A Taxonomy of Environmental Strategies

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Abstract

The antecedents of the broadly accepted ISO 14001 certification of the Environmental Management System are used as a base for the segmentation of the environmental strategies on certified companies. A survey conducted on a sample of sites certified, located in Brazil, was submitted to factor analysis, where four constructs were identified as antecedents: market requirements, environmental responsibilities, process improvement, reward expectancy. Those four constructs were submitted to cluster analysis, where three clusters where identified, and validated with discriminate analysis. The three strategies identified were: holistic, utilitarian, and altruistic. The characteristics of the companies on those thee strategies are described.

1 Introduction

In the operations management field, a well-know work (Miller and Roth, 1994) proposed a taxonomy of operations strategy based on the competitive priorities pursued by manufacturing companies. A later replication of this study (Frohlich and Dixon, 2001) used the same taxons, but with different numerical techniques, and a newer database, and found similar results. In the strategy field, however, the use of numerical techniques for empirically derived

The objectives of this study are 1) to understand the creation of capabilities necessary to the upstream diffusion of the Environmental Management System (EMS) along the supply chain, during the processes of supplier relations, using the Resource-Based View (RBV) as the analytic framework, and 2) formulate some hypothesis for future research.

The paper proceeds as follow. Section 2 introduces the related literature. Section 3 presents the methodology. Section 4 presents the results in two parts: we show the outcome from the interviews. Next, we present the analysis resulting from the data gathered on the interviews. We finalize with our conclusions.

2 Literature Review

2.1 Taxonomies on Operations Strategy

In the operations management field, a well-know work (Miller and Roth, 1994) proposed a taxonomy of operations strategy based on the competitive priorities pursued by manufacturing companies. A later replication of this study (Frohlich and Dixon, 2001) used the same taxons, but with different numerical techniques, and a newer database, and found similar results. For operations strategy, configuration studies are still in its infancy (Bozarth and McDermott, 1998). In the strategy field, however, the use of numerical techniques for empirically derived is widespread (Ketchen and Shook, 1996).

2.2 Strategies of Environmental Operations

Klassen and Whybark (1999b; 1999a) proposed a typology of operations technologies to address environmental impacts: pollution prevention, environmental management system and pollution control. In this context, the mission of operations is to translate the respective operational approach into eco-efficient competitive weapons. Klassen and Whybark (1999b; 1999a) called these weapons the environmental operations technology. Other authors suggested alternative typologies of environmental impact of operations (Hart, 1995; Shrivastava, 1995).

Pollution prevention requires structural investments that involve changing the operations, improving the environmental performance not only at the final product, but throughout the productive process, generating significant economic benefits to the company. For this reason, Hart (1995) indicated that pollution prevention programs are similar to total quality management programs. Both programs try to eliminate losses and wastes in the whole process, given that pollution and the excessive use of materials and energy can be considered process losses. Hence, the resources and capabilities that a firm develops for the introduction of TQM might be useful in a pollution prevention program.

Environmental management systems are infra-structural procedures that affect how the operations are managed. They might include the formalization of operating processes, cross-functional coordination, involvement of stakeholders, monitoring, internal and external disclosure of results, training, certification, and other activities related to the environmental impact of the company (Klassen and Whybark, 1999b).

Pollution controls are the structural investments that deal with final process emissions after they have been generated. They not always reduce the total amount of pollutants that are released or discarded, but they reduce the risk associated with them (Klassen and Whybark, 1999b).

Angell and Klassen (1999) suggest that there are two environmental strategy perspectives: *external constraint* and *component.* Firms that treat the environment as an external constraint will make environmental decisions independently of the operational decisions. Since these decisions made separately are locally optimized, it is unlikely that they are also globally optimal. Firms that treat the environment as an operational component recognize them as legitimate operational factors that must be integrated in all operational decisions. Our research indicates that this last approach generated better results in the Brazilian companies.

Azzone and Noci (1998) proposed a typology of environmental policies that include five orientations: missionary, pro-active, predictive, reactive and not reactive. Klassen and Whybark (1999a) identify a taxonomy of three managerial orientations with regard to their environmental policies: obedience, opportunism and leadership. These taxonomies are neither mutually exclusive nor redundant. Since one typology classifies these policies focusing on the technologies adopted and the other classifies them based on the motivation of the firms, both can be analyzed empirically.

EMSs have been connected to TQM – positive relationships between ISO 14001 and ISO 9001 certification, for example (Corbett and Kirsch, 2001; King and Lenox, 2001; Pil and Rothenberg, 2003), to plant characteristics and personal values of managers (Klassen, 2001), and to lean manufacturing (Klassen, 2000; King and Lenox, 2001; Rothenberg et al., 2001).

