A COMPARATIVE ANALYSIS OF ENVIRONMENTAL MANAGEMENT SYSTEMS: A STUDY OF THE MEXICAN MANUFACTURING SECTOR

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ABSTRACT

A variety of environmental management constructs were operationalized and measured in the field at Mexican maquiladoras. These constructs included: supervisor environmental training, supervisor environmental empowerment, perceived environmental performance, employee environmental training, employee environmental teamwork, and employee environmental empowerment. Facility differences were reflected in higher rated environmental management practices and environmental performance for facilities implementing an EMS than for facilities without an EMS. The same case was partially supported when comparing facilities with a certified EMS to those that implement an uncertified EMS.

INTRODUCTION

The North American Free Trade Agreement (NAFTA) has had diverse impacts on Mexico. These impacts reach a variety of sectors in the general environment including both the economy and society as a whole (Duran, 2005). Some studies show that NAFTA has led to more U.S. foreign direct investment in Mexico’s lower polluting industries (Cole & Ensign, 2005). However, impacts on the natural environment from economic expansion have also tended to be
adverse (e.g. Sweedler, Fertig, Collins & Quintero-Nuñez, 2003). Thus, developing a more complete understanding of environmental management issues is especially relevant in Mexico. An environmental management system (EMS) has the primary purpose of preventing negative effects on the environment and improving a firm’s environmental practices. This is achieved by developing environmental programs and practices. An EMS is a voluntary approach, which can lead to the reduction of environmental impacts such as pollutant emissions (Szymanski & Tiwari, 2004). Previous research also suggests that a strong link exists between HR factors and the implementation of an EMS (Daily, Bishop & Steiner, 2006; Kitazawa & Sarkis, 2000).

This study seeks to compare environmental efforts at a number of Mexican, manufacturing firms. More specifically, the objective of this paper is to examine the relationship between environmental management constructs and environmental management systems. For this study, environmentally related HR factors at both the supervisory and employee levels were identified. Those recognized at the supervisory level include supervisor environmental training and supervisor environmental empowerment. Supervisor perceptions of firm environmental performance were also considered. Additionally, specific environmentally related HR factors pertaining to employees included employee environmental training, employee environmental empowerment, and employee environmental teamwork. Our study extends the literature related to EMSs and environmental management constructs. Second, it tests the role of EMS certification in firm environmental management. Third, the study is the first to compare EMS differences among firms in the Mexican manufacturing sector. Finally, the study has relevant implications for practitioners.

REVIEW OF THE LITERATURE

Environmental Management Systems

The environmental programs and practices associated with an EMS are considered important factors in reducing the impact of businesses on the natural environment. For example, green technologies and products as well as metrics to evaluate and monitor environmental performance can lead to improved environmental performance (Epstein, 1997; Gupta, 1994). An EMS can play an important role in a firm’s environmental performance. Environmental management standards, such as ISO 14001, have been shown to be positively related to both environmental performance and operational performance (Sroufe, 2003). An EMS can be certified through organizations, such as the International Organization for Standardization (ISO), British Standards Institution (BSI), and European and the European Eco-Management and Audit Scheme (EMAS) (Freimann & Walther, 2001; Gupta, 2004). The economic costs of certification can also be a deterrent for firms when considering the adoption of a certified standard such as ISO 14001 or EMAS (Friemann & Walther, 2001; Sroufe, 2003). For example, Sroufe (2003) found that firms with existing EMS’s saw little benefit in expending additional time and resources to attain ISO 14001 certification. Other studies support these findings, but also show further benefits, such as greater visibility, procedural legitimacy, and external recognition. It also assists in maintaining and improving an existing EMS (Jiang & Bansal, 2003).

Environmental Management Constructs

For this study, a number of environmental management constructs were operationalized
and measured in the field at Mexican maquiladoras. These constructs include: supervisor environmental training, supervisor environmental empowerment, perceived environmental performance, employee environmental training, employee environmental teamwork, and employee environmental empowerment. They will be defined and discussed briefly below. It is proposed that facilities implementing an EMS should have higher self-report ratings for these constructs than facilities without an EMS. The same argument should also hold when comparing facilities with a certified EMS to those that implement an uncertified EMS.

