Environmental Management in Brazilian Industry: an Evaluation with Item Response Theory

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Abstract

Growing challenges with respect to preserving the environment have forced changes in company operational structures. Thus, the objective of this article is to measure the evidence of Environmental Management using the Item Response Theory, based on website analysis from Brazilian industrial companies from sectors defined through the scope of the research. This is a qualitative, exploratory, and descriptive study related to an information collection and analysis instrument. The general view of the research problem with respect to the phenomenon under study in based on multi-case studies, with the methodological outline based on the theoretical reference used. Primary data was gathered from 638 company websites from 7 different Brazilian sectors and led to the creation of 26 items approved by environmental specialists. The results were attained with the measuring of Environmental Management evidence via the Item Response Theory, providing a clear order of the items involved based on each item's level of difficulty, quality, and propriety. This permitted the measurement of each item's quality and propriety, as well as that of the respondents, placing them on the same analysis scale. Increasing the number of items involved is suggested for future research in order to permit broader sector analysis. It would also be interesting to build a Computerized Adaptive Test (CAT) for the respondent – the end of the questionnaire – get, immediately, the degree of environment management evidence of your company. As such, a greater reach of the instrument should be considered with the objective to contribute to business management.

Keywords: environmental management performance; industry websites; measurement; item response theory.

1 Introduction

Government and private organizations can no longer ignore aspects related to environment preservation. The environmental variable has become an important competitive advantage, something with which all organizations must be concerned.

In recent decades preserving and restoring the environment has become a worldwide concern. In Brazil, this concern is explicitly expressed in the 1988 Federal Constitution (1988) in Article 225. It states that "everyone has the right to an ecologically balanced environment of common use, essential to a healthy quality of life, necessitating the government and society the duty to defend and preserve it for present and future generations." Furthermore, Article 23 of the same constitution states "common responsibility of Federal, State, Federal District and Municipalities: (...) VI – protecting the environment and fighting pollution in any of its forms". The impacts that affect local, regional, and national economic development rely on the fact that it spreads its coverage. In fact, the social and political issues go beyond the boundaries of environmental policies which are on the agenda of various communications media as a major topic today (BRASIL, 1988).

Concern for the environment has highlighted the importance of deploying an environmental management system, which can provide holistic and systemic management. According to Kaplan and Norton's (2004) assertion that it is impossible to manage something which you cannot measure reinforces the importance of using a method which provides a perspective of the business through analyzing the

results of the principle strategic management perspectives. This will help executives to assess and achieve decision-making goals or to correct their courses to ensure that such objectives are achieved. In this context, there is a need for organizations to effectively manage their information resources and to obtain knowledge to assist the decision-making process.

As suggested by Hronec (1994), performance measurements are vital signs for an organization, confirming that environmental management requires the use of performance measurements to qualify and quantify how the activities of a process achieve their goals. Measuring the quality of this performance is important for companies as they identify aspects of the process to be improved. Constructing such a measurement is a complex task due to the latent nature of the measurement. In fact, few studies concerned with developing adequate environmental performance measurements can be found in the academic literature of business and environmental management.

Within this context, the objective of this article is to verify the viability of using the Item Response Theory to measure Environmental Management evidence among industrials in Brazil, considering the sectors analyzed and based exclusively on information available in these companies' websites. The intention of such measurement is thus to evaluate the quality and propriety of each item individually, placing items and respondents on a single scale.

The Item Response Theory is a tool widely used in educational and psychological (de AYALA, 2009) and has been applied in several areas: medicine (Roos; Meares, 1998; Vidotto et al., 2006; Das; Hammer, 2005); marketing (Bayley, 2001; Singh, 2004); services (Costa, 2001); total quality management (Alexandre et al., 2002); Information Systems (Tezza, Bornia, Andrade, 2011); genetics (Tavares et al., 2004. In general, the IRT is a set of mathematical models that seeks to measure latent traits through a set of items and the construction of a scale, on the scale of the latent trait of the respondent and the difficulty of an item can be compared (Mellenbergh, 1994, Hambleton, 2000, Embretson; Reise, 2000). In this sense, the use of TRI allows: (a) to analyze items and scales, (b) create and administer measures, and (c) measuring individuals or organizations in a construct (latent trait) of interest. The TRI is supported primarily by three reasons: (a) response function of an item, (b) information function and (c) invariance (Reise et. al., 2005).

The innovation of this study is to create of a single scale on which managers are able to interpret the scale values and, consequently, to understand the meaning of achieving a certain level of environmental management performance. They can visualize the principal features of the current level of environmental management performance and can define the actions needed to improve this current level.

