Corporate Environmental Behavior and the Effectiveness of Government Interventions

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Institutional Pressure and Environmental Management Practices:

An Empirical Analysis

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ABSTRACT

Despite burgeoning research on companies' environmental strategies and environmental management practices, it remains unclear why some firms adopt environmental management practices beyond regulatory compliance. This paper leverages institutional theory by proposing that stakeholders—including governments, customers, activists, local communities, environmental interest groups, and industry associations—impose coercive and normative pressures on firms. However, the way in which managers perceive and act upon these pressures at the facility level depends upon facility- and parent company-specific factors, including their track record of environmental performance, the competitive position of the parent company and the organizational structure of the facility. Beyond providing a framework of how institutional pressures influence facility's environmental management practices, we provide preliminary results based on the empirical analysis of a survey of 3160 environmental managers in the United States.

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INTRODUCTION

Why do some firms adopt environmental management practices that go beyond regulatory compliance? Is the adoption of these practices driven by potential performance outcomes or by institutional pressures? Some research has analyzed specific factors external to the firm that drive the adoption of environmental strategies such as regulation and competitive forces (Aragón-Correa, 1998; Christmann, 2000; Dean & Brown, 1995; Hart, 1995; Nehrt, 1996; Nehrt, 1998; Russo & Fouts, 1997; Sharma & Vredenburg, 1998), and pressure from non-governmental organizations (Lawrence & Morell, 1995). Other research has looked at the role of the characteristics of the firm to explain the adoption of "beyond compliance" strategies. This includes the influence of organizational context and design (Ramus & Steger, 2000; Sharma, 2000; Sharma, Pablo, & Vredenburg, 1999) and organizational learning (Marcus & Nichols, 1999). Other analyses have focused on the individual or managerial level, examining the role of leadership values (Egri & Herman, 2000), and managerial attitudes (Cordano & Frieze, 2000; Sharma, 2000; Sharma et al., 1999). While each has provided a piece of the puzzle, there is still a lack of understanding of the conditions under which these various rationales matter to explain the adoption of practices beyond regulatory compliance at the facility level. In a rare exception, Gunningham, Kagan, and Thornton (2003) examined the external and internal pressures that drive firms to improve their environmental performance beyond regulatory compliance in the pulp and paper industry. As others recently pointed out, 'our understanding of factors that foster strong environmental management practices within a firm, particularly with operations at the facility level, still remains limited' (Klassen, 2001, p. 257). This paper offers a perspective that not only evaluates the relative influences of external stakeholders exerting institutional pressures on firms, but also depicts how firm characteristics and organizational structure moderate these pressures. Beyond providing a framework of how institutional pressures influence facility's environmental management practices, we provide preliminary results based on the empirical analysis of a survey of 3160 environmental managers in the United States.

The institutional sociology framework emphasizes the importance of regulatory, normative and cognitive factors that affect firms' decisions to adopt a specific organizational practice, above and beyond the practice's technical efficiency. Institutional theory emphasizes legitimation processes and the tendency for institutionalized organizational structures and procedures to be

taken for granted, regardless of their efficiency implications (Hoffman & Ventresca, 2002). However, the institutional perspective does not address the fundamental issue of business strategy: why do organizations subject to the same level of institutional pressure pursue different strategies? Building on the institutional framework, we argue that firms adopt heterogeneous sets of environmental management practices because they interpret these pressures differently due to facility and parent company characteristics. In our model, managers of different facilities are subject to the same level of institutional pressures but they are expected to perceive these pressures differently due to disparities in their parent companies' organizational structure, strategic position, and financial and environmental performance. This difference between 'objective' and 'perceived' pressure leads to different calculations and responses. The adoption of environmental management practices by firms varies therefore not only due to different levels of institutional pressures but also because of the organizational process that transforms objective pressures into perceived pressures.

To be tested empirically, this comprehensive framework of the drivers of the adoption of environmental management practices necessitates an empirical approach that combines both existing publicly available databases, as well as original data from a survey questionnaire at the facility level. Publicly available databases can provide information on "objective pressures" while the survey questionnaire can give information about the perception of pressure and the actions taken in response. The combination of these sources of information allows the evaluation of the difference between objective and perceived pressures and the resulting adoption of environmental management practices.

INSTITUTIONAL THEORY

Institutional theory emphasizes the role of social and cultural pressures imposed on organizations that influence organizational practices and structures (Scott, 1992). DiMaggio and Powell (1983) argue that managerial decisions are strongly influenced by three institutional mechanisms—coercive, mimetic and normative isomorphism—that create and diffuse a common set of values, norms and rules to produce similar practices and structures across organizations that share a common organizational field. An organizational field is defined as "those organizations that…constitute a recognized area of institutional life: key suppliers, resource and product

consumers, regulatory agencies, and other organizations that produce similar services or products (DiMaggio & Powell, 1983: 148).

Jennings & Zandbergen (1995) were amongst the first to apply institutional theory to explain firms' adoption of environmental management practices. They argue that because coercive forces—primarily in the form of regulations and regulatory enforcement—have been the main impetus of environmental management practices, firms throughout each industry have implemented similar practices. Consistent with most institutional theorists, Jennings & Zandbergen claim that firms that share the same organizational field are affected in similar ways by institutional forces that emanate from them. They cite the examples of how the Three Mile Island crisis undermined the legitimacy of all firms in the US nuclear power industry, and how the discovery that chlorofluorocarbons (CFCs) depleted stratospheric ozone undermined the legitimacy of manufacturing and using those products, and quickly led to institutional coercive forces via the establishment of the Montreal Protocol to phase out the manufacture of CFCs. Delmas (2002) proposed an institutional perspective to analyze the drivers of the adoption of the ISO 14001 Environmental Management System (EMS) international standard in Europe and in the United States. She described how the regulatory, normative and cognitive aspects of the institutional environment within a specific country affect the costs and potential benefits of ISO 14001 adoption, and therefore explain differences in adoption rates across countries. Other researchers have explored how companies operating in different organizational fields are subject to different institutional pressures. As a result, different practices become commonplace. For example, distinct levels of coercive pressures are exerted upon different industries, which may lead to different environmental strategies (Milstein, Hart, & York, 2002).

While such studies examine dynamic and cross-industry institutional forces, they avoid the question more fundamental to strategic management: why do organizations within the same organizational field pursue different strategies, despite experiencing isomorphic institutional pressures? In other words, how might institutional forces lead to heterogeneity, rather than homogeneity, within an industry? Hoffman (2001) argues that while organizations do not simply react to the pressures dictated by the organizational field, they also do not act completely autonomously without the influence of external bounds. Institutional and organizational dynamics are tightly linked. A few researchers have begun to investigate this question empirically (D'Aunno, Succi, & Alexander, 2000; Levy & Rothenberg, 2002).

Levy & Rothenberg (2002) describe several mechanisms by which institutionalism can encourage heterogeneity. First, they argue that institutional forces are transformed as they permeate an organization's boundaries because they are filtered and interpreted by managers according to the firm's unique history and culture. Second, they describe how an institutional field may contain conflicting institutional pressures that require prioritization by managers. Third, they describe how multinational and diversified organizations operate within several institutional fields—both at the societal and organizational levels—which expose them to different sets of institutionalized practices and norms.

D'Aunno et al. (2000) explore the circumstances under which organizations are more likely to abandon institutionalized structures or practices in favor of new ones, such as by diversifying into new services. They find that market forces (proximity to competitors), institutional forces (poor compliance with government regulations, being a member of a multidivisional firm), and mimicry of changes observed in other organizational fields each encourage strategic change that diverges from institutional norms.

We hypothesize that organizational structure, strategic positioning, and performance will affect how firms perceive institutional pressures and how they decide to respond. Individuals in organizations focus on different aspects of the firm's external and internal environments, depending on the cognitive frame through which they view the world (Hoffman, 2001). Cognitive frames are mental representations individuals use to interpret and make sense of their world. Frames can come to be collectively held within organizations, especially through the influence of the organizational leader (Barr, Stimpert, & Huff, 1992; Weick & Roberts, 1993).

Institutional pressures

In this section, we describe a model that links institutional pressures to organizational characteristics to explain the adoption of environmental management practices at the facility level. Figure 1 illustrates our model.

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[Insert Figure 1. about here]

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This figure shows that facility-level managers' perceptions of institutional pressures are a function of stakeholders' actions but are moderated by the organizational characteristics of the facility and the parent company as well as the strategic positioning of the parent company. We describe how these coercive and normative pressures can affect the adoption of environmental management practices by facilities. We focus on a subset of the institutional actors identified by Hoffman (2001) who we believe are most likely to directly influence environmental practices at the facility level: governments, customers, competitors, community and environmental interest groups, and industry associations. The actors we focus upon are important to consider when assessing a firm's environmental performance (Lober, 1996).

Government pressure

Perhaps the most obvious stakeholders that influence firms' adoption of environmental practices are various government bodies. Legislation authorizes agencies to promulgate and enforce regulations, a form of coercive power. Many researchers have focused on the influence of enforced legislation and regulations on firms' environmental practices (Carraro, Katsoulacos, & Xepapadeas, 1996; Delmas, 2002; Majumdar & Marcus, 2001; Rugman & Verbeke, 1998). In particular, Delmas (2002) found that governments play an important role in firms' decision to adopt ISO 14001. First, governments can act as a coercive force by sending a clear signal of their endorsement of ISO 14001 by, for example, enhancing the reputation of adopters. Second, government can facilitate adoption by reducing information and search costs linked to the adoption of the standard by providing technical assistance to potential adopters. In this paper, we refer to political pressure as the level of political support for broader or more stringent regulations. Regulatory pressure represents the extent to which regulators threaten to or actually impede a company's operations based on their environmental performance.

Customer and competitive pressures

In addition to government actors, firms may facilitate coercive and mimetic isomorphism. For example, multinationals are widely recognized as key agents in the diffusion of practices across national borders by transmitting organizational techniques to subsidiaries and other organizations in the host country (Arias & Guillen, 1998). Firms may also mimic practices that successful leading firms have adopted. In addition, firms respond to customer requirements. The customer-

supplier relationship is perhaps the primary mechanism through which quality management standards have diffused (Anderson, Daly, & Johnson, 1999). Several studies have found that firms that adopted environmental management practices were motivated by customer concerns. A survey of the largest Canadian firms showed that customer pressure was the second most cited source of pressure to adopt an environmental management plan, after government pressure (Henriques & Sadorsky, 1996). Khanna and Anton (2002) found that U.S. companies that sell final goods adopt more comprehensive EMSs than companies that sell intermediate goods. This suggests that retail consumers exert more pressure on companies to adopt environmental management practices than commercial and industrial customers. Christmann and Taylor (2001) showed that customers in developed countries have influenced companies in China to improve their environmental compliance and adopt the ISO 14001 EMS standard.

Community and environmental interest group pressures

Local communities can also impose coercive pressure on companies through their vote in local and national elections, via environmental activism within environmental non-government organizations (NGOs), and by filing citizen lawsuits. Several studies have found that company decisions to adopt environmental management practices are influenced by the desire to improve or maintain relations with their communities. Henriques and Sadorsky (1996) surveyed 700 firms in 1992. These firms indicated that community group pressure influenced them to adopt an environmental plan. Florida and Davison (2001) investigated why facilities had adopted EMS's and instituted pollution prevention programs. They found that the adoption of these programs was positively correlated with firms' active engagement with community stakeholders (Florida & Davison, 2001). Another study based on a survey of ISO 14001 certified companies across 15 countries found that one of the strongest motivating factors to pursue certification was the desire to be a good neighbor (Raines, 2002).

Some communities may be better able than others to encourage facilities to adopt environmental practices. Communities with larger minority populations, lower incomes and less education have greater exposure to toxic emissions (Arora & Cason, 1999; Brooks & Sethi, 1997; Khanna & Vidovic, 2001). Some researchers have begun examining whether socioeconomic community characteristics are associated with facilities' decisions to adopt environmental management practices. One study examined facility-level adoption of a United States Environmental

Protection Agency (US EPA) voluntary program, and found that adoption was more likely in communities with higher median household income (Khanna & Vidovic, 2001).

Greater declines in toxic emissions have been observed among facilities located in communities with higher voting rates (Hamilton, 1999) and in states with higher membership in environmental interest groups (Maxwell, Lyon, & Hackett, 2000). Maxwell et al. (2000) assert that higher environmental interest group membership levels indicate a community's pro-environmental stance and greater propensity to use these organizations to lobby for more stringent regulation. As such, the authors conclude that higher membership rates provide a credible threat of increased regulation, which in turn drives firms to self-regulate.

Many of the firms studied by Lawrence & Morell (1995), especially the larger ones, were motivated to improve their environmental performance by their concern over 'environmental organizations that had aggressively publicized firms' lapses in environmental responsibility' (Lawrence & Morell, 1995, p. 111). There are many examples where companies have amended their environmental practices in response to environmental group pressures (Baron, 2003). For instance, after Mitsubishi Corporation was subject to a protracted consumer boycott led by the Rainforest Action Network (RAN), Mitsubishi announced it would no longer use old-growth forest products (World Rainforest Movement, 1998).

Industry pressure

Institutional researchers have argued that organizations are more likely to mimic the behavior of other organizations that are tied to them through networks (Guler, Guillen, & MacPherson, 2002). Several studies have found that industry associations have motivated firms to adopt environmental management practices. Kollman & Prakash (2002) examined why the United Kingdom, Germany and the United States have such different rates of EMS certification. They found that the decision of whether to pursue certification, and which standard to certify against (ISO 14001 or the European Union's Eco-Audit and Management Scheme) was strongly influenced by stakeholder pressures from industry associations in addition to regional chambers of commerce, suppliers and regulators.

Market concentration within an industry may also affect the rate of diffusion of environmental management practices. If an industry is dominated by a few big players that require their

suppliers to adopt particular environmental management practices, this is likely to lead to a greater diffusion of these practices than if the industry were more fragmented. This is a major reason why automotive suppliers in the United States have adopted similar quality and environmental practices.

Interactions

The interaction between these institutional pressures is likely to moderate their individual influence on company practices. For example, the pressure from environmental groups may encourage the formulation of more stringent regulations. This, in turn, can induce industry leaders to encourage laggard firms to adopt environmental practices. Similarly, following its chemical disaster in Bhopal in 1984, Union Carbide along with other large chemical companies faced mounting public pressure for more stringent safety and environmental regulations. In response, the chemical industry developed and promoted a set of environment, health and safety (EHS) management practices—the Responsible Care program—to chemical industry associations in Canada and the United States (King & Lenox, 2000; Prakash, 2000).

The moderating effects of firm characteristics

Within the same industry, firms may be subjected to different levels of institutional pressures. For example, multinational corporations are often held to higher standards for social and environmental responsibility than national companies because they are subject to the additional pressure of stakeholders from foreign countries (Zyglidopoulos, 2002). Furthermore, the visibility of leading firms often subjects them to more pressure. For example, social and environmental activists have targeted Nike, McDonald's, Starbucks and Home Depot in part because of their market leadership position (Roberts, 2003; Rowley & Berman, 2000). Furthermore, firms with historically poor environmental records are often subjected to more scrutiny by their local communities and regulators. Thus, multinational companies, market leaders, and firms with poor environmental records may have more to gain by developing sophisticated mechanisms to anticipate and manage external pressures.

PERCEPTION OF PRESSURE

Firm and facility characteristics can affect not only the level of institutional pressure exerted on a facility, but also how facility managers perceive institutional pressures. This is important because, even if institutional pressures were exerted at the same level on two facilities, these two facilities may well perceive and respond differently.

First, institutional pressures are exerted at various levels of a firm. For example, community pressures are often directly targeted at a particular facility, while shareholder pressures target the corporate level. Second, organizations channel these institutional pressures to different subunits, each of which frames these pressures according to their typical functional routines (Hoffman, 2001). For example, legal departments interpret pressures in terms of risk and liability, public affairs does so in terms of company reputation, environmental affairs in terms of ecosystem damage and regulatory compliance, and sales departments in terms of potential lost revenues. Consequently, the pressure is managed according to the cultural frame of the unit that receives it: either as an issue of regulatory compliance, human resource management, operational efficiency, risk management, market demand, or social responsibility (Hoffman, 2001). One implication of this process is that the internal organization of the firm matters because it influences how institutional pressures are perceived. Facility managers may perceive these external pressures more intensively (and respond to them accordingly) in firms where they have more open channels of communications with the immediate receptor of pressures (corporate functional areas responsible for finance, law, strategy, communication, and the environment).

Information sources may also play a role in cultural framing. Environmental managers may learn about management practices from a variety of sources. For example, a facility may learn in an industry association meeting about a pending boycott of a competitor because of its environmental performance. The source from which managers get their information on existing environmental management practices can also influence their decision to adopt environmental management practices.

A firm's historical environmental performance may also influence both how managers perceive stakeholder pressures and how they respond to them. Managers in firms whose reputations have suffered from pollution accidents may be more sensitive to environmental issues than those in

other companies (Prakash, 2000). After major accidents, firms may rearrange their organizational structure to prevent recurrences and to facilitate more rapid responses. Such reorganizations may also begin actively engaging with those stakeholders from whom the firm expects more scrutiny (e.g., regulators, environmental activities). These reorganizations may also occur within competing firms if heightened institutional pressures spill beyond the firm that experienced the accident. For example, the disclosure of environmental information in the annual reports of oil companies increased significantly in the years following the Exxon Valdez oil spill (Patten, 1992).

FIRM RESPONSES TO INSTITUTIONAL PRESSURES

Firms can adopt various types of environmental management practices in response to institutional pressures. These can be based on (1) environmental strategies of conformance that focus on complying with regulations and adopting standard industry practices, or (2) voluntary environmental strategies that seek to reduce the environmental impacts of operations beyond regulatory requirements (Sharma, 2000). Voluntary strategies involve creative problem solving and collaborative interactions with stakeholders (Sharma & Vredenburg, 1998). For example, firms adopting voluntary approaches can implement EMS elements by creating an environmental policy, developing a formal training program, or instigating routine environmental auditing. In addition, management can choose to have the comprehensiveness of their EMS validated by a third party by pursuing ISO 14001 certification. Management can also convey the importance of environmental management by including it as a criterion in employee performance evaluations (Nelson, 2002).

Companies can also seek to improve relations with regulators and signal a proactive environmental stance by participating in government or industry sponsored voluntary programs. Indeed, the US EPA, some industry associations, and several NGOs have recently created voluntary standards to provide incentives for firms to go beyond minimal regulatory requirements. For example, the US EPA has developed several voluntary agreements between governmental agencies and firms to encourage technological innovation or reduce pollution while providing relief from particular procedural requirements (Delmas & Terlaak, 2001). Industry programs include Responsible Care and Sustainable Slopes (King & Lenox, 2000;

Rivera & de Leon, 2003). NGO programs include the Natural Step and the Global Reporting Initiative Guidelines (Bradbury & Clair, 1999; Hedberg & von Malmborg, 2003).

Companies can also work directly with customers and suppliers to improve their environmental performance. Furthermore, they may engage in "systematic communication, consultation and collaboration with their key stakeholders...(and) host stakeholder forums and establish permanent stakeholder advisory panels at either the corporate level, the facility level, or to address a specific issue" (Nelson, 2002, p. 18).

METHODOLOGY

Data for this study are derived from two main sources: (i) a survey questionnaire sent to 3160 facilities in the fall of 2003; and (ii) publicly available databases. The survey provided information about the management practices each facility has adopted (our dependent variable) as well as the number of environmental staff, the types of environmental auditing conducted, and perceptions of institutional pressures. Various "objective" institutional pressures as well as firm and facility level characteristics were obtained from existing databases.

Sample

Our sample focuses on heavily polluting industrial sectors, which we identified based on their share of toxic chemical emissions reported to the US EPA's Toxic Release Inventory (TRI) program. The following sectors were selected: electric utilities (SIC 49), electrical/electronics (SIC 36), petroleum refining (SIC 29), chemical and allied products (SIC 28), automotive (SIC 37), machinery manufacturing (SIC 35), primary metals manufacturing (SIC 33), and pulp, paper and paperboard mills (SIC 26). In 2001, the 11,622 facilities from these industries represent 47% of the total number of facilities that reported data to TRI and 78% of the total TRI toxic air emissions reported.[1] To ensure we would have access to recent environmental performance data, we restricted our sample to facilities that reported air emissions to the TRI program in at least 3 years within 1996 – 2000. These facilities must report TRI data annually when they employ 10 or more individuals and manufacture, import, process, or use more than designated minimum

[1] EPA 260-S-03-001. July. www.epa.gov/tri/tridata/tri01

thresholds (typically 10,000–25,000 pounds) of any of 650 toxic chemicals.[2] To ensure the availability of financial data, we further restricted our sample to facilities owned by publicly traded companies. These restrictions reduced our sample to 3160 facilities.

Survey questionnaire

Little detailed information about environmental management practices (EMPs) is publicly available at the facility level. Consequently, we conducted a survey to gather this information as well as managers' perceptions of the factors that influenced their facility to adopting EMPs. Our survey also asked about how the facility's environmental management was structured organizationally. The survey questionnaire instrument is included in the Appendix.

Pre-testing. To ensure that our survey questions were clearly understood and easily answerable by our respondents, we pre-tested our survey instrument by having a panel of experts complete the survey. These experts included environmental managers and environmental, health and safety (EHS) managers from twelve large companies in our sample's industries, a few environmental management consultants, and several faculty members whose research interests include environmental management. We then interviewed these individuals to probe their interpretation of each question and to solicit suggestions to clarify them. This process resulted in refinements to several survey questions and response anchors.

Survey respondents. The ideal survey respondent must be knowledgeable about the facility's EMPs and have informed perceptions about the drivers of its environmental management efforts. As such, we targeted the survey toward the facility's environmental manager or EHS manager. The Survey Research Center (SRC) at the University of California at Santa Barbara called each facility to obtain the name of this individual.

Survey administration. The survey was sent to the respondents in three waves. The survey was sent to the entire sample twice, on October 13 and November 4, 2003. The cover letter that accompanied the survey provided a unique login identification number to enable respondents to complete the survey online via a secure website if they preferred that to the enclosed paper

[2] US Environmental Protection Agency. 2001. The Emergency Planning and Community Right-to-Know Act: Section 313 Release and Other Waste Management Reporting Requirements. EPA 260/K-01-001. February. http://www.epa.gov/tri/guide_docs/index.htm

version. To encourage responses, the SRC placed calls to 2312 facilities (73% of the sample) between October 23 and November 12. In addition, postcards were sent in January 2004 to those who had not yet replied.

Response rate. In total, we received 303 responses by mail and 233 by web for a total of 536. Of our total sample of 3160, this represents a response rate of 17%, which is considered as an acceptable response rate for a sample of that size. The response rate among the 2312 facilities that received a follow-up call from SRC was 20.3%, significantly higher than the 7.2% response rate of the other 930 facilities. Sample representativeness was tested in three ways. First, we compared the size of respondent and non-respondent facilities using facility-level employment data obtained from D&B. Respondent and non-respondent facilities employed, on average, 479 and 422 employees respectively, but this distinction is not statistically significant (p=0.19). We then examined the response rates across industries and found they were quite similar, ranging from 13% (Refining and Electric utilities) to 17% (Machinery, Electrical/electronics) to 19% (Automotive, Primary metals). We also compared the pollution levels of the respondents to the non-respondents. The two groups' total annual toxic emissions released to air, logged and then averaged over 2000 and 2001, were statistically indistinguishable (p=.41). In addition, we compared the two groups' average environmental harm by weighting each chemical by the US EPA's TRACI scheme and then aggregating annual totals (Toffel & Marshall, 2004) and logging the result. By this measure, the two groups were also statistically indistinguishable (p=0.80). This provides further assurance that respondents are representative of the entire sample.

Dependent variable

The dependent variable represents the comprehensiveness of environmental management practices at the facility level. We proxy this unobserved quality by aggregating the observed environmental practices adopted by a facility. Our measure includes the extent to which: (1) the facility adopts and communicates an environmental policy; (2) employees receive environmental training; (3) employee performance reviews incorporate environmental performance; (4) procurement decisions incorporate environmental concerns; and (5) the facility participates in government and industry-initiated voluntary environmental programs. In addition, internal and external audit frequency and whether ISO 14001 certification were included.

There are several methods to aggregate these management practices and create the dependent variable. One method is simply to sum up the number of practices that each facility has adopted and the level of implementation of each adopted practice (Khanna & Anton, 2002). This method implicitly weights each practice equally.

A second method is to run a factor analysis on the original variables within each category (e.g., training) and then add the category totals to generate the final dependent variable. The main applications of factor analytic techniques are: (1) to reduce the number of variables and (2) to detect structure in the relationships between variables. Klassen used this method in his study of environmental management practices in the furniture industry (Klassen, 2001).

EMS comprehensiveness via summing variables

Table 1a describes the methodology to derive each category of environmental management practice. We focus on the following categories: environmental policy promotion (POLICY_D); audit frequency (AUDITS_D); training comprehensiveness (TRAIN_D); environmental performance review (REVIEW_D); environmental procurement policy (PROCUR_D); participation in voluntary programs (VOLPRG_D); and ISO certification (ISO_D). Each category is the sum of the variables composing it. For example, the category representing environmental policy is the sum of four variables, each coded 0 ("no") or 1 ("yes"), constructed from the following survey questions: Is your environmental policy distributed to employees? (POLICYD) Is your environmental policy posted on the Internet? (POLICYI) Is your environmental policy discussed with managers or supervisors? (POLICYM) Is your environmental policy posted at the facility? (POLICYP) We then normalized each category sum to a maximum score of 1, and he added these normalized category totals to create the dependent variable (EMP_SUM).

Comprehensiveness of environmental management practices (EMP_SUM)= POLICY_D + AUDITS_D + TRAIN_D + REVIEW_D + PROCUR_D + VOLPRG_D+ ISO_D

As depicted in Figure 2, this variable has a normal distribution, a condition that facilitates the use of ordinary least squares (OLS) regression.