Angell and Klassen (1999) propose that there are several research opportunities to expand our understanding of the sustainable operations management. These opportunities can be

structured similarly to the manufacturing decision categories of Wheelwright (1984) and Wheelwright and Hayes (1985). They show how the operational decision making model is sufficiently robust to incorporate the new sustainability concerns into the operations strategy framework. Likewise, when Angell and Klassen propose these questions in all decision categories, they show how that the environmental concerns affect all areas of operations and integrate with it, which confirms the coherence of the operational component perspective.

Similar to the seminal work on operations strategy taxonomies (Miller and Roth, 1994), the configuration studies reviewed on the environmental management, be them typologies or taxonomies, rely on basically the same taxons: what companies are doing. We propose different taxons to evaluate, classify, and group companies by their environmental strategies: the motivations that brought those companies to seek an ISO 14001 certification to their sites.

3 Methodology

From a listing the 638 ISO 14001 certified sites from INMETRO (Brazilian Institute for Metrology) by 2004, 100 companies responded to a survey, part of DEVISO project (Developing Countries ISO 14001 Survey). After cleaning for missing data, the final data base had 99 cases, 15% response rate. From the instrument, one scale, motivations to certification, has been used as base for this work. This scale had originally 18 items, 5 points Likert-type, validated by academic and practitioners, but due to the scale purification process (Churchill, 1979), only 13 items composed the final scale.

For validity, was used principal components analysis (PCA) with Varimax rotation. Construct validity was assessed with Cronbach's alpha. KMO test value was 0,661, deemed acceptable, Bartlett's sphericity was statistically significant ($p<0.000$) and correlation matrix was 0.007, a low but not null value. These results allows to proceed to the rest of the analysis (Hair et al., 1998). Table 1, below, brings both PCA results as explained variances, eigenvalues and Cronbach's alphas for each construct found. Factor loadings below .4 were omitted to improve the table's readability. The choice for 4 factors is coherent both with the eigenvalue > 1, cumulative percent of explained variance > 60%, and the scree plot criteria. Besides the numerical criteria, the items belonging to each construct had a meaning together. The validity of the scale was satisfactory, with all items belonging to one factor (unidimensionality), except for the item M18, with factor loading near .4 on other factor, but with higher (.677) loading on his own factor. The reliabilities to the two first factors were very good (>.8), good (>.6) for the fourth factor and the third factor had its alpha slightly below .6 (.587), but it will be kept.

Table 1: Validity and reliability of the scale "motivations to certification"

	Factors			
Items	Market expectations M_MER	Environmental Responsibility M_RES	Management Improvement M_GES	Reward expectations M_REC
M13 Our customers expected from us to get certified.	.896			
M06 We fulfill the demands of our customers.	.858			
M04 The market expected that we get certified.	.783			
M02 It was a general trend in our industry.	.689			
M08 It was our contribution to our planet's sustainability.		.856		
M17 We believe in doing our contribution to make a better world.		.818		
M10 We wanted to do something good for the environment.		.812		
M01 It would help our business to work more efficiently.			.738	
M15 It could improve our productivity.			.719	
M18 We believe that it would help us improve our processes.		.406	.677	
M11 We wanted a reward offered to those who get certified.				.861
M16 An external institution motivated us to get certified.				.783
M03 It was promised some benefit if our site got certified.				.550
Eingenvalues	3.010	2.872	1.591	1.196
Cumulative % Variance Explained	23.16	45.25	57.48	66.68
Cronbach's Alpha	0.830	0.824	0.587	0.625

4 Results

4.1 Cluster Analysis

The factor scores from PCA were used to create the cluster. The cluster was obtained with the hierarchical procedure, using Ward's method and squared Euclidean distance as a measure of cases distance. The dendogram suggested a four cluster solution. Cluster validation was performed with discriminant analysis, described on the next section.

4.2 Discriminant Analysis

Before proceeding to the discriminant analysis, the Box's M was executed to assess the equality of the variance/covariance matrix assumption between the groups. The test with 4 clusters was significant (p=0.002), showing that the variances were significantly different. A new specification of the model, with tree clusters, made Box's M test show no significant differences of variance/covariance matrices between groups, what made the 3 clusters the solution of choice. The 4 constructs model, however, could not be used, once Wilks' Lamba for reward expectations

was not significant (p=0.113). Model was then respecified to 3 variables: market expectations, environmental responsibility, and management improvements. Again, Box's M allowed discriminant analysis execution (p=0.167), and the three variables could discriminate the groups, with a Wilks' Lambda statistically significant (p<0.000). The canonical functions could forecast the belonging to the groups: 97% of original cases were correctly classified, and 94.9% of cross validation cases were correctly classified. Diagram 1 shows a plot of the cases according to the discriminant functions.