This article presents the following structure: Methodological Procedures, Item Response Theory, Environmental Management, Methodological Background, Results and Discussion, Conclusion, and References.

2 Methodological Procedures

Gathering secondary data as well as bibliographic research to compose the study's theoretical reference was used as the methodological outline. The primary data collection, supported through evidencing environmental information (disclosure) occurred based exclusively on the company sites analyzed from the database of the Biggest and Best list as provided by Exame Magazine concerning the 7 sectors of this study (Exame, 2011). Then, the researchers accessed respective websites of the companies selected and responded either "yes" or "no" to the items in the questionnaire. Thus, for the intents of this article, the industrial company environmental performance evaluation presents this delimitation and constitutes a basis to outline the current situation as well as bring together critical analysis, suggestions, and conclusions.

The inductive investigative method is utilized. As such, it starts from a particular premise, data, and confirmed facts and builds towards a general premise, a conclusion which contains unverified facts or situations. Gil (2010) highlights that in inductive reasoning; one must not seek a priori generalization, but verify it based on observing concrete cases, sufficiently confirmed from such a reality.

The present study possesses a quantitative nature, related to the data collection instrument, which presents closed questions (yes or no), generating results which are thus analyzed quantitatively with a two-parameter logistic model under the Item Response Theory perspective. This study deals with exploratory research, as it seeks to provide a general view of the problem and to approximate, making it possible to gain greater familiarity and comprehension from the investigator with respect to the phenomenon under study (Gil, 2010). Such an approach results in an upgrading of ideas. This investigation involves a multi-case study in 7 economic sectors. The techniques outlined and procedures utilized in collecting data were defined in 3 phases: (1) Elaborating the items based on exploratory research in literature relevant to the environment, totaling 32 items; (2) Submitting the items to evaluation from 3 experts of the environmental area, with suggestions to improve the semantics and subsequent exclusion of 6 items; and (3), according Figure 1:

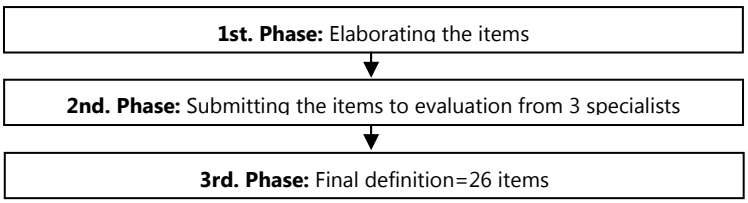

Figure 1. Phases of the study's methodological delimitation

The 26 items are presented in Table 1:

Table 1. Final report of the items

Numbers	Items
1	There is declared concern for environmental questions in the company's mission statement
2	There is the mention of concern for environmental questions in the view
3	There is the mention of concern for environmental questions in policies/ directives
4	The company declares environmental questions in its values
5	Establishes environmental goals and objectives
6	Releases environmental information in a specific report
7	Possesses an implanted Environmental Management System (EMS)
8	Has ISO 14000 implanted throughout the company
9	Has ISO 14000 implanted in part of its operations
10	Has a structured sector/department for the environment
11	Forms environmental partnerships
12	Releases environmental awards
13	Possesses an environmental seal
14	Waste Management
15	Recycling Programs
16	Develops ecological products
17	Efficient use / reuse of water
18	Efficient use / reuse of Energy
19	Uses renewable energy
20	Programs to mitigate/recover degraded/ impacted areas
21	Promotes Education /training to disseminate environmental consciousness
22	Possesses greenhouse gas emission reduction process
23	There is the mention of fines incurred by the company
24	Possesses a foundation / institution to develop environmental projects
25	The visual identity of the company (website design) is geared toward the environment
26	Releases environmental information in the GRI – Global Reporting Initiative – pattern

Source: The authors 2011

The companies analyzed in this article involve 7 (seven) economic sectors. The industrial companies analyzed herein are ordered according to the "Sales" criteria. The data was taken from the Brazilian magazine, Exame (2011), in its annual ranking of the Biggest and Best companies performing in Brazil. Among them are national and international companies, bringing the total sample size to 638 companies under analysis. This research was carried out from August to December of 2011.