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[Insert figure 2. about here]

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EMS comprehensiveness via factor analysis

A specific category of factor analysis is called Principal Component Analysis (PCA). We used PCA to investigate whether we could consolidate some of our variables within a specific category. PCA is an eigenanalysis technique that extracts a set of eigenvectors and their associated Eigenvalues by a step-wise procedure. The first eigenvector is extracted in a manner that causes it to account for a maximum amount of variance in the data. After each eigenvector is extracted a residual data matrix is calculated and the procedure is repeated until there are no significant eigenvectors left. The variance accounted for by each eigenvector is measured by its Eigenvalue. The variance is equal to the square of the Eigenvalue. Examination of the Eigenvalues and their relative magnitudes allows an estimation of the number of significant 'factors' or components in the matrix. We retain only factors with Eigenvalues greater than 1, a very common criterion (Kaiser, 1960).

Not all of the environmental management practices variables could be subject to PCA due to the coding of some variables.[3] We use PCA with the following categories: environmental training; employee performance reviews; procurement; audit frequency; and voluntary environmental program participation. Table 1b describes the PCA analyses and results, including the original variables, the number of factors with Eigenvalues above 1 and their Eigenvalues of these factors, the percentage of variance explained by the factors, and the name of the new variable(s) created.

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[Insert Table 1b about here]

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[3] For example, our variable assessing the existence and communication of an environmental policy consist of dummy variables on which it is not possible to run a PCA.

We add the categories created with PCA to the variable representing environmental policy (POLICY_D) to create the second measure of the comprehensiveness of environmental management practices (EMP_PCA).

Comprehensiveness of environmental management practices using PCA (EMP_PCA) = POLICY_D + AUDITS_C + TRAIN_C + REVIEW_C + PROCUR_C + VOLPRG_C + ISO_C

EMP_PCA is normally distributed, as illustrated in Figure 3.

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[Insert figure 3. about here]

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The two dependent variables that we created (EMP_SUM and EMP_PCA) are highly correlated (0.985) but EMP_SUM (541) has more observations than EMP_PCA (480) due to the difference in methodology used to create the variables.

Independent variables

Many stakeholder pressures can be measured through publicly available data sources, though in a few cases internal company information may be significantly more accurate (e.g., customer pressure). The perception of stakeholder pressure can also be assessed through a survey questionnaire addressed to managers (Henriques & Sadorsky, 1996). Relying on both publicly available databases and a survey enable us to assess differences between "objective pressures" (measured by the former) and "perceived pressures" (measured by the latter).

Political and regulatory pressure

Political and regulatory pressure is measured in several ways. First, we include Congressional members' "National Environmental Scorecard" values published annually by the League of Conservation Voters, a measure that has been widely used for this purpose (Hamilton, 1997; Kassinis & Vafeas, 2002; Viscusi & Hamilton, 1999; Welch, Mazur, & Bretschneider, 2000). The average of the League of Conservation Voters' 1996 scores for the state's US Senate and House delegations to Congress was calculated (LCV96CON). Second, we include the number of

state-level environmental policy initiatives (toxic waste, air pollution and recycling programs) each state has implemented (GINDEX50) (Hall & Kerr, 1991: 142), a measure recently been used by Welch et al. (2000). Third, we incorporate Renew America's assessment of how comprehensively each state's policies have addressed 17 environmental domains (e.g., air pollution, groundwater, soil conservation) (GINDEX17) (Hall & Kerr, 1991: 146). Fourth, we include a variable representing the state's average inverse of pollution intensity over the years 1995-2001 (PII9501). Each year's figure is the ratio of the state's gross product (million current US $) to the unweighted sum of the state's Toxic Release Inventory emissions (lbs).

Competitive pressure

Pressure toward mimetic isomorphism exerted on a facility is measured by the extent to which the facility perceives that its competitors have adopted an EMS (COMPEMS). Survey respondents could choose from five categories representing percentage ranges from 0-20% to 80-100%. We also included an additional "don't know" category that was subsequently recoded as the average response of facilities within in the same industry.

Community and environmental interest group pressure

Community pressure is measured using several indicators, including propensity for collective action, environmental attitudes and demographics. Because communities with a higher propensity for collective action are likely to be capable of exerting greater institutional pressure on local facilities, various proxies for a community's propensity for collective action are employed. First, community environmental activism is measured using the proportion of the population within the facility's state that are members of major environmental and conservation organizations, an approach used in several other studies (Maxwell et al., 2000; Welch et al., 2000; Wikle, 1995). These data were collected through a survey of 80 main environmental and conservation NGOs in 2003 (Delmas, 2004). The number of environmental NGO members per state was normalized by dividing it by thousands of state residents in 2000 (NGOPCS00).

Second, a community's propensity to file lawsuits against facilities based on environmental issues is estimated based on the proportion of a facility's state's population who are environmental lawyers (Delmas, 2003). The number of environmental lawyers per state, obtained

from the Martindale Law Directory, was normalized by dividing it by each state's population (LAWYERST).

Third, community demographics may also matter. The fact that communities with lower income, less education, and greater proportions of minorities are often exposed to more pollution may be due to facilities' perceiving such communities as possessing less institutional power. Community demographics data including income, race, education, and population density in the United States are available from US Census Bureau and have been used in several studies to examine the influence of communities on organizations' environmental practices (e.g., Arora & Cason, 1999; Hamilton, 1993). We include the following variables from the US Census: median per capita income (MDINCT); percentage of the population over 25 years that attended college (EDUCCOL); percentage of population whose race was reported "white" (WHITEPOP); percentage of housing units that are owner-occupied (OWNED); and percentage of urban population (URBAN). Each of these measures represents the average US Census values pertaining to the zip codes within a five-mile radius of each facility.

Perception of pressures

In addition to using objective measures of these stakeholder pressures, we also assess how managers perceived these pressures. Survey respondents reported the extent to which they perceived various stakeholders influencing their facility to improve environmental performance. The list of stakeholders included customers, suppliers, competitors, trade associations, local community, environmental organizations, regulators/legislators, the media, corporate management, employees, other facilities within the company, socially responsible investment funds, and shareholders. Respondents ranked each stakeholder influence on a five-point scale from "no influence" to a "very strong influence." Many of these variables are highly correlated. As with environmental management practices, we conducted a principle components factor analysis with "varimax" rotation to combine these variables into a few factors. Missing observations were excluded listwise. The underlying variables loaded onto three factors: COMMERCIAL PRESSURE (pressure from customers, suppliers, competitors, trade associations), NON-MARKET PRESSURE (pressure from local community, environmental organizations, regulators, media), and FIRM INTERNAL PRESSURE (pressure from corporate management, employees, other facilities within the company). The loading of these underlying

variables on the three factors is reported in Table 5. These three factors explained 58% of the variance. Only two underlying variables (socially responsible investment funds and shareholders) loaded evenly across factors and had lower coefficients (< .50). We ran additional PCA without these two variables. The resulting factors of this subsequent analysis were strongly correlated to the three initial factors (correlations > 0.980 and significant at the 0.01 level).

The moderating effects of firm and facility characteristics

We identify each facility's main business strategy by asking survey respondents to rate, on a 7-point scale, the extent to which their company "provides low cost products or services" versus seeks to "differentiate [their] products" (BIZSTRAT). Facility size is measured through its employee headcount, in thousands (EMPLHERE), which we obtained from Dun and Bradstreet.

A firm's historical environmental record could be measured using the sum of environmental compliance violations and resulting penalties accrued over the preceding years at all of its facilities (Kassinis & Vafeas, 2002; Khanna & Anton, 2002; Russo & Fouts, 1997). We use the plant's logged toxic releases averaged over 2000 to 2001 as a proxy of the attention that the media and community are paying to the performance of the facility (UNW0001L).

RESULTS

Tables 2 and 3 provide descriptive statistics. We run two sets of models. Environmental management practice comprehensiveness, constructed using the two approaches described above (sum and PCA), were regressed on various measures of institutional pressures as well as facility characteristics and industry dummy variables.

- The first set of models includes the "objective" measures of institutional pressure. Results are reported in Table 4.
- The second set of models includes the "subjective" measures of institutional pressures. Results are reported in Table 6.

In the first set of models, few "objective" measures of institutional pressure are significant. None of the regulatory or legislative pressure variables appears to significantly influence the adoption of environmental management practices. Two variables that measure community activism—

median 1999 household income and percentage of white population—are significant and negative. Their significance confirms prior research that finds correlations between community demographic indicators and pollution, though the negative relationship identified here is in sharp contrast to prior findings that poorer communities with more racial minorities are subjected to more pollution. Our findings suggest that companies located in such communities adopt *more* environmental management practices. We also find that competitor pressure, measured by the proportion of competitors a firm believes has implemented an EMS, is positively and significantly related to the number of environmental management practices the firm adopts. This direct relationship suggests that firms may mimic their peer groups in terms of how many environmental management practices to implement, whether this be a lot or few. The variable representing pollution spotlight (average unweighed TRI air releases, 2000-01) is also significant and positive, suggesting that facilities that may attract more media and regulatory attention because of their relatively high mass of emissions have implemented more environmental management practices. Finally, more environmental management practices have been adopted by facilities that are part of an organization with operations across more continents and whose headquarters is outside the US. All of these findings are robust to two alternative ways we measure EMS comprehensiveness (EMP_SUM or EMP_PCA).

In the second set of models, we initially individually included each original "perceived stakeholder pressure" survey variable and found all of them to be significant and positive except the variable representing the perceived influence of regulators/legislators (not shown). Next, we instead included the three-factor solution to the principle component analysis to evaluate the impact of commercial, non-market, and internal pressures. Perceived commercial and internal pressures to improve environmental performance are both positive and significant determinants of adopting environmental management practices. Non-market pressures to improve environmental performance appear to have no influence on the adoption of environmental management practices. Consistent with the previous objective pressure models, firms with their headquarters based in the US adopted significantly fewer environmental management practices, and firms that had a wider geographic scope and more competitor pressure adopted more environmental management practices. In contrast to the objective pressure models, neither community demographic measure is significant here, nor is the variable representing pollution

spotlight (average unweighted sum of TRI air releases, 2000-01). All of these findings are robust to two alternative ways we measure EMS comprehensiveness (EMP_SUM or EMP_PCA).

In view of these results it is interesting to note that 'perceived' pressures have a better explanatory power than 'objective' pressures to predict the adoption of environmental management practices at the facility level. Some of these findings may result from the limitation of the proxy of our 'objective' pressures. It would be interesting to get a better understanding of the regulatory pressure exerted at the facility level by assessing the number of times regulatory agencies have actually contacted, visited or fined the facility. In addition, we still have yet to investigate the relationship between objective and perceived pressures, including when their levels are aligned and, perhaps more importantly, when their levels substantially differ. These findings have potentially important policy implications. Indeed understanding how facilities perceive pressures will help policy makers focus their efforts on the appropriate channels.

Our finding that regulators and other non-market actors apparently do not significantly impact the adoption of comprehensive environmental management practices suggests that other stakeholders are more effective in exerting direct influence. Policy makers can take advantage of these stakeholders to enhance the level of adoption of environmental management practices at the facility level.

CONCLUSION

This paper provides a model that describes how stakeholders including regulators, customers, activists, local communities and industry associations impose institutional pressures on facilities and their parent companies. We also suggest how a variety of facility- and parent company factors moderate how managers perceive and act upon these pressures. Moderating factors include historical environmental performance, the competitive position of the parent company and the organizational structure of the facility.

Our approach complements institutional theory as it suggests that both institutional pressures and organizational characteristics influence organizations to adopt environmental management practices. Firm and facility characteristics are viewed as moderating factors because they are expected to magnify or diminish the influence of institutional pressures.

Our results show that the most important factors explaining the adoption of environmental management practices are how environmental managers perceive the institutional pressures. In particular, we find that stakeholder pressures from the private sector influence facilities' adoption of environmental management practices. We also find that the corporation has a strong influence on facilities' decisions to adopt environmental management practices. The characteristics of the facility and the firm also matter. In particular, large facilities, facilities that are part of firms that operate internationally, and facilities whose headquarters are outside the US tend to adopt more environmental management practices. We plan to further investigate the relationship between objective and perceived institutional pressures, and how various institutional pressures influence the adoption of specific environmental management practices.

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Figure 1. A model of institutional pressures moderated by parent company and facility characteristics

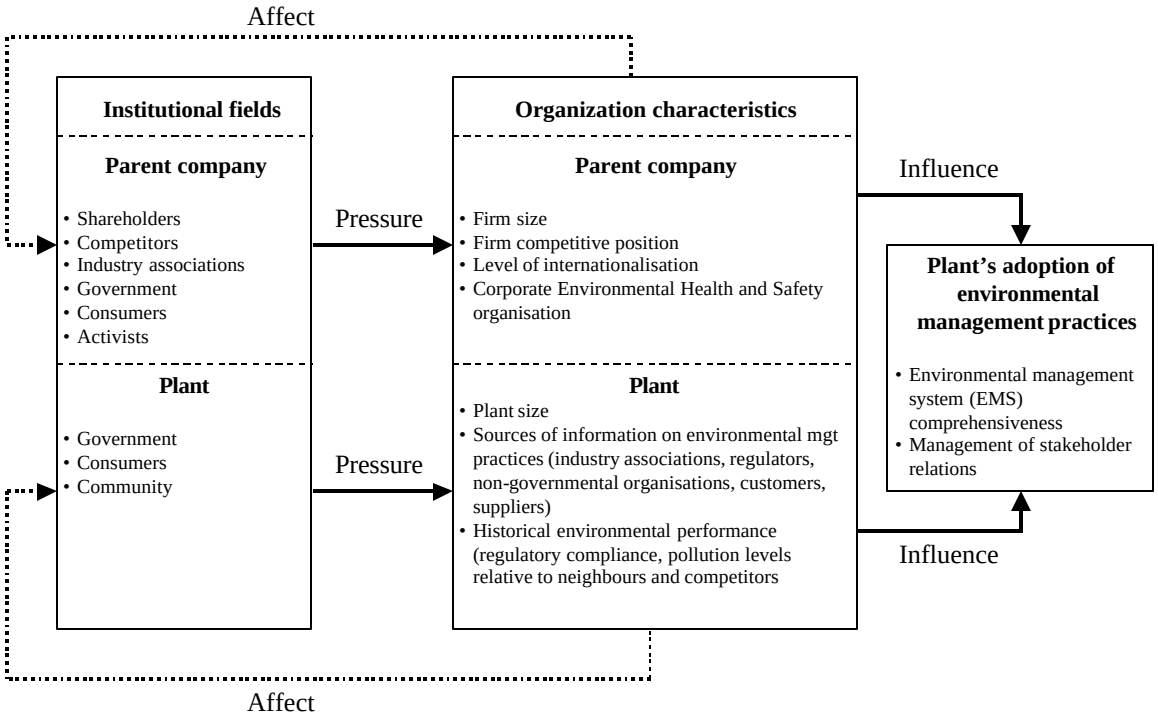

Table 1a. Construction of environmental management practices categories (sum of variables)

Variable name	Construction
Environmental policy promotion (POLICY_D)	S (POLICYD Env policy distributed to employees (0/1); POLICYI; Env policy posted on internet (0/1); POLICYM Env policy discussed with mgr/supervisor (0/1); POLICYP Env policy posted at facility (0/1))/4.
Annual audits (AUDITS_D)	S (AUDITEXT External audits last 3 yrs; AUDITINT Internal audits last 3 yrs)/3
Training comprehensiveness (TRAIN_D)	S (TRAINDES Proportion of engineering/r&d/design dept receive env. Training; TRAINEHS Proportion of EHS dept receive env. Training; TRAINMGT Proportion of management receive env. Training; TRAINMNT Proportion of maintenance dept receive env. Training; TRAINOPS Proportion of operations dept receive env. Training; TRAINPUR Proportion of purchasing dept receive env. Training; TRAINSAL Proportion of sales dept receive env. Training) /number of departments for which responses were given.
Environmental performance review (REVIEW_D)	S (REVDES Env Review of engineering/r&d/design staff; REVEHS Env Review of EHS staff; REVMGT Review of management include env. Performance; REVMNT Review of maintenance staff include env. Performance; REVOPS Review of operations staff include env. Performance; REVPUR Review of purchasing staff include env. Performance; REVSAL Review of sales staff include env. Performance) /number of departments for which responses were given
Environmental procurement policy (PROCUR_D)	S (PURPOL Extent to which purchasing uses green policy; PURISO Extent to which purchasing requests ISO 14001 of suppliers; PURINFO Extent to which purchasing requests env. info of suppliers)/3
Voluntary programs. Extent to which the facility adopts government and industry voluntary (VOLPRG_D)	S (GOVVOL Status of implementing govt voluntary programs; INDVOL Status of implementing industry voluntary programs)/8
ISO certification (ISO_D)	S (ISO9 ISO 9000 status + Iso14 ISO 14001 status)

Table 1b. PCA analyses of environmental management practice categories

Category	**Variables included**	**Eigenvalues > 1**	**Variance explained**	**Variable created**
Annual audits	External and internal audit frequency	1.99	99%	GEN AUDITS_C
Training comprehensiveness	Comprehensiveness of environmental training across seven departments	3.21	54%	TRAIN_C
Environmental performance review	Extent to which performance reviews incorporate environmental management tasks across seven departments	4.36	62%	REVIEW_D
Environmental procurement	Extent to which purchasing decisions incorporate environmental criteria	1.95	65%	PROCUR_C
Participation in voluntary programs	Participation in government- and industry-initiated voluntary environmental programs	1.37	69%	VOLPRG_C
ISO certification	Status of adopting ISO 9000 and ISO 14001	1.47	74%	ISO_C

Figure 2. EMS comprehensiveness based on sum of original variables (EMP_SUM)

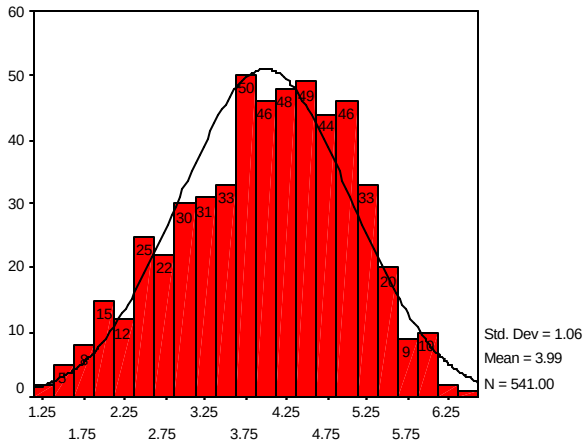

Figure 3. EMS comprehensiveness based on PCA of original variables (EMP_PCA)

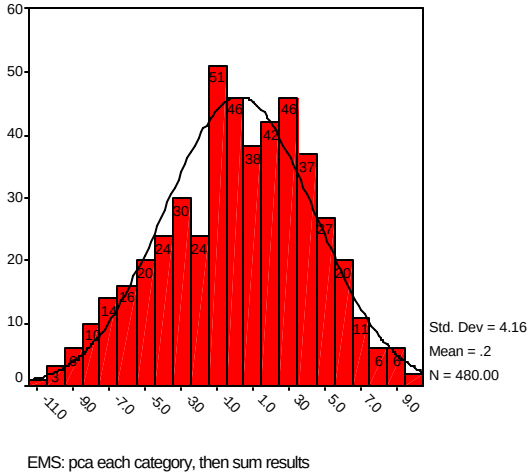

Table 2. Descriptive statistics: objective pressures

	Variable	Description	Obs	Mean	SD	Min	Max	1	2	3	4	5	6	7	8	9
1	STGRN_C5	PCA (lcv96con gindex50 gindex17 pii9501 ngopcs03)	526	-0.02	0.97	-1	2	1.00								
2	LAWPCS03	Environmental lawyers	533	6.39	2.60	2	19	0.45	1.00							
3	LCV96CON	League of Conservation Voters	526	43.61	21.05	0	91	0.75	0.25	1.00						
4	GINDEX50	Number of state env policies of 50 by Hall & Kerr	526	22.17	7.36	5	38	0.92	0.41	0.57	1.00					
5	GINDEX17	Rating of 17 state policies by Renew America	526	90.27	24.23	46	134	0.92	0.26	0.67	0.90	1.00				
6	PII9501	State's average inverse of pollution intensity, 1995-2001	526	0.01	0.01	0	0.1	0.72	0.51	0.40	0.54	0.49	1.00			
7	NGOPCS03	Environmental NGO members per 1000 state residents, 2003	533	2.91	1.71	0.02	8	0.88	0.52	0.52	0.77	0.74	0.70	1.00		
8	COMPEMS	Proportion of competitors with EMS	571	2.97	1.15	1	5	0.03	0.04	-0.02	0.06	0.06	-0.01	0.00	1.00	
9	BIZSTRAT	Company's main business strategy (low cost vs differentiation)	535	4.42	1.87	1	7	0.10	0.00	0.10	0.12	0.16	-0.04	0.06	0.07	1.00
10	MDINCT	Median 1999 household income within 5 miles, in thousands	524	41.45	12.37	9	94	0.41	0.25	0.35	0.35	0.40	0.24	0.38	0.06	0.03
11	WHITEPOP	Percentage population <White alone> race within 5 miles	524	0.79	0.18	0.2	1	-0.04	-0.10	0.03	-0.05	0.02	-0.17	-0.06	0.00	-0.09
12	EDUCCOL	Pct pop 25+ years within 5 miles	524	0.48	0.12	0.2	0.8	0.23	0.17	0.09	0.17	0.24	0.18	0.29	-0.04	-0.01
13	EMPLHRT	Plant employees	421	0.48	0.70	0	6	0.01	-0.13	0.04	0.06	0.10	-0.12	-0.06	-0.01	0.13
14	UNW0001L	Log of Average unweighted TRI air releases, 2000-01	501	8.76	3.47	-4	16	-0.08	-0.19	0.01	-0.07	-0.07	-0.12	-0.09	-0.07	-0.06
15	TRC0001L	Log of Average TRACI-weighted TRI air releases, 2000-01	325	5.00	5.76	-9	19	-0.02	-0.11	0.05	0.01	-0.01	-0.08	-0.06	-0.05	-0.24
16	INTL_D	Geographic breadth of operations	575	0.59	0.41	0	1	0.11	-0.02	0.11	0.16	0.16	-0.07	0.04	0.24	0.21
17	HQUS	HQ located in US	575	0.86	0.34	0	1	0.00	0.00	0.02	-0.02	-0.01	0.02	-0.01	-0.13	0.02
18	INDSTRY1	Automotive industry	575	0.10	0.29	0	1	-0.09	-0.10	-0.08	-0.07	-0.06	-0.09	-0.09	0.21	0.01
19	INDSTRY2	Electrical/Electronics industry	575	0.18	0.39	0	1	0.10	0.04	0.06	0.09	0.10	0.09	0.07	0.12	0.05
20	INDSTRY3	Machinery industry	575	0.10	0.30	0	1	-0.01	-0.12	-0.02	0.03	0.06	-0.07	-0.05	-0.13	0.11
21	INDSTRY4	Primary Metals industry	575	0.14	0.35	0	1	0.12	0.04	0.06	0.14	0.13	0.03	0.11	-0.17	0.08
22	INDSTRY5	Refining industry	575	0.24	0.43	0	1	-0.05	0.20	-0.09	-0.04	-0.09	0.05	-0.02	0.16	0.06
23	INDSTRY6	Utilities industry	575	0.08	0.27	0	1	-0.03	-0.12	0.13	-0.13	-0.11	0.04	-0.03	-0.30	-0.43

Table 2. Descriptive statistics: objective pressures (continued)

	Variable	Description	10	11	12	13	14	15	16	17	18	19	20	21	22	23
10	MDINCT	Median 1999 household income within 5 miles	1.00													
11	WHITEPOP	Percentage population <White alone> within 5 miles	0.16	1.00												
12	EDUCCOL	Pct pop 25+ years within 5 miles	0.65	0.13	1.00											
13	EMPLHRT	Plant employees	0.00	-0.02	0.01	1.00										
14	UNW0001L	Log of Average unweighted TRI air releases, 2000-01	-0.08	-0.11	-0.09	0.11	1.00									
15	TRC0001L	Log of Average TRACI-weighted TRI air releases, 2000-01	-0.08	-0.01	-0.11	-0.11	-0.01	1.00								
16	INTL_D	Geographic breadth of operations	0.11	0.01	0.03	0.16	-0.15	-0.03	1.00							
17	HQUS	HQ located in US (dummy)	-0.09	-0.06	-0.03	-0.06	-0.07	0.08	-0.05	1.00						
18	INDSTRY1	Automotive industry	-0.02	0.12	-0.02	0.22	-0.07	-0.06	0.15	0.02	1.00					
19	INDSTRY2	Electrical/Electronics industry	0.19	0.10	0.09	0.04	-0.20	-0.06	0.17	-0.16	-0.14	1.00				
20	INDSTRY3	Machinery industry	-0.01	0.08	0.11	0.21	-0.22	0.02	0.10	0.07	-0.12	-0.13	1.00			
21	INDSTRY4	Primary Metals industry	-0.07	-0.02	-0.05	-0.10	-0.27	0.24	-0.08	0.10	-0.17	-0.18	-0.16	1.00		
22	INDSTRY5	Refining industry	-0.01	-0.21	0.00	-0.17	0.21	-0.32	0.03	-0.03	-0.24	-0.25	-0.22	-0.31	1.00	
23	INDSTRY6	Utilities industry	0.03	0.07	-0.01	-0.10	0.28	0.22	-0.32	0.07	-0.12	-0.12	-0.11	-0.15	-0.21	1.00