Diagram 1: Discriminant functions plot

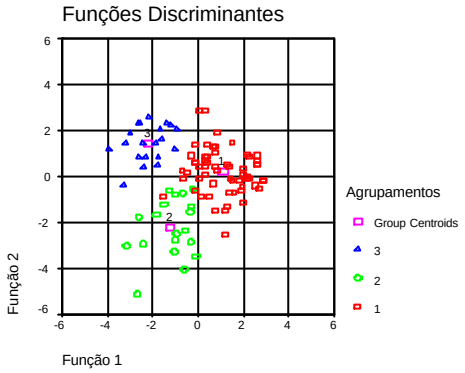

Table 2 shows the coefficients of the Fischer discriminant linear functions and group centroids. The first cluster, called "holistics", holds the companies that sought the certification motivated simultaneously by the expectations of its markets, concerns with its responsibility with the environment and improvements in the management (efficiency). The second group, "utilitarian", show only concerns with expectations from the market. The third group, the "undetermined", sought certification by other reasons not identified by the scale proposed.

Table 2: Discriminant Functions and Group Centroids

	Clusters		
Discriminant constructs	1 Holistics	2 Utilitarian	3 Undetermined
M_MER Market expectations	1.255	.631	-4.364
M_RES Environmental responsibility	.862	-2.154	-.539
M_GES Management improvement	1.185	-3.360	-.363
(Constant)	-1.132	-4.858	-5.078
Cluster centroids			
Function 1	1.103	-1.184	-2.183
Function 2	.216	-2.239	1.480

Table 3, below, shows the coefficients of the discriminant functions and the correlations of the constructs with the discriminant functions, that are stronger evidences of the interpretation above.

Table 3:

A tabela seguinte apresenta os coeficientes das funções discriminantes e a correlação das variáveis com as funções discriminantes, o que reforça a interpretação apresentada acima.

	Coefficients of the discriminant function (not standardized)		**Construct and discriminant function correlations**	
	1	2	1	2
M_MER Market expectations	1.331	-.985	.738(*)	-.668
M_RES Environmental responsibility	.662	.612	.387	.565(*)
M_GES Management improvement	.872	1.040	.245	.278(*)
(Constant)	.000	.000		

* Largest absolute correlation between each variable and any discriminant function.

A tabela a seguir apresenta as estatísticas descritivas. Como se tratam de escores padronizados, era de se esperar que a média total fosse zero e o desvio padrão um. Entretanto, a média dos fatores entre os grupos difere muito, como sugerem as estatísticas anteriores.

Cluster	Construct	Mean	S.D.	N
1 Holistics	M_MER Market expectations	.407	.669	60
	M_RES Environmental responsibility	.300	.802	60
	M_GES Management improvement	.416	.693	60
2 Utilitarians	M_MER Market expectations	.378	.559	19
	M_RES Environmental responsibility	-.829	1.015	19
	M_GES Management improvement	-1.307	.980	19
3 Undetermined	M_MER Market expectations	-1.580	.423	20
	M_RES Environmental responsibility	-.113	1.095	20
	M_GES Management improvement	-.007	.708	20
Total	M_MER Market expectations	.000	1.000	99
	M_RES Environmental responsibility	.000	1.000	99
	M_GES Management improvement	.000	1.000	99

Finally, a oneway-ANOVA was performed to identify which variables, other than the used to create the clusters, would be significantly different between the groups. The variables were: ISO 9001 and 14001 certification year, and sales volumes for the following markets: national companies privately owned, multinational companies buying locally, Stated-owned

companies, final consumer, US or Canada exports, Europe exports, Japan or South Korea exports, Australia or New Zealand exports, and other countries exports. The only variable significantly different between the groups was sales volumes to multinational companies buying locally. After a Bonferroni post-hoc test, it was found that the mean of the sales volume to this kind of organization for the cluster 3 (undetermined) was significantly below from the other clusters. The interpretation for this finding is that companies that sell less to multinational companies locally buying may have another set of motivations not measured on the proposed scale.

5 Discussion, Conclusions and Future Research

This work assesses the motivations to ISO 14001 certification scale and uses it to create a taxonomy of the environmental strategies. The scale is valid and reliable, but does not measure properly the motivations behind the ISO 14001 certification for companies that do not operate on supply chains of multinational companies. It is suggested, then, further research on this kind of corporation to understand their motivations to the ISO 14001 certification, in order to complete the proposed scale and measure more properly the phenomenon.

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