- Agricultural Production. This sector has seen the modernization of agricultural activities based on the Green Revolution technological paradigm, which has gone through great modification in the productive structure of the fields. This has benefitted large landowners with the exploration of export products, propelled by globalization and the opening of international economies, in large part among the most industrialized regions of Brazil (Peixoto, 1998).
- Auto industry. In general terms, one can characterize the evolution of this relatively new industry in principle markets through the advance of globalization, through intensified competition – herein included the intensification of the introduction of new Technologies –, and through the reduction of competitive differences among the leading manufacturers: (...) competitive strategies implemented by automakers in recent years as well as an evaluation of their respective performances in primary automobile markets (Carvalho, 2003, 2005).
- Chemicals and Petrochemical. The petrochemical industry is part of the chemical industry. It is characterized through its use of petroleum or natural gas derivatives as primary materials. However, many of the products denominated as petrochemical, such as polyethylene, for example, may be obtained either through these raw materials or through others, such as coal (South Africa) or alcohol (Brazil). The official classifications of the chemical industry have not utilized a separate "petrochemical" concept. Such industries supply raw materials and products to diverse productive sectors, from agriculture to aerospace (Abiquim, 2011, Thorium, 2011).
- Construction. The peculiarity of this sector resides in its resistance to professionals involved in assuming the uncertainty risks of changing its status quo. Such resistance, added to the multidisciplinary nature of the projects which at times signify an involvement from various companies and the sector's dependence on research for new materials and equipment, has kept civil construction from modernizing to the pace of other productive sectors (Francklin, Amaral, 2008).
- Energy. This sector involves companies which generate and distribute electrical and bio-electrical, thermo-dynamic, and hydro-electrical energies (Moreira, 2001).
- Paper. This includes industries which produce pulp, involving separating the paper fibers from the wood or recyclable paper through mechanical or chemical processes. Paper is obtained through the conversion of these fibers into sheets, and its products are formed through cutting, modeling, coating, and lamination processes (ADVFN, 2011, Souza, 2009).
- Steel and Metals. Industries which operate within the set of procedures and techniques to extract, manufacture, found, and treat metals and their alloys. Metals are used to manufacture utensils, materials such as copper, lead, bronze, iron, gold, and silver, which were amply used in the past. The first foundries appeared in the 8th Centuries. The metals industry had resurgence in the 18th century with the industrial revolution (SIMEMAE, 2011).

The IRT analysis was performed with BILOG-MG® software. This software, developed by Scientific Software, Inc. (Mislevy and Bock, 1990) is one of the most popular IRT programs. The IRT model used was the two-parameter logistic model (2PLM) (Eq. (1)). The BILOG-MG® program performs the analysis in three phases distinguished by the type of tasks performed in each phase (Tezza, Bornia, Andrade, 2011).

3 Item Response Theory

The mathematical models of the IRT estimate item and respondent parameters in order to establish a quantitative measurement scale. To estimate these parameters, one defines a set of variables which cannot be measured directly, but express a theoretical concept defined by "construct" or "latent traits", such as the "environmental management performance" to be answered for a sample of manufacturers located in Brazil. The Item Response Theory (IRT) is a powerful tool that enables the construction of scales from a set of items via mathematical models (Embretson, Reise, 2000, Hambleton et al, 1991).

The IRT provides mathematical models for the latent traits, proposing forms of representing the relationship between the probability of a respondent to give a certain response to an item, and it's latent trait and items characteristics (parameters) in the knowledge field studied. A major advantage of IRT is the

principle of invariance, i.e., the item parameters do not depend on the respondent's latent traits, and the individual's parameters do not depend on the items presented. Other advantages include the possibility of comparing the latent traits of individuals of different populations when they are submitted to tests or questionnaires that have certain common items. It also allows for the comparison of individuals the same population submitted to totally different tests. Lastly, this is possible because the IRT has the items as its central elements (Bortolotti et al., 2012).

For Reckase (1997), an advantage of IRT, for other tools intended for measuring the latent trait, i.e., the Classic Test Theory (CTT) that the first seal characteristics of the item and their combinations in a test as a whole. CTT assumes that the test has already been built and be alert to the score, i.e., the individual: IRT focus item, TCT focus score. Hays et al. (2000), this advantage allows the creation of a scale in which respondents and items are allocated on the same continuum. One of the limitations of CTT is that the proficiency of the respondents and the difficulty of the items cannot be estimated separately. Furthermore, in the CTT is generated only an estimated reliability and standard error of the measurements corresponding, In IRT, each item is handled individually and has a specific error for each item.

In general, the IRT models are presented using a logistic function. The more general model for analysis of unidimensional items with dichotomous response is the 3-parameter logistic model:

$$P(U_{ij} = 1/\theta_j) = c_i + (1 - c_i)\frac{1}{1 + e^{-a_i(\theta_j - b_i)}} \quad [1]$$

Source: Author's 3-parameter logistic model (Birnbaum, 1968).