Table 3a. Descriptive statistics: perceived pressures

Variable	Description	Obs	Mean	SD	Min	Max
EMP_SUM	Comprehensiveness of environmental management practices (sum of normalized category sums)	319	3.95	1.02	1.50	6.10
EMP_PCA	Comprehensiveness of environmental management practices (sum of category-level principle-component factors)	283	0.10	4.00	-9.95	9.37
INFLUPRI	perceived influence of commercial pressures (comp, cust, suppl, trade assoc)	319	-0.02	1.01	-2.46	2.48
INFLUCOM	perceived influence of non-market pressures (community, ngos, regulators, media)	319	0.04	1.00	-2.88	2.65
INFLUFIR	perceived influence of internal pressures (corp mgt, employee, other facilities)	319	-0.04	1.01	-2.79	2.47
COMPEMS	Competitors with EMS	319	2.92	1.14	1	5
MDINCT	Median household income	319	40.28	11.61	9.4	94.2
WHITEPOP	Percentage population white	319	0.79	0.20	0.2	1.0
EMPLHRT	plant employees	319	0.48	0.67	0.001	5.5
UNW0001L	TRI air releases	319	8.72	3.33	0	15.8
INTL_D	Geographic breadth of operations	319	0.60	0.40	0	1
HQUS	HQ located in US	319	0.93	0.26	0	1
BIZSTRAT	Company's main business strategy	319	4.33	1.88	1	7
INDSTRY1	Automotive industry	319	0.12	0.33	0	1
INDSTRY2	Electrical/Electronics industry	319	0.18	0.38	0	1
INDSTRY3	Machinery industry	319	0.11	0.31	0	1
INDSTRY4	Primary Metals industry	319	0.17	0.37	0	1
INDSTRY5	Refining industry	319	0.28	0.45	0	1
INDSTRY6	Utilities industry	319	0.09	0.29	0	1

Table 3b. Correlations: perceived pressures

	Variable	Description	1	2	3	4	5	6	7	8	9	10	11
1	INFLUPRI	perceived influence of commercial pressures (comp, cust, suppl, trade assoc)	1.00										
2	INFLUCOM	perceived influence of non-market pressures (community, ngos, regulators, media)	-0.03	1.00									
3	INFLUFIR	perceived influence of internal pressures (corp mgt, employee, other facilities)	0.04	0.03	1.00								
4	COMPEMS	Competitors with EMS	0.23	-0.12	0.04	1.00							
5	MDINCT	Median household income	0.01	-0.04	-0.13	-0.03	1.00						
6	WHITEPOP	Percentage population white	0.01	-0.16	-0.18	0.03	0.09	1.00					
7	EMPLHRT	Plant employees	0.19	-0.06	0.00	0.04	-0.01	0.03	1.00				
8	UNW0001L	TRI air releases, 2000-01	0.03	0.17	0.10	-0.10	-0.06	-0.07	0.12	1.00			
9	INTL_D	Geographic breadth of operations	0.09	-0.21	0.13	0.24	0.12	0.03	0.17	-0.11	1.00		
10	HQUS	HQ located in US	-0.14	-0.04	0.02	-0.15	-0.09	-0.02	-0.07	-0.05	-0.03	1.00	
11	BIZSTRAT	Company's main business strategy	0.07	-0.06	0.23	0.02	0.04	-0.06	0.14	-0.05	0.25	-0.05	1.00

Table 4 Regression results: Objective institutional pressure. Dependent variable comprehensiveness of Env. Mgt Practices[4]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	PCF
state greenness=PCA	0.07													
	[0.06]													
Environmental lawyers		0.00												
		[0.02]												
League of Conservation Voters			0.00											
			[0.00]											
Number of state env policies				0.01										
				[0.01]+										
Rating of 17 state policies					0.00									
					[0.00]									
State's inverse pollution intensity						1.57								
						[3.76]								
Environmental NGO members							0.05							
							[0.03]							
Competitors with EMS	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.24	0.93
	[0.05]**	[0.05]**	[0.05]**	[0.05]**	[0.05]**	[0.05]**	[0.05]**	[0.05]**	[0.05]**	[0.05]**	[0.05]**	[0.05]**	[0.06]**	[0.21]**
Company's business strategy (	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.04	0.03	0.05	0.17
	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.04]	[0.13]
Median 1999 household income	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01			-0.01		-0.01	-0.05
	[0.00]*	[0.00]*	[0.00]+	[0.00]*	[0.00]*	[0.00]+	[0.00]*	[0.00]*			[0.00]+		[0.01]+	[0.02]*
Percentage population White									-0.60		-0.55	-0.57	-0.21	-2.35
									[0.27]*		[0.27]*	[0.27]*	[0.34]	[1.11]*
Pct pop 25+ years college										-0.66		-0.60		
										[0.43]		[0.43]		
Unweighted TRI air releases	0.05	0.04	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04		0.15
	[0.02]**	[0.02]*	[0.02]**	[0.02]**	[0.02]**	[0.02]**	[0.02]*	[0.02]*	[0.02]*	[0.02]*	[0.02]*	[0.02]*		[0.07]*
TRACI-weighted TRI air													0.00	
													[0.01]	
plant employees,	0.16	0.18	0.17	0.16	0.16	0.17	0.18	0.18	0.18	0.18	0.17	0.18	0.21	0.59
	[0.08]*	[0.08]*	[0.08]*	[0.08]*	[0.08]*	[0.08]*	[0.08]*	[0.08]*	[0.08]*	[0.08]*	[0.08]*	[0.08]*	[0.09]*	[0.34]+
Breadth of oper	0.41	0.40	0.41	0.40	0.41	0.42	0.40	0.40	0.38	0.37	0.40	0.38	0.47	1.32
	[0.14]**	[0.14]**	[0.14]**	[0.14]**	[0.14]**	[0.14]**	[0.14]**	[0.14]**	[0.14]**	[0.14]**	[0.14]**	[0.14]**	[0.17]**	[0.57]*
HQ located in US	-0.50	-0.40	-0.50	-0.50	-0.50	-0.49	-0.41	-0.41	-0.42	-0.41	-0.42	-0.43	-0.15	-2.45
	[0.20]*	[0.20]*	[0.21]*	[0.20]*	[0.21]*	[0.21]*	[0.20]*	[0.20]*	[0.20]*	[0.20]*	[0.20]*	[0.20]*	[0.32]	[0.84]**
Industry dummies	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Constant	3.12	2.98	2.98	2.87	2.93	2.99	2.96	3.00	3.14	2.97	3.41	3.40	3.45	-0.85
	[0.47]**	[0.48]**	[0.46]**	[0.46]**	[0.47]**	[0.46]**	[0.46]**	[0.46]**	[0.48]**	[0.47]**	[0.50]**	[0.51]**	[0.59]**	[2.09]
Observations	354	360	354	354	354	354	360	360	360	360	360	360	236	314
R-squared	0.22	0.21	0.21	0.22	0.21	0.21	0.21	0.21	0.21	0.2	0.22	0.21	0.2	0.22

Standard errors in brackets + significant at 10%; * significant at 5%; ** significant at 1%

[4] Dependent variables: Sum = EMP_SUM; PCA= EMP_PCA

Table 5. PCA Institutional Pressures (Rotated Component Matrix)

		Component		
		1	**2**	**3**
COMMERCIAL PRESSURE	Influence of competitors	.805	.154	.129
	Influence of customers	.784		.165
	Influence of suppliers	.696	.285	.166
	Influence of trade associations	.506	.383	.238
	Influence of SRI funds	.488	.470	.102
NON-MARKET PRESSURE	Influence of media	.278	.758	.133
	Influence of environmental organizations	.296	.699	.161
	Influence of local community	.201	.669	.286
	Influence of regulators/legislators	-.146	.660	.173
FIRM INTERNA L PRESSURE	Influence of corp mgmt	.117		.759
	Influence of other facilities in firm	.206	.172	.721
	Influence of employees		.319	.683
	Influence of shareholders	.420	.298	.509

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Table 6. Regression results of perceived institutional pressures

Dependent variable: Comprehensiveness of environmental management practices[5]

	(1) Sum	(2) PCF
Perceived influence of commercial pressure	0.31	1.25
	[0.05]**	[0.20]**
Perceived influence of non-market pressure	-0.01	0.06
	[0.05]	[0.20]
Perceived influence of firm internal pressure	0.37	1.37
	[0.05]**	[0.20]**
Competitors with EMS	0.20	0.70
	[0.04]**	[0.19]**
Median 1999 household income	0.00	-0.02
	[0.00]	[0.02]
Percentage population White	-0.31	-1.63
	[0.24]	[0.99]
TRI air releases, 2000-01	0.01	0.05
	[0.02]	[0.07]
Plant employees	0.13	0.42
	[0.07]+	[0.31]
Geographic breadth of operations	0.33	1.03
	[0.13]**	[0.53]+
HQ located in US	-0.44	-2.27
	[0.18]*	[0.74]**
Company's business strategy	-0.01	0.05
	[0.03]	[0.12]
Industry dummies	Y	Y
Constant	3.86	0.2
	[0.46]**	[1.93]
Observations	319	283
R-squared	0.43	0.42

Standard errors in brackets + significant at 10%; * significant at 5%; ** significant at 1%

[5] Dependent variables: Sum = EMP_SUM; PCA= EMP_PCA

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SURVEY ON ENVIRONMENTAL MANAGEMENT PRACTICES

Thank you for agreeing to take part of this benchmarking exercise on environmental management practices.

- All individual responses will be kept strictly confidential
- Please try to answer every question, even though you may not be 100% sure of your answer.

If you have any questions, please feel free to contact Paolo Gardinali, Associate Director of the Social Science Survey Center (SSSC) at (805) 893-3887 or paolo@survey.ucsb.edu

Project Principal Investigators:

Professor Magali Delmas Professor Dennis Aigner, Dean

Donald Bren School of Environmental Science and Management
University of California, Santa Barbara

Graduate Research Assistant: Mike Toffel, Haas School of Business.
University of California, Berkeley

Please return this questionnaire to:
Social Science Survey Center
ISBER, 2201 North Hall
University of California
Santa Barbara, CA 93106
Fax: (805) 893-7995

You can also fill the questionnaire online at http://www.survey.ucsb.edu/env
with the code:

Section 1. General information

1. Parent company information

   Parent company name: _____

   Location of parent headquarters (country): _____

2. Does your company operate facilities outside of the United States? ❑ Yes ❑ No
   If YES, where are they located? (check all that apply): ❑ Europe ❑ Asia ❑ Elsewhere

In this questionnaire, we are asking questions about your facility: a facility includes buildings that are on a contiguous site and under common control by a company.

Section 2. Environmental management organization

3. Which of the following most closely reflects your position? Please check one:
   - ❑ EHS manager or specialist
   - ❑ Environmental manager or specialist
   - ❑ Plant manager
   - ❑ Other, please describe_____

4. Approximately how many full time equivalent employees (FTEs) are working on environment, health and safety issues for your facility?

   EHS / Environmental department _____
   Other departments _____
   Total _____

Section 3. Environmental management practices

5. If your facility or company has an environmental policy, how is it communicated? Please check all that apply

❑ We do not have an environmental policy

We have an environmental policy and:

- ❑ post the policy around our facility
- ❑ post it on the internet
- ❑ distribute it to all facility employees
- ❑ most employees have discussed the policy with a manager/supervisor

6. Over the past 3 years, how many times has your facility had an **internal** environmental audit conducted by your facility staff and/or corporate staff? _____ (If none, please enter zero)

7. Over the past 3 years, how many times has your facility had an **external** environmental audit conducted by third-parties such as consultants, not including regulators or corporate staff? _____

8. Approximately, what proportion of your employees at your facility have received environmental training over the past 12 months in the following departments?
   Environmental training includes coursework or team meetings where environmental policies, procedures and impacts are discussed or disseminated.

   Please check one for each department.

	0-20%	21-40%	41-60%	61-80%	81-100%	No such department at my facility
Management	❑	❑	❑	❑	❑	❑
Operations	❑	❑	❑	❑	❑	❑
Maintenance	❑	❑	❑	❑	❑	❑
Engineering/ R&D, Design	❑	❑	❑	❑	❑	❑
Sales	❑	❑	❑	❑	❑	❑
Purchasing / Procurement	❑	❑	❑	❑	❑	❑

9. In job performance reviews for employees at your facility, how important do you consider the contribution of your employees to environmental performance?

   Please check one for each department. Use your best estimate if you are unsure.

	Not part of review	Low importance	Moderate importance	Important	Very important	No such department at my facility
General management	❑	❑	❑	❑	❑	❑
Operations	❑	❑	❑	❑	❑	❑
Maintenance	❑	❑	❑	❑	❑	❑
Engineering/ R&D, Design	❑	❑	❑	❑	❑	❑
Environment, health & safety	❑	❑	❑	❑	❑	❑
Sales	❑	❑	❑	❑	❑	❑
Purchasing / Procurement	❑	❑	❑	❑	❑	❑

Section 4. Relations with stakeholders

	Never	Occasionally	Frequently	All the time
10. To what extent does your purchasing department use a green purchasing policy?	❑	❑	❑	❑
11. To what extent does your purchasing department request your suppliers to be ISO 14001 certified?	❑	❑	❑	❑
12. To what extent does your purchasing department ask suppliers to provide information about their environmental management practices?	❑	❑	❑	❑

	0-20%	21-40%	41-60%	61-80%	81-100%	Don't know
13. Approximately what proportion of your competitors have adopted an environmental management system (EMS)? (Certified or non-certified).	❑	❑	❑	❑	❑	❑

	Not being considered	Future consideration	Planning to participate	Currently participating
14. What is the status of your participation in voluntary US EPA or state programs such as Energy Star, Wastewise, Environmental Performance Track, etc.	❑	❑	❑	❑
15. What is the status of your participation in industry-led environmental programs such as Responsible Care, industry climate challenge programs, etc.	❑	❑	❑	❑

	Never	Rarely	Sometimes	Often	Very often	All the time
16. How often does your facility solicit opinions from environmental non-profit organizations, such as involving them in site planning or in identifying environmental impacts?	❑	❑	❑	❑	❑	❑

17. What is the status of the following certifications at your facility?

	Not being considered	Future consideration	Planning to implement	Currently implementing	Successfully implemented
ISO 9000 certification	❑	❑	❑	❑	❑
ISO 14001 certification	❑	❑	❑	❑	❑

18. Approximately how many complaints has your facility received from the surrounding community about odors, noise, smoke, dust, effluents, water pollution, or aesthetic appearance in the last three years? _____

19. To what extent have each of the following groups influenced your facility to improve its environmental performance?

	No influence	Little influence	Some influence	Strong influence	Very strong influence
Customers	❑	❑	❑	❑	❑
Suppliers	❑	❑	❑	❑	❑
Competitors	❑	❑	❑	❑	❑
Trade associations	❑	❑	❑	❑	❑
Local community	❑	❑	❑	❑	❑
Socially responsible investment funds	❑	❑	❑	❑	❑
Environmental organizations	❑	❑	❑	❑	❑
Media	❑	❑	❑	❑	❑
Shareholders	❑	❑	❑	❑	❑
Corporate management	❑	❑	❑	❑	❑
Employees	❑	❑	❑	❑	❑
Other facilities within company	❑	❑	❑	❑	❑
Regulators/legislators	❑	❑	❑	❑	❑

20. To what extent have the following corporate departments influenced your facility to improve its environmental performance? Please check one for each department:

	No influence	Little influence	Some influence	Strong influence	Very strong influence	Our corporation does not have such department
Corporate environmental management	❑	❑	❑	❑	❑	❑
Corporate legal & regulatory affairs	❑	❑	❑	❑	❑	❑
Corporate public relations	❑	❑	❑	❑	❑	❑
Corporate strategy	❑	❑	❑	❑	❑	❑
Corporate marketing	❑	❑	❑	❑	❑	❑
Corporate product design	❑	❑	❑	❑	❑	❑
Other (please specify): _____	❑	❑	❑	❑	❑	❑

Section 5. Measuring and reporting environmental performance

21. To what extent are your facility's environmental costs identified in cost accounting?

Not at all	To a limited extent	To some extent	To a large extent	To a great extent
❑	❑	❑	❑	❑

22. Which of the following issues are significant environmental issues at your facility?

- ❑ Air emissions
- ❑ Water pollution
- ❑ Solid Waste
- ❑ Hazardous Waste
- ❑ Noise
- ❑ Other, please describe_____

23. For which of these environmental issues do you have objectives and targets?

- ❑ Air emissions
- ❑ Water pollution
- ❑ Solid Waste
- ❑ Hazardous Waste
- ❑ Noise
- ❑ Other, please describe_____

24. Do you disseminate your facility Toxic Release Inventory (TRI) data to the public in an easily accessible format (beyond reporting this data to the US EPA)? ❑ Yes ❑ No

Section 6. Motivations for environmental management practices

25. In addition to improving environmental performance, how important are the factors listed below in motivating your facility to implement environmental management practices?

	Not important	Somewhat important	Important	Very important
Increase customer loyalty	❑	❑	❑	❑
Reach new customers	❑	❑	❑	❑
Improve employee motivation or morale	❑	❑	❑	❑
Help generate new products or services	❑	❑	❑	❑
Improve regulatory compliance	❑	❑	❑	❑
Influence pending legislation or regulations	❑	❑	❑	❑
Improve relations with environmental non-profit organizations	❑	❑	❑	❑
Improve relations with our local community	❑	❑	❑	❑

26. Please describe your company's main business strategy using the following scale, from "provide low cost products or services" (1) to "differentiate our products" (7)?

	1	2	3	4	5	6	7	
Provide low cost products or services	❑	❑	❑	❑	❑	❑	❑	Differentiate our products on the market

27. Please check the following box if you would like to receive a copy of the final report in the future.

❑ Yes, I would like to receive a copy of the report.

Name: _____

E-mail: _____

Facility name: _____

Street address: _____

City: _____

State and Zip code: _____

❑ No, I am not interested.

28. Please provide any comments and suggestions here:

Thank you!

Environmental Management Systems: Informing Organizational Decisions

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Abstract

Approaches to improve environmental performance have expanded to include voluntary programs that encourage organizations to go beyond regulatory compliance. Environmental management systems (EMS) are a recent type of voluntary initiative expected to produce general reductions in pollution discharges. Unlike voluntary programs such as Green Lights or 33/50, the specific goals and benefits of EMS implementation to participating organizations and government regulators has not been defined. Participating companies expect to lower environmental costs or to improve performance. Society should benefit from reduced energy consumption, pollution, and waste generation. However, not all EMS will be equally effective. For example, a process-oriented EMS, such as ISO 14000, may not provide a comprehensive view of environmental issues across an organization or develop the data needed to assess environmental improvements and cost savings. We examined existing EMS at various levels. First, at a macro-level, we assessed the change in environmental performance as a result of adopting an EMS. Second, at a micro-level, we examined the existing EMS in a number of organizations and the extent to which the system provides relevant data and analysis to inform company decisions. The data provide a basis for identifying the EMS attributes that are useful and necessary for decision-making. Organizational leaders can use the results to improve the effectiveness of existing or new EMS. Policy makers can use the results to determine requirements for a potential voluntary program for implementation of environmental management systems.

Introduction

U. S. Environmental Protection Agency actions to improve companies' environmental performance have expanded to include voluntary programs that encourage organizations to go beyond regulatory compliance. Environmental management systems (EMS) are a recent type of voluntary initiative expected to produce general reductions in pollution discharges. At the same time, environmental issues are becoming more strategic to business, so firms are implementing EMSs as a means to capture and assess environmental issues across operations. Participating companies expect to lower environmental costs or to improve performance. Society should benefit from reduced energy consumption, pollution, and waste generation. However, not all EMS will be equally effective at achieving these goals. The research presented here examines existing EMSs to help address the future role of environmental management systems in environmental policy and organizational decision-making. The research recognizes the need for evaluating individual components of environmental management systems, as well as whole systems. If EMSs are effective, then fewer problems from regulatory compliance may occur and the burden of regulation may be reduced. It is essential for both government agencies and firms to know what components and ways of operating the system are most effective in improving environmental performance. This research investigates how EMSs and environmental information in general are used by organizations and, in turn, proposes a design for an EMS that provides the information needed for better decisions.

The research examines EMSs at two distinct levels. First, at the macro-level, we assess facility performance in relation to ISO 14001 EMS adoption and certification. The macro-level analysis uses publicly available information, most of which is collected by government agencies via regulatory requirements, in order to assess overall patterns in environmental performance. The analysis provides a picture of what can be learned from existing data about environmental performance. Specifically, the analysis assesses the ISO 14001 environmental management system standard in relation to these data providing policy makers with information on how the standard currently integrates with other environmental initiatives. The results show little difference between the environmental performance of facilities. These results have serious implications for policy makers in how certified environmental management systems should be used to evaluate facility environmental performance.

Once we know generally how firms with a formal EMS compare to those without, the micro-level analysis allows us to find out why. By investigating the environmental information available internally to an organization, we learn what data are used merely for regulatory reporting and which are used to guide decision makers. An effective EMS is expected to include information collection and dissemination of useful, relevant, and timely data to inform company decisions. Results show that most data are regulatory based, reported outside environmental groups infrequently, and thus limit their use in decision-making toward improvements in environmental performance. This detailed inquiry into data availability and use can help businesses and policy makers choose measures that reflect environmental performance, can be understood by various stakeholders, and lead to improvements across industry.

The overall results of the research lead to suggestions for improving environmental management systems for organizational decision-making and policy development. First, EMSs must stretch beyond the current regulatory issues to be effective in long-term improvement. Unlike other voluntary programs, EMSs do not require organizations to operate outside the boundary of current regulatory issues. Second, EMS goals, targets, and resulting performance must be made more transparent. The link between efforts to reduce environmental problems via an EMS and reported

environmental performance metrics is tenuous. Finally, as various environmental issues continue to shift in importance, EMSs must adapt to changing organizational focus and monitor potential future regulatory issues. For example, corporate social responsibility and calls for sustainability (incorporating social and economic factors, as well as environmental factors) and the global importance of carbon emissions (currently unregulated in the U.S.) are influencing corporate strategy. An EMS should support decision-making on these pressing issues, especially for multinational companies operating under different regulatory schemes.

Macro-Level Analysis – Facility Environmental Performance In Relation to ISO 14001 Certification

The ISO 14000 series for environmental management systems continues to grow in popularity as a means for organizations to address environmental issues in their facilities across operations. Approximately 62,000 organizations worldwide have been certified as following the ISO 14001 EMS standard as of December 2003, but only about 3,500 in the U.S. (1). Since participation is voluntary, certification to ISO 14001 is regarded as an indication of a firm's interest in environmental improvement and going "beyond compliance" to address environmental problems. This research investigates the level of environmental performance in facilities in relation to certification to the ISO 14001 EMS standard. The analysis focuses on automobile assembly facilities in the U.S. consisting of approximately 50 facilities in 20 states producing a variety of cars, vans, trucks, and SUVs. The sector has a history of dealing with environmental issues. Both the emissions and wastes from manufacturing operations as well as from the use-phase of the final product have resulted in public and regulatory attention to the industry. In addition, the automotive industry has been a leading sector in ISO 14001 EMS certification. Ford Motor Company initiated a commitment to establishing EMSs and certifying its facilities to the ISO 14001 EMS in the early stages of the standard. All of Ford's U.S. facilities were certified by early 1999. The other two major U.S. firms as well as foreign-owned firms followed this lead and began to implement the standard in their own facilities. To further reinforce their commitment to environmental management systems, the major U.S. firms announced that suppliers would be required to implement and certify to the standard as well, with deadlines for certifying in late-2002 or mid-2003 (2, 3). Approximately one-fifth of all U.S. certifications are held by facilities with business related to the automotive sector (4).

The study examines four different measures of environmental performance over the period from 1993 to 2003. The measures include toxic chemical releases, criteria air pollutant emissions, hazardous waste generation, and compliance to regulatory requirements. Most performance measures have been normalized to production, allowing a comparison of facilities on a per-vehicle basis. During the time period, all facilities, regardless of EMS status, made steady progress in reducing their environmental burdens. The analysis shows that in later years, certified facilities are not performing better than facilities that chose to certify their EMS later. In addition, the results give no indication that the facilities are achieving an increase in the rate of improvement that was seen prior to adopting and certifying to the standard. In some cases, certified facilities are more likely to have worse performance once the EMS is operating.

The ISO 14001 EMS standard defines an EMS as "that part of the overall management system which includes organizational structure, planning, activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing, and maintaining the environmental policy" (5). The intent of the standard is to provide a structured framework for an EMS that is based on a commitment to continual improvement in overall environmental

performance. By periodically reviewing and evaluating the environmental management system, the organization will identify opportunities for improvement.

These implications of the standard lead to two main hypotheses. First, facilities that have established and implemented an ISO 14001 EMS and now have a system for and commitment to environmental performance improvement should have better environmental performance than those facilities without such a system in place. A structured EMS gives a facility the ability to systematically identify and address environmental problems, which presumably leads to reduced environmental discharges.

Second, facilities that have established and implemented an ISO 14001 EMS have undergone a change in operations. In theory, the system provides them with a tool to reduce environmental impacts that was previously unavailable. Once the standard is in place and operations are regularly being assessed and evaluated, the facilities should continually improve on the past performance levels and likely at a greater rate of improvement. From year to year after certification, one would expect a facility with a certified ISO 14001 EMS to make additional reductions in overall environmental impact than had been achieved previously.

Research Method

The sample includes approximately 50 automobile assembly facilities in the U.S. across the time period from 1993-2003. The number of facilities in each analysis varies depending on data availability. The Automotive News Market Databook provides parent company, facility location, vehicle descriptions, and production information. Company websites or correspondence supplied some data and helped to validate existing data. The World Preferred Registry provides a list of entities holding registrations to the ISO 14001 EMS standard and the date of certification. Three variables were constructed from the information on ISO certification. First, we separate the facilities into two groups, defined as "early adopters" if certification occurred in 1998 or 1999 and "late adopters" if certification occurred in 2000 or after (adoption status). Second, the date of certification establishes the stage of implementation of the ISO 14001 EMS in a facility (ISO Stage). The variable is a counter variable that increases by one as a facility moved through different stages – from no system (0), implementing (1), certifying (2), and operating under the EMS (3 and up). A third variable represents the status of the EMS as either certified or not certified in a given year (ISO status).

Environmental performance data were collected from the U.S. Environmental Protection Agency public databases. The Toxics Release Inventory (TRI) (1993-2001), AirData on criteria air pollutant emissions (1996 and 1999), National Biennial RCRA Hazardous Waste Report (1993-2001, odd-numbered years), and the Enforcement and Compliance History On-line (ECHO) (1996-2003) provide data. We construct the final sample for each metric by matching entries in the various databases by the name of the facility, address information, and EPA facility information which includes identification numbers for the facilities under various programs.

