvement of economic, environmental and social performances.</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Image and brand improvement resulting from environmental and socially responsible posture.</td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>					Item	Degree of relevance				Low	Average	High	Very High	Meeting environmental and social legal requirements					Economic results associated to environmental and social improvement initiatives.					"Triple bottom-line", balanced improvement of economic, environmental and social performances.					Image and brand improvement resulting from environmental and socially responsible posture.				
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**Defining the Clusters**

To separate the sample into clusters, an analysis was made of the responses to the questions concerning the companies' strategic planning processes and

the consideration of sustainable development in these processes (topics 2 and 3). This perspective was chosen so as to explore the first hypothesis: that businesses' strategic planning practices are determinant



factors in defining their posture to sustainable development.

The following variables were considered in the process of clustering the businesses into groups and selecting the variables that would determine these clusters:

- The following variables were selected from the “characterization of the company’s strategic planning process” topic: mission (V1), organization values (V2), vision (V3), planning process (V4), strategy communication process (V5), follow-up process of objectives and targets (V6), and workforce incentive process (V7). They were chosen because it is considered that these are enough to characterize a company’s planning process.
- The following variables were selected from the “characterization of the planning process for sustainable development” topic: inclusion of the planning process for sustainable development in the company’s strategic planning process (V8)<sup>2</sup>, Influence of sustainable development on the company’s strategic planning (V9)<sup>3</sup>, people involved and process of identifying sustainable development priorities (V10), alignment of sustainable development with the company’s strategic objectives (V11), and process for following up on sustainable development objectives (V12). They were chosen because it is considered that these are enough to characterize the extent to which a company’s sustainable development planning process is integrated into its strategic planning process.

Multivariate statistics were used in the analysis, which were supported by the computer application SPSS (Statistical Package for the Social Sciences). The sample was split into three clusters using principal components analysis (PCA) [23], whose description is beyond the scope of this paper.

To perform the multivariate analysis, the scores for each of the answers assigned to the variables above were taken into account. Since the scale ranges between 1 and 4, the postures in Table 2 could simply be categorized according to the mean of the answers, as follows:

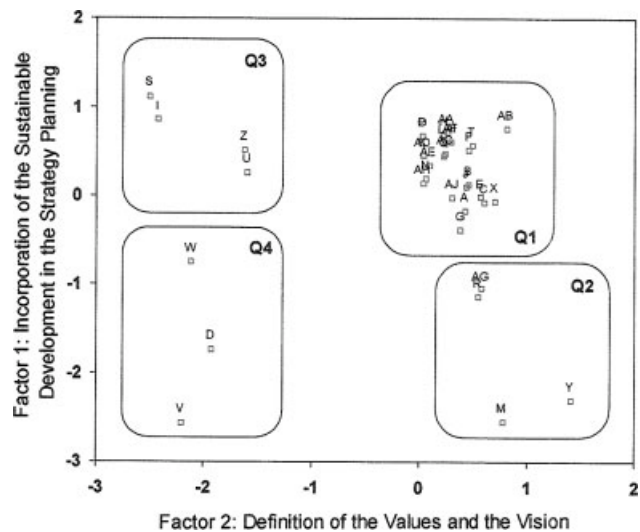
- Reactive posture: 1 to 1.75;
- Functional posture: greater than 1.75 to 2.5;
- Integrated posture: greater than 2.5 to 3.25; and
- Proactive posture: greater than 3.25 to 4.

By using PCA, we identified two factors that could describe 61.2% of the total variance in the sample data:

- Factor 1 - incorporation of sustainable development into the strategic planning process, which is defined by variables V8, V9, V10, V11, and V12; and
- Factor 2 - the company’s values and vision, which is defined by variables V2 and V3.

<sup>2</sup>In other words, an assessment of the procedural aspect (whether a company’s planning process involves the sustainable development planning process or not).

<sup>3</sup>In other words, how important sustainable development is in the company’s current plans.



**Figure 1.** Clustering of the companies according to their posture regarding sustainable development.

According to the theory behind PCA, the variables that were not considered (V1, V4, V5, V6, and V7) had little influence on the sample variance, which means that the responses to them provided by all the respondents were similar. However, the variables taken into account for Factor 1 provide a very comprehensive account of how much sustainable development is incorporated into the companies’ strategic planning. As to Factor 2, it shows that there are differences among the companies as to how clearly they consider their values and their long-term vision in their strategic planning process.