[1] Where:

- $P(U_{ij}=1/\theta_j)$ represents the probability of a positive response.
- θ_j represents the level of the latent trait. In this case, environmental management performance of industrials.
- b_i represents the difficulty of item i at a certain scale and represents the value of latent variable θ, In which there is 0.5 ou $1+c_i)/2$ probability of the individual j choosing the answer represented by $U=1$.
- The coefficient a_i is the discrimination parameter of item i, proportional to the slope of the Item Characteristic Curve – ICC at point b_i.
- The parameter c_i represents the probability of a hit casual.

During the analysis process, it created a scale related to the latent trait, with mean zero and standard deviation one, the parameters of the items are estimated (a, b, c). In the estimates are generated Characteristic Curves of the Items (CCI), in these curves we can see the probability of hitting the item depending on the skill of the respondent (θ). Figure 2 illustrates the CCI of two hypothetic items.

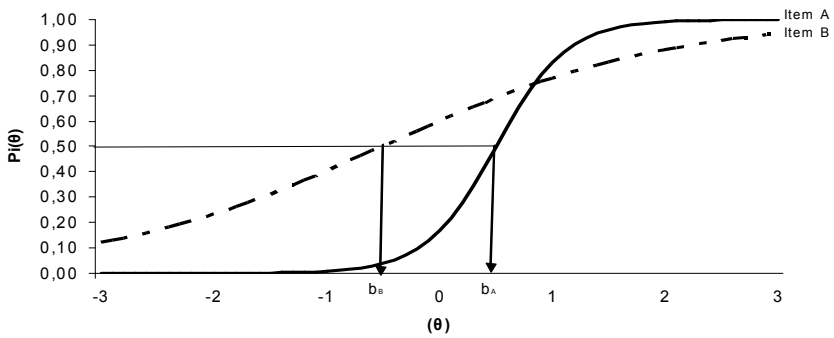

Figure 2. Characteristic Curves of the Items (CCI). Source: Tezza; Bornia; Andrade (2011)

The y-axis represents the values of the probability function Pi(θ)) ranging from zero to one. The x-axis shows the scale of ability (θ) generated by IRT. On this scale, the items and respondents are positioned.

Thus, it is possible to compare the performances of the respondents and the quality of items vertically and longitudinally. A Figure 2 mostra que o item "A" exige uma maior proficiência em relação ao item "B". Thus, an individual with ability (θ) equal to -0.5 has a 50% probability of getting the item "B" and 4% probability of hitting the item "A".

With IRT the respondents and items are located on the same scale (metric). The responses given by a group of respondents to a measuring instrument is used for the estimation of the items and the respondents in this same scale. For an item to be useful, it must be able to differentiate between respondents located in different points along the scale. Respondents are characterized by their position on the latent variable and items are characterized according to their position and capacity to discriminate between respondents (de Ayala 2009).

According Bortolotti et al. (2012) several IRT models were developed and the main distinction between these models refers to the assumption about the relation between the answer choices of a question and the level of the latent trait. There are two types of response processes, the cumulative one and the unfolding one. Cumulative and unfolding models were developed for dichotomous or binary data and polytomous, nominal or graded, parametric and non-parametric models and unidimensional and multidimensional models. Cumulative IRT models are built on the notion in which the probability of an individual giving or choosing an affirmative answer to an item increases as his latent trait increases, i.e., higher levels of latent trait lead to a higher probability of affirmative answers, resulting in a monotonic behavior in the CCI. Among the cumulative IRT models for items with dichotomous responses: corrected as right/wrong (the case of this study). Three models are presented: the 1-parameter logistic model referred as the Rasch model (1PL), the 2-parameter logistic model (2PL) and the 3-parameter logistic model (3PL). The 2-parameter logistic model is defined as:

$$P(\theta_j, a_i, b_i) = \frac{1}{1 + e^{-a_i(\theta_j - b_i)}} \qquad \text{Equation (1)}$$

In this model, bi is the difficulty parameter of item i, represented on the same scale as the latent trait θj, and ai is the discrimination (or inclination) parameter of item i. Usually, b is represented on a scale with mean zero and standard deviation one. The Item Characteristic Curve (ICC) represents the P(θj, ai, bi) relationship with respect to the probability of a certain response to an item, the respondent's latent traits and the item's parameters (Santor et al., 1994).