Results

Table 1 shows the average total toxic chemical releases and average total toxic chemical waste managed per vehicle for the facilities from 1993 to 2001. The number of facilities in the Certified Facilities group increases each year as facilities certify their EMSs. Overall, the facilities show a decreasing level of chemical releases and wastes per vehicle as expected. From 1997 to 2001, the non-certified facilities show a much larger improvement in total toxic chemical releases and amount

of toxic chemical waste managed – almost twice that of the certified firms. It should also be noted that the variance in releases per vehicle is large for the group of facilities, ranging from a low of ~0.0 pounds/vehicle to a high of 8.0 pounds/vehicle in 2001.

Table 1: Trend in Average Toxic Chemical Releases and Waste Management.

	Total Releases (pounds per vehicle)		**Total Waste Management (pounds per vehicle)**	
	All Facilities		**All Facilities**	
1993	6.19		13.18	
1994	5.10		10.74	
1995	4.80		11.26	
1996	4.63		10.96	
1997	4.01		9.85	
	Certified Facilities	**Non-certified Facilities**	**Certified Facilities**	**Non-certified Facilities**
1998	3.64	3.87	9.24	8.11
1999	3.64	3.66	8.66	7.92
2000	3.36	3.30	8.28	8.11
2001	3.32	2.77	8.40	6.03
% Change 1997-2001	-17%	-31%	-15%	-39%

Using standard OLS multiple regression analysis to determine if any difference exists between facilities once certification has been achieved produced no significant statistical support for the two proposed hypotheses.

Table 2 shows the results of three different regression models. For each regression model, the dependent variable is pounds of toxic releases per vehicle. As expected, coefficients for time and production are negative, suggesting improvement over time and some scale efficiency. Facilities that assemble trucks produce only about 0.5 pound more toxic chemicals per vehicle than those facilities that assemble cars. Facilities in the DaimlerChrysler company have lower emissions than average, compared to both Ford and General Motors facilities which have higher emissions of the same magnitude. Foreign or multiple-owner facilities are the base case. Each of these seven parameter coefficients are significant (p-value < 0.05). Adoption status, differentiating between early and late adopters, has a negative coefficient indicating that early adopters generally have lower toxic wastes per vehicle than later adopters. Likewise, the longer the ISO 14001 EMS is in place the lower toxic wastes per vehicle, as noted by the negative coefficient of the ISO stage variable. The ISO Status variable, indicating whether a facility has a certified ISO 14001 EMS in place in a given year, has a positive coefficient indicating increased toxic wastes for these facilities. However, none of these three coefficients is statistically significant (p-values >0.4) and the estimated magnitude of the effect is small. Similar results are achieved for the other TRI variables investigated. No difference is seen across facilities in each group for total waste managed, waste that is recycled, recovered, or treated, or when weighting the chemicals for toxicity prior to analysis. In addition, no statistical significance is found for other model specifications considering such variables as change in TRI pounds and change in production from the previous year

Table 2: Results of OLS Regression for Toxic Chemical Releases.

	Model 1	Model 2	Model 3
Constant	4.43 (0.737)	4.470 (0.769)	4.457 (0.758)
Time (years since 1993)	-0.35 (0.043)	-0.357 (0.064)	-0.354 (0.057)
Production (1000's of vehicles)	-0.0083 (0.0011)	-0.0083 (0.0011)	-0.0083 (0.0011)
Car	2.50 (0.443)	2.498 (0.444)	2.498 (0.444)
Truck	3.03 (0.417)	3.032 (0.418)	3.031 (0.418)
DaimlerChrysler	-1.08 (0.525)	-1.075 (0.526)	-1.076 (0.525)
Ford	1.12 (0.396)	1.116 (0.398)	1.118 (0.397)
GM	0.94 (0.466)	0.935 (0.467)	0.935 (0.467)
Adoption Status (early vs. late)	-0.33 (0.469)	-0.353 (0.492)	-0.345 (0.485)
ISO Stage (years with certified EMS in place)		-0.024 (0.128)	
ISO Status (certified EMS in place)			0.060 (0.371)

p-values all less than 0.05 except for adoption status (Model 1: p-value = 0.48, Model 2: p-value = 0.47, Model 3: p-value=0.47), ISO stage (Model 2: p-value = 0.85), and ISO Status (Model 3: p-value= 0.87).

Table 3Table 3 and Table 4 show the average tons of criteria air pollutant emissions per 1000 vehicles from 1996 and 1999. Nineteen facilities are in the group of early adopters certified by 1999, while 27 facilities are in the group of late adopters certified after 1999. First, consider the comparison of the "average" facility in 1996 – when no facilities were certified – to the two groups of facilities in 1999 – certified and non-certified (Table 3). Both groups of facilities achieved reductions in criteria air emissions over the average 1996 levels despite increases in production, with facilities with a certified EMS having an overall lower level of emissions per vehicle in 1999 than facilities without a certified EMS. In fact, facilities without certified EMS had an increase in particulate matter emissions.

Table 3: Average emissions of criteria air pollutants (tons/1000 vehicles).

	1996	1999	
	Average Facility	**ISO-Certified**	**Not ISO-Certified**
Production	207,000	246,000	217,000
CO	0.371	0.231	0.309
NOx	0.882	0.341	0.679
VOC	6.311	4.348	4.890
SO2	0.618	0.043	0.513
PM25	0.088	0.025	0.120
PM10	0.117	0.082	0.163
Total	8.301	5.047	6.556

Table 4Table 4T indicates, however, that the facilities which certified an EMS by 1999 (the early adopters), did not attain reductions in criteria air pollutant emissions to the extent that facilities which did not certify an EMS (late adopters) were able to attain. Overall, late adopters show a greater reduction in air emissions – a 37% decrease, versus a 5% decrease for the early adopters who were implementing and certifying their EMSs in the interim years. During this time, the late adopters also increased production considerably. The largest absolute improvements came in VOC emissions which account for 75% of all emissions. The early adopters made large relative improvements in emissions of sulfur dioxide compared to the late adopters; however, the total reduction of sulfur dioxide by late adopters was more than three times the amount. Regression analysis using OLS methods again did not indicate any statistical significance in the ISO certification variables. Statistical analysis to determine if a difference exists between the mean values for the different groups of facilities did not show significance.

Table 4: Average emissions of criteria air pollutants (tons/1000 vehicles).

	1996		1999	
	ISO-Certified by 1999	**ISO-Certified after 1999**	**ISO-Certified by 1999**	**ISO-Certified after 1999**
Production	240,000	183,000	246,000	217,000
CO	0.126	0.543	0.231	0.309
NOx	0.489	1.158	0.341	0.679
VOC	4.468	7.608	4.348	4.890
SO2	0.112	0.974	0.043	0.513
PM25	0.080	0.094	0.025	0.120
PM10	0.103	0.127	0.082	0.163
Total	5.299	10.413	5.047	6.556

For hazardous wastes, again a general trend of improvement is seen across all facilities, although no difference is apparent between facilities with certification and those without certification of an EMS. Table 5 shows the trend in hazardous waste generation from 1993 to 2001. Both groups of facilities experienced similar generation rates in the latter years as some facilities were undergoing implementation and certification of an EMS. In comparing the initial 1993 figures to the final 2001 figures, facilities that had certified the EMS to ISO 14001 had a higher percentage of reductions – a 27% decrease over the 8 years, versus 19% decrease for those without certification. In a statistical comparison of the mean tons per 1000 vehicles for each year, no significant difference exists between the two groups of facilities, indicating that time of adoption does not have a greater

influence on hazardous waste generation. Again, OLS regression shows no statistical significance in the ISO-certification variables in relation to waste generation per vehicle.

Table 5: Trend in Hazardous Waste Generation.

	Hazardous Waste Generation (tons per vehicle)	
	All Facilities	
1993	7.15	
1995	6.03	
1997	5.78	
	Certified Facilities	**Non-certified Facilities**
1999	4.82	4.33
2001	4.22	4.67
% Change 1997-2001	-27%	-19%

The data for regulatory compliance appear in Table 6. Note that the data represent information for a two-year period inclusive; inspections, violations, penalties or corrective action could have occurred at any point in the two-year period. The first column represents a period when no facilities had an EMS certified to the ISO 14001 standard, although several facilities were in the implementation phase. The second column represents 1998-2000 and the facilities are separated into two groups – those which certified an EMS during the time and those which did not (effectively early adopters and late adopters). The third column represents 2001-2003 and again the facilities are separated into two groups – those with EMSs which had been certified and in operation during the time period and those which were implementing an EMS for certification (again, effectively early adopters and late adopters). Inspection rates across the first two time periods are consistent, as are rates between the groups in the final year. This provides a baseline that compliance issues are not biased by a change in inspection activity from regulators.

The data reveal several differences between the groups of facilities. First, facilities that are in the implementation phase prior to certification show higher occurrences of violations or noncompliance events. This is true for the early adopters in the 1998-2000 period, and the late adopters in 2001-2003, although it is more pronounced for the early adopters. Perhaps more importantly, 77% of facilities with an established EMS had a regulatory compliance issue, indicating that the EMS is not entirely successful in allowing facilities to maintain compliance. The overall rate of violations or noncompliance events for all facilities in 2001-2003 is 78%, similar to the rate in 1996-1998 without any certification. On average, facilities were out of compliance for 6 of the 8 quarterly periods over each time frame. It is possible that violations and non-compliance events are likely getting resolved more quickly over time. The number of continuing events (those with 8 quarters of continuous noncompliance) decreased from 66% in the first period to about 40% in the last period.

Table 7: Regulatory compliance of firms from 1996-2003 in relation to ISO 14001 EMS certification.

	1996-1998	1998-2000		2001-2003	
	No facilities with EMS certified	Facilities with EMS certified during time period	Facilities with no EMS certified during the time period	Facilities with EMS certified prior to time period	Facilities with EMS certified during time period
Total number of facilities	50	22	28	30	20
Facilities that have been inspected	46	20	26	26	17
Total number of inspections	186	71	99	75	42
Percent of facilities inspected	92%	91%	93%	87%	85%
Average number of inspections per facility	4.0	3.6	3.8	2.9	2.5
Facilities with violation or noncompliance event	38	20	19	23	16
Percent of facilities with violation or noncompliance event	76%	91%	68%	77%	80%
Quarterly periods with 1 or more violation or noncompliance event	240	115	112	159	96
Average periods with violation or noncompliance event per facility	6	6	6	7	6
Continuing noncompliance/violations	25	11	10	9	7
Percent of facilities with continuing noncompliance or violations	66%	55%	53%	39%	44%
Facilities with significant noncompliance	13	4	1	12	10
Percent of facilities with significant noncompliance event	34%	20%	5%	52%	63%
Facilities with pollutant release exceedances	9	4	3	6	4
Number of parameters over limit	18	6	4	8	5
Average number of parameters over limit per facility	2	1.5	1.3	1.3	1.3
Percent of facilities with pollutant exceedances	18%	18%	11%	20%	20%
Number of reports over limit	92	28	21	26	14
Number of reports submitted	9843	6116	3246	5495	1429
Facilities with pollutant spills	10	3	0	10	9
Total number of pollutant spills	13	5	0	15	19
Average number of pollutant spills per facility	1.3	1.7	0	1.5	2.1
Percent of facilities with pollutant spills	20%	14%	0%	33%	45%
Facilities where enforcement actions were taken	9	9	3	18	5
Number of Facilities assessed penalties	4	5	1	17	5
Total penalties assessed	$144,000	$490,000	$56,000	$1,650,000	$176,000
Total number of enforcement actions taken	15	14	5	24	6
Average number of enforcement actions taken per facility	1.7	1.6	1.7	1.3	1.2
Percent of facilities where enforcement actions taken	18%	41%	11%	60%	25%

In the latter time period, of the 39 facilities which had a violation or noncompliance event, 22 had events with significant noncompliance ratings corresponding to 52% of facilities with EMS certified prior to the time period, and 63% of facilities in the implementation stage. These percentages are a large increase from the baseline year (34%) or the middle period (20% and 5%). Facilities with no certified EMS had fewer pollutant release exceedances. More pollutant spills are occurring in the facilities over time. During the last period, almost 40 spills occurred at 20 facilities, about twice that of the initial period. Facilities with an operating EMS received far more enforcement actions (18 out of 30 facilities) and faced more fines ($1.7 million) than the other groups of companies despite having a comparable number of enforcement actions per facility.

Discussion of Results

The results do not support either hypothesis formulated about the relationship between facility environmental performance and ISO 14001 certification. The first hypothesis proposed that facilities that have established and implemented an ISO 14001 EMS and now have a system for and commitment to environmental performance improvement should have better environmental performance than those facilities without such a system in place. Overall, the U.S. automobile assembly facilities exhibit no substantial difference in environmental performance in relation to the implementation and operation of an EMS certified to ISO 14001. The total emissions and wastes from all facilities decreased over the 1993-2001 period which is to be expected. Emissions and wastes for individual facilities trend downward, although fluctuations both up and down are widespread. Similarly, the wide variance in performance for any metric in any year indicates that some facilities have large volumes of waste or emissions that have been eliminated by other facilities with low volumes. Regulatory compliance has not changed considerably over the time period, for better or for worse.

The second hypothesis proposed that facilities with a certified ISO 14001 EMS should continually improve on past performance levels and likely at a greater rate of improvement. However, once a facility had certified an EMS to the ISO 14001 standard, improvements in environmental performance did not accelerate from past performance. In some cases, facility performance was actually worse after an EMS was implemented and certified to the ISO 14001 standard.

One important consideration is whether the performance measures chosen for the analysis match areas where the facilities put efforts for improving performance. Within the ISO 14001 EMS framework, each facility may choose specific impacts to target for reduction or improvement. These goals and targets are not made public and may not correspond to the environmental performance measures represented by the public data used in the analysis. However, as the ISO 14001 EMS standard claims to provide a framework for overall improvement in environmental performance, some relationship would be expected. As the facilities move to organized methods of documenting impacts, assigning responsibilities, and incorporating a general awareness of environmental issues, all environmental impact areas should see some improvement.

The firms in the automobile assembly industry publicize their performance in environmental areas using a variety of metrics. Most common for facility performance are measures of energy use and carbon dioxide emissions, measures of materials consumption and waste generation, and water consumption. None of these data are public at the facility level, except hazardous waste data which is only a small portion of waste generation (on the order of 1% of total waste). So, a relationship would be expected, and this is the area where we see the strongest support of performance in relation to ISO 14001 certification. Early adopters decreased hazardous waste generation by 27% while late adopters only decreased generation by 19% from 1993 to 2001. Still, no statistically

significant difference in the groups exists. In addition, the early adopters experience a 24% increase in hazardous waste generation from 1999 to 2001 when the facilities would have had an ISO 14001 EMSs in operation approximately 3 years. Clearly not continued improvement in environmental performance.

One aspect outside the scope of this research is how cost influences changes in environmental performance. It is possible that through implementing and certifying an EMS to the ISO 14001 standard that facilities achieved reduction in waste or emissions, which may be equal to reductions at facilities which did not initiate ISO 14001 implementation, at a lower cost. The standard may allow facilities to identify more cost-effective methods of improving performance. Organizations would then have to consider if these cost savings match the costs of implementing and maintaining the EMS to the ISO 14001 standard.

Two factors of how the ISO 14001 EMS standard is structured may explain to the results and, after a longer time period, may lead to better performance. First, given the work related to implementing the standard, facilities undergoing certification may have a better grasp of environmental impacts existing at the facility. From a thorough audit and investigation of facilities operations for creation of an EMS, facilities may identify sources of waste and emissions, do a better inventory of wastes and emissions, or become aware of or more diligent of compliance issues. This would increase the figures used to measure performance in comparison to earlier years without the standard. Yet, these figures would be a more accurate depiction of actual performance. If this is true, longer time periods of analysis would identify improvements once the baseline for emissions and waste generation had been shifted to these new levels. However, the data for toxic releases and hazardous wastes, which provide measures for about 20 facilities after 3 years of implementation do not show significant improvements with time. Similarly, the number of violations and noncompliance events for these facilities with well-established ISO 14001 EMSs are similar to those prior to implementation.

A second factor of the ISO 14001 EMS standard that may not be reflected in the performance data is the potential impact of better general management of environmental issues once a facility implements ISO 14001. The standard requires facilities to identify responsibilities and initiate a cycle of audit and review of operations of the EMS. These requirements, while not necessarily having a direct impact on day-to-day performance of operations, may in the long run assist in reducing environmental impacts, especially one-time problematic events. For example, if an employee with environmental oversight leaves the position, the duties and concerns of the position are documented and more easily transferred to other personnel. This ensures continuity of operations and reduces the chance that certain activities, such as monitoring an effluent or annual training, will go unchecked. Better overall management of environmental issues would not be directly translated to environmental performance improvements. This then identifies a shortcoming in the ISO standard for achieving improvements.

Micro-Level Analysis – EMS Structure and Information Systems

An EMS is intended to address all activities related to environmental issues, including such activities as monitoring wastes and emissions, complying with regulatory requirements, developing new products, and providing service to customers. In many cases, organizations gather existing environmental activities under a single framework to establish a formal EMS. The ISO 14001 EMS is becoming the de facto model for EMS. The standard provides a structure to EMS by outlining

specific elements that must be included, but is non-prescriptive in how the elements might be fulfilled, allowing for flexibility among users.

The basic components of an EMS include: a mission statement, documented environmental policy, goals, timelines, data collection and organization, information systems, identification of environmental impacts, regulatory requirements, personnel responsibility and task list, training and awareness, management review, organizational decision process, audits, annual reports, security measures, and emergency plans (6-9). The general process for developing an EMS is to document how tasks with an environmental impact are to be done, complete the tasks as documented, and check periodically to verify that the tasks are being done as intended and, if not, correct the problem. Implementation includes obtaining commitment from top management, communicating the importance of environmental efforts, establishing environmental policy and objectives, assessing current impacts, developing a plan for improvement, assigning responsibilities, recording achievements, auditing results, and reviewing the system.

Given this wide consensus in content and implementation, one might expect that all EMS would be similar, regardless of the type of the organization. To test this claim, we investigated the EMSs of nine companies via structured and open-question interviews, a likert-scale survey, facility visits, and a review of publicly available information. The case studies involved both EHS and non-EHS personnel and inquired about both the EMS and environmental management information systems (EMIS) used to support EMS. In the area of EMS generally, the research considered the components and structure of the EMS and the value the EMS had provided to the organization. The intent of the research was to determine if a consensus EMS existed, and to identify components, if any, that were unique. One particular interest was the integration of environmental, health, and safety (EHS) issues at some companies, and the influence it has on EMSs. The research on EMIS considered the data use and availability within the organization for decision-making. The intent was to determine if common data were available, if unique data existed, and how the data were utilized across the firm.

Case Study Methods

Nine companies agreed to participate in the case study research. The companies' names have been withheld to maintain anonymity. The companies that participated are from a variety of industry sectors in the United States including leaders in the fields of electronics, transportation, chemicals, and construction. Eight of the nine companies fall within the North American Industry Classification System (NAICS) manufacturing sectors (32 and 33). The other company is from the construction industry (NAICS 23). All companies are multinational corporations with operating sites around the world, resulting in a complex array of environmental requirements that must be followed. With a range of employees from 10,000 to 100,000, the range of environmental issues is wide.

For each company, we conducted the investigation at one representative location, and in some cases interviewed corporate environmental staff as well. The facilities were typical sites of the firms. Corporate staff provided a broader picture of the EMS function across the firm. The companies represent an opportunity sample selected from contacts of the researchers. Selection resulted in many of the participants being known environmental leaders in their fields, although among the nine companies environmental performance varies widely. The status of EMSs at each company varied as well, with some having mature EMSs to some only beginning to implement formal EMSs. All of the companies that participated had at least a few facilities (ranging from 5% of facilities to

100% of facilities) that were ISO 14001-certified. Six of the nine facilities visited were ISO 14001-certified. Further certification of facilities will depend on the demands of the customers as well as corporate policy decisions. Seven of the nine companies have integrated the functions of environment, health, and safety issues. This integration of function influences the make up of the EMS. Safety and health information was identified by most participants as part of the EMS information.

Each case study consisted of an initial conversation detailing the project and verifying a company's willingness and interest in participating, an exchange of information on the company's EMS or environmental programs, a site visit with a tour of the facility, a structured survey, a set of open-ended questions, additional questions that arose during the visit, and then follow-up contacts to fill in data gaps and verify information. The information exchanged by the company with the researchers on their EMS or environmental programs ranged from entire EMS manuals to corporate presentations. The information for each case study was augmented with publicly available environmental information for both the company and the facility available through company websites, press releases, and government databases. Due to the small sample size, complex statistical analyses of the data do not produce reliable conclusions. However, qualitative information and simple statistics were used to summarize the data collected. A summary of the responses from some questions results in statements on general trends and the beginning of a contingent typology of EMS and EMIS within corporations.

Comparison of EMS Components

Based on the nine companies that participated, the major components of the EMSs were the same. The reliance on common components suggests that a "consensus" EMS has been established across many industries. Each company had a corporate-wide environmental policy recognizing responsibility in environmental matters (and in health and safety matters in some cases). Policies pledged various activities, usually compliance with regulations, communication with stakeholders, and continuous improvement of performance. Often, companies included establishing an EMS as part of its policy or pledge.

Each company has established goals for its environmental performance to be monitored and measured by its EMS. Four of the nine companies use the strategic plan of the corporation to develop strategic environmental goals. Once corporate goals are established, the goals are handed down to divisions and business units, which in turn pass them down to individual facilities for achieving them. Seven companies reevaluate goals annually, one semi-annually, and one company reevaluates goals "as needed" to maintain improvements. Various tools and techniques are used to identify environmental issues that the EMS monitors. Four of the companies use cross-functional teams to assess operations. These teams involve environment, health, and safety staff, business division staff, and research and development personnel. Three of these teams use formal tools – an assessment matrix, a checklist, and a product characterization process – in their evaluation. Other companies look only toward their EHS staff to identify issues. Past audit results are the main source of information, while brainstorming exercises or offering employee incentives are also used to identify environmental issues.

All of the companies conduct internal environmental audits at each site with at a frequency ranging from 2 to 5 years. Audits require a few days to two weeks. Often these audits consist of employees, particularly environmental professionals, from many different facilities who are able to share their expertise. Some of the companies have developed self-auditing tools which can be used

to prepare for audits or do internal audits more frequently. These tools include checklists, electronic tracking systems, email reminders, and guidance documents. External audits occur as specified by any certifications.

Each company did have unique characteristics of its EMS. Some companies have developed extensive process maps or mass balances of their facilities in order to identify all inputs and outputs as well as environmental impacts that should be covered by the EMS. Some companies have incorporated a means to track, identify, and prioritize future risks to their business and facilities into the EMS. Many have produced EMS skeletons to help ease the implementation burden as the EMS is initiated at different facilities. A few companies have seen a benefit from industry-wide groups that bring environmental professionals together to share successes and challenges in EMS activities. Within some industry sectors, e.g., the chemicals sector, sharing of EHS strategy occurs. In other sectors, each company independently deals with these issues. The EMSs are similar across all sectors, however. Finally, while most companies have a procedure to determine if capital expenditures have any environmental consequences as part of the EMS, few have procedures to involve EHS staff early in product development

EMS Structure

While the organization's EMS had similar components, the management structure of the various EMSs was different across firms. By structure, we mean how the EMS is arranged and operated within the organizational layout of the firm. For example, some systems are centralized at the corporate level while others operate independently at the business unit or facility level. One company has a corporate certification to ISO 14001 where all manufacturing facilities are covered and audited for conformance on a rotating basis. Two other companies have a corporate-wide EMS protocol (not ISO 14001) which covers (or will cover once fully implemented) all facilities. Some facilities within one of those organizations are certified to ISO 14001, however. The other companies, while maintaining a central, corporate EHS function, have facility-level environmental management systems. Many of these facility EMSs conform to the ISO 14001 standard. The structure of an EMS depends on whether a company repeatedly produces the same product year-to-year, changes the product continuously, provides a service rather than a product, or has a few large manufacturing facilities versus many, small manufacturing facilities. These variations affect the complexity as well as the core of the EMS in terms of personnel, documentation, responsibilities, and information systems.

Six of the companies shared their EMS manuals with the researchers of this study. Although two of these were not ISO 14001 certified, all of these manuals aligned with the ISO 14001 suggested structure and contained detailed information about procedures and responsibilities. Most environmental personnel commented on the large amount of time and work required to compile these manuals, but they also acknowledged the benefits in employee training, knowledge transfer, and overall organization when complete. All of the companies identified customers or suppliers as influences on their EMS. Several facilities within the organizations in the case study had implemented EMSs according to the ISO 14001 standard based on customer demands. But this customer demand had not influenced corporate mandates for EMS development. Individual facilities took the initiative to implement the standard. Two companies had incorporated product information (not simply process or operating information) into their EMSs based on requests for product standards from customers.

Value of the EMS

We asked participants to rate the value of their environmental management system in different areas. Most respondents consider the EMS to provide the most value to the EHS department itself, rather than outside the department. There could be some bias here as environmental staff answered the question. Thus, this is how the environmental staff perceives non-environmental staff to view the EMS. Each facility was asked to evaluate on a scale of 0 to 5 ("not valuable" to "extremely valuable") how the EMS contributed to the following eight business opportunities as shown in Table 7. Companies may not perceive the valuation scales exactly the same.

Table 7: Valuation of environmental management systems

EMS Characteristics	Company									
	A	B	C	D	E	F	G	H	J	average
Improved Environmental Impact	5	5	5	3	*	5	3	*	5	4.43
Performance Enhancement of Products or Processes	4	4	5	4		4	4		3	4.00
Managing Regulatory Requirements	4	5	2	3		4	3		4	3.57
Communicating with Management	5	3	4	4		2	1		4	3.29
Communicating with Employees	3	4	4	4		2	4		3	3.43
Financial Savings	3	3	5	2		3	3		3	3.14
Time Savings	4	5	1	1		2	4		3	2.86
Communicating with External Stakeholders	2	1	3	2		2			2	2.00
Overall value average	3.75	3.75	3.63	2.88		3.00	3.14		3.38	

Respondents were asked to rate the value of the EMS with regard to the activities on a scale of 0 to 5 from not valuable to extremely valuable. *Companies E and H not included because they either do not have formal EMSs or their EMS is still in the implementation phase and are unable to rate their EMS.