Factors 1 and 2 were the basis for dividing the sample into four quadrants, as seen in Figure 1. Responses in quadrant Q1, with a high incorporation of sustainable development and clearly defined corporate values and vision, were labeled “pro-active,” as they were the closest to the description of the environmental and social planning process in Table 2. The mean of the companies’ responses in this quadrant was within the expected range for this category (3.45). Quadrant Q4, with the least incorporation of sustainable development and the least clearly defined corporate values and vision, was ranked as “functional.” The mean of the companies’ responses in this quadrant was 2.13 (within the functional range). Quadrants Q2 and Q3, which had one factor low and the other high, were ranked in the “integrated” category. The mean of these companies’

**Table 5.** Percentage of answers with high or very high relevance.

Period	Cluster		
	Functional (%)	Integrated (%)	Proactive (%)
Short-term	88	81	81
Long-term	78	93	98



**Table 6.** 2001 to 2004 Average economic, social, and environmental indicators.

Indicator	Cluster				ABIQUIM Average
	Functional	Integrated	Pro-active	Sample	
Productivity (t product/employee)	50.7	611.1	941.1	885.0	833.1
Productivity (t product/employee and contractor)	48.1	384.5	441.5	433.1	475.6
Profitability/net equity (%)	15.1	19.0	2.6	4.3	5.4
EBITDA/net operating income (%)	7.2	21.3	15.9	16.2	15.7
Lost time accident rate (employees) (accidents/million man-hours worked)	5.16	2.63	1.77	1.92	2.33
Lost time accident rate (employees and contractors) (accidents/million man-hours worked)	5.54	3.17	2.89	2.91	3.49
Environmental programs involving the community (programs/100 companies)	16.7	293.8	548.0	447.2	290.4
Visitors from the community (persons/company)	33.3	642.8	2,601.6	1,952.3	962.6
Expenditure on training for employees (US\$/employee)	91.4	328.0	478.5	452.9	Unavailable
Waste generated (kg/t product)	33.5	15.2	10.8	11.2	9.6
CO <sub>2</sub> emissions (kg/t product)	Unavailable	282.0	644.4	608.7	395.2
Effluents discharged (m <sup>3</sup> /t product)	Unavailable	3.3	3.1	3.1	3.7
Electricity consumption (kWh/t product)	99.2	213.7	439.4	416.9	416.8
Water consumption (m <sup>3</sup> /t product)	Unavailable	6.6	8.6	8.4	8.9

responses was 2.87 (within the scores for the respective range). Therefore, the samples were clustered as follows:

- Proactive (25 companies): A, B, C, E, F, G, H, J, K, L, N, O, P, Q, T, X, AA, AB, AC, AD, AE, AF, AH, AI, and AJ;
- Integrated (8 companies): I, M, R, S, U, Y, Z, and AG;
- Functional (3 companies): D, V, and W.

#### CLUSTER ANALYSIS

The clusters of companies were assessed as to the relevance they gave to sustainable development and their economic, social, and environmental results. The responses in the “relevance of sustainable development to the management” topic were used for the first analysis, while a number of ABIQUIM data were used for the second (ABIQUIM, internal data; [5, 24]). The purpose of this analysis was to assess the validity of the second hypothesis of the study: that when a company has a more mature posture towards sustainable development, this will have a positive impact on its economic, social, and environmental results.

#### Relevance Given to Sustainable Development

The individual responses to the questionnaire provided the basis for an assessment of the mean responses for each cluster. For each aspect, each company was asked about the relevance it gives to sustainable development in the short-term (next 2 years) and the long-term (over 10 years). The responses could be any of four options: low, medium, high, or very high. Table 5 summarizes the responses given as high and very high relevance.

Most of the companies considered sustainable development issues to be of importance, a fact already identified in other papers analyzing the chemical industry [18, 20].

As expected, the companies in the proactive cluster tended to consider sustainable development increasingly important and more important than those in the integrated and functional clusters.

One thing that drew attention was the fact that the companies classified as functional gave more importance to sustainable development in the short-term than in the long-term. This is consistent with the expectation that for this group, environmental and social issues are “hygienic”, i.e. basic conditions for survival but not strategic for the businesses’ perpetuity. Additionally, the environmental and social dimensions were more strategic for the integrated and proactive clusters and were seen as having a growing importance in the long-term.