The majority of IRT models, including the two parameter logistics model, are based on the assumption that the items measure a single latent and continuous value θ, varying from - ∞ to + ∞, or rather, that presumes uni-dimensionality of the construct.

Uni-dimensionality of a scale may be evaluated through factorial analysis. Factorial analysis most frequently found in relevant literature is exploratory and confirmatory. However, for dichotomous responses, these approaches present some mathematical limitations resolved using the approach described by Bock and Aitkin (1981), Bock, Gibbons and Muraki (1988), in which dichotomous item treatment and factor weight loads are performed through the technique called full information factor analysis, based on the item response theory. According to Reeve (2002) the uni-dimensionality assumption may be examined comparing the relationship between the first and second eigenvalue from the tetrachoric correlations matrix. This is an indicator of first dimension strength of the data. According to Reckase (1979), if the first factor explains 20% or more of the variance of the set, one can thus assume uni-dimensionality. The dimensionality of a set of data may also be verified by means of testing the variance analysis (Anova), Chi-squared, Akaike's information criteria, and others (Chalmers, 2011).

In this article, the results show unidimensionality, with the first factor explaining 69.% of the total variance, as seen in Figure 3:

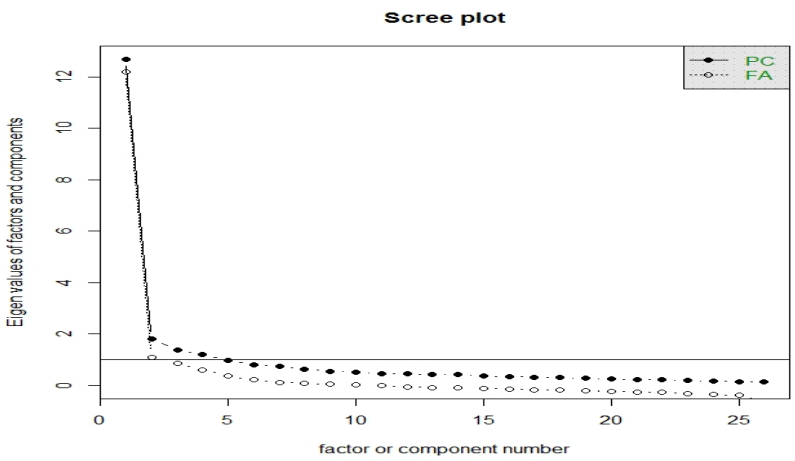

Figure 3. Factorial Analysis. Source: The authors 2011

Another basic assumption of the IRT is local interdependence, which signifies that if the level of the trait is maintained Constant, there should not be any association between the item responses (Thissen, Steinberg, 1988). The lack of either of these two assumptions may generate unstable and inconsistent estimates.

The construction of a set of items as well as a scale to measure the environmental management performance of industrials based on IRT is proposed. This study is structured as follows: (1) the context of the study is presented, followed by an explanation of scale construction, the IRT, and industrial company environmental management performance; (2) the methodology is described; (3) the findings are presented and then discussed, and finally; (4) the conclusions.

It is possible to establish a scale to measure the Brazilian industrial environmental management performance and to follow its evolution over time. It is also possible that new firms, responding to all items, check what their level is on the scale. The scale can be constantly updated with the inclusion of new items, ensuring comparison by keeping the same established unit of measurement. This results in a calibrated item database in the performance range of environmental management, which can be extended to evaluate other industries throughout Brazil.

4 Environmental Management

Companies increase their trend to market value if they state that they are adopting environmental management systems (Jacobs et al., 2010). Thus, the environmental information Expressed through official company website is a good way for Evaluate environmental performance in the whole industry.

Previous studies of environmental management in Brazil include Jabbour et al. (2012), Jabbour (2010), Jabbour and Santos (2009), Gavronski et al. (2008), and Seiffert (2008), Shigunov Neto et al (2009), Nascimento et al. (2008), Barbieri (2007).

Jabbour et al. (2012) analyzed if environmental management can be considered a new competitive priority for manufacturing enterprises located in Brazil. A cross-sectional survey was conducted with Brazilian companies certified by ISO 14001. Sixty-five valid questionnaires were analyzed through Structural Equation Modelling (SEM). The first conclusion is that environmental management presents a preventive approach in the sample analyzed, focused on eco-efficiency, what potentially do not to create a competitive advantage. This preventive approach inhibits environmental management from being regarded as a new competitive manufacturing priority, in the full sense as defined by the literature. Another important result is that environmental management, although following a preventive focus, may influence positively the four manufacturing priorities: cost, quality, flexibility and delivery.