Environmental training has been identified as a critical factor of environmental management (Daily & Huang, 2001; Fernandez, Junquera & Ordiz, 2003; Wee & Quazi, 2005). The environmental training constructs are based on the perceived availability, use, effectiveness, and satisfaction with environmental training. Environmental training creates awareness among employees regarding environmental control requirements, increases flexibility, and fosters a proactive attitude towards the natural environment (Rothenberg, 2003; Wee & Quazi, 2005). Environmental training was investigated at both the supervisor and employee levels.

The role of empowerment in organizational environmental issues has received significant attention in recent years (Daily et al., 2006; Daily & Huang, 2001; Fernandez, et al., 2003; Govindarajulu & Daily, 2004; Forman & Jorgensen, 2001; Ramus, 2002). Theoretically, empowerment embodies a process through which those with authority share their power with subordinates. Employee decision-making and autonomy in the workplace reflect this view. Therefore, environmental empowerment is defined as a process through which authority shares its power with employees to address environmental issues. Similarly, supervisors can be empowered by upper management regarding the natural environment.

The importance of teamwork in environmental management is well noted. Environmental teamwork is defined as teamwork designed to solve environmental problems. Specifically, teams innovate, promote, and implement environmental improvements (Daily et al., 2006). A review of the literature on environmental management indicates that teams contribute significantly to improved environmental performance (Beard & Rees, 2000; Daily & Huang, 2001; Daily et al., 2006; Govindarajulu & Daily, 2004) and problem solving and cooperation (Daily & Huang, 2001; Ramus, 2001).

Environmental performance is defined by ISO 14031 as an organization’s success in managing the relationships between its activities, products, or services, and the natural environment. Thus, reducing the environmental impacts created from an organization’s activities, products, and services, improves environmental performance (Rikhardsson, 1998). Commonly utilized environmental performance measures include a variety of economic costs, profits, and environmental impacts (Characklis & Richards, 1999; Illinitch, Soderstrom, & Thomas, 1998). Due to the complexity of such measures and the lack of availability of such data, self-report measurements of environmental performance are often employed (e.g. Daily et al., 2006; Judge & Douglas, 1998; Melnyk, Stroufe, & Calantone, 2003a). Thus, perceived environmental performance is a perceived measure based on the dimensions of the ISO 14031 definition.

Hypotheses

We contend that that there will be comparative differences between facilities implementing an EMS and those facilities that do not. In addition, facilities that use a certified EMS are likely to differ significantly from those facilities that do not. Facility differences should
be reflected in environmental management practices and environmental performance. Thus, such differences can be tested in relation to specific environmental management variables. The following hypotheses are global hypotheses which aim to test the difference between groups across multiple dependent variables based on the abovementioned theoretical background.

**H1:** There will be a significant difference between facilities that have an EMS and facilities that do not have an EMS for all environmental management variables.

**H2:** There will be a significant difference between facilities that have a certified EMS and facilities that have an uncertified EMS for all environmental management variables.

**METHODS**

*Survey Development, Sample, and Setting*

The survey instrument was self-report format with attitudinal variables. Each item consisted of a seven-point Likert scale ranging from “strongly disagree” to “strongly agree”. The items utilized in this particular study measure supervisor environmental training, supervisor environmental empowerment, hourly employee environmental training, supervisor environmental empowerment, hourly employee environmental empowerment, hourly employee use of environmental teams, and perceived environmental performance. Survey items pertaining to training, empowerment, and teamwork were developed based on items from Daily et al. (2006) and Curkovic (1998). Additionally, perceived environmental performance items were based on Melnyk et al. (2003a). Two professional translators translated the survey to Spanish and back-translated the survey to English. One translator was assigned to each task. Effort was undertaken by the principal investigators to make sure that the survey was not only linguistically equivalent, but also as culturally and psychometrically equivalent as possible. The survey was administered as a pilot study among twenty-five maquiladoras. Several items were rephrased or removed as a consequence of suggested feedback from managers and analysis.

The survey was administered by a Mexican marketing firm. They administered the survey to 220 maquiladora managers in the El Paso/Juarez area. Respondents were primarily senior level managers, which included plant or environmental managers. The manufacturing facilities included in this study had to have some level of environmental management; however, no restrictions were placed on the size, industry, product, or ownership criteria. The principal investigators validated survey participation among a sample of respondents via telephone. A total of 205 of the surveys were deemed usable.