An EMS provides the least value to communicating with external stakeholders. All of the participants had information regarding their environmental programs on the corporate website, yet the information did not correspond with components of the EMS. All companies publicized the environmental policy and commitments to monitoring environmental issues. Only one company stated their actual EMS goals. Some companies either on the website or within a published report on environmental or corporate responsibility communicate performance metrics, but these are often data already public. These data include safety accident data, toxic release inventory releases, and total waste generation. Other information included status of ISO 14001 certification and environmental awards presented or earned by the company or individual facilities and personnel. While this information is beneficial to community stakeholders, it does not reflect the efforts and activities of the companies' environmental management systems.

Comparison of Environmental Management Information Systems

Information systems are used to manage regulatory requirements, compare facilities to one another, and monitor time trends. Table 8 lists the types of data available in environmental, health, and safety information systems at the facilities. Note that the categories do not reflect individual software tools, only that information of a given type is available via electronic form. Most data are collected for regulatory purposes; some other data that have internal value are also collected. The

most common data in information systems collected by at least two-thirds of the companies include: air emissions management, injury and illness incident statistics, key performance indicators, non-conformance statistics, chemical inventory and management, EHS auditing, and notice of violation tracking. Examples of data collected for non-regulatory use include greenhouse gas emissions, waste minimization efforts such as recycling, energy consumption, and non-reportable injury and illness statistics. Most of the companies in the study have adopted corporate-wide environmental information systems within the past three years.

Table 8: Environment, Health, and Safety Data Available in Company Information Systems

Data Category	**Company**								
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**
Injury & Illness Incident Statistics	X	X	X	X	X		X	X	X
Air Emissions Management	X	X	X	X	X			X	X
Key Performance Indicators	X	X	X	X	X			X	X
Non-Conformance Statistics	X	X	X	X	X			X	X
Chemical Inventory/Management	X		X	X	X			X	X
EHS Auditing	X			X	X	X		X	X
Notice of Violation Tracking		X	X	X	X			X	X
Waste Management	X				X	X	X	X	X
Computer Based Training for Environmental	X			X	X	X			X
MSDS's - Incoming from vendors	X			X	X			X	X
Spill Tracking and Notification			X	X	X	X			X
Computer Based Training for Health & Safety	X			X	X				X
EHS Documents/Knowledge Base			X	X	X				X
Energy Consumption/ Energy Management	X		X				X		X
ISO 14001 Management System	X	X		X					X
MSDS's - On the Web for Customers		X	X		X			X	
Pollution Prevention	X			X	X			X	
Toxic Release Inventory	X		X		X			X	
MSDS Creation - Outbound for Customers		X		X	X				
Other				X				X	X
Regulatory Tracking Calendar		X		X				X	
Wastewater Management		X						X	X
EHS Project Management				X	X				
Product Liability/Product Stewardship		X			X				
Regulatory Interpretation Library				X		X			
Stormwater Management						X		X	
Toxicology Information				X	X				
EHS Cost Analysis					X				
Voluntary Program Participant Requirements									

As information systems have become more common-place, companies have begun to migrate to formal databases or web-based systems. Companies are beginning to establish intranet systems to accommodate multiple site data requests, such as waste generation from all facilities within a single business unit. Often these systems utilize workers outside of EHS personnel to input and track data. However, some data remains segregated in non-networked systems, limiting availability of the data for decision-making.

Companies were asked about the level of integration of their EMIS. The level of integration reflects the linkage of the environmental management information system with other business information systems. The level of integration can be determined by the number of other business information systems that are linked with the environmental information systems. The survey options for systems that may be integrated included: accounting/ financial, business development, human resources, inventory control, maintenance, manufacturing, and purchasing. Each of these systems can be considered a level of integration. Few of the case study companies had integrated the EMS data with more than 2 other business information systems. Most commonly integrated was inventory control, reflecting a need to monitor chemicals.

Each company was asked how frequently environmental data are requested with the following seven choices: daily, weekly, monthly, quarterly, annually, infrequently, never as well as the option of "all that apply." The question was answered for three parts of the company: management outside the EHS function at the facility, EHS management at the corporate level, and management outside the EHS function at the corporate level. Table 9 shows the frequency of data requested by each company. Management within the EHS divisions at the corporate level usually requests information more frequently than management within the non-EHS divisions of the facility and always requests information more frequently than management within the non-EHS divisions of management at the corporate level.

Table 9: Data Requests by Management

	A	**B**	**C**	**E**	**F**	**G**	**H**	**J**
Management within the EHS Function of the Company								
Daily	X						*	
Weekly	X	X			X			
Monthly		X		X				X
Quarterly			X	X				
Annually			X	X				
Infrequently								
Management outside the EHS function of the Company								
Daily							X	
Weekly								
Monthly	X				X		X	
Quarterly		X	X	X			X	X
Annually				X			X	
Infrequently						X		
Management outside the EHS function of the Facility								
Daily							X	
Weekly	X			X				X
Monthly	X	X	X	X	X		X	
Quarterly				X			X	
Annually				X		X	X	
Infrequently						X		

* Company D did not answer this question because they said that using the data is an ongoing process and that the frequency of data requests varies. Company H did not answer the question for EHS staff because they continually have access to this data - so they do not ever have to request it

An intensity value was assigned to the frequency from infrequently (1) to daily (6). Table 10 shows the average data request frequency across companies. Management within the EHS divisions at the corporate level requests data weekly (average of 4.75), management within the non-EHS divisions of the facility company requests data more than once a month (average of 4.1), and non-EHS divisions of management at the corporate level requests data more than once a quarter (average of 3.1). The total intensity index averages the intensity value for each level of management per company. Table 10 also shows the total intensity index by company. Across levels of management, Company A requests data most frequently, and Company G requests data the least frequently.

Table 10: Data Request Frequency and Intensity

	A	B	C	E	F	G	H	J	average
Management within the EHS Function of the Company	6	5	3	4	5	5	*	4	4.75
Management outside the EHS function of the Company	4	3	3	3	4	1	4	3	3.1
Management outside the EHS function of the Facility	5	4	4	5	4	2	4	5	4.1
Total Intensity Index	5	4	3.33	4	4.33	2.67	4	4	

The total intensity index averages the intensity value for each level of management per company.

In addition to the frequency of data requested, there are differences in which types of data are requested and which parts of the company request the data. In at least 6 of the 9 companies, management within the EHS divisions of the company request data from: waste management, injury and illness incident statistics, air emissions management, chemical inventory/ management, EHS auditing, and MSDS's - incoming from vendors. The only information requested by more than half of the management with the non-EHS divisions of the company was the injury and illness incident statistics, which technically is not even an environmental item. The next most requested items (by 4 of the 9 companies) included waste management and EHS auditing. Management within non-EHS divisions of the facility most commonly (by 5 of 9 companies) requests information on waste management and injury and illness incident statistics. The interest in these two items probably occurs because both are easy to define, easy to measure, and linked directly to costs.

Value of EMIS

The EHS information systems are considered to be valuable in many areas. Each facility was asked to evaluate (on a scale of 0 to 5 from “not valuable” to “extremely valuable”) how the EHS information system contributed to eight business opportunities. The valuations by each company are listed in Table 11. Companies may not perceive the valuation scales exactly the same. An average was taken across the nine companies to prioritize the areas. From the averages, these companies receive the most value from information systems in managing regulatory requirements and improving environmental impact. Note that the range of value for the categories is lower than the valuation given previously for EMSs. More value is perceived from the overall management system than from the information system used in conjunction with the EMS. Communicating with external stakeholders remains the lowest category for gaining value.

Table 11: Valuation of environmental information systems

	A	B	C	D	E	F	G	H	J	average
Improved Environmental Impact	5	3	5	3	3	3	3	5	3	3.67
Managing Regulatory Requirements	5	2	4	4	3	2	3	5	5	3.67
Communicating with Management	4	2	5	3	3	3	3	5	3	3.44
Communicating with Employees	3	2	5	3	3	4	2	4	3	3.22
Time Savings	4	3	1	1	1	5	4	5	5	3.22
Performance Enhancement of Products or Processes	4	3	3	3	0	4	3	3	2	2.78
Financial Savings	3	3	2	1	1	3	4	3	2	2.44
Communicating with External Stakeholders	2	1	5	2	0	1	3	4	1	2.11
Overall value average	3.75	2.38	3.75	2.5	1.75	3.13	3.13	4.25	3.0	

Respondents were asked to rate the value of the EHS information system with regard to the activities on a scale of 0 to 5 from not valuable to extremely valuable.

Discussion

The micro-level analysis demonstrates the commonalities among EMS and information systems in various organizations. The components within an EMS typically relate to existing regulatory requirements. Thus, EMSs are likely to be helpful in identifying compliance issues as these issues are targeted for action and personnel can access data readily. Each of the companies participating in the case studies had violations against environmental permits and had received enforcement action for environmental compliance issues in the past two years (10).

Given the commonalities in environmental management systems across corporations of various industries, sizes, and locations, managers can take advantage of the experience from individual facilities to build up new EMS or strengthen existing ones. The unique collaboration among environmental professionals that some of the participants had initiated is an aspect that facilitates learning.

In this study, management within the EHS divisions at the corporate level usually requests information more frequently than management outside the EHS function of the facility and always requests information more frequently than the management outside the EHS function at the corporate level. These results indicate that environmental data may not be utilized throughout all areas of an organization. Business managers should realize that decision-makers in all areas should be able to access environmental data. One potential aid to exchange is integration of the EMS information into other management information systems. Few companies had links between the environmental data and the data in the traditional business systems, although data from these systems is crucial to decisions. Without this integration, the EMSs are limited in how they might assist decision makers.

Respondents in the study evaluated where environmental information systems contributed to business opportunities. Environmental information systems provide the most value in improving environmental impact and managing regulatory requirements. The environmental information systems provide the least value in communicating with external stakeholders. Similarly,

environmental management systems provided the most value in improved environmental impact and performance enhancement of products or processes. Like the environmental information systems, the environmental management systems provided the least value in communicating with external stakeholders.

Implications for Policy Makers, Organizations, and the Public

The results of the analyses have important implications for policy makers, organizational managers, and the public. From the macro-level analysis, certification of an EMS to the ISO 14001 standard cannot be used as a proxy for improved environmental performance, and possibly more importantly, cannot be used as a proxy for regulatory compliance. As the data indicate, facilities with a certified EMS continue to struggle with violations and noncompliance of environmental regulations. Regulators cannot assume that presence of a certified EMS guarantees against infringement and resulting environmental impacts. Since no difference in operating performance is evident, policy makers must not consider EMS certification to be a means to an end. Continued reductions in currently regulated wastes and emissions are not assured. Any policy which gives regulatory preference to a facility on the basis of implementing and certifying an EMS to ISO 14001 should be considered only with additional transparency of the underlying goals and targets of the EMS. Additional transparency allows for a more robust analysis of efforts and accomplishments made by facilities in relation to the EMS.

Likewise, from the micro-level analysis, both EMS and EMIS revolve around regulatory compliance issues, the systems may be less useful in allowing companies to go beyond compliance. Unlike other voluntary programs intended to improve environmental performance by targeting issues outside the regulations, EMSs may only assure that firms are aware and improving areas already under scrutiny. Without additional data reporting (either internally to a firm, or externally) on non-regulated issues or integration with non-environmental data, using the systems continues to address only impacts with compliance aspects. At the same time, use of the data outside EHS management is also essential in having EMS become part of the decision-making processes in an organization.

One must consider, however, if *how* a facility is dealing with environmental issues is more important that what the performance is. The ISO 14001 EMS structure emphasizes continuity and consistency in addressing environmental impacts. As noted above, do the management aspects of the standard have benefits outside of general environmental performance over time which serve to improve operations? Benefits such as codifying responsibilities, establishing protocols, increasing awareness of environmental issues, and documenting these items, albeit cumbersome, may be shown to improve management of environmental issues overall. These factors may benefit organizations and encourage continued use and implementation of EMSs.

But since improving environmental performance in ways that are clearly identifiable to policy makers, local citizens, and the general public is the main goal of regulation, then the existing ISO 14001 standard is not sufficient. The fact that a consensus EMS exists can support regulators as policies and programs develop around the concept of EMSs. Regulators can determine which elements are essential for improving performance and concentrate on strengthening those components within facilities, and focusing on those elements during audits. Assistance programs can be generalized to promote further adoptions of EMS that allows for the company to have flexibility in establishing a corporate-level or facility-level EMS.

The results of the two analyses, along with discussion from a workshop on environmental management for multinational corporations attended by corporate-level environmental, health, and safety executives, led to the development of five essential elements of an EMS to aid environmental decision-making. The five elements, shown in Table 12, provide decision makers with key information on how environmental issues influence day-to-day and long-term operations of the firm. The scope of issues confronted on a daily basis in multinational firms requires a broad EMS that captures more than just regulatory requirements.

Table 12: Five elements for environmental management systems to aid organizational decision-making.

1. Process diagrams identifying material and energy inputs and outputs
2. Quantifiable goals for both short- and long-term performance consistent with the organization's strategic plan
3. Reliable methods of collecting and disseminating environmental data
4. Risk assessment tools for current and emerging environmental issues for operations and products
5. Collaboration and education of environmental personnel both within the organization and outside

These EMS elements are not universal, even among ISO 14001 certified EMS. Other than establishing goals and targets (element 2), these elements are not required for ISO 14001 certification, although at various levels a certified system may have these attributes. The five elements do not focus on regulatory issues or compliance. Most organizations (with or without an ISO-certified EMS) have existing systems to address regulatory requirements. Instead, the elements center on the goal of the EMS to provide timely, relevant information for decision-making on environmental issues that may occur across the organization.

The overall results of the research lead to suggestions for improving environmental management systems for organizational decision-making and policy development. First, EMS must stretch beyond the current regulatory issues to be effective in long-term improvement. Unlike other voluntary programs, EMS do not push organizations to concentrate efforts on addressing impacts outside the regulatory issues. Second, EMS goals, targets, and resulting performance must be made more transparent. The link between efforts to reduce environmental problems via an EMS and reported environmental performance metrics is tenuous. Finally, as environmental issues continue to shift in importance, EMS and must adapt to changing organizational focus and monitor potential future regulatory issues. For example, corporate social responsibility and calls for sustainability (incorporating social and economic factors, as well as environmental factors) and the global importance of carbon emissions (currently unregulated) are influencing corporate strategy. An EMS should support decision-making on these pressing issues.

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FORMALIZED ENVIRONMENTAL MANAGEMENT PROCEDURES: WHAT DRIVES PERFORMANCE IMPROVEMENTS? EVIDENCE FROM FOUR U.S. INDUSTRIES

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ABSTRACT

This paper examines changes in environmental performance and management benefits associated with the introduction of environmental management systems (EMSs), and factors influencing these outcomes. Specifically, we sought to determine whether there are systematic differences, in EMSs themselves and in resulting environmental performance, between organizations that adopt EMSs for their own organizational reasons ("self-initiated"), or under coercion from corporate or customer mandates, and those that have not adopted such systems at all. Data included a survey of 3,200 plant managers in four sectors that include many suppliers to the automotive industry, which has mandated EMS adoption by its subsidiaries and suppliers, plus data from EPA's IDEAS database. The results suggest important findings concerning the roles of specific objectives for performance improvement, as opposed to adoption of an EMS per se; the limited effects of business-to-business EMS mandates; the perceived benefits of environmental performance improvement to business objectives; and the continued importance of governmental regulation and inspection to environmental performance on some key indicators.

KEYWORDS: EMS, environmental management systems, ISO 14000, compliance, pollution prevention, eco-efficiency, product stewardship, environmental performance, voluntary standards

INTRODUCTION

The adoption of formalized sets of environmental management practices by manufacturing facilities has proliferated over the past decade, but the efficacy of such practices in promoting environmental performance improvements remains uncertain. Over 50,000 organizations worldwide, including approximately 3,000 in the United States, have certified to the ISO 14001 environmental management system (EMS) standard, and more are currently in the process of registration.[2] Many other businesses have adopted formalized sets of environmental management practices, but have not officially registered to the ISO 14001 standard. While some may have adopted EMSs equivalent to the ISO 14001 standard and chosen not to formally register, others have adopted systems which fall short of ISO requirements. Nonetheless, efforts to install

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[2] See http://www.ecology.or.jp/isoworld/english/analy14k.htm. Note that some ISO 14001 certificates may cover multiple facilities of the same parent organization, while others may cover only a specified subset of functions even at a single facility site.

systematic procedures for environmental management are becoming increasingly common, and in some cases a de facto condition for operating in certain industries and markets.

It is plausible to expect that the actual efficacy of an EMS in promoting environmental performance improvements may vary depending on the motivation of the business in introducing it. An EMS might be introduced, for instance, to improve compliance with environmental regulations, or to improve pollution prevention and increase "eco-efficiency" in the use of materials and energy in production processes (Coglianese and Nash 2001), or to improve the environmental performance of a company's products all the way from raw materials through recycling or waste management ("product stewardship") (Gallagher 2002). Alternatively, it might be introduced with an eye to improving overall plant management, whether or not it achieved significant improvements in environmental performance per se (Florida and Davison 2002). Or it might be introduced simply as a paper process, either to promote the business's "green" image (Darnall 2002) or merely to satisfy a mandate from corporate headquarters or a major customer.

Many facilities are increasingly under pressure from corporate parents and major customers to adopt formal environmental management practices. A number of major businesses have recently mandated introduction of environmental management systems (EMSs) by their subsidiaries and suppliers, particularly in the automotive and electronics industries: prominent among these are recent mandates from Ford and General Motors that all company facilities, as well as facilities of their first tier suppliers, must adopt and register an EMS in conformance with the ISO 14001 standard (Hutson 2001). Government agencies also have begun to promote such systems with public recognition and incentives, such as EPA's National Performance Track and similar state-level initiatives.[3]

A key unanswered question is what differences in actual environmental performance are associated with the introduction of such systems, and particularly, whether such systems produce positive changes in performance and other benefits when they are mandated or encouraged by external incentives.

The objective of this research project was to determine what changes in environmental performance result from the implementation of environmental management systems (EMSs), and what differences in organizational characteristics, motivations, and decision making are associated with these changes. Specifically, we sought to determine whether there are systematic differences, in EMSs themselves and in resulting environmental performance, between organizations that adopt EMSs for their own organizational reasons ("self-initiated"), or under coercion from corporate or customer mandates, and those that have not adopted such systems at all. Both public policymakers and businesses themselves will benefit from better information on the consequences of EMSs for environmental performance, and on their associated benefits and costs.

The research addressed a series of more specific questions concerning the impact of EMS adoption:

[3] http://www.epa.gov/performancetrack/, and state initiatives e.g. in Colorado, Illinois, Indiana, Maine, North Carolina, Oregon, Texas, Virginia, Wisconsin and others.

- First, is the adoption of a formal environmental management system a good predictor of environmental performance improvement? Do facilities that have introduced ISO-certified EMSs – or comparably formalized EMSs – improve their environmental performance more than other facilities in the same industrial sector?
- Second, if so, are some environmental performance indicators (EPIs) more likely to improve than others? Do they improve across the board, or merely in some more limited set of performance indicators – and if the latter, what lessons might be drawn for understanding the strengths and limitations of EMS impacts on environmental performance?
- Third, are such improvements associated with EMS adoption per se, or with more specific characteristics of the EMS such as the particular types of goals and performance objectives adopted? One required characteristic of an ISO-equivalent EMS is the adoption of explicit objectives for performance improvement, but the nature and stringency of these objectives is left to the discretion of the adopter. Do facilities experience greater environmental performance improvement for outcomes that are targeted by their EMS performance objectives?
- Fourth, do facilities that adopt a formalized set of environmental management practices reap business benefits as well? That is, do they experience improved management efficiencies, improved positioning in the market place, or other business benefits in addition to (or even independent of) their actual environmental performance changes?
- Finally, do facilities that are subject to explicit requirements from corporate parents or customers to adopt environmental management practices perform differently than facilities that are not subject to such pressures, and that presumably therefore implement environmental management practices – whatever ones they do implement – under their own initiative?

Data sources included a survey of plant managers from a stratified random sample of facilities in four industrial sectors, as well as publicly available data for those facilities from EPA's IDEAS regulatory compliance database and its Toxics Release Inventory.[4]

FORMALIZED ENVIRONMENTAL MANAGEMENT SYSTEMS AND BENEFITS

To answer these questions, one must consider three bodies of theory and evidence: what impacts does an EMS have on environmental performance, what impacts might one expect it to have on business outcomes such as management and market benefits, and what expectations of business benefits might explain the imposition of business-to-business mandates for EMS adoption on subsidiaries and suppliers?

Environmental Performance

To date, studies that have attempted to determine the effects of EMSs on environmental performance have shed some light on the issue, but have not produced systematic or consistent answers. Case studies of facilities that have adopted EMSs point to a myriad of environmental improvements associated with the management systems, but have not produced systematic or reliable results (Berry and Rondinelli 2000; Rondinelli and Vastag 2000; Ammenberg 2001).

[4] Analysis of the TRI data is still in progress.

Several survey-based studies also have reported the impacts of EMSs on environmental performance, some too early after ISO 14001 adoption (in 1996) to produce compelling results (Melnyk et al. 1999; Hamschmidt 2000), and others with improved reliability but limited generalizability (Florida and Davison 2001; Mohammed 2000; Anton 2002; Andrews et al. 2003). Two studies have sought to measure performance outcomes using EPA's Toxics Release Inventory (TRI) database, with conflicting results: Matthews (2001) found that facilities in the auto industry with EMSs did not perform better than those without them, while Russo (2001) found that ISO 14001 was a significant predictor of reduced toxic emissions in the electronics industry. The findings of these latter studies may have differed due to differing methodological approaches and/or sectoral variance. In any case, the results focused only on toxic emissions rather than on a broader array of environmental performance indicators.

Additionally, most existing studies do not address the great range of discretionary variation that exists among the EMSs that facilities adopt. ISO 14001 provides a standard template for the process elements of an EMS – identifying environmental aspects and impacts, setting goals and objectives, assigning responsibilities, training, corrective and preventive actions, periodic review, and so forth – and it specifies three overarching goals for that process (compliance, pollution prevention, and continual improvement). But all the specific content – what environmental aspects and impacts will be considered, what environmental performance objectives will be priorities and how rapidly they are to be achieved, and others – are left entirely to the choices of the adopter, and businesses that do not seek ISO 14001 certification are not bound even to the ISO template. One previous study found great variation in practice both among aspects and impacts considered, and in the determination of which of these impacts were considered significant and targeted as priorities for improvement (Andrews et al. 2003). An important question for further inquiry is what impact the facility's choice of objectives – not just its decision to adopt a formal EMS – has on environmental performance and other outcomes.

Management and Market Benefits

The implementation of a formal EMS can be an expensive and time consuming endeavor (Darnall and Edwards *forthcoming*). Several theoretical justifications have been offered as to why an EMS might produce benefits both to environmental performance and to business outcomes. First, systematic management of functions with negative environmental consequences, rather than haphazard and inconsistent methods for addressing them, is more likely to produce outcomes that have both environmental and business benefits, such as minimizing costs, environmental liabilities, regulatory penalties, and risks to the firm's image and associated brand value (Coglianese and Nash 2001). Second, managers who address environmental problems with formal management systems may also reap improvements in product quality and process efficiencies that lead to positive financial outcomes (see also Porter and van der Linde 1995; Hart and Ahuja 1996; Klassen and McLaughlin 1996; Sharma and Vredenburg 1998; Dowell, Hart and Yeung 2000; Christmann 2000).

Third, an EMS can contribute to broader patterns of beneficial management and cultural changes within a business organization, such as integrating environmental management with other primary management functions and with organization-wide quality management procedures (Florida and Davison 2001, Coglianese and Nash 2001). Additionally, management-based approaches may be less costly and more effective than government imposed regulation, may lead

to greater buy-in from management due to a greater sense of legitimacy, ownership and control, and may promote innovation and social learning (Coglianese and Lazar 2003). However, some suggest that claims about the ability of EMS to lead to performance improvements may be overstated, and must be empirically tested (Walley and Whitehead 1994).

Business-to-Business Mandates

It is becoming increasingly common for business decision makers to include comprehensive environmental management plans as part of a broader corporate strategy. Such strategies may include strong encouragement, as in the case of IBM, or explicit requirements, such as those mandated by Ford, General Motors and others, for subsidiaries and suppliers to adopt formal environmental management systems.

A corporation may require that its own facilities adopt EMSs for at least three reasons (Andrews, Hutson, and Edwards, *forthcoming*). One is to minimize legal and financial liabilities associated with poor environmental performance by its subsidiaries: through more explicit procedures for environmental management and associated accountability, firms may prevent accidents and better understand the potential legal risks they face. A firm may be harmed by poor environmental behavior of its subsidiaries and may therefore seek a unified strategy to reduce current and potential risks. Second, a company may mandate EMSs by its subsidiaries in order to protect or improve its image, reputation, and brand value. Adoption and certification of EMSs may be a means for presenting an image to the external world of the company's commitment to good environmental management practices, whether or not this image in fact represents better performance than that of other comparable firms (Darnall 2002). Third, the increasingly widespread geographic distribution of manufacturing sites, which has coincided with the globalization of manufacturing, has increased the need for greater standardization of practices. Firms that use standard operating procedures throughout their global operations – including standardization of environmental management practices – may improve both communication and overall efficiency, both of which may improve financial performance by reducing costs and minimizing waste.

Firms may extend such requirements to suppliers and business partners for similar reasons. In an increasingly global economy, where firms often subcontract manufacturing functions to a geographically disperse network of suppliers, firms face a host of challenges. First, corporations in some sectors face shared threats to their reputations, which are addressed by creating sector-wide standards to which members must adhere (Kollman and Prakash 2002), or "lead industry regulation" to influence the practices of suppliers or customers whose behavior may affect their own reputations or liabilities (Nash 2002). Second, large brand-visible firms may choose to have their more anonymous suppliers adopt formal sets of practices and/or codes of conduct in an effort to protect their brand image and reputation from harm caused by potential environmental or human rights abuses down the value chain (Gereffi et al. 2001, Klein 1999). Finally, the adoption of standardized practices by suppliers may result in increased efficiencies, cost reductions, and even innovations whose benefits which can then be shared with lead firms (Geffen and Rothenberg 2000, Corbett 2002). In essence, firms seek to reap the same benefits from their suppliers as they expect from their own subsidiaries.