#### Economic, Social, and Environmental Results

The results obtained for each cluster were calculated from the individual results of the companies, based on information provided by ABIQUIM. This information is updated periodically from data provided by the companies themselves.

For the economic dimension, the results were assessed using the following indicators: productivity, profitability, and EBITDA<sup>4</sup>/net operating revenue.

<sup>4</sup>EBITDA: Earnings before interest, taxes, depreciation and amortization.

**Table 7.** Percentage variation between 2001 and 2004 for some economic, social, and environmental Indicators.

Indicator	Cluster				
	Functional	Integrated	Pro-active	Sample	ABIQUIM Average
Profitability over net equity (%)	-64.13	+151.53	+756.99	+580.39	+674.38
EBITDA/net operating income (%)	+45.02	-3.61	+30.79	+27.84	+22.35
CO <sub>2</sub> emissions (%)	Unavailable	-2.48	-14.10	-14.15	-7.77
Electricity consumption (%)	+110.60	-32.07	-1.36	-3.51	-14.99
Water consumption (%)	Unavailable	-32.00	-55.01	-53.78	-27.70

These criteria are indicative of the economic health of any company.

The following indicators were used for the social dimension: the frequency of accidents involving employees and contractors for which they have leavel, any corporate environmental outreach programs, the number of visitors to the company, and investments in training for employees. These indicators represent the companies' concern about their internal and external community.

The following indicators were used for the environmental dimension: waste generation, effluent discharge, CO<sub>2</sub> emissions, electricity consumption, and water consumption. These indicators cover the main environmental aspects of any chemical industry. Tables 6 and 7 summarize the results.

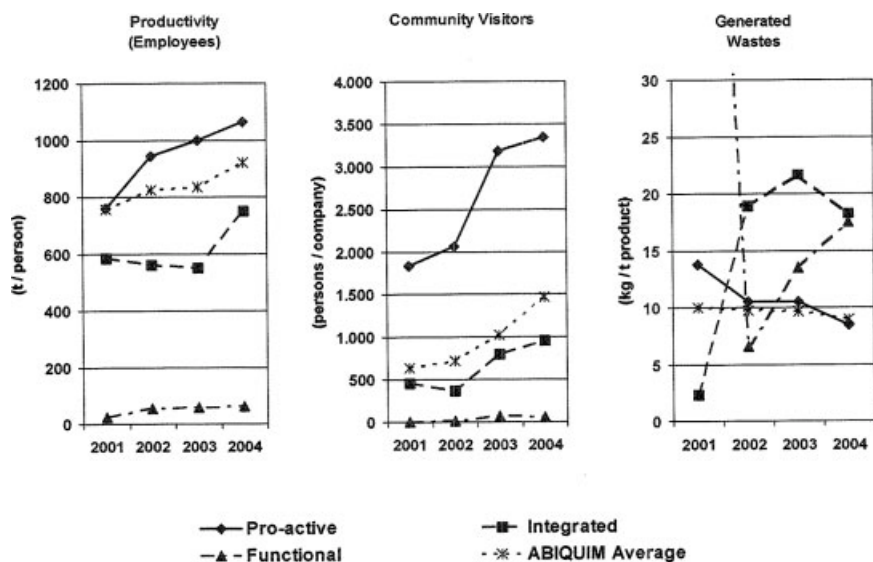
It is clear from Table 6 that the proactive cluster's results are better for most of the economic, social, and environmental indicators (9 out of 14). In the economic indicators, the profitability over net equity and EBITDA/net operating income of this group were not the best, but in both cases it presented a positive variation from 2001 to 2004, while the other clusters' variations were not always positive (Table 7). For all the social indicators, the proactive cluster was

the best in absolute terms. In the environmental dimension, it also had better results for waste generation and effluent discharge. For all the other three indicators (CO<sub>2</sub>, electricity, and water), there was an improvement trend amongst the proactive companies. This situation was expected, considering that sustainable development was defined as a process rather than a performance level to be achieved. Figure 2 shows graphically the best position of the proactive cluster for three indicators.

#### ANALYSIS OF RESULTS

The PCA allowed us to test the importance of strategic planning processes in defining companies' behaviors towards sustainable development. It was possible to classify each company into a different cluster according to their strategic planning practices, which strengthens the first hypothesis.