**RESULTS**

*Item Reliability*

Reliability was used to evaluate the extent of consistency between multiple measurements of the variables. The inter-item reliability was calculated using Cronbach’s coefficient of alpha. As Cortina (1993) points out, high alphas are often associated with a large number of items and fewer dimensions. Thus, most variables contained between two and seven items. Generally, alphas greater than .70 are accepted as the lower limit for scale reliability.
All coefficient alphas for the variable scales fell within an acceptable range. Each alpha coefficient exceeded .91, ranging from .91 to .98. An item was dropped from two variables, both supervisor environmental empowerment and employee environmental empowerment. However, the three item scales still showed reliability with corresponding alphas exceeding .93. Table 1 illustrates the Cronbach’s alpha for each variable along with the number of corresponding items. Thus, inter-item reliability is supported.

Overview of Variables and Scale Measures

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>No. Items</th>
<th>Mean</th>
<th>S.D.</th>
<th>Cronbach's Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of Company (years)</td>
<td>1</td>
<td>7.29</td>
<td>6.71</td>
<td>NA</td>
</tr>
<tr>
<td>Number of Employees</td>
<td>1</td>
<td>533.64</td>
<td>743.75</td>
<td>NA</td>
</tr>
<tr>
<td>Supervisor Environmental Training</td>
<td>5</td>
<td>3.67</td>
<td>0.25</td>
<td>0.95</td>
</tr>
<tr>
<td>Supervisor Environmental Empowerment</td>
<td>4</td>
<td>3.54</td>
<td>0.18</td>
<td>0.94</td>
</tr>
<tr>
<td>Perceived Environmental Performance</td>
<td>7</td>
<td>4.19</td>
<td>0.34</td>
<td>0.97</td>
</tr>
<tr>
<td>Employee Environmental Training</td>
<td>6</td>
<td>3.95</td>
<td>0.20</td>
<td>0.98</td>
</tr>
<tr>
<td>Employee Environmental Teamwork</td>
<td>2</td>
<td>3.49</td>
<td>0.09</td>
<td>0.94</td>
</tr>
<tr>
<td>Employee Environmental Empowerment</td>
<td>3</td>
<td>2.65</td>
<td>0.12</td>
<td>0.93</td>
</tr>
</tbody>
</table>

Table 1. Scale reliability and descriptive statistics.

Factor Analysis

A confirmatory factor analysis was employed to verify that the items loaded as theoretically predicted. This process served as a measure of discriminant validity among constructs. A common factor analysis was conducted using SPSS Version 15.0 software. The analysis was set to extract six factors based on theory, with eigenvalues greater than 1.0. Maximum Likelihood Estimation (MLE) with pairwise deletion of missing values was used. We also employed oblique rotation using OBLIMIN in SPSS in order to allow for correlated factors (Hair et. al, 2006). Bartlett’s test of sphericity was used to determine the presence of correlation among the measures. The test was significant at the alpha level of 0.05. Communality values for each item were above the cutoff of 0.50 (Hair et al., 2006). Thus, all items possess an acceptable level of explanation.

Two items were removed due to noticeable cross loading. Oftentimes, with cross-cultural research in which language translation takes place, the measurement scales do not generalize as expected (Hulin & Mayer, 1986). The results of the factor analysis provided a six factor solution with acceptable item reliability. Item EO1 did not have a significant loading on Factor 2, employee environmental teamwork. However, the item was retained due to its theoretical foundation and the fact that the scale for employee environmental teamwork only had two items. Factor scores for each item were calculated using SPSS for further use in this study. Unlike summated scales, factor scores for each of the six factors are linked directly to the factor loadings. Thus, each item contributes to the factor score based on the size of its loading instead of arbitrarily using means as in most summated scales (Hair et al., 2006).

MANOVA

MANOVA was used to simultaneously evaluate the difference among the multiple metric
dependent variables in this study. The analysis was conducted to test if there is a significant
difference between facilities that have an EMS and facilities that do not. Additionally, we ran
separate MANOVAs to test whether a difference exists between facilities having certified or
non-certified EMSs. In both cases, regressed factor scores were used for each variable in the
study. Alternatively, MANOVAs were also performed using each item as a variable to validate
the results using the factor scores. The findings will be discussed in more detail below. SPSS
Version 15.0 software’s general linear model function was used to conduct these statistical tests.