How effectively those who are subject to requirements from corporate parents and customers respond to mandates is still untested. While some evidence suggests that mandates are motivating suppliers to adopt formal EMSs, many for the first time (Hutson 2001), no systematic studies have been conducted on mandates to adopt EMS, nor on the resulting effectiveness of such mandates in inducing environmental performance improvements. The possibility exists that EMSs, which are touted as efforts to "regulate from the inside," may in practice be perceived more like traditional regulatory mandates by governments (which "regulate from the outside") when they are imposed on suppliers and business partners. Even though facilities can choose how to adopt the systems, and are not constrained by strict performance targets, they may choose to adopt the system simply as a paperwork burden, or do so in the most limited form necessary to meet the requirements. Alternatively, it is also possible that facilities which adopt environmental management practices under pressure may do a more thorough job of implementation, as they perceive that doing so is a precondition of their contractual relationships; or that having initially adopted the EMS only because of a mandate, they may subsequently discover that it has unanticipated benefits to them.

DATA AND MEASURES

Data

The data used in this analysis were collected through a survey of plant managers from a random sample of manufacturing facilities in four U.S. industrial sectors: Motor Vehicles Parts and Accessories (SIC 3714), Chemicals and Chemical Preparations (SIC 2899), Plastic Products (SIC 3089) and Coating, Engraving, and Allied Services (SIC 3479). These sectors were chosen to include a high number of certified environmental management systems, strong supplier relationships to the automotive sector (which has mandated supplier EMSs), and significant environmental impacts based on EPA's Toxics Release Inventory (TRI) data. The sample included facilities that had adopted EMSs with and without external pressures or incentives to do so, as well as controls that had not adopted formal EMSs at all. From our original sample we discarded approximately 500 due to facility closures, re-location and incorrect mailing addresses, and sent the survey to plant managers of over 3,200 facilities. From these we received 617 responses, a response rate of 20%, well distributed among the industries sampled.[6] For each facility, the survey requested information on current environmental management objectives and activities, specific motivations or requirements to develop an EMS, and changes in environmental performance indicators (EPIs) and other benefits that the respondents had observed as a result of environmental management activities. Plant managers were the target respondents.

Dependent Variables

The study used two primary groups of dependent variables, as reported by the respondents: changes in seventeen environmental performance indicators, and ten categories of management and market benefits (figure 1). Facility responses indicated whether environmental indicators increased, decreased or were unchanged during the past three years, corresponding roughly to

[6] A response rate of 19.56% was achieved after accounting for facility closures, re-location and incorrect mailing addresses.

2000 thru 2002.[7] The respondents similarly indicated the significance of management and market benefits realized due to the adoption of environmental management activities, on a scale ranging from 'no benefits' to 'high benefits.' [8]

Figure 1: EPI and Management Benefits Examined

EPIs	Management Benefits
• Water use	• Cost savings in terms of inputs or taxes
• Energy use	• Avoidance of non-compliance penalties
• Recycled inputs	• Increase in productivity
• Recycling of waste	• Increase in market share
• Chemical inputs per unit output	• Ability to reach new markets
• Total material inputs	• Product differentiation
• Hazardous waste generation	• Improved company/plant image
• Non-hazardous solid waste generation	• Improved access to capital markets
• Wastewater effluent	• Improved competitive advantage
• Air pollution emissions	• Improved management efficiencies
• Greenhouse gas emissions	
• Noise generation	
• Smell generation	
• Disruption of the natural landscape	
• Soil contamination	
• Severe leaks or spills	
• Legal violations or potential violations	

Independent Variables

Three primary independent variables were used to explain environmental performance outcomes and management benefits: the degree to which environmental practices and activities were formalized at the facility level, the relative priorities each facility placed on particular objectives for their environmental practices, and the existence of external market pressures to adopt an environmental management system. (For a detailed description of measures see Appendix I).

Control Variables

The study also included two types of control variables in the analysis to account for other sources of variability in performance outcomes. The first included *endogenous* resources and capabilities that might influence environmental performance outcomes, such as prior management systems or cultural norms of the organization. The second category included *exogenous* factors, such as industrial sector and regulatory pressures, which have the potential to alter environmental results at the facility level. (For detail on control variables see Appendix II).

[7] Facilities were given the option to indicate that the listed indicator either was not tracked by the facility or was not applicable to site operations.

[8] Additional tests using TRI data as dependent variables measuring environmental performance change are still in progress.

METHODS AND RESULTS

Models

This study used a binomial logistic regression model to investigate the effects of the variables of interest on resulting environmental performance and management benefits. This model applies a maximum likelihood estimation technique to estimate the likelihood of a certain outcome.

The model takes the linear form:

$$z = \alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k$$

While the parameter estimates produced by this method are not necessarily intuitively meaningful, the regression coefficients can be transformed to show either the percent change in the odds of the outcome's occurrence per a one unit change in the independent variable or the percent change in probability in the outcome's occurrence at the margin for the mean probability given a one unit change in the independent variable. Both transformations are useful in understanding the effects of our independent variables on environmental performance and management benefit outcomes. However, the former transformation allows us to generalize the impact of the independent variables on the likelihood that improved environmental performance is reported without assumptions about mean probability that such improvements will occur. In contrast, the latter transformation is dependent on the sample mean for each dependent variable of interest.

For the seventeen EPIs and ten management benefits as well as a comparison of overall benefit or cost of environmental practices, the models take the following general form: [9]

$$\text{Log } p(epi_k) = \alpha + \beta_1(\text{EMS formalization}) + \beta_2(\text{system objectives})_i + \beta_3(\text{business mandate})_i + \beta_4(\text{attitude}) + \beta_5(\text{involvement}) + \beta_5(\text{time}) + \beta_6(\text{size}) + \beta_7(\text{industry})_i + \beta_8(\text{ownership}) + \beta_9(\text{resources}) + \beta_{10}(\text{capabilities})_i + \beta_{11}(\text{location})_i + \beta_{12}(\text{regulatory pressure})_i$$

$$\text{Log } p(benefit_k) = \alpha + \beta_1(\text{EMS formalization}) + \beta_2(\text{system objectives})_i + \beta_3(\text{business mandate})_i + \beta_4(\text{attitude}) + \beta_5(\text{involvement}) + \beta_5(\text{time}) + \beta_6(\text{size}) + \beta_7(\text{industry})_i + \beta_8(\text{ownership}) + \beta_9(\text{resources}) + \beta_{10}(\text{capabilities})_i + \beta_{11}(\text{environmental performance})_i$$

The model results for each of the seventeen (17) self-reported EPIs are shown in Tables 1 and 2.[10] The model results for each of the ten management benefits are shown in Tables 3 and 4. The Wald chi-square statistic is presented for each model along with a Max-rescaled R-Square statistic. The parameter coefficient is reported along with a point estimate of its effect on the odds that improved environmental performance was reported along with the standard error of the parameter coefficient.

[9] The model presented below is a generalized model. Slightly different specifications were used for some classes of management benefits. See Tables 3 and 4 as well as Figure 5 in Appendix II for more detail.

[10] The models for four EPIs – greenhouse gas emissions, disruption of the natural landscape, soil contamination and noise generation – did not produce statistically significant results and are not included in the referenced tables.

Table 1: Logistic Regression Results for Self-Reported Environmental Performance Changes: Regulated and Quasi-Regulated Indicators

EPI Model	Hazardous Waste			Air Pollution			Wastewtr Effluent			Spills			Violations		
Chi Square		**50.84****			**52.65****			**48.37****			**47.66****			**46.70****	
R2		**0.19**			**0.27**			**0.19**			**0.25**			**0.16**	
n		**429**			**348**			**393**			**344**			**376**	
	Parameter Estimate	Point Estimate	S.E.	Parameter Estimate	Point Estimate	S.E.	Parameter Estimate	Point Estimate	S.E.	Parameter Estimate	Point Estimate	S.E.	Parameter Estimate	Point Estimate	S.E.
Variables of Interest															
EMS Practices Formalization													0.30**	1.35	0.16
Customer Mandate															
Corporate Mandate															
Both B2B Mandates															
Compliance Goals	-0.32**	0.73	0.14							0.31*	1.36	0.18	0.32**	1.38	0.16
Pollution Prevention Goals													0.23*	1.26	0.12
Eco-Efficiency Goals	0.20*	1.22	0.11												
Product Stewardship Goals	0.27**	1.31	0.12	0.22*	1.25	0.13									
Endogenous Controls															
Other Plans															
Quality Management Systems							0.60*	1.82	0.34						
Attitude Toward Env. Mgmt															
Employee Involvement				0.17*	1.11	0.07									
Time with Formal EMS	0.14*	1.13	0.07												
Exogenous Controls															
Auto Supply Sector				0.91*	2.49	0.42									
Plastics Sector				1.02**	2.77	0.40	-0.71*	0.49	0.37	-1.01***	0.36	0.38			
Coatings Sector										-1.56***	0.21	0.41			
Private Ownership				-0.76**	0.47	0.31	-.055**	0.58	0.28						
Recent Inspections+				0.31***	1.36	0.09	0.02*	1.02	0.01						
Recent Non-Compliance+	0.03*	1.03	0.02										0.04***	1.04	0.01
Recent Fines+															
Region 1															
Region 2															
Region 3							-1.08*	0.34	0.56	-1.20**	0.30	0.61			
Region 4	-1.25***	0.29	0.47	-0.92*	0.40	0.54									
Region 5	0.89**	0.41	0.46												
Region 7	-1.60***	0.20	0.58												
Region 8															
Region 9										1.20**	3.31	0.62			
Region 10															
Facility Size+															

*p ≤ 0.10, ** p ≤ 0.05, *** p ≤ 0.01, + see Appendix II for discussion of variable construction

Table 2: Regression Results for Self-Reported Environmental Performance Changes: Non-Regulated Indicators

EPI Model	Water			Energy			Recycled Inputs			Recycled Waste			Chemical Use			Material Use			Smell			Non-Hazardous Waste		
Chi Square		**58.85*** **			**52.13** **			**61.56*** **			**57.97*** **			**44.17***			**47.78***			**46.25** **			**59.12*** **	
R2		**0.22**			**0.17**			**0.27**			**0.20**			**0.17**			**0.16**			**0.28**			**0.20**	
n		**445**			**462**			**382**			**449**			**399**			**415**			**279**			**465**	
	Parameter Estimate	Point Estimate	S.E.	Parameter Estimate	Point Estimate	S.E.	Parameter Estimate	Point Estimate	S.E.	Parameter Estimate	Point Estimate	S.E.	Parameter Estimate	Point Estimate	S.E.	Parameter Estimate	Point Estimate	S.E.	Parameter Estimate	Point Estimate	S.E.	Parameter Estimate	Point Estimate	S.E.
Variables of Interest																								
EMS Practices Formalization							0.36**	1.43	0.16	0.34**	1.40	0.15												
Customer Mandate																								
Corporate Mandate	-0.61*	0.54	0.36																					
Both B2B Mandates													-0.85**	0.43	0.35									
Compliance Goals							-0.37**	0.69	0.17	-0.31**	0.73	0.15							0.44*	1.55	0.26	-0.36***	0.70	0.14
Pollution Prevention Goals																								
Eco-Efficiency Goals				0.34**	1.41	0.11	0.40***	1.49	0.13	0.32***	1.38	0.12				0.22*	1.25	0.13				0.29***	1.34	0.11
Product Stewardship Goals																			0.31**	1.37	0.16			
Endogenous Controls																								
Other Plans	0.78*	2.17	0.37				1.17***	3.22	0.45	1.12***	3.07	0.36										0.70*	2.02	0.37
Quality Management Systems	0.63**	1.88	0.33	0.57*	1.77	0.31							0.60*	1.82	0.32									
Attitude Toward Env. Mgmt																								
Employee Involvement													0.10*	1.11	0.06	0.16**	1.17	0.06						
Time with Formal EMS																			0.17*	1.19	0.10			
Exogenous Controls																								
Auto Supply Sector	0.81**	2.25	0.36	0.81**	2.25	0.35	-0.78**	0.46	0.46				1.12***	3.06	0.37	1.34***	3.82	0.39	-1.08**	0.34	0.52			
Plastics Sector	-0.57*	0.56	0.35				-0.79**	0.46	0.37															
Coatings Sector							-1.00***	0.36	0.36				0.92***	2.51	0.36							-0.71**	0.49	0.32
Private Ownership																								
Recent Inspections+				0.26**	1.01	0.01										0.04*	1.04	0.02						
Recent Non-Compliance+																						0.04***	1.04	0.01
Recent Fines+																0.00*	1.00	0.00						
Region 1				1.22*	3.39	0.66																		
Region 2	1.44**	4.21	0.63																					
Region 3																								
Region 4							1.03**	2.81	0.48	0.98**	2.67	0.43				-0.82*	0.44	0.47						
Region 5	0.97**	2.56	0.43																			0.67*	1.96	0.40
Region 7																								
Region 8																								
Region 9													0.88*	2.40	0.52									
Region 10													1.62**	5.07	0.77				1.96*	7.08	1.16	1.84**	6.30	0.77
Facility Size+							0.39***	1.48	0.11							-0.26**	0.77	0.11	0.33**	1.39	0.14			

*p ≤ 0.10, ** p ≤ 0.05, *** p ≤ 0.01, + see Appendix II for discussion of variable construction

Table 3: Regression Results for Self-Reported *Internal* Management Benefits[11]

Management Benefits Model	Cost-Benefit			Inputs			Penalities			Productivity			Mgmt Efficiency			Comp Advantage		
Chi Square		**35.20****			**49.67*****			**31.09***			**52.71*****			**59.09*****			**88.75*****	
R2		**0.10**			**0.18**			**0.27**			**0.17**			**0.21**			**0.32**	
n		**491**			**434**			**293**			**485**			**465**			**480**	
	Parameter Estimate	Point Estimate	S.E.	Parameter Estimate	Point Estimate	S.E.	Parameter Estimate	Point Estimate	S.E.	Parameter Estimate	Point Estimate	S.E.	Parameter Estimate	Point Estimate	S.E.	Parameter Estimate	Point Estimate	S.E.
Variables of Interest																		
EMS Practices Formalization	0.29**	1.33	0.14										0.37**	1.45	0.18	1.05***	2.85	0.27
Customer Mandate				1.23***	3.44	0.42				0.65*	1.92	0.40				0.86**	2.37	0.42
Corporate Mandate																		
Both B2B Mandates				0.70**	2.02	0.33												
Compliance Goals																		
Pollution Prevention Goals				0.19**	1.24	0.11												
Eco-Efficiency Goals				0.27**	1.30	0.11							0.23**	1.26	0.12	0.25**	1.28	0.11
Product Stewardship Goals										0.27***	1.31	0.11				0.62***	1.85	0.12
Endogenous Controls																		
Other Plans																		
Quality Management Systems	0.65**	1.91	0.27															
Attitude Toward Env. Mgmt																		
Employee Involvement										0.17***	1.19	0.05						
Existence of Parent Org.	0.58**	1.79	0.27										0.58*	1.79	0.34			
Time with Formal EMS																		
Environmental Performance+				1.27***	3.57	0.37	1.37***	3.92	0.55									
Exogenous Controls																		
Auto Supply Sector				-0.59*	0.55	0.33	1.03*	2.80	0.62									
Plastics Sector							2.35	10.45	0.87	-0.53*	0.59	0.31						
Coatings Sector							1.43	4.17	0.69									
Private Ownership																0.60**	1.82	0.27
Recent Inspections+																		
Recent Non-Compliance+																		
Recent Fines+																		
Region 1																		
Region 2																		
Region 3																		
Region 4																		
Region 5																		
Region 7																		
Region 8																		
Region 9																		
Region 10																		
Facility Size+							-0.39**	0.68	0.18									

*p ≤ 0.10, ** p ≤ 0.05, *** p ≤ 0.01, + see Appendix II for discussion of variable construction

[11] Individual variables that were not included within each respective model are marked in solid black.

Table 4: Regression Results for Self-Reported *External* Management Benefits[12]

Management Benefits Model	Market Share			New Markets			Product Differentation			Plant Image			Capital Access		
Chi Square		**79.58*** **			**89.43*** **			**70.74*** **			**39.14** **			**44.78*** **	
R2		**0.28**			**0.32**			**0.26**			**0.38**			**0.23**	
n		**463**			**468**			**439**			**177**			**306**	
	Parameter Estimate	Point Estimate	S.E.	Parameter Estimate	Point Estimate	S.E.	Parameter Estimate	Point Estimate	S.E.	Parameter Estimate	Point Estimate	S.E.	Parameter Estimate	Point Estimate	S.E.
Variables of Interest															
EMS Practices Formalization				0.54**	1.72	0.27									
Customer Mandate	1.21***	3.37	0.44	0.77*	2.16	0.42									
Corporate Mandate				-0.96**	0.38	0.41									
Both B2B Mandates	0.86**	2.36	0.36	0.61*	1.84	0.34									
Compliance Goals				-0.29**	0.75	0.14									
Pollution Prevention Goals	0.40***	1.49	0.12	0.31***	1.36	0.12	0.30***	1.35	0.12						
Eco-Efficiency Goals															
Product Stewardship Goals	0.43***	1.53	0.12	0.44***	1.55	0.11	0.58***	1.80	0.12				0.63***	1.88	0.15
Endogenous Controls															
Other Plans							0.71*	2.04	0.41	1.97**	7.16	0.84			
Quality Management Systems													0.84**	2.32	0.44
Attitude Toward Env. Mgmt															
Employee Involvement															
Existence of Parent Org.										2.02*	7.58	1.07			
Time with Formal EMS	-0.16**	0.85	0.07	-0.14*	0.87	0.07									
Environmental Performance+										2.17**	8.75	0.95			
Exogenous Controls															
Auto Supply Sector															
Plastics Sector				0.59*	1.81	0.33									
Coatings Sector	0.71**	2.03	0.35	1.05***	2.86	0.34							0.71*	2.03	0.39
Private Ownership															
Recent Inspections+															
Recent Non-Compliance+															
Recent Fines+															
Region 1															
Region 2															
Region 3															
Region 4															
Region 5															
Region 7															
Region 8															
Region 9															
Region 10															
Facility Size+															

*p $\leq$ 0.10, ** p $\leq$ 0.05, *** p $\leq$ 0.01, + see Appendix II for discussion of variable construction

[12] Individual variables that were not included within each respective model are marked in solid black.

Results

Environmental Performance

The formalization of EMS practices was a significant predictor of improved environmental performance for only three of thirteen environmental indicators. Facilities that had adopted a *formal EMS* or *ISO 14001 equivalent EMS* were significantly more likely to report increases in recycling of waste (86 percent), in use of recycled inputs (80 percent), and in reductions in regulatory violations (70 percent), than were those with less formalized environmental management practices. However, the formalization of environmental management practices had no significant associations with other important environmental performance indicators, such as air and water quality, hazardous and non-hazardous waste generation, material and energy inputs, or even control of spills. The proportions of facilities reporting improvement in each EPI are presented in Table 5.

The presence or absence of a formal mandate to adopt an EMS, either from a facility's corporate headquarters or from a customer, did not appear to have any significant influence on its environmental performance. The only indicator for which a mandate variable appeared to predict a change in environmental performance was chemical use, for which facilities with both a customer and corporate mandate were less likely (57 percent) to report improvement. Without any plausible rationale or additional evidence to explain this result, we are inclined to dismiss it as spurious.

However, the priority each facility placed on particular goals of their environmental management activities (compliance, eco-efficiency, or product stewardship) was a broadly significant indicator of performance improvements. Facilities that placed emphasis on compliance-centered goals were significantly more likely to report improvements in reducing violations (38 percent), spills (36 percent), and smells (55 percent), but were significantly less likely to report improvements in hazardous and non-hazardous waste management (27 and 30 percent, respectively), recycling of wastes (27 percent) and use of recycled inputs (31 percent). Conversely, facilities that placed emphasis on eco-efficiency goals were significantly more likely to report improvements in recycling and use of recycled inputs (38 and 49 percent, respectively), in energy and materials use (41 and 25 percent, respectively), and in hazardous and non-hazardous waste generation (22 and 34 percent, respectively). However, similar improvements were not reported for water or chemicals use. Finally, facilities that placed emphasis on product stewardship were significantly more likely than others to report improvements in hazardous waste generation (31 percent), in air quality (25 percent), and in smells (37 percent), though not in other indicators.

A second variable that was broadly and significantly associated with patterns of environmental performance improvement was the presence of a formal pollution-prevention or waste-minimization plan. Facilities that had such plans were significantly more likely to report improvements in recycling (207 percent), in use of recycled inputs (222 percent), in water use (117 percent), and in non-hazardous waste generation (102 percent).

Table 5: Reporting of Improved EPI Performance

Environmental Performance Indicator	Improved	Not Improved	Not Applicable	No Response	Total	n
» Water use	0.38	0.49	0.12	0.01	100%	617
» Energy use	0.37	0.53	0.08	0.02	100%	617
» Recycled inputs	0.37	0.35	0.24	0.03	100%	617
» Recycling of waste	0.35	0.51	0.12	0.02	100%	617
» Chemical inputs per unit output	0.36	0.41	0.20	0.03	100%	617
» Total material inputs	0.28	0.52	0.15	0.05	100%	617
» Hazardous waste generation	0.58	0.33	0.08	0.02	100%	617
» Non-hazardous solid waste generation	0.43	0.48	0.07	0.02	100%	617
» Wastewater effluent	0.35	0.41	0.21	0.02	100%	617
» Air pollution emissions	0.49	0.42	0.07	0.02	100%	617
» Smell generation	0.20	0.35	0.43	0.02	100%	617
» Severe leaks or spills	0.32	0.33	0.33	0.01	100%	617
» Legal violations or potential violations	0.30	0.41	0.27	0.02	100%	617

Recent inspections and non-compliances appeared to have a positive impact on environmental performance for the most heavily regulated indicators, though not for others. For example, facilities that had experienced recent inspections were significantly more likely to report improvements in air pollutant emissions (36 percent), energy use (1 percent), reductions in materials use (4 percent), and wastewater effluent (2 percent). Facilities that had recently identified non-compliances were significantly more likely to report improvements in non-hazardous waste generation (4 percent), in reducing violations (4 percent), and in hazardous waste generation (3 percent).

Several other factors appeared to be associated with performance changes as well. The greater the involvement of a broad range of employees in environmental management activities, the more likely it was that changes would be reported in some of the outcomes that were harder to achieve, such as reduction of material use, reduction of chemical use, and air quality. For example, we could predict that if a facility involved all site employees and other interested parties the likelihood of reducing materials used in production might increase by 270 percent. However, because these findings lacked consistent statistical support across other logically similar input variables, we are inclined not to place too much emphasis on this finding.

Interestingly, the attitudes of the responding managers toward environmental issues appeared to have no significant effects on any of the environmental performance indicators. This finding stands in contrast to other studies that have found positive attitudes about environmental management to be significant drivers of environmental performance improvements (see e.g. Kagan, 2004 *forthcoming*).

The presence of formal quality management systems was significantly associated with an increased likelihood of reducing wastewater effluent (82 percent), as well as water use (88 percent), chemical use (82 percent) and energy use (77 percent). However, in most of these cases (with water use as the exception) such findings were present only at the significance level of

p=0.10. While these effects are not statistically striking, the convergence is worthy of comment. Input variables such as chemical, water and material use may be affected by quality management initiatives that seek to limit waste and increase efficiency.

The single most systematically influential predictor seen in the data was the greater improvement of firms in the auto supply sector compared to the chemicals sector. Facilities in the auto supply industry were nearly 150 percent more likely to report improvements in air pollutant emissions than were chemicals firms and 100-200 percent more likely to report improvements in use of most production inputs including material inputs, chemical, water, and energy use. Only in the use of recycled inputs and in smell generation were auto supply firms significantly less likely than chemical plants to have improved (54 and 66 percent, respectively). Facilities in the plastics industry were also more likely than the chemical industry during the period of this study to improve their air pollution emissions (177 percent), although they were less likely than chemical firms to reduce spills (64 percent) and to increase the use of recycled inputs (54 percent).

Finally, we note several strong regional associations that deserve further investigation and explanation. Facilities in EPA Region 10 (Pacific Northwest) were more than 500 percent more likely to reduce non-hazardous waste generation and over 400 percent more likely to reduce chemical use than did firms in the base region (Region 6, the south central states). Facilities in Region 5 (Great Lakes) and those in Region 2 (New York/New Jersey) showed disproportional improvement in water use (156 and 321 percent, respectively), and those in Region 4 (Southeast) showed disproportional improvement in recycling (167 percent) and use of recycled inputs (181 percent). Several other regions showed significantly less improvement in some outcomes than the base region. Whether these differences reflect differences in regional policies and priorities of EPA itself, or in the industrial mix or other exogenous influences in those regions, they suggest regional patterns or influences that deserve further investigation.

Management Benefits

The formalization of environmental management activities by facilities also appeared to be a significant predictor of some management benefits. Overall, facilities with formalized environmental management practices in place were more likely to report the benefits of those activities as greater than the costs (33 percent) than those with less formalized activities. These facilities also were more likely to report increased management efficiencies (45 percent) and improved access to new markets (72 percent), and were much more likely to report improved competitive advantage (285 percent) associated with their environmental management activities. Table 6 shows the proportion of facilities reporting some benefits for each investigated activity.

The presence of business-to-business mandates also appeared to be a significant predictor of some management outcomes. However, some important distinctions must be made regarding the *type* of business-to-business mandate to which a facility is subject. Facilities subject to an EMS mandate from their corporate parent were not more likely to report any management benefits, and in fact were less likely (62 percent) to report improved access to new markets. Conversely, facilities subject to a customer requirement to adopt a formal EMS were not only more likely to report several management benefits, but were *much* more likely to do so for some such benefits. For example, facilities subject to a customer mandate were more likely to report increased

savings from inputs and taxes (244 percent), increased productivity (92 percent), increased market share (237 percent), improved competitive advantage (137 percent), and improved access to new markets (116 percent).