Gavronski et al. (2008) did a survey with 63 Brazilian companies from the chemical, mechanical and electronic industries. A Structural Equations Model (SEM) analyzed the relations between motivations and benefits related to the certification. An exploratory factor analysis identified four sources of motivation: reaction to pressures from the external stakeholders; proaction in expectation of future business concerns; legal concerns; and internal influences. Four dimensions characterized the benefits of an ISO 14001 certification: operational changes; financial impacts; relationship with business stakeholders (customers, competitors, suppliers); and relationship with societal stakeholders (government, society and NGOs). The motivations appear in two levels. Internal and legal motivations are the first level (antecedents), while reactive and proactive motivations are second level (consequents). Internal motivations explain reactive and proactive motivations and production benefits. Legal motivations explain proactive motivations, financial benefits, and benefits in relationships with societal stakeholders.

According Seiffert (2008) cCertification of an ISO 14001 Environmental Management System (EMS) is currently an important requirement for those enterprises wishing to sell their products in the context of a global market. The system's structure is based on Environmental Impact Evaluation (EIE). However, if an erroneous or inadequate methodology is applied, the entire process may be jeopardized. Many methodologies have been developed for making of EIEs, some of them are fairly complex and unsuitable for EMS implementation in an organizational context, principally when small and medium size enterprises (SMEs) are involved. The proposed methodology for EIE is part of a model for implementing EMS. The methodological approach used was a qualitative exploratory research method based upon sources of evidence such as document analyses, semi-structured interviews and participant observations. By adopting a cooperative implementation model based on the theory of system engineering, difficulties relating to implementation of the sub-system were overcome thus encouraging SMEs to implement EMS.

The definitions of corporate environmental management share the inclusion of a systematic approach to the appropriate consideration of environmental issues at all organizational levels from strategic to operational and from theoretical to applied (Jabbour, 2010).

Jabbour and Santos (2009) highlight the fundamental role of human resources and implementation of environmental management systems. They state that while the specialized literature concerning the technical aspects of environmental management expands, there is a gap in the bibliography: integrated approaches between human resource dimensions and environmental management. A model that analyses the relationships between these dimensions and the typical phases of an environmental management system is presented, within a perspective of application for academicians and managers.

According Shigunov Neto et al (2009): Environmental management may be defined as the set of management function activities which determine the environmental policy, objectives, and responsibilities of the company and place them into practice through intermediaries of the environmental system, environmental planning, environmental control, and environmental management improvement. As such, environmental management is the efficient management of the organization's relationship with the environment.

Companies seek to demonstrate and secure effective and efficient environmental performance control in order to reach sustainable development within the objectives and goals de-fined by high management. In order to do so, it is necessary to integrate the components of company environmental management, evidencing the diverse areas involved in the organization's structure. This view points to implementing policies and directives which orient the decision making process in all the actions developed in order to demonstrate the permanent strategy of investing through environmental management systems in the generation of expected results, defined in the objectives outlined by organizations.

Nascimento et al. (2008) defines the Environmental Management System (EMS) as: the set of procedures which will help the organization to understand, control, and reduce the environmental impacts of its activities, products, and/or services. They also add that an efficient EMS permits companies to improve the management of environmental aspects and impacts, beyond interacting in changing organizational attitudes and cultures, improving its results in economic terms upon acting towards the continued

improvement of processes and services. Barbieri (2007) also highlights the importance of placing environmental issues strategically in the organization.

Based on the results of the EMS, the company must carry out critical analysis in order to at-tend its stakeholders' demands and legal aspects in seeking constant perfection. It is thus fundamental to contemplate the environmental management areas with critical analysis, based on a total environmental evaluation, as shown in Figure 4:

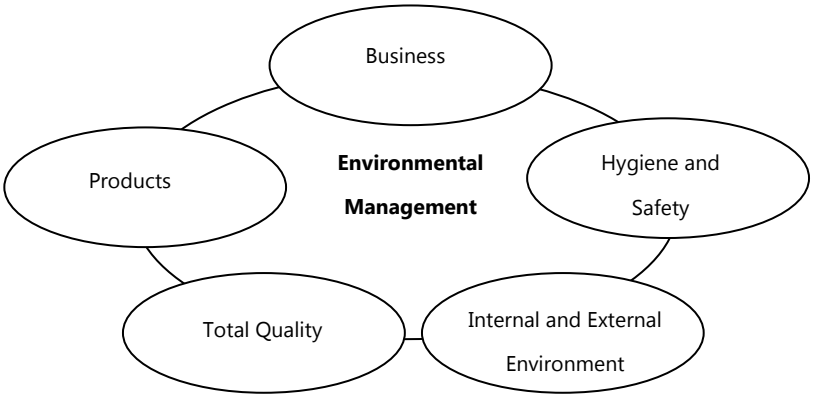

Figure 4. Components of Environmental Management. Source: The authors 2011

The integration of these concepts provides the company with a differential which is recognized and valued by the market. However, it cannot be represented or directly measured through a single element, but rather through a set of attributes which can evidence competitive advantage.