Assumptions of MANOVA

Independence of observations is assumed among respondents, because a random
sampling plan was employed. Generally, neither the assumptions of homogeneity nor
homoscedasticity were met. Levene’s test and Box’s M test were used respectively. To test
whether dependent variables are significantly correlated, we used Bartlett’s test for sphericity.
The test indicates that a significant degree of intercorrelation exists (p = .000, \( \alpha < 0.05 \)). We also
examined boxplots for each of the dependent variables to determine if any potential outliers
exist. No outliers were found. Normality of the dependent variables was also investigated. Using
Shapiro-Wilk and Kolmogorov-Smirnov tests to assess univariate normality of the dependent
variables, which indicates that all dependent variables are nonnormally distributed (\( \alpha < 0.05 \)). In
general, the assumption of normality is not supported. Hair et al. (2006) suggest that violations of
this assumption have little impact with large sample sizes; the sample sizes in this study were
moderate. Because the sample sizes are moderate and the nonnormality appears to be due to
skewness rather than outliers, we believe that violations are modest (Hair et al., 2006).

Covariates

Several covariates were included in an effort to control for effects of the dependent
variables that were not part of the research design. Thus, the company’s age and the number of
employees were included as possible covariates. The company’s age was not found to be a useful
covariate. It did not correlate with the dependent variables. However, the number of employees
was found to be correlated with each of the dependent variables, which is a requirement for
covariates. It was also correlated with the independent variable, environmental management
systems (.380). Although inclusion as a covariate could potentially reduce the amount of
variance explained by the independent variable, the results were still significant (p = .001, \( \alpha < 0.05 \)). In terms of correlation, the number of employees showed greater applicability for use as a
covariate in the analysis of difference in environmental management system certification. The
correlation with the independent variable was smaller (.232), and it was more highly correlated
with each of the dependent variables. However, it was not significant (p = .37, \( \alpha < 0.05 \)). Thus,
neither covariate proved particularly useful in explaining extraneous influences from the
dependent variables.

Tests of Hypotheses

MANOVA models were estimated and fit was assessed. Table 4 presents the results of
the multivariate tests for hypothesis one (H1). We adopted an alpha level of 0.05. Using each of
the multivariate tests (e.g. Pillai’s Trace, Wilk’s Lambda), provided significant results. Hair et al.
(2006) recommends the use of Pillai’s Trace criterion, because it is considered more robust and
should be used if there are unequal cell sizes or violations of homogeneity, which are present in this study. Overall, the six independent variables based on factor scores are significantly different for facilities that have an EMS versus those that do not (Pillai’s Trace = .433, F = 20.39, df =160, p = 0.00). As mentioned above, the covariate, number of employees is also significant (p = 0.001). However, the covariate, age of the company, is nonsignificant (0.489). Therefore, the independent variable, EMS, has a significant difference in terms of the dependent variable outcomes (employee environmental training, employee environmental teamwork, supervisor environmental empowerment, perceived environmental performance, employee environmental empowerment, supervisor environmental training). Thus, these six factor score variables show differences by group. An examination of the between subject effects reveals the univariate statistical results for the dependent variables. The outcomes for all dependent variables were significant for the independent variable groupings (α < 0.05). A MANOVA was also performed using each item as a dependent variable. Such an approach is not uncommon when comparing differences between groups across multiple dependent variables derived from survey instruments (e.g. Arambewela & Hall, 2006). An examination of the between subject effects shows that the outcomes for all dependent variables were significant for the independent variable groupings (α < 0.05). The results also support hypothesis one. Thus, two separate approaches corroborate the difference between facilities having an EMS and facilities without an EMS. The mean responses were higher for all facilities possessing an EMS. Therefore, this provides further support for hypothesis one using either method.

Hypothesis two (H2) stated that facilities with a certified EMS will be different from facilities with an uncertified EMS on all variables. Once again, this relationship was tested utilizing two forms of the dependent variables in MANOVA. Using each of the multivariate tests (e.g. Pillai’s Trace, Wilk’s Lambda), provided significant results. The results suggest that overall, the six independent variables based on factor scores are significantly different for facilities that have a certified EMS versus those that do not (Pillai’s Trace = .158, F= 2.78, df = 89, p = 0.016). As mentioned above, no covariate candidates were significant. Therefore, the independent variable, EMS Certification, has a significant difference in terms of the dependent variable outcomes (employee environmental training, employee environmental teamwork, supervisor environmental empowerment, perceived environmental performance, employee environmental empowerment, supervisor environmental training). Thus, overall these six factor score variables show differences by group, those facilities with an EMS and those without an EMS. However, an examination of the between subject effects reveals the univariate statistical results for the dependent variables. The outcomes for two of the dependent variables were not significant for the independent variable groupings (α < 0.05). Both employee environmental teamwork (p = .136, α < 0.05) and perceived environmental performance (p = .116, α < 0.05) were not significant. A MANOVA was also run using each item as a dependent variable. The results of these tests did not support hypothesis two. Thus, the second approach does not verify that a difference exists between facilities having a certified EMS and facilities using an uncertified EMS. All four multivariate tests for the MANOVA using the items as dependent variables were nonsignificant (e.g. Pillai’s Trace p = .22, α < 0.05). Examining the data more closely shows that items ES3, ES4, EP3, EP5, EP6, EP7, and EO6 were not significant for tests of between subject effects. Thus, hypothesis two is only partially supported.