Table 6: Reporting of Management Benefits

Management Activity	Benefit	No Benefit	Not Applicable	No Response	Total	n
» Cost savings in terms of inputs or taxes	0.40	0.40	0.16	0.04	100%	617
» Avoidance of non-compliance penalties	0.77	0.12	0.08	0.03	100%	617
» Increase in productivity	0.51	0.37	0.09	0.03	100%	617
» Increase in market share	0.32	0.51	0.13	0.03	100%	617
» Ability to reach new markets	0.37	0.47	0.12	0.04	100%	617
» Product differentiation	0.28	0.51	0.18	0.03	100%	617
» Improved company/plant image	0.79	0.13	0.05	0.03	100%	617
» Improved access to capital markets	0.26	0.51	0.19	0.03	100%	617
» Improved competitive advantage	0.47	0.40	0.10	0.03	100%	617
» Improved management efficiencies	0.68	0.22	0.07	0.03	100%	617

As with environmental performance, the priority each facility placed on specific goals of their environmental management activities (compliance, pollution prevention, eco-efficiency or product stewardship) was a significant predictor of the management benefits facilities reported. Facilities whose activities focused on pollution prevention activities were more likely to report cost savings in terms of inputs and taxes (24 percent), increased market share (49 percent), improved access to new markets (36 percent), and product differentiation (35 percent). Facilities whose activities centered on eco-efficiency goals were more likely to report cost savings from inputs and taxes (30 percent), improved management efficiency (26 percent), and improved competitive advantage (28 percent) stemming from their environmental management activities. Facilities that focused on product stewardship goals reported the widest range of benefits, with such facilities more likely to report benefits from increased productivity (31 percent), increased market share (53 percent), access to new markets (55 percent), product differentiation (80 percent), access to capital (88 percent), and competitive advantage (85 percent). The only management benefits that such facilities were not more likely to report were cost savings from inputs and taxes, avoidance of non-compliance penalties, and improved image.

While the goal of a facility's EMS was an important predictor of an increased likelihood of reporting management benefits, the value of focusing specifically on a regulatory compliance goal was less impressive. Facilities that emphasized regulatory compliance as their EMS goal were no more likely than others to report *any* management benefits from their environmental management activities. In fact, such facilities were *less* likely to report improved access to new markets (25 percent). However, facilities that had a recent legal violation were more likely to report benefits from avoidance of non-compliance penalties (292 percent) and improved company or plant image (775 percent). Additionally, facilities with a parent organization, and those with a waste minimization or pollution prevention plan in place, were much more likely to report improved image benefits from their environmental management activities (658 percent and 616 percent, respectively).

FINDINGS AND IMPLICATIONS

The results of this study offer new insights into the roles that environmental management systems play in improving environmental performance, and into their potential for management benefits to facilities that adopt them.

Finding: One should not expect to see substantial changes in environmental performance simply because a facility adopts a formal EMS.

The most evident changes in environmental performance associated with EMS adoption were changes in relatively marginal practices at the day-to-day operating level. These changes did not extend to other impacts, such as air and water pollution, that might require more significant changes in technologies and capital investments. In short, it appears that the kinds of improvements that were most often reported in association with formalized EMSs were those that were easiest and cheapest to improve at the margin in day-to-day operations at the facility level ("better housekeeping," for instance), whereas those less often reported as improved were those that would require more significant changes in actual production technologies and processes (and perhaps, therefore, more significant capital investments, and approval from decision makers located outside the individual manufacturing facility).

Finding: Specific goals for improvement, rather than simple EMS adoption, appear to be a better predictor of the success of environmental management activities.

The specific goals of environmental management practices appear to be much better predictors of performance improvements than mere presence of a formalized environmental management system. Our results suggest strongly that improvements in environmental performance indicators stem not from adoption of environmental management systems per se, but instead from adoption of specific objectives aimed at correcting impacts of particular manufacturing processes or products. Facilities that focused their environmental management efforts on areas such as eco-efficiency and pollution prevention tended to report improvements in EPIs which reflected those goals. Improvements reported by facilities with formal pollution prevention and waste minimization plans in place (in addition to EMSs) add further support for this conclusion, as such facilities were much more likely to report improvements in EPIs that these plans targeted. For environmental regulatory agencies and the interested public as well as other potential adopters, these findings suggest strongly that attention and any rewards or recognition should focus on the specific environmental performance improvements targeted as priority objectives in the EMS, and on the facility's success in achieving them, not merely on the adoption of an EMS per se.

Finding: Environmental regulation plays an important role in promoting improved environmental performance.

Whatever the benefits of voluntary initiatives such as adoption of an environmental management system, government regulation continues to play an important role in environmental performance improvements. Indicators that were regulated and inspected regularly showed greater

improvements than those that were not. For instance, recent inspections were strongly associated with improvements in air pollution; this association was expectable and even reassuring, since air pollutant emissions are arguably the most systematically monitored and inspected indicator of environmental performance (water pollution is monitored more variably, and primarily by the states rather than EPA). Facilities with recent non-compliances, or potential non-compliances, were also more likely to report improvements in hazardous waste generation and reduced violations: these too are understandable and reassuring results, since hazardous waste management is an area of high potential economic liability to the facility if non-compliances should be discovered on inspection and cited as formal violations.

Reductions in regulatory violations and non-compliances are not by themselves a surprising result, given prior research on the impact of formalized environmental management techniques (Andrews et al. 2003), and they reinforce the importance of regulation in promoting environmental performance improvements when used in conjunction with voluntary "beyond compliance" measures such as EMS adoption. But perhaps paradoxically, facilities that emphasized compliance as a primary goal of their environmental management activities were less likely to report either the additional environmental performance improvements or the management benefits that facilities with other goals reported. While a compliance-focused EMS may well have helped to reduce regulatory violations, it did not appear to promote improvements in beyond-compliance environmental performance measures such as eco-efficiency or product stewardship. Further, facilities that designed their EMSs with multiple environmental performance objectives that spanned all four areas (compliance, pollution prevention, eco-efficiency and product stewardship) had greater potential to accrue a suite of separate benefits associated with each category.

Finding: The accumulation of management-related benefits also is associated more with specific management goals than with EMS adoption.

Facilities with formal EMSs in place were more likely to report a number of management benefits, but the specific goal of a facility's environmental activities was a much better predictor of what kinds of management benefits a facility could expect to achieve than was the mere presence of an EMS. Those facilities that focused their activities on pollution prevention goals were more likely to report more *external* benefits (such as market share, access to new markets, and product differentiation) than *internal* benefits (such as cost savings from inputs and taxes). Conversely, facilities with a focus on eco-efficiency were more likely to report more *internal* benefits (including cost savings and improved management efficiencies) than *external* benefits (though such facilities were more likely to report increased competitive advantage, which can be thought of as both an internal and external benefit). Facilities with a focus on product stewardship were more likely to report a broad array of both internal and external benefits, and more likely in general to report a greater number of management benefits, than facilities with other priorities for their environmental activities. Such findings suggest that facilities with "higher-order" environmental objectives, such as product stewardship, may achieve greater management benefits as well (see Appendix I for discussion of "higher-order" environmental objectives).

The finding that facilities with a compliance focus were less likely to report management benefits reveals an important additional point. Facilities that limit themselves to achieving legal compliance, instead of broadening the scope of their activities to include more advanced practices and to integrate environmental management with other management practices and objectives, may be missing fundamental opportunities to extract additional value from their investments in such activities.

Sectoral differences, where automotive parts manufacturers were more likely to report environmental performance improvements compared with the chemical industry, may reflect technological and historical differences that deserve further investigation and comparative study. In the chemical industry, end products are highly resource dependent: nearly all inputs (chemical and otherwise) are potential product. Over the past two decades, the chemical industry has been much more proactive in the adoption of systematic environmental management practices. Since the Bhopal disaster of the mid-1980s and the subsequent introduction of the Responsible Care© initiative a decade ago, many within the chemical sector may already have gone through a period of intensive environmental management improvement, a process which auto supply facilities are just now beginning to experience.

Finding: Business-to-business mandates offer limited potential to promote environmental protection.

Facilities that were required to adopt environmental management activities by a customer, corporate parent, or both, were no more likely to report performance changes than those who were not subject to such requirements. On its face, this result appears to lend little support to advocates of systematic efforts by the private sector to issue mandates in order to promote environmental protection. However, if these mandates serve as an impetus for EMS adoption by facilities that otherwise would have no such formalized practices in place, they may nonetheless spur performance improvements if the resulting systems are designed correctly. That is, if the EMSs that emerge in these facilities place emphasis on specific performance-related goals such as eco-efficiency, pollution prevention, and product stewardship, and not simply on adoption of EMS procedures, then explicit requirements may nonetheless lead to eventual performance improvements.

Finding: Private sector mandates may lead to management benefits, depending on who issues the mandate.

While mandates did not appear to affect environmental performance, customer mandates, at least, did appear to affect management benefits. Facilities subject to corporate mandates were not more likely to report management benefits in any category, but those subject to customer mandates were more likely to report benefits, of multiple types.

Two possible reasons might account for the absence of reported management benefits associated with corporate mandates. First, facilities subject to corporate mandates might have been subject to stricter environmental management regimes prior to the mandate, as larger corporations have been ahead of the curve in this regard, and may thus have been less likely to experience additional improvements in internal management benefits. In checking this possibility, however,

we determined that while facilities with corporate mandates were more likely to have a pollution prevention plan already in place – thus suggesting the existence of a previously-developed environmental management regime – they were no more likely to have a pre-existing waste management plan, total quality management plan, or ISO 9000 certification, and when these proxies were combined there was no difference. Second, it is possible that corporate subsidiaries market their products primarily through their parent corporations (or through higher-level business units within them) rather than directly to outside markets, and thus may be less likely than non-subsidiaries to experience changes in external benefits such as increased market share or access to new markets, which are primarily the concern of those at the corporate level. The corporation as a whole may well receive benefits from company-wide adoption, but these may not be as directly salient at the facility level. This possibility requires further investigation of the extent of subsidiary independence in marketing and other decision-making.

Facilities subject to customer mandates, conversely, might perceive internal benefits as being greater because for many these efforts might be their first foray into formal environmental management, or might at least represent a greater step forward. Many auto suppliers subject to automotive mandates to adopt ISO 14001, for instance, have had no formal system in place prior to those mandates (Hutson 2001). However, our data do not appear to show that facilities with customer mandates were less likely to have had pre-existing pollution-prevention or waste management plans, which could provide proxies for the presence of prior environmental management activities. Customer-mandated facilities might also report external benefits more frequently because unlike their counterparts who are corporate subsidiaries, they may be more likely to market their products to a variety of customers. In such cases, concerns about market share, competitive advantage, and plant/company image may be more salient at the facility level. This possibility also deserves further investigation.

CONCLUSION

Taken together, the findings we have presented in this paper point to three main conclusions for policy makers and business leaders.

First, broad environmental improvements should not be expected from the simple adoption of an EMS, either voluntarily or as a result of a business-to-business mandate (nor probably, by extension, in response to government rewards or other incentives). While adoption may be valuable as a tool for helping facilities to reduce regulatory violations, to better manage day-to-day activities such as recycling, and more generally to instill more explicit environmental management procedures and accountability, EMS adoption does not by itself lead to environmental performance improvements across a broader spectrum of performance indicators. Those interested in EMS as a tool for substantive improvement in environmental performance, such as reduced natural resource use or pollutant emissions, should concentrate instead on promoting specific performance improvements as EMS goals, and ensuring that these targets are achieved.

Second, the management benefits that facilities may gain from EMS adoption appear commensurate with their efforts to move beyond compliance and focus on "higher order"

environmental goals such as eco-efficiency and product stewardship. For the business community, such results suggest that a serious commitment to environmental performance improvements may have economic rewards. Moreover, facilities whose environmental objectives represent a broad array of performance goals may achieve a wider array of benefits, both environmental and management, than facilities whose objectives are more narrowly tailored.

Finally, voluntary efforts at self-regulation should be complements to, not substitutes for, more traditional environmental regulation and enforcement by state and federal agencies. While environmental management practices may in fact deliver environmental performance improvements, particularly toward goals that are specifically targeted for improvement, facilities that were subject to recent inspections were more likely to report such improvements in performance indicators that are subject to inspection. The persistence of traditional regulation may therefore facilitate the effectiveness of self-regulatory efforts.

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APPENDIX I: PRIMARY VARIABLES OF INTEREST

EMS Formalization

In order to determine the degree to which a formalized environmental management system (EMS) was in place, respondents were asked to identify specific practices in place at their facility. Responses were evaluated and coded on a three point scale to measure the degree of environmental activity formalization. Environmental management activity formalization is summarized in figure 2.

Figure 2: Environmental Management Activity Formalization

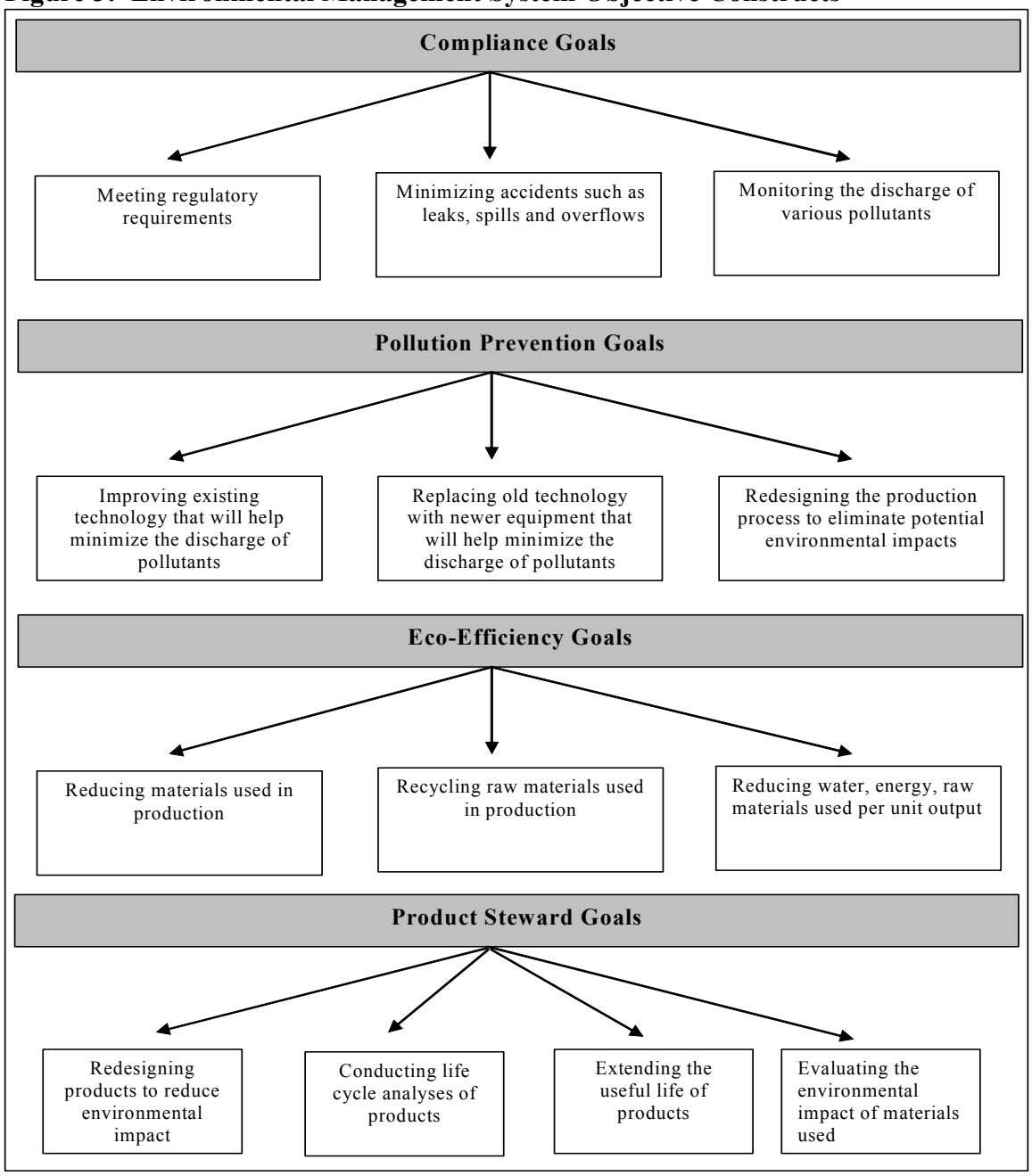
Environmental Activity:	**Formal EMS**	**ISO Equivalent EMS**
adopted a written statement of environmental policy goals.	✓	✓
set specific environmental performance objectives.	✓	✓
planned specific, measurable steps to meet environmental performance objectives.	✓	✓
has a single manager who has primary responsibility for environmental management activities.		✓
trains employees in specific activities related to environmental aspects of their jobs.	✓	✓
has a procedure in place for identifying legal requirements.	✓	✓
regularly tracks and manages environmental **compliance** indicators.	✓	✓
regularly tracks and manages environmental indicators **other than compliance.**		✓
makes some environmental performance data available to the public.		✓
makes results of environmental performance available to employees.	✓	✓
has a formal procedure for documenting environmental management practices.	✓	✓
has procedures in place for responding to environmental spills or accidents.	✓	✓
periodically conducts top management reviews of environmental performance.	✓	✓
conducts regular **internal** audits of environmental procedures or conducts regular **external** (3rd party) audits of environmental procedures	✓	✓

System Objectives

Facilities were asked to describe the priority placed on written objectives at the site in order to gain insight into what impact specific goals of environmental activities might have on subsequent environmental performance. Facilities rated twelve statements on a scale of 0 (no objective) to 4 (high priority), and were grouped into four categories of potential EMS focus based on their responses (Gallagher, 2002).[13] Figure 3 illustrates the relationships between these constructs and the survey questions.

[13] Gallagher (2002) argues that a facility's EMS goals move along a continuum from regulatory compliance toward environmental sustainability. Within this paradigm, facilities with less aggressive goals place a narrow focus on achieving compliance goals while more enterprising facilities place an emphasis on goals that are progressively centered on pollution prevention, conservation of raw materials (eco-efficiency), product design (product stewardship), and ultimately consideration of the facility's impact on environmental quality for future generations (sustainability). While our data cannot confirm or refute a nested, directional, and cumulative relationship among the concepts in this typology, this categorization of facility EMS goals appears consistent with our observations.

Figure 3: Environmental Management System Objective Constructs



Business to Business Mandates

Because many manufacturing facilities have recently made the decision to adopt a formal EMS in the context of industry pressures, respondents were asked to rate the impact of customer and/or corporate pressures on the decision of whether or not to adopt an EMS. Facilities were coded into four mutually exclusive categories based on the presence of specific pressures from customers or corporate parents: no mandate, customer mandate, corporate mandate, and customer and corporate mandate. Dummy variables were created for each mandate category.

APPENDIX II: CONTROL VARIABLES

Endogenous Controls

Facilities that have developed a broad array of management competencies often extend these competencies to include the adoption of environmental management practices (Christmann 2000; Florida and Davison 2001; Darnall 2002; Andrews et al 2003). Specifically, firms that have previously acquired systematic knowledge in quality management and pollution prevention are better able to leverage these internal capabilities toward development of environmental management activities (Melnyk et al 1999; Corbett and Kirsch 2000; King and Lenox 2001). Accordingly, this study has included several control variables that take such management capabilities into consideration.

With respect to other specific management plans or systems, the survey asked respondents whether or not the facility had formal pollution or waste minimization plans in place. Facilities with either a formal pollution prevention or waste minimization plan were code 1, facilities with neither plan were coded 0. Similarly, facilities with a Total Quality Management (TQM) system in place were coded 1, facilities with no TQM system were coded 0. Whether or not the facility belonged to a larger organization was also considered. Facilities with a parent organization were coded 1, independent facilities were coded 0.

The length of time a facility has engaged in environmental activities may be an important consideration in environmental performance changes at the facility level. For instance, the "80-20 rule" argues that as a rule of thumb, 80% of environmental benefits can be reaped with 20% of the costs: generally the first environmental problems to be solved are the easiest and most visible. Such activities include recycling or pollution prevention practices, where facilities may be able to garner impressive improvements over a short period of time. Over time, however, the additional marginal benefits gained by reducing environmental impacts may be less than the costs of more fundamental changes that sustain prior environmental improvements. To control for the potential effect of time on environmental performance, facilities were asked how long the environmental management system had been in operation. Facility responses were evaluated and coded on a 0 to 4 scale where 0=no management system, 1=less than one year, 2=one to two years, 3=two to three years and 4=more than three years.

At the pre-testing phase of research, environmental professionals reported (through anecdotal observation) two additional factors that deserved attention. Both the general attitude a facility manager has towards environmental practices in place, and the degree to which employees of all levels are committed to them, may influence the effect of environmental management activities on performance outcomes. Accordingly, we included two additional control variables to account for the influence of managerial attitudes about, and employee involvement in the facility's environmental activities. Respondents were asked to rate five statements related to experience with environmental activities on a 0 (strongly disagree) to 6 (strongly agree) scale (Figure 4). The median response was used to measure the facility attitude toward its environmental management activities. The survey instrument also asked respondents to describe the degree to which five categories of employees and stakeholders were involved with environmental management activities. Respondents rated the involvement of the environmental manager/engineer, plant manager, non-management employees, contract service providers and

interested parties/citizen groups on a 0 (not involved) to 3 (highly involved) scale. Facility responses were evaluated and the rating for each category of interested party was summed. The total score for each facility (0-15) measured the overall level of involvement.

Figure 4: Statements of General Attitude Toward Environmental Activities

Overall, environmental management activities have resulted in better risk management, improved company image, cost savings, and other benefits.
Overall, environmental management activities have added extra costs and consumed scarce resources without adding much value to our operations.
Overall, the more experience we have with our environmental management activities, the more opportunities we find for cost-effective improvements.
Overall, the more experience we have with our environmental management activities, the more it becomes just a paperwork routine.
Overall, the more experience we have with our environmental management activities, the more it becomes a strategic driver in our overall business management decisions.

Exogenous Controls

Factors outside the direct control of facility management may also affect environmental performance. The industry within which a facility operates is perhaps one of the most important such factors. Facilities operating in different sectors often have dissimilar impacts on the natural environment, face distinctive regulatory pressures, and have unique opportunities for environmental improvement. Industry dummies were constructed for each of the four sectors examined in this study.[14] Facilities in the chemical industry were used as the base category in this analysis.

Facilities that are owned by large, publicly traded corporations often consider environmental performance measures in corporate reports and assume pro-active environmental strategies due to pressure from shareholders and environmental groups. The analyses used dummy variables (ownership as publicly traded or privately held) to control for the potential effect of ownership status on environmental performance.

Backed by the power of state and federal governments, regulators have the power to command changes in environmental performance at the facility level. To control for the effect of regulatory pressure on facility environmental performance, we constructed three variables using data from EPA's IDEAS database. The number of inspections, number of non-compliances and the amount of fines at each facility during the three years prior to the study period were modeled. Two separate variables were used in the analyses depending on the indicator being modeled; for air pollution emissions only data from the AIRS database were considered, for hazardous waste generation only data from the RCRA database were considered. For all other indicators, each variable was summed across the AIRS, RCRA and NPDES databases.

[14] Facilities were grouped by four-digit SIC codes as reported in the EPA TRI database.

Within the United States, the degree of regulatory pressure to which manufacturing facilities are subject may vary due to differing state laws, rigidity of enforcement, industrial composition, and public attitudes towards environmental protection. To control for potential regional differences, we constructed dummy variables based on the EPA region (1-10) in which these facilities are located. EPA Region 6 (south central) was used as the base category in this analysis.

Finally, the complexity of facility operations may impact its environmental performance. Large, multi-faceted facilities may experience greater challenges in controlling the number and magnitude of their environmental impacts due to complex or diverse production processes. As a proxy for this aspect of facility operations, respondents were asked to report the total number of full-time employees at their site. Facility responses were evaluated and coded on a seven-point scale consistent with the U.S. Census Bureau's classifications for the 1997 U.S. Economic Census. The following scale was used for number of full-time employees reported by the facility: 1=less than 20, 2=20-99, 3=100-249, 4=250-499, 5=500-999, 6=1000-2499, 7=more than 2500.

Facility environmental performance was also considered within the management models since many of the hypothesized efficiencies are expected to accrue to the facility from an increased management of their impacts on the natural environment. More specifically, self-reported environmental data were included in four of the eleven benefit models. Figure 5 shows which variables were included within the specific models.

Figure 5: Inclusion of Environmental Performance Outcomes in Management Benefit Models

Model	Self-Reported EPI Included
Cost savings in terms of inputs or taxes	Water Use
	Energy Use
	Recycled Inputs
	Chemical Inputs
	Material Inputs
Avoidance of Non-Compliance Penalties	Legal Violations or Potential Violations
	Severe Leaks or Spills
Improved Company/Plant Image	Legal Violations or Potential Violations
	Severe Leaks or Spills
	Noise Generation
	Smell Generation
Improved Access to Capital Markets	Legal Violations or Potential Violations

Transcription of Session V Discussant Comments by Chuck Kent (U.S. EPA, Office of Policy, Economics, and Innovation)

Thank you very much. First of all let me say that all three of these papers I find fascinating and of great interest to my work. Let me describe a little bit about *what* that work is and *why* I'm so interested.

As part of the Office of Policy, Economics, and Innovation we attempt to—we try new ideas, we pilot projects, we pilot all kinds of proposals with companies, with states, and at the federal level. For example, we have a National Performance Track Program that incorporates some of the ideas that you are hearing here today in terms of focusing on performance, trying to get companies to articulate what they would try to improve over a period of time, and in what categories are they willing to measure their accomplishments against those items and share that information with the public and with the government, and so on and so forth.

We also decided to make that program partly dependent on having an EMS in place—an EMS not being the most important element of that program but a necessary condition to being a member, and the idea there was that it might provide a better sense of sustainability, of dependability, whether that company would continue to perform at a higher level. But, the kinds of things that we hear from the literature continue to raise questions for us in terms of: Is that program design the best that we can make it, and what does it have to say for future programs of this type?

Let me talk for a few minutes about each of the papers and then come back and talk about some broader policy initiatives that are under way and how this research might help us even further.