One interesting fact was that 69.4% of all the companies involved were categorized as proactive, while none of them were rated reactive. At first sight, this finding is surprising, but when one considers that they are all members of the same industry and are subject to similar external pressures, it starts to make



**Figure 2.** Examples of economic, social, and environmental results of the three clusters.

**Table 8.** Average membership of Responsible Care.

Cluster	Average membership (years)
Functional	8.7
Integrated	9.8
Proactive	10.8

more sense. Banerjee [25] and Abreu [20] anticipate this particular feature.

Banerjee [25] analyzed the influence of corporate environmentalism on corporate decision-making and found that a company's environmental orientation depends on the managers' perception of the relevance of environmental issues and the need to respond to external pressure applied by stakeholders. The external pressure felt by all these companies is similar: they are all in Brazil and are therefore exposed to similar legal controls and pressures from their communities and society at large. One may infer that the companies analyzed have a similar corporate decision-making process, at least regarding environmental and social issues. All but one are members of Responsible Care, which seeks to foster improvements in the environmental, health, and safety performance of chemicals companies. Its scope reaches beyond mere compliance with legal requirements, which is one characteristic of less the reactive cluster. Table 8 shows the average time the companies in each cluster have been members of this program.

The companies in the proactive cluster have the longest membership on average, which means a better behavior towards these issues should be expected from them.

It would, however, be erroneous to say that the Brazilian chemical industry does not contain reactive companies. As seen before, the amount of responses received from smaller companies was lower than from biggest companies. Winsemius and Guntram [7] found that one driver for more mature stances concerning sustainable development is when a company grows in size. It could therefore be expected that more reactive postures would be expressed by smaller companies. Table 9 shows that the highest number of smaller companies are in the functional cluster, while there are more large companies in the proactive cluster than in the role of the sample.

**Table 9.** Percentage of companies from each size category in each cluster.

Size	Cluster			Sample (%)
	Functional (%)	Integrated (%)	Pro-active (%)	
Small	67	0	16	17
Medium-sized	33	63	36	42
Large	0	38	48	42
Total	100	100	100	100

Additionally, as expected, the companies classified as proactive considered the different issues involved in sustainable development to be of greater importance and of growing relevance in the future. Indeed, this group had better results than the integrated group, whose results were in turn better than those of the functional cluster. In 9 of the 14 performance indicators, the proactive cluster had the best results, thus strengthening the second hypothesis of this study, that companies with more mature postures towards sustainable development will have better results. It also could be inferred that the longer they have been committed to corporate responsibility (via Responsible Care), the better their performance, at least as regards occupational safety and the environment.

Finally, it would be erroneous to consider the definitions given to the clusters as absolute truths. As Aaker *et al.* [23] note, giving meaning to the different factors and interpreting them is a subjective process and PCA has its statistical limitations. Additionally, objective questionnaires with preset alternatives may induce respondents to overestimate their posture, or the responses may have been provided by the more mature companies as concerns their posture towards sustainable development. Notwithstanding, the analysis of the results was purely relative, since it just compared the clusters amongst themselves. At no point was it stated that a company's performance was satisfactory for any of its stakeholders. All things considered, the findings allow us to state that the more proactive a company is, the better its results are likely to be in the three dimensions studied: economic, social, and environmental.

#### CONCLUSIONS AND RECOMMENDATIONS

From the literature review, it was possible to identify the main factors associated with different corporate behaviors towards sustainable development and to present four categories of corporate posture.

The hypothesis that a company's strategic planning process is decisive in its behavior regarding sustainable development was strengthened by the analysis of 36 companies in the Brazilian chemical industry. The better defined the companies' values and vision were and the more they integrated sustainable development into their strategic planning process, the better their behaviors were towards sustainable development.

The analysis of the importance given to sustainable development and of economic, social, and environmental results for each cluster served to strengthen the hypothesis that different postures bring about different end results. The companies that give sustainable development greater importance and which give greater consideration to finding a balance between economic, social, and environmental issues in their strategic planning process presented the best results.

If the discussion about companies' roles in promoting sustainable development is to be deepened, it would be interesting to use a similar strategy to analyze the chemical sector of other countries and to analyze the different postures and results of other business sectors. This would make it possible to extrapolate the hypotheses proposed by this study to other contexts.

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