DISCUSSION
The analysis showed that there is a significant difference between facilities implementing an EMS and facilities that do not have an EMS on all of the environmental management variables as indicated by the MANOVA results. These results are substantiated by the convergence of the results from two separately run MANOVAs. Both the composite factor score variables and the single item variables confirm the difference. As expected, facility differences were reflected in higher rated environmental management practices and environmental performance. These findings support previous research on the influence of EMSs on environmental practices, performance, and operations (Daily et al., 2006; Epstein, 1997; Gupta, 1994; Jiang & Bansal, 2003; Sroufe, 2003). When considering the relative significance of these environmental management constructs, it appears that facilities that utilize an EMS emphasize the importance of these constructs more than those facilities that do not have an EMS in place. This conclusion is drawn from the mean scores analysis of the single item variables forming each construct. For example, Mexican manufacturing facilities with an EMS reported the highest average score for the variables accounting for perceived environmental performance (EP7 = 5.88). In contrast, facilities that do not utilize an EMS reported an average score of 2.46 for the same item. This trend holds true for the entire gamut of variables accounting for each of the six environmental management constructs.

The second hypothesis was only partially supported. Using the composite factor score variables provided significant results for a difference between certified and uncertified EMS facilities across the multiple dependent variables. This relationship was proposed due to the theoretical and practical advantages associated with operating a certified EMS. Typically, certified EMSs, such as ISO 14001, afford a firm with greater visibility, procedural legitimacy, and external recognition while maintaining and improving existing EMSs (Jiang & Bansal, 2003). However, the second MANOVA used to test this relationship was not significant. Single item variables did not generate the same results as the composite variables. Since MANOVA is an overall comparison test, it is possible that the composite factor score variables hide similarities found among the larger number of single item variables. In addition, the mixed opinions regarding the benefits associated with certification and non-certification could account for somewhat inconclusive results. For example, the economic costs of certification often deter firms that are considering the adoption of a certified standard, such as ISO 14001 (Friemann & Walther, 2001; Sroufe, 2003). Firms with existing EMSs often see little added benefit to performance in expending time and resources to attain ISO 14001 certification (Sroufe, 2003).

The results of this study have application for practice as well. Practitioners should be aware of the importance of environmental training, environmental empowerment, and environmental teamwork to firms with an EMS. Environmental training should be practiced and employees should be empowered to make decisions regarding environmental issues. Teamwork is also crucial to address environmental issues. Additionally, a similar viewpoint could also be extended to the argument to adopt a certified EMS. Although the results are somewhat mixed, it appears that facilities with certified EMSs could gain in terms of improved implementation of these environmental management and performance variables.

A number of limitations are evident in this study. Because only one method was used in this study (e.g. self-report survey), it is possible that a mono-method bias is present. Other biases associated with cross-cultural studies and translating surveys might be undetected within the results. Additionally, although perceived measures of environmental performance are acceptable, a more concrete measure such as a continuous metric would be preferred. Due to the specific focus on the Mexican manufacturing sector, the generalizability of this study is debatable.
Additional studies are needed to broaden the scope of generalizability, as well as to confirm these results. Several other potential avenues for future research exist. First, what are the antecedents of an EMS in Mexican companies? Some researchers have investigated this question in the United States, but little has been done in Mexico (Melnyk, Sroufe & Cantalone, 2003b). Another interesting project could utilize similar methods to conduct a comparative study between U.S. and Mexican manufacturing facilities. In general, EMSs and environmental management appear to be a growing area of research with a variety of opportunities. Although future research is needed to elucidate the differences between certified and uncertified EMS, this study provides insight into the perceived effectiveness of an EMS. Additionally, it contributes to the growing body of literature on environmental management in developing nations such as Mexico.

REFERENCES