With regard to the first paper, I am fascinated by the look into the difference between perception and objective pressures on corporate decision making. Since my business is trying to influence the behavior of corporate decision makers, it's very interesting to me to understand better how they think and what causes them to do what they do. It looks like an enormously complicated enterprise, and I'm looking forward to the future iterations of this work. I am fascinated that there's apparently stronger pressure from private sector sources and corporate sources than even the community. That's a bit counter-intuitive to me, but in one respect consistent with the notion that what we're seeing, for example in Performance Track, is that where you have a corporate executive who chooses to go a certain direction with the firm, chooses to change the reputation of the firm and to do it in a visible way, *amazing* things can happen. In fact, it's so prominent a feature of the behavior that we're seeing that we are adding a component to Performance Track this year that will recognize the corporate level of commitment. Heretofore, the program has been designed at a facility level, just looking at performance and commitments at a facility level, and now we're actually going to recognize corporations that have chosen to do something at a corporate level and are pushing hard.

A couple of sort of minor comments, and I'm by no means the right person to comment on the methodologies and the elaborate statistical manipulations that are going on here. I've been out of graduate school since 1975, and I don't know most of these terms, but in terms of your Figure 1, Magali, on the right-hand side where you're talking about sort of the outcome that you're trying to monitor, your paper talks a lot about the emphasis on performance, but that figure only refers to whether there is an EMS in place. So, you might try to reflect the performance element on the right-hand side as the desired outcome. Also, I think it's generally acknowledged that TRI data don't always match up very well with some of the things that we're actually trying to—both what companies are trying to do with an EMS as well as the kinds of things we're trying to measure overall, but I don't think I need to dwell on that.

One other minor point is that as we look at what you call the *"proxies"* for something like community pressure, it seems to me that the ones that you ended up choosing are a bit remote. I know it's very difficult to find good measures of things like that, but counting the number of environmental lawyers in a community almost sounds like the beginning of a good joke, no offense to the study. I would hope that maybe there are more-direct measures of pressure that we could find ultimately—perhaps counting legal actions, complaints, hearings, --who knows? I'm also reminded that Bob Kagan's work has talked about the concept of social licensing, and I'm intrigued by that in relationship to this paper, and I'm actually surprised not to see a reference, since you're both from the University of California. So, you might want to think about whether that's relevant.

As the proud co-founder of the Environmental Studies Program at Santa Cruz in 1969, I'm pleased to see Santa Barbara and Berkeley and others all working together on these things.

So much for attempting to focus on data and methods, because I recognize that this is a very difficult task. I noticed in your histogram on stakeholders, Magali, "corporate management" seemed to be the highest influence; "regulators" was the second highest—you didn't talk about it, but the third highest was "employees." That caught my eye, because one of things I'm seeing—at this point, it's more anecdotal, but I've heard it referenced in certain literature and from corporate executives who use EMS's—and what they're finding is that one of the most interesting impacts of environmental management systems is the impact they have on employees' motivation, and thinking, and acceptance, sort of the legitimacy of the environmental agenda within a corporation. That's an interesting dynamic that I think deserves more attention, because it can be sort of a hidden force within a corporation, or even a small business, in terms of *how* the work gets done and the sense of *ownership* of environmental values.

But clearly your work at this point is showing strong business motivation as drivers for behavior, and, as I said before, the corporate pressure is something that I'm beginning to see and we're recognizing it in the design of Performance Track. So, I look forward to seeing future iterations of this work, and I commend you for handling such a large data set. I wish you the best of luck.

With regard to Deanna's work, I recall the first iteration of this a couple of years ago. In fact, as I recall, when you were presenting it, you were about to give birth as well, right? I'm wondering if Pete has something equally productive to show for his . . . [Pete Andrews interjected: "My first grandchild next month!"] There we go—there's another pattern we should take into consideration here.

I must say that the overall conclusion that there's no substantial difference in performance in this particular sector in response to an industry mandate is not a *huge* surprise to me. I've been personally skeptical about Ford Motors telling their suppliers, "you've gotta have this piece of paper by a certain date; otherwise, we won't buy your stuff," and what kind of behavioral modification that might bring about. Similarly, I have concerns about the role of government in terms of requiring that firms have that piece of paper and what kind of behavior *that* would induce. As you may know, EPA has been very cautious about requiring EMS's as part of our regulatory policy, and I'll talk more about that in a moment.

I am interested, as you pursue your work, Deanna, whether you intend to gather more information on the motivations of the individual companies as they apply the EMS in their own context—motivation other than the customer requirement—because I think that does have a lot to do with what *gets done* with the EMS. In fact, I kind of wish the microanalysis that you did, which I guess was of other companies, could have been focused on the same sector, because it would have helped us learn a great deal more about how they think. But, obviously, there were probably methodological reasons for that.

Minor points: I would ask you all to be careful about the language you use when you talk about EPA's voluntary programs. I think it's probably an exaggeration to suggest that voluntary programs are somehow *taking the place* of regulatory programs at EPA. They are certainly prominent and there are bunches of them. They're a little bit sloppy—as Jay may have talked about earlier today, we're launching a major initiative to try to add some considerable discipline to the design and management of voluntary programs at EPA. But, try to avoid the suggestion that voluntary programs are sort of taking over the world, because I don't see it that way.

In summary, I would say that we have a great interest in the motivational factors that drive a sector like the auto assembly sector. Particularly, we're interested in the effect of mandates. We, as an *agency*, are certainly *not* comfortable in focusing on the *how* over the *what*, because ultimately we think that, as tax payers, you're more interested in the *what*.

With regard to Pete's work, this is the second major piece of work from this study. We've followed Pete's work with great interest, and it has informed our thinking, as well, as we've designed programs at the Agency. We're particularly interested in his probing into the difference between a self-initiated EMS and a required EMS. I'm a little disappointed that so far the data really don't show much difference—that's just me wishing for something more useful out of that particular probe. But, I would hope that

each of you would think about that and see whether there's more that you can draw out of your research and what you can tell us at EPA.

I *did* notice that the presence of a formal mandate, although it didn't appear to influence performance, generally, *where specific goals were set*, appeared to make a difference. This is a really important theme that I think we'll be hearing more and more about, and that is—and you've said this before, Pete—an EMS maybe serves better as a *window into* an organization, how they think and how they operate, than almost anything else. *If* you have a clear vision about what you want to accomplish, an EMS may, in fact, be a very useful tool for getting you there, but in and of itself, there's no magic in an EMS that's going to get you what you want. That ties into the major point that Pete made that *goals matter*. When you set out to do a compliance-focused EMS, what you get is better compliance, usually. When you set out to do eco-efficiency, you tend to get some of that a little better, and so on and so forth. And when you tackle something *big*, like stewardship, *surprise*—you get something bigger than you otherwise would. I find that very encouraging. To me, it should be part of the message to *all* of us, in government and in the private sector, who try to *use* these systems: let's not be bashful—let's go for something more dramatic.

Let me shift then to just a quick description of recent policy initiatives at EPA that relate to this work that you would want to know about and that you, in turn, can inform. On April 12th the Deputy Administrator signed a major new EMS strategy. It doesn't change our *policy*, but what it does is articulate first of all the set of principles that are pretty well stated already in EPA's position statements. But then we lay out, I think, six major policy ideas to *test*, and what we're responding to is a great deal of interest, particularly in several states around the nation, to try to incorporate EMS ideas and concepts into permits and regulations—and even at the federal level there's been quite a bit of discussion of this. So, what we're doing is trying to *channel* the thinking and the analysis along the lines of at least these six broad area policy ideas to test. I would have you at least be aware of those in your work and see whether you can help inform that debate as well. I won't read them all; Jon Silberman is here in the audience, and he was one of the major authors of this document, as well as George Wyeth and many other people at EPA. We will have that document on the web within days, I'm told. We do have one copy here, and Jon is willing to be the contact point for copies of this document. I would have you take a look at that—it helps clarify both the Agency's position and the things that we want to learn.

Finally, I just want to say that I'm the chair of an Agency-wide policy group on EMS, and we're trying to establish a *learning* kind of climate within the organization so that it's clear *what* questions we're trying to *answer*, it's clear what we would *do* with those answers, and try to incorporate those into the regulatory design of our programs.

Thank you.

Session V: Discussant Comments
Patrick R. Atkins, Alcoa

Introduction

Alcoa is a large company with over 385 manufacturing sites in 40 countries throughout the world. We have determined that an effective management system is a requirement for driving the appropriate systems and behaviors throughout our company to achieve our goals of excellent environmental performance and continual improvement. We have 160 companies certified to the ISO 14001 Standard and have a Global Certificate from BSI that recognizes that our corporate management systems conforms to ISO 14001. Locations can be certified to ISO 14001 under that global certificate.

We find that environmental performance does improve through the application of the principles of the 14001 EMS, and that our locations demonstrate continual improvement when the management system is utilized. The ISO process requires the locations to identify the activities at the facility that can impact the environment, prioritize those impacts and establish a plan and process to address the critical issues on a priority basis. Legal and other (corporate, community, customer, etc.) requirements also have to be identified and used in the risk matrix that establishes the priorities for the issues.

I believe it boils down this, (perhaps too simplistic a view): Businesses with good Business Management Systems and practices are able to leverage the ISO 14001 structure and get additional value from the process. Businesses that are weak in other Management areas have difficult with ISO 14001. GE and Toyota have found value from ISO 14001 because the whole organization understands the value of a proper executed management system.

With this background in mind, I offer the following comments:

Formalized Environmental Management Procedures: What Drives Performance Improvements? Andrews, et al.

Andrews concludes:

> First, broad environmental improvements should not be expected from the simple adoption of an EMS, either voluntarily or as a result of a business-to-business mandate (nor probably, by extension, in response to government rewards or other incentives). While adoption may be valuable as a tool for helping facilities to reduce regulatory violations, to better manage day-today activities such as recycling, and more generally to instill more explicit environmental management procedures and accountability, EMS adoption does not by itself lead to environmental performance improvements across a broader spectrum of performance indicators. Those interested in EMS as a tool for substantive improvement in environmental performance, such as reduced natural resource use

> or pollutant emissions, should concentrate instead on promoting specific performance improvements as EMS goals, and ensuring that these targets are achieved.

This seems to be a misunderstanding of the intent of ISO. The system itself is not the end product, the end product and value is the execution of the Objectives and Targets defined by the system. An organization should not put all their energy in the system but in the making the management activity work. This conclusion should be restated to emphasize that value is obtained when the intent of the standard is met. (This is more clearly defined in the ISO 14001:2004 revisions.)

He then concludes:

> Second, the management benefits that facilities may gain from EMS adoption appear commensurate with their efforts to move beyond compliance and focus on "higher order" environmental goals such as eco-efficiency and product stewardship. For the business community, such results suggest that a serious commitment to environmental performance improvements may have economic rewards. Moreover, facilities whose environmental objectives represent a broad array of performance goals may achieve a wider array of benefits, both environmental and management, than facilities whose objectives are more narrowly tailored.

I tend to agree. The goals and objectives have to have a long-range strategic component or the organization will lack direction and will make not make leaps of progress. However, this means that all stakeholders' definition of environmental performance improvement cannot be satisfied at once.

His third conclusion:

> Finally, voluntary efforts at self-regulation should be complements to, not substitutes for, more traditional environmental regulation and enforcement by state and federal agencies. While environmental management practices may in fact deliver environmental performance improvements, particularly toward goals that are specifically targeted for improvement, facilities that were subject to recent inspections were more likely to report such improvements in performance indicators that are subject to inspection. The persistence of traditional regulation may therefore facilitate the effectiveness of self-regulatory efforts.

I think an important point that is missing in this conclusion is the following: Significant aspects are controlled in the management system because they have a higher risk. A business focuses resources and attention voluntarily on ISO 14001 system objectives, which frequently supports compliance. State and Federal regulation of a site is not always risk based. Regulatory agencies and Business should align their efforts to ensure compliance. This can be address from both sides: State and Federal regulation should become more risk based, and Business should be able to obtain regulatory relief for well functioning management system.

Environmental Management Systems: Informing Organizational Decisions: Matthews and Lave

This is an ambitious effort to use several sets of data to measure environmental performance changes in facilities that have ISO certification as compared to the performance of facilities that have not been certified to ISO 14001. The researcher then attempt to use a survey technique to better understand why environmental performance improvement is not being seen

A major problem with this work in my opinion is it attempts to use nationally published goals as measures of EMS success…is this appropriate? Can it even be done, given the wide range of variables in such data, the recognized poor quality of the data in such data sets, and the many other variables that impact plant performances such as product mix changes, investment strategies by the corporation, process changes within the plant, etc?

Another problem appears to be a lack of understanding about how an ISO EMS is supposed to operate. The paper notes that each facility may choose the areas for reduction or improvement, but then claims that since EMS should provide for overall improvement in environmental performance, some relationship should be expected, and the timing of the work suggests to me that they expect this improvement in any and all environmental improvement parameters to be immediate (within a year of certification). This is certainly a high (and rapid) hurdle for measuring success, especially when the ISO system is not designed to perform this way. The results seem inconclusive, as I would suspect from the flawed study design.

The case study approach resulted in the conclusion that an ISO EMS may not be focused on the areas that are important to all the stakeholders…especially regulators. I agree with this conclusion. The authors then proposed that there are five elements that should be used to all environmental decision making:

- Process diagrams and material flows
- Quantifiable goals and targets
- Reliable data
- Risk assessment tools
- Environmental personnel collaboration and education

I contend that a good EMS will include these elements and much much more.
EMS must recognize how an organization operates and how best to achieve the goals and targets within the organizational systems that exist.
All stakeholders must be included in the management process…including communities, customers, suppliers, regulators, investors, employees and even the public at large.

Perhaps a more useful approach for the next effort would be to work directly with the auto company that were the subject of the first part of the paper to determine the true impacts of EMS on the business and the company's environmental performance

Institutional Pressure and Environmental Management Practice: Delmas and Toffel

This research relies on a questionnaire approach to gather information on the drivers behind environmental management practices. I am pleased to see that a great deal of effort was invested in the form of the questionnaire and the processes to extract and analyze the data. Such steps are critical in studies like this. I was disappointed in the return rate, given the degree of effort expended by the researchers. I think a higher response rate would make the data set more robust.

The study indicates that corporate and private pressures are more important than community/regulator pressures or customer supplier pressures. I am not in full agreement with this conclusion, and suspect that the data may have been biased by the level of people in the organizations that responded to the questionnaires. Often a person "in the trenches" at an operating location will have a view of the world that is a bit too narrow, and will provide responses that can place the focus on the clear signals from a corporate directive, when actually there are strong community and regulatory pressures that are also influencing the entire management structure of the location and hence the management system.

I suggest there be more focus on case studies as this work goes forward. Issues with the complexity of the question of performance drivers cannot be adequately addressed via questionnaires.

Summary of the Q&A Discussion Following Session V

Matt Clark (U.S. EPA, Office of Research and Development)
(relaying a question from William D'Alessandro, one of the remote participants, who addresses this question to the entire panel, but specifically to Dr. Andrews)
Stipulate for a moment that the following statement is a fact: ISO 14001 was battled over ferociously and ultimately approved to require companies headquartered in the U.S. to do *absolutely nothing* they were not already required to do by law and nothing they *chose* not to address. How well would this explain the findings of your work?

Pete Andrews (University of North Carolina, Chapel Hill)
Dr. Andrews said he did not dispute the point, but he also did not think it affects the usefulness of what companies are doing with EMS's or the work he and his colleagues are doing to try to clarify that. He stated, "A lot of the firms *are* choosing to do this, and so it becomes relevant and interesting and quite *important* for us to examine what, in fact, they do when they're doing it. Particularly where public agencies are now offering benefits for it, or encouraging it, our point is to point out that, depending on what goals companies choose to adopt, they can really get some *good* results—so they can get something that just, maybe, achieves better compliance but gets them *no* other business benefits, or if they focus on compliance, it may not get them better performance in other ways, or vice versa."

Jon Silberman (U.S. EPA, Office of Enforcement and Compliance Assurance)
Directing his comments to Dr. Andrews, Mr. Silberman said, "I couldn't help but think of Maslow's hierarchy of needs and his behavioral research for individuals when we were talking about compliance-based EMS's, and product stewardship, and e-Gov efficiencies, etc. I guess my question for you is: Do you think there's some kind of similar effect like that for EMS's, for example for companies that are unlikely to be able to reach higher levels of higher order goals until they first satisfy their lowest order goals, and maybe that's why some of these companies are getting compliance-focused EMS's? Would it be a natural progression, do you think, that they would move up along the continuum more towards the higher order goals over time?"

Mr. Silberman closed by stating that EPA believes "it's *much* better for EMS's to focus on higher order goals," and as evidence he cited the fact that the Office of Enforcement and Compliance Assurance has required only "26 total compliance-focused EMS's as adjunctive relief in settlements since 1993 in literally thousands of cases. We *really* try to save them for the companies that really are not able at all to manage their compliance."

Pete Andrews
Dr. Andrews responded, "In answer to your question, we've puzzled a lot about this and you may know the work of one of my former colleagues who is now teaching at Duke, Deb Gallagher, who has done some of the most detailed efforts to try to figure out whether these are, in effect, *nested* goals—if you'd start with compliance and move on."

He also said he'd be interested in hearing Pat's [Pat Atkins, Alcoa] reaction to the question, as "a voice from the industry sector itself." He added, "Certainly for the existing facilities we've looked at, it looks like some of that may be going on, but it may be historical," and he pointed out that claiming that an initial focus on compliance is a "necessity" for progressing to higher-order goals "would leave out the whole category of unregulated industries."

Pat Atkins (Alcoa)
Mr. Atkins commented, "I think one of the big issues is metrics, and compliance is a pretty good yes/no kind of metric and everyone can follow it, and I would equate it with safety and public-reportable injuries, a pretty good metric that everybody can understand, and it's easy to track and to report on. But, once you get that metric in place and begin to move beyond it, and start looking at healthy workforce or off-site accidents or the education of people on how to be safe in their own lives, it takes on a much broader impact on the company. I think that's what will happen with the environmental management systems—perhaps your first steps and objectives will be those that you can easily measure, and compliance may be one of those, particularly if you're in a highly regulated environment like the United States. And once you show progress in those areas, you will begin to grow your list of aspects and things will migrate upward in terms of impacts and risks of your business. So I think you're right—it will grow."

Michael Lenox (Duke University)
Dr. Lenox voiced his concern about the causality issue in Dr. Andrews' work, saying, "I'm a little worried—could it be that firms are in *ex-post*, justifying their objectives based on the benefits that they received or the behavior that they have created? But more importantly, are there some other kind of underlying factors that are driving both the objectives and then ultimately what happens at the end of the day, *or* is it a recommendation that we can give to other firms to simply adopt these types of objectives and then the outcomes will follow? Those could be very different prescriptions."

Dr. Lenox also commented on Dr. Andrews' suggestion that it would be great if all the firms with EMS's would disclose the data they are collecting to the general public. Dr. Lenox said that at first the idea sounded reasonable to him, also, but then he realized that companies required to disclose the internal data they collect for their EMS's might simply choose not to write EMS's, thereby defeating the whole purpose.

Pete Andrews
Dr. Andrews responded to the causality question by saying, "Remember, we didn't just ask them what their goal was—we constructed those from what they told us about actual changes they've made. So, I don't *think* that we're just getting an artifact in that sense. There may well be underlying factors of some sort. Clearly, there are a lot of other relationships we didn't talk about, such as, like others, we do see it affect prior practices like ISO 9000 and so forth. Clearly, companies that already have that management framework in place find it easier to piggyback and to model this into that larger integrative framework. Cary Coglianese and Jennifer Nash have done a lot of thinking

about the root underlying factors behind all of this, and I think there probably *are* some. But I *do* think that what we're trying to do—finding out "What effect *does* it make what people choose to focus on?"—in a sense, shouldn't be rocket science. The things they focus on are the things that improve—what gets measured gets managed—what gets chosen as objectives gets managed. That, to me, is simply reinforcing the point that it is what companies *choose* to do—what they prioritize and what they choose to really make the management system *work* for—that matters rather than just that they have this labeled management system in place. That's *reassuring* in a sense, but it also says, "Okay, so let's talk about performance and not just about using the EMS or the certification for *public* purposes as a proxy for good performance."

Regarding the second point that was raised, about disclosure, Dr. Andrews pointed out, "I'm trying to make a point that I wanted to really make a difference between what companies choose to do for their own purposes and what they choose to do for public benefits . . . There's a larger interesting conversation going about: many companies now *do* produce environmental reports, but there's no comparability, there are no standards for them, and so forth, so they become, basically, PR exercises. There is an attempt, the Global Reporting Initiative—there may be some other attempts as well—to create a more standardized basis, partly on the grounds that it may be in the company's own interests to do that. As you get more folks—you know, social-screening funds—barraging you with questionnaires every year, all different, and so forth, it might even be beneficial to them. But it *certainly* would be beneficial to the *leaders* to have a common set of data. It may not do everything, but let's have common, comparable kinds of data that would be worth having. In that sense, disclosure is a larger conversation than EMS. I certainly wouldn't say that we ought to drive them away from doing EMS by requiring them to disclose everything in the EMS. But, if they're trying to come to EPA or to a state agency and say, "I'm a good environmental steward, so I want flexibility or I want a prize for it, such as a governor's recognition award," I'm saying let's not just talk about whether you have an EMS. If you say you have an EMS, it means that you've thought about this—you're achieving these performance changes—let's talk about what you're achieving and focus on the performance."

Dinah Koehler (University of Pennsylvania)
Dr. Koehler commented that she thought Dr. Andrews had concluded "somewhat wistfully" that "Gee, wouldn't it be great if they were to make serious capital investments in product changes and process changes." She said that led her to "think that perhaps we're expecting too much of an ISO standard." She challenged the entire panel to consider what exactly can be expected from ISO 14000 and she wondered what has been learned from ISO 9000 that might help. She closed by asking, "Are we to expect these leaps or will we just see incremental, tiny changes in whatever outcome measure we think we're looking at, as a function of some quality management system?"

Magali Delmas
Citing her experience, Dr. Delmas said, "When you talk to environmental managers, they will tell you that it takes several years before they see any improvement, and that actually

was the case with 9000—it would sometimes take 4 years. At first you would get more information, actually, about how much emissions . . . and then they make progress 4 to 5 years down the road, so maybe what we are observing right now is that it's just too early to say *anything.* Facilities started adopting ISO 14000 here in the U.S. in 1999, and the majority—the big wave—was in 2000. So, it's really early to say anything. We should just be more positive and wait a little bit more before drawing negative conclusions."

Deanna Matthews (Carnegie-Mellon University)
Dr. Matthews stated, "I think your comment that maybe we're expecting too much from ISO 14000 might be a good way to phrase it, but perhaps some on the management side have looked at this as—going back to the signaling issues—this is something that we just need to do for business, and, thus, we're not really going to see any change in performance. If that's so, then policy makers and business managers do need to look at it from a different perspective and figure out what they need to do to make the big changes. As Pat says, ISO 14000 is *not* the end product—it is trying to get it into that strategic element of business strategy that's going to give the capital projects that are going to change the processes that are going to make the *big* steps in how facilities improve. I could reflect on some of Alcoa's goals for their 20/20 Vision that *are* technology dependent, that are built into the long-term strategy and not simply based on an individual plant having ISO 14000 or an EMS."

Pete Andrews
Dr. Andrews gave "a couple of quick responses," saying, "I think that's right. First of all, ISO 14001 was one of the largest suite of ISO 14000 guidelines, guidance documents, and so forth for business. I don't know if anybody's ever even looked at the question: Do companies that have ISO 14000 *care* at all about the other ISO documents. Do they use the other documents to inform this toward a larger strategic process? I haven't seen it, and I'd be interested but surprised if it were happening. I think so much attention has been focused on 14001, because it's *certifiable* and so forth, that that's happening. It *might b*e that it just takes longer, but more likely, I think, is that we've all been looking at the facility level, and it may be that the real changes don't happen [at that level]. What happens is one facility, at some point, gets out-competed or outmoded and gets closed down and the production goes to some more-modern facility somewhere else. That's not something that the facility manager is going to tell you about at that facility, and it's either happened or not."

He concluded by saying, "So, I think ISO 14001 *is* valuable for mainstreaming environmental considerations—again, you may be right, Deanna, that it's not happening at the facilities you looked at, but I think it is happening at some others, and to the extent that it *does* mainstream these considerations . . . into the job description of other managers, it *can* help at the margin, with managing a particular facility, but I do think it is process-based and we need to look to some larger processes as public policy experts or people who care about actual environmental performance outcomes . . . how do we *really* reduce large-scale environmental impacts?"

Monica Araya (Yale University)
Dr. Araya directed her comments to Dr. Delmas, saying, "We all agree that it's difficult to capture that action [i.e., the role of activists] in an empirical picture. My impression is that monitors are saying that those activists in communities are not the reason they are doing this. . . . My question is: Do you think that their perceived reasons for engaging in environmental management systems should be taken as the reason why they do it? The reason why I'm asking this is because in the area I work in, which is corporate environmental reporting, companies sometimes say they are reporting because of internal reasons, but, in practice, they are doing it because of actions that are coming against them. So, the fact that they don't mention that in a survey doesn't mean that it is not happening. So, could you in your study come up with a way of capturing this by taking companies that have a corporate mandate and companies that do not and see how they react to external pressures?

Magali Delmas
Dr. Delmas asserted that she thinks "it's really important to have objective measures and survey measures *together*, so here what we are trying to do is to see how can you assess community pressure objectively and how do environmental managers perceive this pressure, so we will be able to look at the difference with this. . . . So we will be able actually to compare both to be able to see the distance between perceived and objective pressure.

Glenn Farber (U.S. EPA, Office of Solid Waste and Emergency Response)
Dr. Farber stated, "My office often maintains that minimizing waste or other kinds of environmental compliance or performance improvements provide business benefits, even if it's only reducing the burden that we ourselves have imposed in the first place, but I've never heard that associated with product stewardship, and I was *surprised* by your result, Pete, that showed business benefits deriving from EMS's that had product stewardship as an objective. I was wondering if you found that surprising as well."

Pete Andrews
Dr. Andrews responded, "We're interested in it, too. We'll try to figure it out."