The consequences of environmental management performance should not be restricted to the interests of the company in terms of operational efficiency and costs but should reach strategic levels and all stakeholders. For this reason, measuring environmental management performance is fundamental for opening these borders. Zeng et al. (2008) state that environmental management and ISO 14001 are relevant to the growth of international sales.

5 Results and Discussion

Table 2 demonstrates the estimated parameters for the 26 items based on the sample of 638 companies from the sectors under analysis. These items were ordered according to their Level of difficulty, represented by the parameter "b". The parameters were estimated according to a normal distribution N (0,1), in other words with a mean of zero and a variance of one.

Table 2: Parameters of the ordered items according to degree of difficulty (expressed by the parameter b)

Items	a	SE	b	SE
I23	2.433	0.342	1.555	0.082
I08	0.808	0.127	1.457	0.195
I02	1.286	0.151	1.369	0.124
I13	1.908	0.229	1.333	0.093
I26	3.777	0.417	0.979	0.047
I01	1.281	0.134	0.901	0.096
I24	3.579	0.354	0.891	0.047
I12	2.177	0.211	0.749	0.059
I06	3.624	0.355	0.720	0.043
I04	1.409	0.136	0.584	0.073
I11	3.715	0.387	0.542	0.043
I09	1.452	0.152	0.535	0.070

I10	2.981	0.264	0.534	0.044
I19	2.852	0.275	0.487	0.045
I22	2.639	0.250	0.470	0.045
I16	2.369	0.212	0.407	0.048
I05	3.297	0.342	0.392	0.041
I18	4.421	0.507	0.348	0.032
I20	3.524	0.367	0.300	0.037
I17	4.263	0.426	0.229	0.034
I07	2.485	0.242	0.191	0.045
I21	3.191	0.325	0.153	0.039
I15	3.823	0.331	0.094	0.038
I03	2.568	0.240	0.083	0.045
I25	2.914	0.226	0.069	0.043
I14	4.636	0.447	-0.030	0.035

Source: The authors 2011

In practical terms, based on the parameter b, it is more probable that companies which have a degree of Environmental Management evidence surrounding the mean (in this case, zero) possess the majority of the characteristics evidenced in the items. Merely 4 items demonstrate a greater level of difficulty, with one above 1. These items are: item 23 (b = 1.555), item 8 (b = 1.457), item 2 (b = 1.369) and 13 (1.333). Thus, the company must be able to attend the set of items elaborated in order to evidence its Environmental Management. In other words, the instrument as a whole showed low levels of difficulty.

Item 23 "There is the mention of fines incurred by the company" (b=1.555) is the most difficult of the 26, meaning that the majority of the organizations did not provide evidence they declared that they were fined due to punitive action concerning environmental questions, as determined by supervisory fiscal organizations.

Item 8 is the second most difficult of the 26 items: "Has ISO 14000 implanted throughout the company" (b=1.457), meaning that the majority of the organizations did not provide evidence of having the ISO 14000 implemented throughout the company. However, this item showed the least discriminatory power, as represented by the parameter (a = 0.808). This parameter represents the item's quality with respect to its information. However, even with the lesser parameter "a" compared to those remaining it is still above 0.7, as recommended by literature: items with low "a" values (generally less than 0.7): "(...) a low discrimination parameter of a < 0.700, which indicated items offering little information and possibly not directly related to the latent trait" (Tezza, 2011).

Item 2 "There is the mention of concern for environmental questions in the view" (b=1.369), the third most difficult, demonstrates that not all companies mention concerns for environmental questions in declaring their vision. However, the mission statement, represented by item 1 (b=0.901). It demonstrated greater evidence as these two items are inherent to the company's strategic formulations.

Item 13 "Possesses an environmental seal" (b=1.333), which refers to the environmental seal, is characterized as difficult for companies to evidence.

Item 14 (b= -0.030) showed itself to be the easiest. This means that the large majority of the companies involved have Waste Management in order to demonstrate their environmental management.

In the item 25 "The visual identity of the company (website design) is geared toward the environment" (b=0.069), showed itself to be the second easiest. This means that the majority of the companies analyzed are evidencing their visual identity related to the environmental question, which may facilitate that the user identifies environmental practices of these organizations.

In item 3 (b=0.083), the third easiest item, one observes that the majority of the companies present the mention of concern for environmental questions in their strategic policies and directives. This may be

related to the fact that the definition of environmental variables inserted into the organization's directives is guided by its strategy to simulated scenarios within the environmental conjecture. Thus, one verifies the company tendency to initiate their strategic planning with focus, including in sustainability questions, concerning themselves primarily with their environmental policy definition.

Items 12 "Releases environmental awards" and 6 "Releases environmental information in a specific report" with respective "b" parameters of 0.749 and 0.720 showed to be very close in their positioning on the scale, which indicates they are at the same level as attending Environmental Management. This demonstrates that the company values transparency in releasing environmental information to their stakeholders with respect to their actions concerning awards obtained and disclosed in their annual reports.

Items 19 "Uses renewable energy", 22 "Possesses greenhouse gas emission reduction process" and 16 "Develops ecological products" with respective "b" parameters of 0.487, 0.470 and 0.407 showed to be very close in their positioning on the scale, which indicates they are at the same level as attending Environmental Management. Such positioning demonstrates that companies concerned with releasing information related to eco-efficiency programs.

Items 5 "Establishes environmental goals and objectives", 18 "Efficient use / reuse of Energy" and 20 "Programs to mitigate/recover degraded/ impacted areas" with respective "b" parameters of 0.392, 0.348 and 0.300 showed to be very close in their positioning on the scale, which indicates they are aligned as attending Environmental Management. This indicates that efficient energy use as well as prevention programs and mitigation to degraded areas show themselves to be related to the environmental policies of the companies analyzed.

Figure 5 refers to the total information curve, which is represented by the sum of the information from all the items. It demonstrates that the construct presents greater precision above the mean in order to measure the Degree of Evidencing Company Environmental Management among the sectors analyzed.

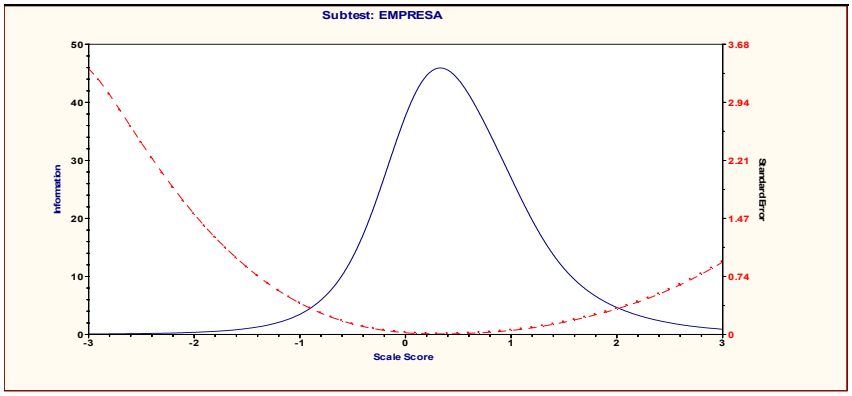

Figure 5. Total information curve for the test (function test information: continuous line; standard error of measurement: dotted line). Source: The authors 2011.

6 Conclusion

Based on the resulted obtained, one can verify the viability of measuring and thus evidencing Environmental Management among the companies in the analyzed sectors, using the IRT. In fact, it has presented many advantages with respect to item selection in composing the questionnaire, as it permits quality and propriety evaluation for each item individually while placing them within a single scale: items and respondents, which is not possible through the use of other tools. This is particularly useful when evaluating constructs which are difficult to observe or abstract, such as evaluating Environmental Management.

One can observe a clear order of the items based on each item's estimated level of difficulty as well as each item's quality. Thus, characteristics related to fines disclosed (Item 23) and possessing ISO 14000 throughout the company (Item 8) are verified as little practiced by companies in the scale generated and possess a greater level of difficulty than the remaining items.

As to the limitations of the company Environmental Management Evidence evaluation questionnaire, presented in Table 1, construction of a greater number of items it suggested and their continuous improvement.

It would also be interesting to build a Computerized Adaptive Test (CAT) for the respondent – the end of the questionnaire – get, immediately, the degree of environment management evidence of your company. As such, a greater reach of the instrument should be considered with the objective to contribute to business management.

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